DENTISTS, DENTISTRY AND DENTAL DISEASES IN ANCIENT EGYPT

by

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DEDICATION

I wish to dedicate this work to special people who have been instrumental in making my life what it is today and who are no longer with me. In loving memory then to: My mother (1920-1962) who instilled love in me; My father (1910-1999) who instilled the love of books in me which ultimately also became my life; My only sister Marié (1939-2010) who showed me what a life of pure altruism is; My only son Willem (1976-2003) whose untimely death underlined the transience of life. I miss them all and I so wish them to have shared some special moments of my life with me, but alas, too late.

To the living: I dedicate this dissertation to my three daughters (Tanya, Brittani & Romi) whose respect and unrelenting love I humbly relish. To three grandchildren (JP, Demi & Alexa-Jade) who are God's gift to the elder: it will be the coolest thing ever if I could inspire them to ever explore the deep well of unconscious cerebration (Henry James 1843 - 1916).

Lastly, I take pleasure to also dedicate this work to my previous promoters; Professors W S Boshoff and M le Roux, who squarely put me on the endless road of acquiring knowledge – the more you know, the more you know how little you know. I am most grateful to you.

Casper Greeff

DECLARATION

Student number: 34587950

I, CASPARUS JOHANNES GREEFF, declare that **'DENTISTS, DENTISTRY AND DENTAL DISEASES IN ANCIENT EGYPT'** is my own work and that all the sources that I have used or quoted have been indicated and acknowledged by means of complete references.

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DR CJ GREEFF

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DATE

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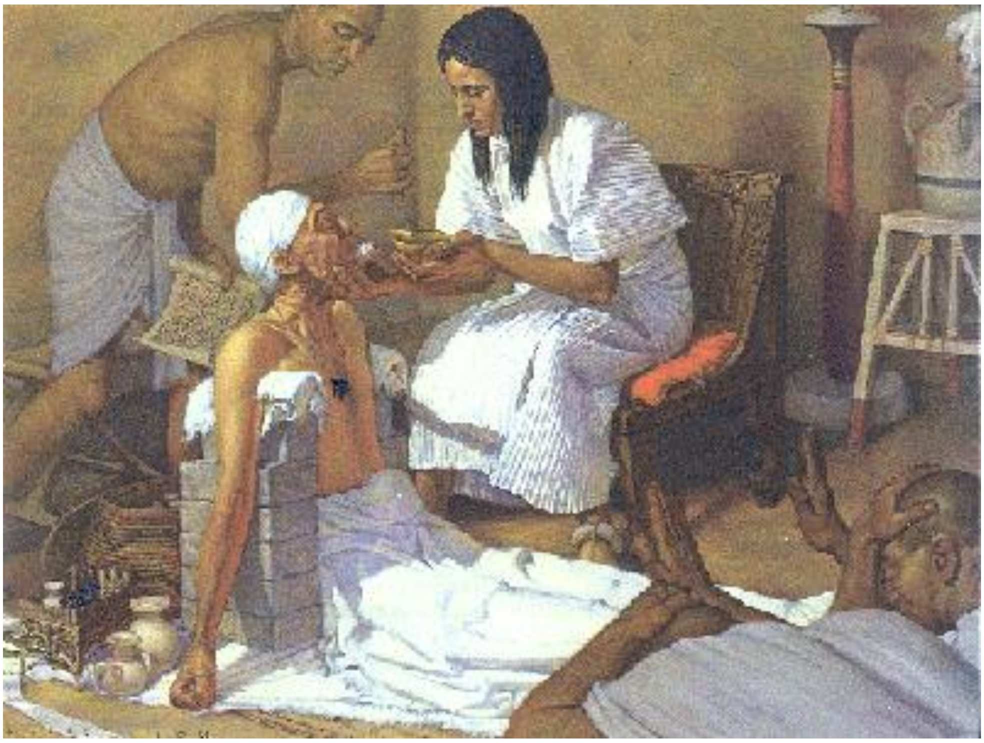
ABSTRACT

Ancient Egyptian dentists come into the spotlight in this dissertation. While some scholars doubt their existence, it is indisputably shown that not only did they exist as a profession, but evidence is offered as to the various diagnoses and treatments they rendered. The Ebers medical papyrus together with other ancient similar medical 'textbooks' are analysed and prescriptions dealing with dental maladies are presented. Dentistry as a profession is elucidated in all its facets: diagnosing and treating dental diseases; prevention and care; and restorative and surgical treatment.

This dissertation discusses dental anthropology as a vital part of bioarchaeology, which is the study of human remains in archaeological contexts in ancient Egypt. Dental enamel is the hardest material in the human body, and teeth are often preserved even when bones are not. Teeth are one of the most informative parts of the human body, and are incredibly well preserved archaeologically. Teeth provide insight into numerous issues that palaeodemography and historians are concerned with, including diet changes, general stress, how closely groups were related, and markers of social identity.

Key terms: ancient Egyptian dentists, dentistry, medical papyri, dental diseases, dental wear.



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GLOSSARY OF DENTAL AND MEDICAL TERMS

Abscess	A localized collection of pus in part of the body, formed by tissue disintegration and surrounded by an inflamed area.
Acellular	Composed of tissue not divided into separate cells.
Aerobes	An organism, especially a bacterium that requires air or free oxygen for life.
Aetiology	Study of causes of diseases.
Alveolar bone	The alveolar process (alveolar bone) is the thickened ridge of bone that contains the tooth sockets on bones that bear teeth.
Amelogenesis	The developmental process of forming tooth enamel.
Anaerobes	An organism, especially a bacterium, which does not require air or free oxygen to live.
Anaemia	Pathology. A quantitative deficiency of the hemoglobin, often accompanied by a reduced number of red blood cells and causing pallor, weakness, and breathlessness.
Analogous (adj.)	Biology. Corresponding in function, but not evolved from corresponding organs.
Anthropology	The scientific study of the origin, the behaviour, and the physical, social, and cultural development of humans.
Archaeology	The systematic study of past human life and culture by the recovery and examination of remaining material evidence.
Artefacts	Something made or given shape by man, such as a tool or a work of art, especially an object of archaeological interest.
Atrophy	The wasting away of the body or of an organ or part, as from defective nutrition or nerve damage.
Bimaxillary (adj.)	Relating to or affecting both jaws.
Bioarchaeology	The scientific study of human remains from archaeological sites.
Biochemistry	The study of the chemical substances and vital processes occurring in living organisms.

Biological Of, relating to, caused by, or affecting life or living organisms.

Bioscience Any science that deals with the biological aspects of living organisms.

Calcareous (adj.) Of, containing, or like calcium carbonate; chalky: calcareous earth.

Calculus A hard, yellowish to brownish black deposit on teeth formed largely through the calcification of dental plaque; also tartar.

Cartouche An oval or oblong figure, as on ancient Egyptian monuments, enclosing characters that represent the name of a sovereign.

Cementum The bonelike acellular tissue that forms the outer surface of the root of the tooth.

Congenital Of or pertaining to a condition present at birth, whether inherited or caused by the environment.

Cranium The part of the skull that encloses the brain.

Crypt A slender pit or recess; a small glandular cavity.

Cusp A pointed or rounded projection, such as on the crown of a tooth.

Deciduous Being shed at the end of a period of growth, i.e. the primary dentition or milk teeth.

Dentinogenesis The formation of dentin.

Dentine The calcareous tissue, similar to but denser than bone, that forms the major portion of a tooth. Dentine surrounds the pulp cavity, and is situated beneath the enamel and cementum.

Dentistry The science concerned with the diagnosis, prevention, and treatment of diseases of the teeth, gums, and related structures of the mouth and including the repair or replacement of defective teeth.

Diagenetic The physical and chemical changes occurring in sediments between the times of deposition and solidification.

Dimorphism Existence of two or more different forms within species: In sexual dimorphism: male and female.

Diphyodont (adj.) Having two successive sets of teeth, in most mammals.

Distal	Directed away from the sagittal plane or midline of the face, along the dental arch.
DNA	A long linear polymer found in the nucleus of a cell and formed from nucleotides and shaped like a double helix; associated with the transmission of genetic information
Ecology	The branch of biology dealing with the relations and interactions between organisms and their environment.
Embryology	The science dealing with the formation, development, structure, and functional activities of embryos (initial stage of development).
Enamel	Dental enamel; the hard, thin, translucent substance covering and protecting the dentin of a tooth crown and composed almost entirely of calcium salts.
Endocrine (adj.)	Of or pertaining to an endocrine gland or its secretion.
Epidemiology	The scientific and medical study of the causes and transmission of disease within a population.
Epithelium	A thin layer of tightly packed cells lining internal cavities, ducts, and organs of animals and covering exposed bodily surfaces.
Ethnography	The branch of anthropology that deals with the scientific description of specific human cultures.
Fibroblasts	A cell that contributes to the formation of connective tissue fibres.
Follicle	A small cavity, sac, or gland.
Genetic	Pertaining to or determined by genes.
Gingiva	The technical name for the gum.
Heterogeneous (adj.)	Different in kind; unlike; incongruous.
Hieroglyphs	A formal writing system of ancient Egyptians, *viz*. a combination of logographic and alphabetic elements. Signs interpreted as phonograms & ideograms.
Hominid	Any of the modern or extinct bipedal primates of the family *Hominidae*.
Homologies	A fundamental similarity based on common descent.

Hydroxyapatite A mineral, $Ca_{10}(PO_4)_6OH_2$, the principal storage form of calcium and phosphorus in bone.

Hygroscopic Absorbing or attracting moisture from the air.

Hypoplasia Incomplete or arrested development of enamel.

Immunochemistry The study of the chemistry of immunologic substances and reactions.

Isotope Each of two or more forms of a chemical element with the same atomic number but different numbers of neutrons.

Labially Referring to the lip side of anterior teeth.

Lactobacillus acidophilus A species of Lactobacillus bacteria associated with the production of dental caries.

Lacunae One of the numerous minute cavities in the substance of bone. Containing nucleate cells.

Leucocytes Any of the various large unpigmented cells in the blood.

Lumen The canal, duct, or cavity of a tubular organ.

Malocclusion Faulty occlusion; irregular contact of opposing teeth in the upper and lower jaws.

Microanatomy The branch of anatomy dealing with microscopic structures.

Macromolecular A very large molecule, as a colloidal particle, protein, or especially a polymer.

Macromorphology The gross structures or morphology of an organism visible with the unaided eye or at very low levels of magnification.

Macrostructures Overall structure or organizational scheme.

Mandibula The lower jaw of a vertebrate animal. Also mandible.

Maxilla Either of a pair of bones of the human skull fusing in the midline and forming the upper jaw.

Medico-scientific Of or pertaining to medicine and science.

Mental foramen Opening of the mandibular canal on the body of the mandible through which the mental nerve passes.

Mesenchyme Cells of mesodermal origin that are capable of developing into connective tissues, blood, and lymphatic and blood vessels.

Mesial	Directed toward the sagittal plane or midline of the face, along the dental arch.
Mesiolingual (adj.)	Of or relating to the mesial and the lingual surfaces of a tooth.
Microorganisms	Any organism too small to be viewed by the unaided eye, as bacteria, protozoa, and some fungi and algae.
Molecular biology	The branch of biology that deals with the physical and chemical interactions of molecules involved in life functions.
Morphological	Relating to or concerned with the morphology of plants and animals.
Mummified	To make into a mummy by embalming and drying.
Necrotic	Death of a circumscribed portion or cells of animal.
Nomenclatures	A set or system of names or terms, as those used in a particular science or art, by an individual or community, etc.
Nosographical (adj.)	The systematic description of diseases.
Occlusal	Pertaining to the masticating surfaces of the premolar and molar teeth.
Odontoblasts	One of a layer of cells lining the pulp cavity of a tooth, from which dentin is formed.
Odontography	A description of the teeth.
Odontology	The scientific study of the teeth.
Odontometrics	Physical measurement of teeth.
Oestrogen	Female steroid hormone.
Ontogenetic (adj.)	Of or relating to the origin and development of individual organisms.
Osteomyelitis	Painful inflammation of the bone and bone marrow, usually caused by bacterial infection.
Palaeoanthropology	The branch of anthropology concerned with primitive man.
Palaeobiochemistry	The study of the biochemical constituents of fossil organisms.
Palaeoecology	The branch of ecology that deals with the interaction between ancient organisms and their environment.
Palaeodemography	The study of ancient human mortality, fertility, and migration.

Palaeodontology The study of teeth in ancient populations.

Palaeontology The study of fossils to determine the structure and evolution of extinct animals.

Palaeopathology The study of diseases from former times as found in skeletal and mummified remains.

Papilla The small projection of tissue at the base of a hair, tooth.

Papyri (pl.) A material on which to write made from the pith or the stems of the papyrus plant, used especially by the ancient Egyptians.

Pathogenesis The production and development of disease.

Pathognomonic Characteristic or diagnostic of a specific disease.

Pathology The study and diagnosis of disease.

Periapical (adj.) Encompassing or surrounding the tip of the root of a tooth.

Periodontal Relating to or affecting tissue and structures surrounding and supporting the teeth.

Periodontitis Inflammation of the periodontium caused by bacteria that infect the roots of teeth and the surrounding gum crevices, producing bleeding, pus formation, and gradual loss of bone and the tissues that support the teeth.

Periodontosis A degenerative disease of the periodontal ligament and tooth sockets, characterized by looseness and migration of teeth.

Pharmacopoeia A book, usually of an official nature, containing a list of approved drugs and medicines, with information regarding their properties, preparation and use. Drugs/herbs used, their preparation and administration.

Pharmacotherapy Treatment of disease through the use of drugs.

Phenetic Pertaining to or based on the observable similarities and differences between organisms without regard to assumed genealogy.

Phylogenetic Relating to or based on evolutionary development of a group.

Physiognomy The face or countenance, especially when considered as an index to the character, physical appearance.

Physiology The science which treats of the functions of the living organism and its parts.

Polymerase	Any of several enzymes that catalyze the formation of a long-chain molecule by linking smaller molecular units, as nucleotides with nucleic acids.
Pontics	An artificial tooth in a bridge.
Prosthodontics	The branch of dentistry that deals with the restoration and maintenance of oral function by the replacement of missing teeth and other oral structures by artificial devices.
Protocone	The mesiobuccal cusp of molar teeth.
Pulpitis	Inflammation of dental pulp.
Radio-carbon	Also called carbon 14. A radioactive isotope of carbon with mass number 14 and a half-life of about 5730 years: widely used in the dating of organic materials.
Radiograph	An image produced on film or another sensitive surface by radiation such as X-rays.
Radiolucency	Almost entirely transparent to radiation; almost entirely invisible in x-ray photographs and under fluoroscopy.
Recto	The front surface of a manuscript or papyrus.
Resorption	The destruction, disappearance, or dissolution of a tissue or part by biochemical activity, as the loss of bone or of tooth dentin.
Ricinus plant	A genus of plants (*R. communis*), known as the castor-oil plant.
Sacerdotal	Of priests; priestly.
Sagittal plane	A longitudinal plane that divides the body of a bilaterally symmetrical animal into right and left sections.
Salicylic acid	Water-soluble powder, $C_7H_6O_3$, used in the manufacture of aspirin, a remedy for pain, rheumatic and gouty conditions.
Scriptoria	A room where manuscripts are stored, read, or copied.
Scurvy	A disease marked by swollen and bleeding gums, livid spots on the skin, prostration, etc., due to a diet lacking in vitamin C.
Sociocultural	Involving both social and cultural factors.
Sociology	The scientific study of social relationships and phenomena.
Stelae	An ancient upright stone slab bearing text and or markings.

Streptococcus mutans	A species of *Streptococcus* bacteria associated with the production of dental caries.
Stomatitis	Inflammation of the mouth.
Tartar	See *calculus*.
Taxonomic	Biology. The science dealing with the description, identification, naming, and classification of organisms.
Technocultural	Technology used within a specific culture.
Temporomandibular	Relating to, or affecting the joint between the temporal bone and the mandible that allows or the movement of the mandible.
Traumatology	A branch of surgery dealing with major wounds caused by accidents or violence.
Trephination	An act of perforating the skull with a surgical instrument.
Verso	Back surface of the manuscript or papyrus roll.
Vertebrate	Having a spinal column (vertebrae).
Viscera	The organs in the cavities of the body, especially those in the abdominal cavity.

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND

All the interest in disease and death is only another expression of interest in life.

(Thomas Mann [1875 – 1955] German Writer: The Magic Mountain)

Human beings share certain experiences: they are born, suffer illnesses during a lifetime and all must sooner or later die, whether from disease, degenerative processes, accident or violence. The anthropologist's view of ancient populations is incomplete if he fails to take these phenomena of the state of health and diseases into account. Skeletal and mummified human remains then become the vehicles that physical anthropologists use to probe for signs of unwholesomeness because those are the fascinating parts of the unfortunate human remains that are able to tell a story; a tale of lifestyle, suffering and perhaps the cause of death of the individual, among many others. This dissertation focusses on only a small part of the human remains, albeit of momentous value to understand the above phenomena – the teeth, and the surrounding oral structures.

Philo described the quintessence of teeth in the following manner:

The law also commands that if any one strike [sic] out the tooth of a slave he shall bestow his freedom on the slave; why is this? … because life is a thing of great value, and because nature has made the teeth the instruments of life, as being those by which the food is eaten.

(in Yonge 1995:1173 XXXVI [198])

An individual of any age who have lost all their teeth in ancient times would according to Philo inevitably die not long after; probably because there was no replacement for the dentition as we are used to today. The digestion of the ancient diet would undoubtedly have been severely affected.

Bioarchaeological dental samples reveal important information about demographical data such as diet, subsistence technology, morbidity, mortality, occupational and habitual activities, and the age at death of the individual through the scope of dental structures that show changes as the result of natural and unnatural aging processes (Palichuk 1994: Abstract).

Teeth[1] are often the only preserved biological remains of the vertebrate organism. Teeth are extremely valuable sources of palaeodontological information. Teeth develop early in life, are embedded in the jaws and are uniquely protected from external environmental influences by enamel. Teeth can therefore provide a vast amount of information about the genetic constitution and development (phylogenetic and ontogenetic) of the individual. On the other hand changes in the amelogenesis[2] of the enamel, dental wear signs and changes in the tooth's macro- and microstructures can reveal much about the diet and food processing of the individual.

At times an entire skeleton may be represented by only the shells of enamel from the crowns of teeth as demonstrated by Beeley and Lunt (1980:371). Hillson (1996:10) pointed out that teeth are common finds on archaeological sites where human remains are to be found and that teeth are of the best sources of evidence for both identification and studies of demography, biological relationships, diet and health in ancient human communities.

> *… the only two tissues of the human body that survive time: bone and teeth. Everything else disintegrates, for even the loveliest woman is biochemically just four buckets of water and one bucket of salts.*
>
> (Martí-Ibáñez 1961:25)

Teeth in ancient Egypt[3] were associated with the creator god Ptah. Teeth supposedly took part in the creation because they were inside the mouth of Ptah and thus were regarded as an important element in the pronunciation of the words that facilitated the creation (Forrai 2009:189).

[1] Teeth, and specifically the enamel covering of the dental crown, constitute the most enduring component of the human body (cf. overview in Brothwell 1963; Butler and Joysey (eds.) 1978; and Alt and Türp (eds.) 1997).
[2] Amelogenesis is the formation of tooth enamel during the developmental stages of a tooth.
[3] For the purposes of this study, 'ancient Egypt' will be limited to include the period from the Pre-Dynastic Period, the Old Kingdom through to and including the New Kingdom Period to the Roman Period (see Appendix II).

1.2 RESEARCH QUESTIONS

Following the introduction and background of this dissertation; in tackling the issues mentioned, the following questions will be examined:

- Did dentistry as a profession exist in ancient Egypt?
- Given the resource material that we have available, is there sufficient information contained therein to develop a history of dentistry in Egypt?
- What was the extent of dental diseases in ancient Egypt?
- Did the dentists perform restorative and surgical procedures?
- To what extent does ancient Egyptian dentistry compare with the overall development of knowledge and science during the same period?

1.3 HYPOTHESIS

There are many conflicting reports as to whether the discipline of dentistry, in any, or all its facets existed in ancient Egypt. The author is confident to reveal the existence of the discipline of dentistry in all its fundamentals in ancient Egypt in the conclusion of this research. It is necessary to reach consensus on this subject in order that the traditional diagnoses and treatments of dental maladies to referred in the Medical Papyri are valid. It is also necessary to examine the validity of certain references to dental surgical and prosthetic interventions in the literature and in the physical evidence found in mummies and in in other bioarchaeological human remains. These and other dental issues are persistently denied by a number of scholars involved in palaeodontology *per se*. Research in this field may prove to be of value in enlightening modern dental science.

The theorem that the dental profession existed in ancient Egypt will according to Wynbrandt (1998:10) in all probability lead to the understanding of the extent of dental diseases including the effects of severe dental wear experienced by the individual and ultimately by the entire population who lived under the same conditions in the same environment.

1.4 SOURCES

Although the ideal situation for research for this dissertation would have been an empirical study, it unfortunately appears that such studies can only be the providence of a privileged few who can do their research *suo loco*. For the rest the obvious course may only be a literature-based research. Therefore, a re-evaluation of germane literature (or 'a review of existing scholarships', as Mouton (2001:87) choose to call it) is intended wherefrom new scientific deductions can be made in addition to practical augmentations in research rationales and methods in aid of the field and research laboratory archaeologists excavating within the boundaries of Upper and Lower ancient Egypt.

The bibliography reflects the literature that the author had studied and falls into several categories. Careful assessment of different sources was employed during the course of this study. The primary sources of information include textual and archaeological evidence, equal emphasis has been given to each. A substantial number of secondary sources have also been consulted, particularly for information on the archaeological evidence. The primary sources, on which secondary source material was based, were consulted wherever possible.

The question of 'Did a dental profession exist in ancient Egypt' and the reasons why dentist needed to exist: namely to diagnose and treat the various dental pathologies, encourage research in the following types of source material:

a) The dental state of human remains from ancient Egypt

b) Surviving artefacts regarding odontology

c) Pictorial and epigraphic evidence

d) Documents in Egyptian medical and non-medical literature

e) Historical accounts

1.4.1 Primary literary sources

When faced with writing a dissertation on a subject like dentistry in ancient Egypt one would expect it to be, preponderantly and unavoidably, based within the medico-scientific field.

Archaeology *per se* is instituted in the field of the social sciences. It was however, stimulating to venture into the combination of these two major fields of study. Primary literary sources like Nunn's 'Ancient Egyptian Medicine' (1996) dealt with the social life in ancient Egypt, as well as history of the people of the land ere it provided an excellent view of the medical/dental sciences of the day. 'Medicine in the days of the Pharaohs' by Halioua and Ziskind (2005) is another textbook on the same topic as Nunn's (1996) book but includes references to the sojourn of the Israelites stay in Egypt.

Any research in the social sciences of the ancient land of Egypt cannot divorce itself from the unique writing system (hieroglyphs) that carried all the data needed for studying the social, socio-economical, and socio-religious lifestyle of arguably the most ancient civilisation in the world. In the hieroglyphic writing the classical work of Gardiner's 'Egyptian grammar' (1973, 3rd edition), 'a Concise dictionary of Middle Egyptian' by Faulkner (1981) and Gertie Englund's 'Middle Egyptian, an introduction' (1988) were more than suitable when medical and dental terminology were needed when confronted by ancient texts. This book combined hieroglyphic grammar with a digest of social life in the Middle Kingdom period.

The achievements of the ancient Egyptians were unquestionably unique in every sense. This included, amongst other things, the discipline of medicine and arguably that of dentistry as well. Fortunately the Egyptians created a writing system[4] known to us as hieroglyphics[5] without which the history of Egypt would have been much poorer.

The author researched all the possible references to dental diseases and idiosyncrasies in the known hieratic medical papyri dating from the New Kingdom to the Middle Kingdom.

[4] Egyptian is written in four major scripts: hieroglyphic, hieratic, Demotic and Coptic, in that order from the Old Kingdom Period (3 100 - 2 686 BCE): hieroglyphic writing from the third to eighth dynasties but some specimens are known to have been written even until the fourth century CE, used mainly in royal funerary spells and rituals; to the classical Middle Kingdom Period: hieratic writing, which extended from the end of the Old Kingdom to the middle of the 18th Dynasty (2 160 - 1 400 BCE). This was followed by a final cursive form of writing (demotic) which lasted from about 700 BCE to 400 CE, in the New Kingdom Period. The demotic style was mainly used for business and administration purposes. And finally, Coptic writing: a flowing cursive writing system which started perhaps in 700 BCE when between 400 and 800 CE Coptic was supplanted by Arabic (Freedman et al. 2000:381-382).

[5] Hieroglyphics (Gr ἱερογλυφικός (hieroglyphikos) is a writing system developed as one of the Afro-asiatic languages (3 200 BCE – CE 400). There is a variation/development of the language over time, thus aiding the dating of hieroglyphical texts (Davies 1990:75-136).

Amongst those that were found as the only surviving written papyri are the following: the Georg Moritz Ebers papyrus (1873), commonly referred to as the Ebers papyrus (containing eleven prescriptions or recipes referring to teeth and periodontal tissues (Joachim 1973); the Edwin Smith surgical papyrus (1862); the Kahun medical papyrus (1889); the papyrus Anastasi; the Berlin papyrus (early 1900). Other secondary medical papyri are the Chester Beatty papyrus IV, Hearst papyrus, London papyrus, Brooklyn papyrus, Carlsberg papyrus VIII and the Ramesseum IV and V papyri. An outstanding classical ground plan (*Grundriss*) of medicine that no research on medicine or dentistry in ancient Egypt can do without: this collection deals with all aspects of medicine and dentistry in ancient Egypt and covers all the medical papyri is the 'Grundriss der Medizin der Alten Ägypter' collection. The collection houses dictionaries of medical texts, translations from hieroglyphic texts into German and additions to the medical papyri, principally written by Von Deines Grapow and Westendorf.

The primary evidence on dental matters derives from archaeological bio-remains. Only the elite of the Egyptian society had the means to create and support an eternal resting place as well as undergoing typical Egyptian mummifications at death (Jánosi 1999:27, cf. Cockburn et al. 1980:52). Funerary methods influenced the condition of bioarchaeological human remains. The literature of archaeologists' reports has been consulted where possible. The more important medical papyri consulted in this research are:

- The Ebers Papyrus dated from around 1 550 BCE contains 700 formulas and folk remedies. Of these: 11 recipes are related to tooth and periodontal maladies (Nunn 1996:25-30). However, Reeves (1980:12) reports that some 900 prescriptions are set forth in the Ebers papyrus.
- The Edwin Smith Papyrus which dates to about 1 700 BCE and is primarily a surgical treatise which includes a number of dental related prescriptions (Nunn 1996:25-30).

It is difficult to distinguish between primary and secondary literary sources in most cases. The data from the medical papyri are not themselves studied but merely other scholars' and historians' accounts of these data. Of the various medical papyri available, only those that pertain to the subject of dental disease will be discussed.

1.4.2 Secondary literary sources

A great number of secondary sources will be examined: these include articles, internet sources and books. The purpose is to seek and explain the effects that various dental diseases had on the population and the diagnosis and treatment which were on offer by designated dentists, priests and magicians. In some instances the actions of the prescribed medications will be critically evaluated and compared to modern treatments.

A listing of the more important works consulted for the discussion of the different aspects and dimensions of ancient dentistry start with the classical field work on dental abnormalities of Sir Armand Ruffer's 'Study of abnormalities and pathology of ancient Egypt' (1920); on diet, Wilson's 'Egyptian food and drinks' (1988); on the Medical Papyri: Ebbel (1937), the 'Papyrus Ebers', Breasted's 'The Edwin Smith Surgical Papyrus' (1937) and Ebers' own 'Papyrus Ebers translated by Cyril P Braun' (1930).

Changes in the morphological structure of teeth is the result of the aging process and utilising this phenomenon is used to determine age at death; Gustafson (1950) uses dental non-metrical traits to determine group and racial affinities; Irish (2006) uses non-metrical traits to distinguish the Egyptian people from other population groups. On other dental anthropology matters in general and specifically on the morphology of the human dentition the research of Scott and Turner (1988) and (1997) proved to be indispensable.

1.5 METHODOLOGY

The qualitative research approach has been selected for this dissertation in the quest to understand the people of ancient Egypt in terms of their cultural, social and environmental existence. Archaeology is the scientific study of past human culture and behaviour, from the origins of humans to the present. Archaeology studies past human behaviour through the examination of material remains of previous human societies. This would entail having a clear perception of the sociocultural aspects of life within a specific time/space frame. This study is centred on the health and disease component of the ancient population and specifically focused on the dental aspects of the population.

Central to the pragmatics of the definition of archaeology[6] in ancient Egypt is the understanding of the lifestyle of the ancient Egyptian population. An archaeological approach was selected for this dissertation. This will involve a methodological approach in researching archaeological and historical records[7] of the period in question; researching the cultural[8] history of the peoples through bioarchaeological human remains; using the most modern technology available in the field of radiography, a non-destructive method of accessing medical and dental information from mummified human remains; teeth play a role in the description of ethnic groups, but contrariwise research in the ethnography of the known ethnic groups will succour a genetic nosographical study (the description of diseases and the detailed classification of known diseases) as well as the various dental traits to be expected when viewing dental remains. Ethnographical studies evidently reveal the cultural anthropology of a group which in turn reveals the variation among humans with reference to cultural elements, such as among other the diet and food preparation custom of the group.

Referring to the textual approach, the author will rely heavily on the available literature based on the various disciplines of odontology as sources for his research. This non-empirical survey of ancient Egyptian palaeodontology draws not only on all available sources and previous studies (e.g. Harris & Ponitz 1980 and Smith 1986) but also on major ideas of other authors which will be presented and critically evaluated. The author will ensure that his interpretation of the work of others will receive a fair and honest exposition. In addition to considering the incidence of dental disease, this dissertation also examines the diet of the ancient Egyptians, the role of medical practitioners who had the title of dentist, and the prescriptions of dental relevance found in the medical papyri. There is also an assessment of the evidence that

[6] Archaeology is the study of past peoples based on the things they left behind and the ways they left their imprint on the world. Chipped-stone hand axes made hundreds of thousands of years ago and porcelain teacups from the eighteenth century carry messages from their makers and users. It is the archaeologists' task to decode those messages and apply them to our understanding of the human experience. Smith (2010:185) advocates that archaeology and historical records have both their limitations. Historical records are dependent on interpretation, have selected written accounts of class and time, are rarely complete, and cannot be an objective impression of the whole of the Egyptian society, it merely reflects a certain class and place of the population within a timeframe. Archaeology also has the same limited value.

[7] Smith (2010:185) advocates that archaeology and historical records have both their limitations. Historical records are dependent on interpretation, have selected written accounts of class and time, are rarely complete, and cannot be an objective impression of the whole of the Egyptian society, it merely reflects a certain class and place of the population within a timeframe. Archaeology also has the same limited value.

[8] A definition of culture according to Seale: The term culture is enormously complex, for it includes not only the society's ways of using material things, such as tools and weapons and shelter and clothing and food, but also language, morals and manners, religion and science, economics and art, government and family relationships, and even its ways of sitting down and making love and committing suicide and *oral hygiene* [Seale 1974: s.v. Culture] Italics mine.

researchers have proposed in support of the theory that dental treatment was practised in ancient Egypt.

As a result of the lack of abundant literature expressly focused on dental wear in Ancient Egypt, sources from all over the ancient world was collected and indications of dental maladies sought similar to that of the populations of Ancient Egypt, and subsequently compared. Whenever certain physical dental phenomena are expected to be present among the Egyptian population and are not found, then an important archaeological axiom may sometimes be proposed, namely: the absence of evidence is not evidence of absence.

The literature on bioarchaeology of specifically mummies of Ancient Egypt is copious and will be critically reviewed to evaluate the extent of dental wear amongst not only the more affluent societies but also from limited dry skeletal remains of the majority of the indigent population buried in shallow graves or pits in Ancient Egypt. Nunn (1996:65) reported excellent preservation resulting from desiccation caused by burial in dry sand with no coffin. Cockburn (1980:3) believes that many millions of bodies must still be preserved in the desert sand.

Deciphering the ancient texts compelled the author to research the linguistics of the comparative medical and dental characters of the ancient writing system of the ancient Egyptians namely hieroglyphic symbols, as well as the cursive format of the hieroglyphic logography, known as hieratic logography. The author endeavours translating certain hieroglyphic texts relevant to this study, albeit from classical German translations.

1.6 OUTLINE OF DISSERTATION

This section will provide a general analysis of background information pertinent to gaining a better understanding of the topic of this dissertation.

Chapter 1 initiates the background to the importance of teeth *per se* and odontology as a discipline. The discipline of palaeodontology has become an important partner in the medico-scientific world. Scholars of a number of other disciplines, especially those Egyptologists of past and present who have paved the way to where we are today, are quoted and honoured in the comprehensive bibliography at the completion of this work.

This is followed by the research questions, the hypothesis and the methodological consideration of the dissertation. To elucidate the origin of research substance utilised before and during the writing of this dissertation a number of major literary sources are shared with the reader to substantiate the rationality and validity of authors that have gone this way before and some who were the stalwart pioneers in this comparatively new field in human anthropology.

Chapter 2 will briefly focus on the general odontological situation of the ancient Egyptians (Egyptian palaeodontology). An anatomical review of the standard macromorphology of dentition follows in order to recognise the idiosyncrasies and diseases of the oral structures. Diseases and conditions of the dentition and other oral structures like the temporomandibular joint will be discussed, including the interaction that certain diseases have on an individual’s lifestyle. Extreme dental wear was found to be ubiquitous among the ancient Egyptian population. Rose and Ungar (1998:349) attest that wearing away of the tooth surface during chewing of food is a natural process, however, severe dental wear will be shown to be the causative factor of a number of dental diseases and therefore may have direct influence on the individual’s morbidity and sometimes even mortality.

Chapter 3 addresses the question as to whether a dental profession existed in ancient Egyptian times and if it did, were they operative dental surgeons or were they mere dental pharmacists? The rationale of this Chapter will focus on the author’s research which confirms the first theorem although, as in modern times, the dentist could also be seen as a dispensing practitioner. Evidence from various forms, principally from the medical papyri, hieroglyphic inscriptions found in tombs, stelae and monuments and lastly physical examination reports of dental conditions in mummies and from dry skeletons are taken into account (see also Pahor 1995:39). The medical papyri dental entries are focussed on diagnoses and are mostly pharmacopoeiac in nature providing pharmacotherapy and magical incantations but little operative treatment. However, all entries on dental matters within the available medical papyri are analysed and presented as evidence for dentistry. The hieroglyphic symbols that are in any way dentally related, whether in the medical papyri or on any other surface relating to dentistry, are analysed and translations offered to elucidate further investigations.

Chapter 4 will focus predominantly on the positive aspects of mild to moderate dental wear and attrition and how science can benefit from this condition. There are a number of instances where normal wear and attrition will be beneficial to the natural development of the dentition. The correct spatial relationship between the mandible and the maxilla results in improved dental function, natural physical appearance, and improved upper respiratory function. Another use of investigation and registering all aspects of dental wear found in human remains, skeletal or mummified, is its value in determining age at death of the individual. This factor is of indispensable value in palaeodemography issues.

Chapter 5 deals with the demographical issues of ancient Egypt which originate directly and indirectly from palaeodontology research through non-metrical dental information acquired from human remains. Statistical assessment of changes in the macro- and microstructures of the dental research material due to natural aging processes determines the age at death of the individual. Much of the above information is amassed from the examination of dental remains in a modern *modus operandi* by non-invasive X-ray technology. Various methods and techniques acquired from the latest X-ray equipment are analysed that will ensure the highest possible accuracy to use when compiling demographic data.

Chapter 6 will look at a conclusion and overview of the research concerning dentists, dentistry and dental diseases in ancient Egypt in all its facets. The ultimate objective is the understanding of the way of life of the ancient Egyptians and draw conclusions from the research. Proposals for future research questions will be given.

CHAPTER 2

PALAEODONTOLOGY – MACROMORPHOLOGY OF TEETH

Abstract:

Teeth are common finds on archaeological sites where human remains are to be found, and are of the best sources of evidence for both identification and studies of ancient peoples. Ancient Egypt is exceptionally rich in dental remains. The rationale and history of palaeodontology and palaeopathology is introduced which holistically blankets these two disciplines as a necessary science in human anthropology. Identification and analysis of the macro- and micromorphology of teeth takes precedence to the status of teeth as archaeological artefacts. Teeth are easily recognisable entities with unique characteristics which should also be identifiable by dental anthropologists and archaeologists alike. The standard macro- and microanatomy of teeth merit a short introduction prior to the discussion of dental anomalies and dental diseases such as caries, periodontal diseases, dental wear, dental abscesses, hypoplasias, calculus or tartar and DNA technology as part of dental palaeobiochemistry.

Key words: Palaeodontology; palaeopathology; tooth macro- and micromorphology; dental anatomy: dental diseases; palaeodemography; palaeobiochemistry.

2.1 INTRODUCTORY REMARKS

The macro- and micromorphology of human teeth are of great importance to the discipline of palaeodontology. Morphological studies concerning the interrelation between the form and the function of teeth are essential to the understanding of the ontogenetic and phylogenetic processes (Alt *et al*. 1998:17). The task of odontography is to allow the precise identification of each tooth, whether it be deciduous (primary) or permanent (secondary), maxillary (upper jaw) or mandibular (lower jaw), left or right, and to give its exact position within the dentition (e.g. permanent mandibular lower left second molar). Knowledge of the variation within the human dentition is indispensable for population studies and forensics. Although, at a superficial level, the teeth of different individuals may appear similar but on closer examination they exhibit great variation in both form and size. Descriptions of normal tooth form are the product of subjective observation. All forms within a certain tolerance can be described as variants of a norm (Türp & Alt 1998:71), or otherwise referred to as non-metrical traits.

Non-metrical variation does not implies not measuring a specific feature; it only implies that it is difficult and impractical to define measurements which can consistently be reproduced. Non-metrical features include presence/absence of teeth, size and number of cusps, shape of grooves in molar occlusal surfaces, presence of pits and form of ridges to name but a few (Hillson 2005:262). Findings which go beyond biological variation are abnormalities and extreme cases are regarded as malformations. Non-metrical variations and its importance to palaeodemographical studies will be discussed in more detail in Chapter 5.

This study sets out to enlighten and inform the archaeology fraternity interested in the palaeodontology of ancient Egypt about the significance of teeth in the scientific arena of dental anthropology. The author hopes to instil interest in palaeodontology so that archaeologists can take notice of teeth from a new perspective; that of research in the biosciences, with teeth being the tools to explore biochemistry; palaeoecology; genetics; molecular biology and physiology; palaeodemography; sociology; cultural palaeoanthropology and population migratory tendencies. The author proposes 'promoting' palaeodontology in ancient Egypt by showing the interrelationship between palaeodontology and the above mentioned disciplines, to show that these disciplines are in some way dependent on palaeodontology; in short – on a tooth.

The theme of this dissertation 'Dentistry, dental diseases and dental wear in Ancient Egypt' entails a research in palaeodontology: the dental discipline revealed in the archaeology of ancient Egypt. The consequence is plausibly apt to be riddled with dental and archaeological terminology verbiage which the author will where necessary expound[9] (see Glossary terms, page xiv).

2.2 TEETH AS ARCHAEOLOGICAL ARTEFACTS

The significance of palaeodontology may be attested by a slightly amended citation:

> *A [tooth fracture] is not momentous just because it occurred 3 000 years ago; it is important if it helps answer questions about the population in which the individual lived* [My insertion; originally a 'Collis fracture'].
>
> Anderson (1966:119)

[9] The spelling of certain terminologies may be deemed a problem: archaeology or archaeology; palaeo- or paleo- is the question (Shanks 1975:8). The diphthong 'aeo' within various words (i.e. palaeodontology) is the classical and the preferred version in this dissertation. The 'eo' version within a number of bibliographic entries and/or quotations will be respected and left unchanged.

The value of the human dentition in bioarchaeological remains is significant. Recognition of dental artefacts is however imperative for the palaeodontal research. Providentially every single one of the 32 permanent and 20 deciduous teeth of the human being differs from each other and can readily be identified. Different races, even populations exhibit variation in certain dental traits; the fundamental shape is usually still recognisable.

Disi *et al.* (1983:515)[10] found that bones and teeth were commonly unattractive to archaeologists in the eighties, but intensive studies on all skeletal remains have demonstrated that the study of human skeletal remains inclusive of the dental component are not a less important or fruitful subject of archaeological research than artefacts such as pottery, metals, architecture or any field of historic and prehistoric studies are.

Teeth are often the only parts of the body that survive to be excavated, due to their durable and enduring structure. This issue is fortunate, as they provide a wealth of information about diet, oral hygiene, stress, occupation, cultural behaviour and subsistence economy amongst other (Lukacs 1989:261)[11]. Tooth enamel is known to be the best-preserved structure of human remains in archaeological excavations because of its resilient and robust structure; the hardest single structure of the human body (Henke 1998:179). Beeley and Lunt (1980:371) demonstrated that at times an entire skeleton may be represented only by the shells of enamel from the crowns of teeth. This view was shared by Hedges *et al.* (1995:285). Roler (1992:2) added that teeth could therefore under certain circumstances provide larger sample sizes to work with than with skeletal bones when compiling statistical data. Hillson (1986a:149) states that a disproportionally large amount of information can be added to the general research record of an archaeological excavation site when dental data is incorporated.

Hillson (1996:10) pointed out that teeth are common finds on archaeological sites where human remains are to be found and that teeth are of the best sources of evidence for both identification and studies of demography, biological relationships, diet and health in ancient communities.

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[10] For a further discussion on the importance of human skeletal remains in the broader archaeological domain (Eakins 1980:91).

[11] Other authors that share similar opinion of the importance of teeth within the archaeological context are Humphreys (1951:16) and Roberts & Manchester (1995:44).

Ancient Egypt has proven to be very rich in dental remains, which as the result of mummification[12] of bodies are often in a pristine condition.

A less expensive form of mummification for the common people is reported by Millet *et al*. (1980:71), that of simply wrapping the body in linen. This style invariably led to inferior preservation of skeletal structures. The dry climate ensured relatively good mummification. Natural mummification[13] has been found in the desert sands of Egypt where many a fellahin's body was interred in the hot sand, without wrapping whatsoever.

The hot sands of Egypt produce a desiccative state of the human remains (natural loss of moisture) optimal for natural mummification with skin and hair frequently preserved in good condition. Dawson (1924:83) concurs, mentioning that such bodies are absolutely intact with even the soft tissues perfectly preserved – skin, hair, muscles, nerves and even the viscera; in all, sometimes better preserved than any impeccable mummified remains. The property of soils of which the sand component separate easily are characteristically 'sandier' in contrast with the stickier nature of the heavier groups of soils (Brady 1974:372). Some sands are calcareous and have a high pH balance (alkaline), preservation of human remains will then be good to excellent. This phenomenon emerges as the result of the extremely desiccated climate of the desert environment and because of the sterile air (Ceram 1958:150, 151). The quote from Martí-Ibáñez's (1961:25) below should be considered:

> *…the only two tissues of the human body that survive time: bone and teeth. Everything else disintegrates, for even the loveliest woman is biochemically just four buckets of water and one bucket of salts.*[14]
>
> (Martí-Ibáñez 1961:25)

[12] Brier & Wade (2001:120) cited the removal of the brain during mummification. The procedure of removal of brain tissue through the right nostril with bronze wire is left to speculation as to how much damage was done to the anterior teeth in the process.

[13] Thekkaniyil *et al*. (2000:10) remind us that any form of mummification has provided science valuable information about the evolution of human disease.

[14] This quotation is not an accurate reflection of facts: the enamel covering of the tooth crown makes it virtually indestructible, in comparison to bone tissue, which when interred in soil with a low pH (acidic) may be predisposed to diagenetic changes and ultimately dematerialise (Gordon & Buikstra 1981:566).

To illustrate the importance of teeth in archaeology, an arbitrary isolated tooth found at an archaeological site of, for argument's sake, the Iron Age I period was examined. Without reference to any other finds at the site, Hillson (1986b:1-4) takes us on an amazing scientific journey of the anthropological and scientific importance that this single tooth can reveal.

It is possible to identify this tooth as a human upper right canine of an individual who had died at the age of over 60 years, someone who had suffered from health and growth disturbances (due to infections and malnutrition that are revealed through hypoplastic lesions) at around the individual's chronological age of between 3 and 5 years. Poor oral hygiene is suggested from traces of calculus and tartar on one or more tooth surfaces; the level thereof on the tooth would suggest a longstanding periodontal disease. The amount of dental wear would, apart from ageing the individual at death, also indicate the possible diet of the individual. In the event that this tooth had worn down to the level of the pulp and exposed the pulpal tissue with resultant pulpal infection or possibly a carious lesion that had penetrated the pulpal tissue, an abscess can be presumed ensued with accompanying morbidity of the individual. It may even have been the cause of death because of an unchecked infection of a compromised immune system of the individual due to perhaps a general disease condition or malnutrition. Had this tooth been impacted and unerupted, it may be possible through DNA studies of the well preserved remains of the pulpal tissue to establish the sex of the individual (Pill & Kramer 1997:674, cf. Dixon & Roberts 2001:191). Radio-carbon dating, as well as Electron Spin Resonance (ESR)[15] dating will confirm that the individual had lived in a specific period of antiquity, in this hypothetical case, the period of` 950 years BCE (Beginning of the 22nd Dynasty with the accession of King Shoshhenq: see Kitchen 1996:328).

The discovery by Howard Carter in 1903 and the ensuing later sequel of this discovery elucidates the impact a single tooth root had in identification of the fifth Pharaoh of the eighteenth Dynasty's, the widow of Amenhotep II (ca. 1 490 – 1 436 BCE), Hatshepsut's, mummified remains[16] (Kitchen 1996:325). Chip Brown (2009:105) recorded the discovery of what was thought to be the denuded bodies of Hatshepsut together conceivably, with her wet-

[15] The basis of Electron Spin Resonance (ESR) dating technique is the trapping of free electrons by defects in the enamel apatite crystal lattice (Hillson 1996:225).
[16] Kitchen (1996:325) presents Hatshepsut as the only female pharaoh in the known chronology list of the rulers of ancient Egypt.

nurse in tomb KV60. The bodies were 'rediscovered' by Donald Ryan in 1998 but there were no clarity as to the identity of the bodies.

During the period of 2006-7 under the auspices of Hawass a computed tomographic scan (CT scan) was taken of the cranium confirmed a remaining root in the region of the Queen's upper right molar tooth[17]. A wooden container marked unmistakably with Hatshepsut's cartouche[18] was found in 1881 with perhaps the remains of her liver together with another smaller box with a tooth inside. The tooth proved to be an upper right molar with one root missing. Upon re-examining the body which had the remaining root – the match was made, indisputably the body of Hatshepsut[19] (see figure 2.1 of the x-ray images of the missing root compared to the extracted tooth that confirms the diagnosis as belonging to the same person).

Figure 2.1 Confirmation using a CT-scan: the missing tooth is a perfect match to the extracted tooth's root left intact in the maxilla. The x-ray image on the left is that of the tooth found in the box marked as that of Hatshepsut while the x-ray image on the right is that of the fractured root between other teeth is clearly identified in the centre of the image (Hawass 2008:1).

The importance of recovering all types of material or artefacts from archaeological sites has long been recognised. Hoffmeier (2008:12) emphasised that *all* objects from archaeological sites should be preserved. The archaeology of bones and teeth has in recent years provided crucial evidence for the study of anthropology in antiquity. Ancient Egyptian mummification processes in the majority of cases and in all periods ranging from Predynastic through to the

[17] Landers (2011:54) calls the discovery of the missing tooth and the discovery of the root 'a dental forensic connection'. A combination of an archaeologist's work solved by a latter day dentist.
[18] The small wooden box is inscribed with the throne and birth names of Hatshepsut, the only object from the cache to bear the great queen's cartouche (Hawass 2007:24).
[19] See also Hawass (2007:24) rendition of this discovery.

Roman Period are excellent sources for well-preserved oral structures[20] (Weinberger 1947:178).

2.2.1 Palaeopathology versus palaeodontology

Arensburg (1985:21) defines palaeopathology[21] in skeletal collections as any abnormal condition of human remains' bony structures to be considered as 'pathological'. The term would include traumatic lesions or intentional trephinations, deformities of bony structures including congenital malformations, manifestations of infectious diseases, tumours, metabolic and endocrine disorders. The oral structures are not mentioned by Arensburg, but certainly not excluded; the oral structures, inclusive of the teeth, have for centuries been included in a number of human anatomical books, albeit frequently in a separate section and never explored in its full dimension. Apart from the dentition and alveolar bone *per se*, the rest of the oral structures are not dissimilar to any other structures of the body. Teeth however, are different to bones in their biology. This was recognised by the anatomist Andreas Vesalius as long ago as 1742 CE. Hillson (1986b:3) believed it to be clear that teeth cannot be considered part of the bony skeleton in the true sense of the word. The anatomy, physiology and pathology of teeth differ vastly from that of bone as teeth are highly specialised structures.

Janssens (1970:1) held that ancient art forms and ancient literature on a specific period and subject could also be utilised in addition to other scientific explorations of human remains to form a holistic representation of palaeopathology, all towards the full status of palaeodontology as an interdisciplinary science. Angel (1981:509) integrated supplementary techniques in palaeopathology namely immunochemistry and coprolitology. Coprotherapy however, is a term used by Arensburg (1985:26), relating to the often therapeutic use of animal manure in a number of prescriptions found in the Medical Papyri of ancient Egypt.

[20] The author is of the opinion that amongst all human tissues, the amount of data gathered from a single tooth is unique, especially considering the proportional size of a tooth. It stands to reason that if a single tooth can be of such gargantuan importance then no tooth should ever be disregarded nor discarded at any archaeological site.

[21] Anthropological and pathological studies of human skeletons have been carried out ever since the discoveries of mainly the Egyptian mummies and other remains inside European caves at the turn of the previous century by archaeologists like Sir Flinders Petri (Albright 1949:52-61).

Lock *et al*. (2000:611) pointed out that there are many problems that beset palaeopathologists concerning skeletal remains in archaeology; the most observable is that mainly diseases that affect the skeleton can be regarded as study material, and in the International Classification of Disease (ICD), the number of skeletal diseases that cause death are said to be but a few, and that only a small percentage of diseases actually leave skeletal signs. This argument can be substantiated by the fact that few epidemic and communicable diseases ever leave signs or marks on skeletal tissue. Less than ten percent of syphilitic patients ever showed bone impairment (Møller-Christensen 1965:604).

The term ‘palaeodontology’ on the other hand merely suggests a study of ancient teeth (Greek palaeo = ancient; odont = pertaining to teeth; logos = word or thought) (Liddell (ed.) 1996: s.v. Palaeo; Odont; Logos). The term does not specifically imply the study of disease at all, unlike palaeopathology, which clearly implies a study of the pathology of ancient tissues. Palaeodontology as a discipline however does *not* exclude pathological processes of teeth, nor of any of the other oral tissues. It does however include all abnormalities of healthy as well as anomalies of oral structures.

The rationale of palaeodontology is to provide answers to some questions: the relevance of dental remains to the study of the human social situation, environment and human behaviour in general. The study of human skeletal and dental remains will reveal the life history at both the individual and the population levels (Larsen 1999:3). Inherited skeletal features have among other been widely used to resolve conflicting land claims by indigenous peoples (Walker 2000:21). Similarly, evidence of bone and tooth disease has been important in medical evaluation of inherited predispositions for certain diseases like diabetes and anaemia. Nutritional assessments of traditional diets have also benefited from long term perspectives developed through chemical studies of ancient bone and teeth (Buikstra & Ubelaker 1994:2).

2.2.2 History of palaeodontology in ancient Egypt

Palaeodemography research has for the last century relied on information gained from skeletal structures (see Chapter 5). The racial history and kinship of ancient Egypt has also been questioned for a long time. Historically age and sexual dimorphism determination were mainly from skeletal remains, in particular from the pelvis and the cranium. Non-metrical characteristics of the cranium were used to establish race at the same time. Modern research however, sees the utilisation of multidisciplinary techniques, incorporating the mandible and the dentition (Milner *et al.* 2000:475).

Researchers have been engaged in the study of dentitions since antiquity. Scott and Turner (1988:99) reported that the term 'dental anthropology' first appeared in the title of an article published in 1900 by George Buschan. Scott and Turner (1988:100) also revealed that the 19th century natural historians Rousseau, Koch, Henle and Owen had already recognised the value and qualities that teeth possess, namely: '*teeth are durable*[22]*, evolutionarily conservative and yet adaptable, rich in genetically determined traits, and reflective of behaviour, ecology and diet. Jaws and teeth are more durable compared to the rest of the skeletal remains. Teeth and jaws undergo less post-mortem decomposition, are commonly the best represented part of skeleton and are frequently the only record of fossil species*' (Alt *et al.* 1998:2).

Research categories in dental anthropology include fossil hominid dental studies and palaeodontology constitutes the studies of dental anatomy, odontometrics, health, evolution, growth, genetics usage, forensics and ethnographic studies. These qualities are described as valuable for anthropological and archaeological studies by Scott and Turner (1988:100), who also add the evolutionary conservatism of the dentition as an important factor for palaeodontology research. Osborne (1967:947) pointed out the importance of dental non-metrical traits for evolutionary studies: '*the dentition may truly be the best, if not the only link between genetics and the palaeodontal record as it constitutes the most valuable complex of non-metric traits for establishing population affinities and the study of genetic variance consequent to evolution*' (see section on non-metrical traits in Chapter 5).

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[22] Because of the durability of the enamel of the tooth crown, one could expect to find a number of good quality teeth in most bioarchaeological excavations, even when the rest of the skeleton is in pitiable condition or only fragmentary and no more of any research value (Kieser *et al*. 1983:11).

and pathology of teeth differ vastly from that of bone as teeth are highly specialised structures. Alt *et al*. (1998:17) reveal that teeth are occasionally included in human anatomical literature; one of the oldest sources to include comparative anatomical reflections about teeth is to be found in De generatione animalium by Aristotle (384-322 BCE) followed by Hippocrates's script, the Corpus Hippocraticum which originated in the 5th century BCE, which is believed to be an anthology of the writings of several authors, although popularly attributed to Hippocrates of Kos, known as the father of medicine (Guthrie & Rhodes 2008: s.v. Corpus Hippocraticum, cf. Prabhakara 1985:369, Horstmanhoff 1990:181). Riddle (1993:xi) disagrees with these authors that Hippocrates should be called the Father of Medicine; quoting Imhotep (ca. 2 686 BCE) of Egypt as the possible protagonist to wear the crown, the difference is an incredible 2 300 years.

Hillson (1986b:3, 4) pointed out that the first microscopic studies of dental tissues were done by Marcello Malphigue and Anthony van Leeuenhoek in the latter part of the 17th century. Van Leeuenhoek was also said to have been the first to identify microorganisms which he discovered in dental plaque. Microscopic dental anatomy was first meritoriously described in the 19th century by such scholars as Purkinje, Retzuis, Preiswerk, Owen and Von Ebner. Sir John Tomes in particular is often regarded as the father of modern dentistry (Hillson 1986b:4). Fauchard is cited as the father of modern dentistry whilst Hunter was the first to have described dental diseases (Prabhakara 1985:370).

2.2.3 The rationale of palaeodontology

Dental anthropology provides an excellent view into biological, ecological and cultural aspects which help to detect and understand human behaviour, living conditions, and environments. Teeth are used to reflect individual and group patterns of demography, biological relationships in the context of affinity and kinship, aspects of diet and cultural adaptation, and supply information on dental health, diet, art, cult, and custom in fossil and archaeological series (Alt *et al* 1998:1).

Teeth and jawbones are used to address questions in numerous disciplines including palaeoanthropology, palaeontology, prehistoric anthropology, archaeology, dentistry, comparative anatomy, genetics, embryology, and forensic medicine. Teeth possess a high degree of morphological individuality, recognised as dental traits representing personal, kinship, and population characteristics, in other words the strict heredity of many dental traits can be directly observed and evaluated in both living and past populations (Alt *et al.* 1998:17).

Due to teeth's high heritability in their morphology, they are useful in assessing evolutionary and population origins, developments and dynamics; they reflect dietary and cultural behaviour and environmental effects. Non-metrical dental traits have been identified as excellent indicators of genetically transferable characteristics which are relatively free of sex- and age biases (Ullinger *et al*. 2005:467). In the research concerning measurable traits, Pietrusewsky (2000:375) explained that measurement and description of dental and skeletal remains as a paradigm focus on investigation of human population structures and past biological relationships, including the assignment of unknown specimens to reference groups.

Ancient Egypt is a civilisation where all the above demographic data is of the utmost importance for unremitting scientific studies. Phenetic distances of size and shape in odontometric studies is expressed by Perzigian (1984:193) at the hand of demographical issues: size coefficients generally reflect technocultural development (hunting/gathering versus agriculture) while shape coefficients generally reflect known taxonomic associations. Perzigian (1984:195) further argues that tooth size can be explained by evolutionary forces, enmeshed in technocultural and dietary changes. In Egypt as elsewhere there is a marked decrease in tooth size over time and it becomes relevant when comparison is to be made between Predynastic and Dynastic dental remains, or between contemporary groups of the Egyptian populace (Sofaer *et al*. 1986:265). LeBlanc and Black (1974:417) reported an average reduction in tooth size of 2 percent per every thousand years for maxillary teeth and 1 percent for mandibular teeth in the Eastern Mediterranean countries over a period of 9 000 years.

And finally, the non-genetic characteristics of teeth such as wear and disease make them well suited for research of dietary adaptations, regional variation in disease manifestations, epidemiological status and others. Dental anthropology makes ample use of this research potential. This discipline has a unique holistic view of teeth, striving to place them in every possible context, but will ultimately focus on the dental diseases and wear of teeth found in ancient Egypt (Alt *et al* 1998:1).

2.3 TOOTH MACROMORPHOLOGY

Dental anatomy is a common ground shared by palaeontologists, palaeodontologists, dental anthropologists, geneticists, and dentists. Certain academics like palaeontologists are interested in the evolutionary aspect only and have developed nomenclatures relating to homologies in tooth structures, others are more concerned to use the basics of tooth crown features, for example terms like mesiolingual cusp instead of protocone. The following information is meant for the latter group.

The accurate identification of the morphology of individual teeth is a prerequisite for any archaeologist involved with fieldwork. The field archaeologist should not only to be able to identify an artefact like a healthy human tooth *per se*, but also diseased dental structures, including fragments of teeth and fragments of jawbones. Individual teeth in an archaeological environment are described by Hillson (1986b:10) as artefacts that most of the time do not have the appearance of the pearly white objects that are known to us, but may be partially annihilated by extreme wear, rampant caries, fractured or may be unrecognisably discoloured by diagenetic changes that teeth undergo in soil, rendering it unrecognisable as a tooth. Archaeology of ancient Egypt is no different to any other region: it may be straightforward and undemanding to identify teeth when faced by mummified human remains in general but may be far more challenging when faced by disarrayed skeletal remains. The familiarity with the holistic morphology of teeth led archaeologists to identity the mummy of Hatshepsut (Brown 2009:105) and is a classic example, as discussed on page 31 above.

Dental morphological characteristics can be a useful tool for general palaeoanthropological studies: firstly for their overabundance in archaeological human remains because of their durability, and secondly because dental variability provides information on phylogenic and ontogenic studies for understanding the variation within and between populations (Palomino *et al*. 1977:61).

Carlson (1987:10) suggests that the basic reality that all human teeth have similar macroscopic composition made it possible to have developed a single descriptive system common to all tooth types based on the modern conception of the fundamental macro-morphology of teeth. Mammals are known to be diphyodont (the ability to grow two sets of teeth in a lifetime, namely a set of deciduous- (20 teeth) and a set of permanent teeth (32 teeth). The dentition is divided into an upper or maxillary component and a lower or mandibular component, each component having 10 deciduous teeth and 16 permanent teeth.

2.3.1 The primary dentition

The primary or deciduous dentition is often colloquially referred to as the 'milk' teeth. Milk teeth have a relatively short lifespan before they are exfoliated (shed) to be replaced by the permanent teeth (between the ages of 5 and 12 years). It is also known as the deciduous dentition because of the fact that the entire dentition will in most cases be shed at a certain age. The shorthand dental formula found in Van Beek (1983:11) is as follows:

DI $\frac{2}{2}$ DC $\frac{1}{1}$ DM $\frac{2}{2}$ = 10 teeth, where DI = deciduous incisor; DC = deciduous canine; DM = deciduous molar.

The fraction $\frac{2}{2}$ for example denotes two upper or two lower teeth of the same kind. There are thus two incisors, one canine and two molar teeth in every quadrant. Dental development is widely regarded as the most accurate means of determining age at death in individuals who have not reached dental maturity (Brickley 2004a:21).

2.3.2 The intermediate dentition

Woelfel & Scheid (2002:16) defined the mixed dentition as a condition and/or period when certain teeth of both the primary and permanent dentitions are simultaneously present. The mixed dentition (transitional dentition period) begins with the emergence and eruption of the mandibular first permanent molars and ends with the loss of the last primary tooth, more or less at the age of 11 or 12 years. Ash and Nelson (1940:41) explained that the initial phase of the transition period lasts about 2 years, starting at about 6 years of age, during which time the permanent first molars emerge.

The primary incisors are shed and the permanent incisors emerge and erupt into position. A permanent tooth encased in a follicle or crypt does not begin with eruptive movements until its crown has been completely formed. The second phase of the mixed dentition starts when the deciduous canine teeth make way for the permanent canines, followed by the deciduous molar teeth being replaced by the permanent premolar teeth.

2.3.3 The permanent dentition

The archaeologist would frequently be confronted with only permanent teeth because infant skeletons are rare at most archaeological sites (Le Roux 1995:109, cf. Gordon & Buikstra 1981:566). The archaeologist may also occasionally find solitary teeth at an excavation site in the vicinity of human remains; in that event identification according to a simple description, even a photograph may not be nearly sufficient to help with a positive identification[23].

The full complement of teeth in the permanent dentition is 32; 16 teeth in the maxillary arch and 16 teeth in the mandibular arch. Starting from the midline, they are as follows:

Central incisor	Incisor teeth
Lateral incisor	
Canine	
First premolar	Premolar teeth
Second premolar	
First molar	Molar teeth
Second molar	
Third molar	

[23] One of the better dental anatomy handbooks on tooth morphology is the one by Woelfel and Scheid (2002). These authors have compiled a series of photographical studies on every tooth in both the deciduous and the permanent dentitions, presenting a display of various shapes and sizes within the norm for each individual permanent tooth. It should aid the interested palaeodontologist in making a better-calculated choice when challenged to identify a solitary tooth. This kind of presentation is the next best thing to model plaques in plaster.

The dental formula of the permanent dentition is as follows (Woelfel & Scheid 2002:16):

$I\ \frac{2}{2}\ C\ \frac{1}{1}\ PM\ \frac{2}{2} M\ \frac{3}{3} = 16$, where I = incisors; C = canines; PM = premolars and M = molars.

2.3.4 The tooth numbering system

For dentists and scholars interested in odontology, one of the fundamental issues would be to communicate with one another. Therefore, in order to be able to converse, keeping of records and conducting dental research work, it is essential to use a notation system that can identify every one of the 52 teeth of the human dentition. In order that the identification of teeth is rendered speedier and simpler, a form of dental shorthand was employed (Van Beek 1983:3; cf. Schroeder 1991:314). Every tooth is assigned a number or a letter of the alphabet; see below in figure 2.4. Recording grids for the FDI Two Digit System for the permanent and deciduous dentition are depicted below in figures 2.2 and 2.3 below.

18	17	16	15	14	13	12	11	21	22	23	24	25	26	27	28
48	47	46	45	44	43	42	41	31	32	33	34	35	36	37	38

Figure 2.2: Recording grid for permanent dentition: FDI Two-digit system, original by Greeff (2009:58).

55	54	53	52	51	61	62	63	64	65
85	84	83	82	81	71	72	73	74	75

Figure 2.3: Recording grid for deciduous dentition: FDI Two-digit system, original by Greeff (2009:58).

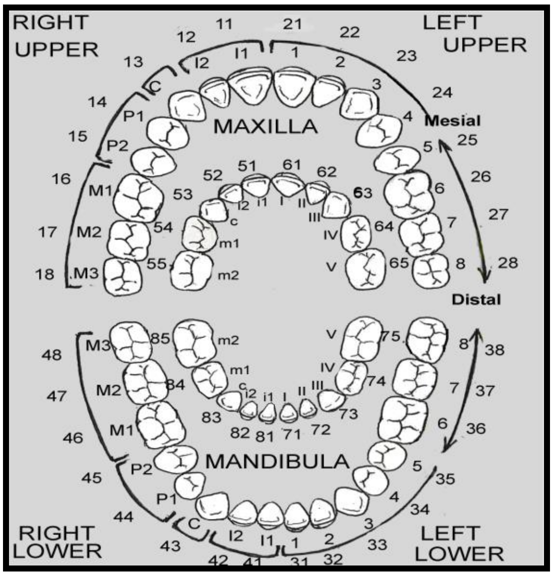


Figure 2.4: The identification chart for the maxillary and mandibular deciduous and permanent dentition. The teeth of the deciduous (inner) and permanent (outer) dentition of the maxilla and the mandible depicted in various manners of identification: The most common system is the FDI two digit system. For the permanent teeth the system is depicted as 11 to 18; 21 to 28; 31 to 38 and 41 to 48, seen on the outer circle above, and for the deciduous teeth, 51 to 55; 61 to 65; 71 to 75 and 81 to 85 as seen above the outer circle of the deciduous teeth. The other systems, namely the Universal and Zsigmondy/Palmer systems are also included in figure 1 (Peck & Peck 1993:643).

2.4 TOOTH HISTOLOGY

All primate teeth have an analogous microscopic constitution. Carlson (1987:22) argues that this similarity lies in the fact that the genetic code for teeth operates with only a relatively limited number of units. Furthermore, this similarity is enhanced by the fact that the dental units have an easily recognisable and stable set of characteristics. Teeth are the most chemically stable tissues in the body and they therefore survive in such a good way (Roberts & Manchester 1995:44).

A tooth consists of a crown and one or more roots. The crown is the functional part that is visible above the gum. The root is the unseen portion that supports and secures the tooth in the jawbone. The root is suspended to the tooth-bearing bone - the alveolar processes of the jaws by a fibrous ligament called the periodontal ligament or membrane. The ‘neck’ of the root is embraced by the fleshy gum tissue, the gingiva. The basic component structures of teeth are: enamel, dentine and cementum.

2.4.1 Enamel

Enamel is known to be the best-preserved structure of human remains in archaeological excavations. This is the view of Roler (1992:2) who adds that teeth can therefore provide larger sample sizes to work with than with skeletal bones. This fact is largely due to the microstructure of tooth structure in comparison with human bone structure and other ectodermal structures. Teeth are often the only parts of the body that survive to be excavated, due to their hard and robust structure, which is fortunate, as they provide a wealth of information about for example, diet, oral hygiene, stress, occupation, cultural behaviour and subsistence economy (Lukacs 1989:261). Hillson (1986b:113) described mature enamel as unique amongst mammal tissues for it is almost entirely inorganic by weight; it contains 96 - 97 percent inorganic material 0,4 - 0,9 percent organic material and 2,1 - 3,6 percent water. Because of its high mineral content and crystalline arrangement, enamel is the hardest calcified tissue in the human body. Locked into the layered structure of enamel, the growth history of an individual can be followed chronologically, not entirely unlike year-rings of trees.

Enamel is a non-living structure, containing no nerves and is unique in that it never regenerates; Langsjoen (1998:403) metaphorically alluded to hypoplastic enamel lesions as a biological window through which one can observe the long-term consequences of metabolic stress and it provides a record from which an investigator may infer the time at which the hypoplasia formed and therefore the time of the stressful event that caused the insult (see also Goodman & Armelagos 1985:488). Hillson (2000:272) asserted the great potential in gaining anthropological information from the study of hypoplastic lesions in teeth, above all, the knowledge of what it was like to grow up in past human societies. Hypoplastic lesions may be causative of dental wear patterns following damaged enamel prisms.

2.4.2 Dentine and the dental pulp

Dentine is a hard tissue of mesenchyme origin that has differentiated from mesenchyme cells of the dental papilla, thus the dental pulp is the seminal organ of dentine (Ten Cate 1998:128). Dentine is less hard than enamel but harder than bone. Dentine has a pale yellow colour which contributes to the colour of the clinical crown because of the translucency of the enamel layers. Like bone, dentine mainly consists of collagenous matrix mineralised with apatite, a calcium phosphate (Shellis 1981:166). The composition of fresh dentine was listed by Türp and Alt (1998:73) by weight: inorganic material 70 percent (calcium and phosphates in the form of hydroxyapatite); 20 percent organic material (mainly collagen) and 10 percent water.

Lundeen and Roberson (1985:40) do not distinguish between dentine and pulp tissue. Dentine is merely a product of the differentiated odontoblasts of the pulp tissue. The cellular processes of these odontoblasts remain in the dentinal tubules; therefore dentine and the pulp can be seen as a unit (Morse 1991:723). The dental pulp occupies the pulp cavity of the tooth. The coronal pulp occupies the pulp chamber (within the crown part) and the radicular pulp fills the root canals. The pulp contains the odontoblasts, fibroblasts, undifferentiated mesenchyme cells, nerve fibres, blood- and lymph vessels. The whole of the pulp cavity is lined out with odontoblasts, even within the mature pulp. The odontoblast cells are responsible for the predentine, dentine, as well as the secondary dentine that develops later (Türp & Alt 1998:73).

The dentinal tubules contain sensory nerve endings and are therefore sensitive to touch and temperature stimulation, for both cold and hot stimuli. The rationale of the study of the dentine and pulp is centre to this study because extreme pain is usually experienced when dental wear has worn though the enamel covering, reaching the dentine. Although the worn areas may still be small in extent, sensitivity can cause severe pain and discomfort.

The phenomenon of all types of dental wear can easily be observed by the basic response to this stimulus on the pulp chamber by nature which develops a calcific deposit, the so-called secondary dentine, which then starts to occupy the lumen of the pulp chamber (Phillippas 1960:1186). The deposit of secondary dentine has the advantage that it blocks pain stimuli, and the dentine islands becomes less sensitive to touch and extreme temperatures.

Increase in secondary dentine is one of the main aging factors of Gustafson's methods in the determination of age at death of skeletal and mummified human remains. Solheim (1992:193) however warns that secondary dentine is contrary to common belief, only a minor factor in determination of age in all sorts of dental wear because the formation thereof seems only to a minor extent to be influenced by wear.

2.4.3 Cementum and the periodontal ligament

Cementum (also called root cementum) is often described as part of the periodontium, the supporting structure of teeth (Türp & Alt 1998:71). Cementum is a calcified connective tissue also known as the periodontal ligament, that covers the anatomical root of a tooth and is firmly 'cemented' to the dentine of the root, having an original thickness of 50 to 200 µm at the root apex and 30 to 60 µm around the cervical or cemento-enamel junction (CEJ) (Wilkins 1999:189). The periodontal ligament furnishes the tooth with elasticity that acts as shock absorbers during mastication. Cementum is bonelike and hard but unlike bone, is acellular, 50 percent being mineralised with hydroxyapatite crystals (Ten Cate 1998:5). Jones (1981:197) reported that cementum contains 65 percent minerals (wet weight), less than either enamel or dentine. Cementum frequently has a concentric layered structure. It is likely that these layers result from the density of cementocyte lacunae, or the density of collagen fibres, or mineralization of these fibres, or all of the above-mentioned (Hillson 2005:196). Rhythmic deposition of cementum takes place and is comparable to annual rings found in tree trunks, also known as cementum annulation[24] (Stott *et al*. 1982:814).

The rationale of the study of cementum in palaeodontology is its ability through age linked augmentation to contribute to demographical information and is therefore relevant to this study's later discussion on palaeodemographic situation in ancient Egypt in Chapter 5 (Miles 1978:455). Gustafson (1950:47) also makes use of this age-linked augmentation in his quest to find ways to establish accurate ageing methods of human remains. The approach of Gustafson is elucidated in the cementum build-up on the root of a tooth, related to periodontosis – where the continuous repositioning of the tooth in the alveolar bone necessitates extra layers of cementum, also known as apposition of cementum on the apex.

[24] It is suggested by Renz and Radlanski (2006:29) that counting cementum annulation rings are probably the most accurate method of age determination in human remains.

2.5 DENTAL DISEASES IN GENERAL

2.5.1 Dental caries

Caries is an infectious disease with a multifactorial aetiology. Caries is basically the result of fermentation of food sugars, mainly sucrose in the diet, by bacteria that occur in the mouth. These microorganisms are the Lactobacillus acidophilus and Streptococcus mutans (Powell & Mielke 1985:315). As caries progresses, the initial destruction is that of the enamel, then the dentine, and eventually exposing the pulp. The notion that caries is caused by a worm[25] is one of the oldest myths regarding caries, the pulp tissue was probably mistaken as a worm (Blackburn 1977:24-30, Marion 1996:16).

Dental caries is a transmissible disease in which progressive destruction of the tooth structure is initiated by microbial activation on the tooth surface (Pindborg 1970:256). Dental caries is perhaps the most common of all the dental diseases and is usually the most reported disease, more than any other dental disease and arguably one the most ubiquitous diseases in human skeletal bioarchaeology (Roberts & Manchester 1995:45). This generalisation does however not apply to most periods of ancient Egypt. Ruffer (1920:356), one of the pioneers of Egyptian skeletal and dental field researchers quoted the following regarding caries in Egypt: 'Both in Nubia and Egypt the ordinary form of caries is exceedingly rare in Predynastic and Protodynastic people, and among the poorer classes it never became at all common until modern times ...'.

Disease in bone tissue may result in an increase or decrease in bone substance. Bone is also known to remodel after injury. These are dynamic responses to a bone disease process. By contrast, dental caries as a disease causes permanent destruction of tooth substance, never to remodel again, hence the cavity that forms in response to the disease (Mays 1997:146). Diagnosis of carious lesions in bioarchaeology is not all that difficult.

[25] The first and most enduring explanation for what causes tooth decay was the tooth-worm, first noted by the Sumerians around 5000 BCE. The hypothesis was that tooth decay was the result of a tooth worm boring into and decimating the teeth. This is logical, as the holes created by cavities are somewhat similar to those bored by worms into wood. The notion that caries is caused by a worm is one of the oldest myths regarding caries in ancient Egypt as well (Leek 1967:51).

2.5.2 Dental wear

Dental wear is not a disease *per se* but can predispose other dental pathology, e.g. caries and abscesses (Roberts & Manchester 1995:52). Dental wear was rampant in ancient Egypt and most authors discussing wear in ancient Egypt refer to the condition as *severe* dental wear (Marion 1996:15, Derry 1933:112, Leek 1966:60). Since dental wear was the most ubiquitous dental condition in ancient Egypt, much more on this subject will follow in ensuing chapters.

Dental anthropologists have studied dental wear for more than a century. However, during the last 30 years the advent of 'new archaeology' and 'new physical anthropology', dental wear[26] has become increasingly significant in its methodology and interpretation to understand the lifestyle of ancient populations and the concomitant circumstances that leads to a discipline known as palaeodemography, especially in age determination of the individual and lately the research into the palaeodiet of a population.

Tooth wear occurs when the outer tooth surface is lost as a result of chemical or mechanical activity in the mouth. Tooth wear is an increasingly common problem; teeth can simply wear down (abrasion or attrition) or dissolve away (erosion) to varying extents as time passes. This is in contrast to tooth decay and gum disease which are caused by the action of bacteria in the mouth.

Dental wear, despite and because of the multi-factorial aetiology of tooth surface loss, is the general term for frictional loss of tooth substance and has been divided into three basic groups, dependant on the aetiology thereof. The three groups are: attrition, abrasion and erosion and will be elaborated on page 124 below. Attrition has its provenance in tooth-surface on tooth-surface friction. Interproximal tooth wear occurs at the point where two teeth adjacent to each other touch but because of the periodontal ligament which supports the tooth in the alveolar socket allows slight movement in the process of mastication, even in bruxism and clenching. This phenomenon can be compared with that of an individual tooth shock absorber not unlike

[26] Tooth surface loss (TSL) not caused by caries or trauma may be purely physiological and occurs as a natural consequence of aging. Davies *et al*. (2002:11) therefore argue that it cannot be assumed that all tooth surface loss is pathological.

that of that which is found in a motor vehicle. Due to the movement of one tooth's surface against another tooth the process is that of attrition. Forshaw (2009a:421) suggests that the term 'tooth wear' should be inclusive of the components of attrition and abrasion.

2.5.3 Dental abscess

Dental caries and dental wear can predispose the development of dental abscesses through extreme wear and rampant caries when the pulp cavity becomes exposed, becomes necrotic and gets infiltrated by bacteria. Abscess formation can also occur in cases of periodontal disease when a periodontal pocket forms harbouring bacteria (Roberts & Manchester 1995:50). The prevalence of dental abscesses due to primary caries in ancient Egypt is rare but omnipresent as the result of extreme dental wear (Hillson 1986b:306).

Periodontal abscesses are due to periodontal disease, caused primarily by severe calculus formation due to poor oral health. What is often regarded as an abscess when viewing a periapical cavity physically or on an x-ray is regarded by Dias & Tayles (1997:548) as a misnomer. The authors regard a periodontal apical cavity only as an area which may have contained an abscess in the past, later infiltrated by granulomatous tissue. The symptoms of both dental and periodontal abscesses are localised severe pain with systemic effects such as fever and general malaise.

Viewing a cavity reminiscent of an abscess in dental bony structures physically or on x-rays may perhaps not have resulted in anything more than a period where symptoms would have ceased and the infection most likely have subsided. This may occur when the over-all immunity of the individual is good and the individual is able to fight off the infection, resulting in pus[27] formation that is an accumulation of dead white blood cells, dead tissue, bacteria, and blood

[27] The formation of pus may cause pressure to build up which when this occurs in the mouth can result in agonising pain. Pressure build up within the confines of alveolar bone tissue escapes via an area within the bone with the least resistance, usually then via the thinnest part of the bone which in the maxilla is the buccal bony plate and in the mandibula via the buccal plate in the anterior region and often the lingual plate in the case of an abscess of molar teeth. Once relief occurs through an escape route in the bony plate, a sinus is formed and pus can then discharge into the oral cavity and relief of pain symptoms is almost immediately. The infected cavity eventually becomes sterile and may sometimes undergo cyst formation. A cyst is an encapsulated sac, having no opening, enclosing liquid or semi-solid pathological or foreign material but usually sterile. The cyst wall, formed of fibrous connective tissue or of muscular fibres, has an inner surface lined with epithelium.

serum. The areas identified as dental abscesses in ancient Egyptian skulls commonly thought to be abscesses may in most cases be a misnomer as coined by Dias & Tayles (1997:548) and more likely have been mere sterile granulomas.

Dias and Tayles (1997:548) describe the pathogenesis of isolated tooth infection as follows: infection of the apical tissue may ensue as a result of exposure of the pulp of a tooth to microorganisms through caries, dental wear or trauma. Infection of the pulp spread through the apical part of the root canal to the periapical region. An inflammatory response, either acute or chronic, occurs in the periapical tissues comprising the periodontal ligament and surrounding alveolar bone. The response to this process depends on the immunity of the individual and the virulence of the infection. If the host's immune response is adequate the inflammation will resolve and the surrounding area will return to normal and the individual will be totally pain free during most of the process. If the infection persists, an acute reaction will result which, in time may subside and become chronic. With a low-grade infection the inflammation will become chronic without going through the acute phase. The most common chronic inflammatory response is the formation of a periapical granuloma[28]. A cavity ensues with sterile granulomatous tissue can be seen as a radiolucency on an X-ray. Rarely, a particular virulent organism will cause an acute abscess that may spread to surrounding bone to develop into acute or chronic osteomyelitis which can be fatal.

2.5.4 Calculus

Calculus (also known as tartar) is a hard deposit of mostly organic material that forms on teeth at or under the gingival crest and is composed mainly of calcium and phosphorus, as a phosphate salt. There is a definitive chemical relation between the ions of calcium-phosphate and the surrounding oral saliva. The pH of saliva is critical in the process of calculus formation. When the critical pH differs from the actual pH by more than one unit, then the concentration fluctuations increase the tendency of saliva to deposit mineralise calculus (Gurney and Huschart 1950:67). These changes are directly related to dietary factors.

[28] A granuloma is a mass or nodule of chronically inflamed tissue with granulations within a periapical cavity that is usually associated with a post infective process.

Dental plaque consists of micro-organisms embedded in a sticky matrix of proteins, food particles and saliva. The mineralisation of plaque to form calculus originates from crystallites of minerals which are then deposited in the plaque (Hillson 1986b:284). Hillson (1979:150) argues that the incidence of calculus among the ancient Egyptian population was found to be present on 50 percent of the population compared to modern times where it is a universal phenomenon. The reason for a smaller amount of calculus formation is the far less sugar consumption of the ancient Egyptians compared to modern times. Hillson suggested that the Egyptians had a high consumption of proteins in the form of meat, mainly fish; a diet which contains almost no carbohydrates and therefore would not contribute to the growth of plaque deposits. Lieverse (1999:228) does not agree with Hillson's theory stating that a higher intake of protein results in a higher oral alkalinity, which in turn would aid the formation of dental calculus. Lieverse (1999:229) remarked that there was a markedly increase in the incidence of calculus as subsistence patterns shifted from hunting-gathering to transitional to agricultural, favouring the protein/calculus theory of Hillson.

The presence of calculus adherent to the area of the cement-enamel junction (CEJ) and exposed root surfaces in association with alveolar resorption in human dental remains is usually indicative that the individual had suffered from periodontal disease (Ortner & Putschar (1981:443). Lieverse (1999:219) added that the non-mineralised plaque build-up on calculus is the primary aetiological agent for periodontal disease, or inflammation of the gingival tissues and the bony response of alveolar resorption.

2.5.5 Periodontal disease

Periodontal disease (periodontitis) is characterised by resorption of the alveolar crest as result of bacterial induced gingivitis[29] or from severe dental wear which when exposure of the pulp occurs, causes retrograde pulpo-alveolar periodontitis, which when bacterial contamination of the endodontic cavity occurs, often spread to the periodontal ligament. This type of

[29] The definition of gingivitis is basically an infection of the soft tissue (gingiva) surrounding teeth. Leek (1972a:292) rates the aetiology of gingivitis in ancient civilizations as follows: a) calculus, b) neglected oral hygiene, c) abrasion, d) class III malocclusion (because there are no self-cleansing processes), e) food impaction between teeth, f) infection by micro-organisms, and g) mouth breathing.

periodontitis usually results in an abscess, followed by a granuloma and eventually may be the reason for tooth loss (Clarke 1990:371).

The aetiology of periodontal disease is multifactorial. The mineral calcification of plaque is known as calculus which is generally believed to be the cause of gingivitis periodontal disease (Jones 1981:59). However, he states that plaque, rather than calculus is the causative agent in periodontal disease. Langsjoen (1998:401) attests that the most common cause in antiquity was severe dental wear, and particularly when the result of dental wear is the loss of contact areas between teeth.

Periodontal disease is known to have affected all human populations since ancient times. The traditional notion of the pathogenesis of the disease was that the involvement of disease causing oral microbes in the initial phase of the disease, with a gradual progressive attack on the alveolar crest causing active resorption to the point of tooth loss due to no support tissue (Clarke *et al.* 1986:173). Ruffer (1920:235), when examining Egyptian teeth, noted teeth that were ground down completely to leave a cavity surrounded by a ring of dentine and enamel. The ensuing infection of the pulp he erroneously believed that it is the initial response of severe suppurative periodontitis instead of a dental abscess.

This theory that horizontal alveolar bone loss due to periodontal disease has come under severe criticism by modern scholars who have empirically shown that horizontal periodontitis has usually not been responsible for tooth loss, other factors do come into play as will be shown on Egyptian mummies further on (Clarke 1990:371).

2.5.6 Enamel hypoplasia

Dental hypoplasia is a quantitative deficiency of enamel and is often termed an 'indicator of stress' (Goodman 1991:280). Per definition; dental enamel hypoplasia is a deficiency in enamel thickness (even total absence) resulting from a disruption in the matrix formation phase of amelogenesis (Goodman 1991:281, cf. Ash & Nelson 1940:31). The developing tooth is a unique biological recorder of both health and disease, mainly because of the influence that metabolic conditions have on tooth development. Sarnat and Schour (1941:1989) reported that the development of enamel and dentine yields permanent, accurate and punctual records of both the normal fluctuations and pathologic accentuations of mineral and general metabolism. Because of the rhythmic and orderly growth patterns of dental enamel structures, recording of changes can be pinpointed when causative factors and resultant defects are known. The defect aetiology factors of hypoplasia defects are copious but can broadly be categorized into two groups: nutritional deficiency and childhood illness such as measles, intestinal parasites, diarrhoea, scurvy, general malnutrition or any systemic disease that causes fever (Mays 1997:158). Hypoplasia is known to weaken enamel structure which may influence the rate of dental wear (Roberts & Manchester 1996:59).

2.5.7 Other dental enamel maladies and associated diseases

Not very dissimilar to hypoplasia lesions on the enamel of teeth are certain systemic diseases that affect teeth in specific patterns which in a number of diseases may result in it being pathognomonic of that specific disease. Examples of this phenomena are ‘mulberry molars’ and ‘Hutchinson incisors’ in association with ‘sabre-shin tibia’ for positive identification of primary syphilis (Steinbock 1976:108).

Positive identification of leprosy lesions on the skeleton depends on the typical signs of atrophy of the anterior nasal spine, rounding of the nasal aperture together with partial resorption of the premaxillary alveolar process with or without loss of anterior incisors (Ortner & Putschar 1981:177). In leprosy, the phenomena of facies leprosa[30] syndrome as mentioned above, in combination with atrophy and truncation of the fingers and toes, would appear to be almost pathognomonic for leprosy, according to Ortner and Putschar (1981:179). Leprosy in biblical times in the region of Egypt and the southern Levant has been fiercely debated for many decades (Greeff & Boshoff 2006:1193). Arensburg *et al.* (1985:75) stated that it should be noted that not a single case of leprosy or syphilis in any of its forms has ever been found in the southern Levant in the pre-Christian period.

[30] The typical maxillary signs of dental leprosy are the atrophy of the anterior nasal spine, loss of anterior teeth of the maxilla due to loss of supporting alveolar support, rounding off of the nasal aperture bony structures and palatal lesions. These symptoms give rise to the appellation facies leprosa or leonine syndrome, a lion-like facial appearance of the skull (Greeff & Boshoff 2006:172).

2.6 DENTAL PALAEOBIOCHEMISTRY

The study of surviving hard and soft tissues is required for the comprehensive analysis of ancient diseases. In the mouth this constitutes the teeth and the periodontal tissues. Barraco (1980:312) suggests that the chemical composition of the oral structures can reveal its interaction with the environment and can together with other palaeobiological approaches constitute a coordinated effort to clarify the relationship between diseases of a population and to its heredity and diet factors.

Tooth structure chemistry may also be utilised for absolute dating (radiocarbon- and electron spin resonance dating methods), perhaps not the first choice, but teeth might be the only human remains recovered in certain instances. Diet of the ancient populations is inferred from certain enamel changes, sometimes directly related to ageing factors as would dental wear appear to be. Other methods of establishing diets from dental and skeletal tissue are possible by stable isotope analysis and by trace element research (Hillson 1986b:249).

Recent techniques in molecular biology have come to light that eliminate contamination problems, therefore making it possible to obtain ancient DNA fragments in archaeological specimens. The recovery of DNA from ancient tissues is now possible. With the development of the polymerase chain reaction (PCR, the amplification of specific DNA sequences) and with the advent of biomolecular studies, genetic information about ancient human populations is becoming readily accessible, including gender and race (Sutton *et al*. 1996:263). Such information can also be coupled with dietary data; even gender-based differences in diet are possible to detect (Jouy-Avantin *et al*. 2003:371). The technology and methodology of DNA science have improved to the point where morphological previously undiagnosed specimens can be examined by genetic DNA tests (Hermann & Hummel 2003:147). The future of DNA research may well be that every skeleton or part thereof could be genetically scanned to determine not only the cause of death, sex and diet, but also what other underlying diseases the individual was suffering from.

Ancient DNA (aDNA) is a relatively new field in which the tools of molecular biology are being applied to archaeological materials. The discovery of the polymerase chain reaction

(PCR) is one such tool. It allows the retrieval of infinitesimal amounts of DNA and its amplification from biological samples; even when molecules are damaged and degraded, it may still provide enough DNA strands to perform PCR (Greenblatt & Spigelman 2003:v).

Macromolecular constituents in ancient tissues like proteins, salts and lipids are the source of information on the diet of ancient populations and indirectly on the life style of a person in a given society. Information on the presence and causes of diseases, and possible information on the ethnic occurrence of heritable diseases in ancient times (Barraco 1980:314).

2.7 CONCLUSION

The rationale of discussing palaeopathology is perceptible when odontology is viewed as the study of the dentition and its surrounding tissues are inseparable from the human body, viz. human anatomy. The dentition is enfolded by alveolar bone within skeletal spongy and compact bone, and cartilage, not unlike any other skeletal bone that consists of collagen fibres and calcium phosphate. The jawbone (mandibula) is under the same influences of bio-physiology and diseases as any other skeletal bone. Arensburg (1985:26) suggests that the ancient Egyptian knowledge of human anatomy was at a much higher level than most other civilizations. Their knowledge was gained from the mummification procedures that were practiced by priests and medico-magicians[31]. Understanding the aetiology of disease i.e. the cause or origin of a disease or diseases (Bateman *et al.* 2005:9) in ancient Egypt, varied from the rational to magical and spiritual as did the treatment thereof. Embalming gave the Egyptian priests the opportunity to study human anatomy and physiology, as well as comparative anatomy due to the culture of embalming domestic animals (Reeves 1980:4).

Human remains were merely a consequence of the broad concept of archaeology which was probably more concerned with the hunt for more interesting artefacts. There is no doubt that the search for man-made artefacts and art objects was the major driving force of many an archaeological expedition in the early years of archaeology in the southern Levant. It is

[31] The extent to which magic is used varies across the texts. The bulk of the papyri were medical in nature with some relying on medical incantation. One cannot ignore the role of the gods in what we perceive to be scientific use of certain recipes (Bouwer 2012:238).

assumed that the archaeologist who encounters a skeleton may probably be merely interested in the artefacts in the vicinity thereof.

Ornamentations in the shape of jewellery[32] worn as decoration by the human beings were highly sought after artefacts (Humphreys 1951:17). However, the importance of recovering all types of material from archaeological sites has long been recognised. In his classical study 'Primeval Antiquities of Denmark', Worsaae emphasised that all objects from archaeological sites should be preserved (in Hoffmeier 2008:12). Since then, the archaeology of bones and teeth has provided crucial evidence for the study of anthropology in antiquity.

The value of the human dentition in archaeological remains is significant. Providentially every single one of the 32 permanent and 20 deciduous teeth of the human being differs from each other and can readily be identified. Different races, even groups exhibit variation in certain dental traits. Teeth are often very useful in body counts at archaeological sites where remains are fragmentary and where interpretation is based on the practice of determining a 'minimum number of individuals' (MNI). In modern times teeth serve to identify individuals in catastrophic disasters like aircraft accidents, as part of dental forensic science[33] (Humphreys 1951:8).

Teeth have a complex form in their natural or standard state within the human body, and in addition they show a remarkable degree of variation in form. The form of individual teeth is relatively little affected by the environment in which growth takes place (Hillson 2005:284). Teeth are formed full-size from the onset of dentinogenesis; therefore teeth of juveniles can be compared directly with adult teeth, in strong contrast to any other anatomical structure of the human being. This has positive implications in the research of dental pathology and

[32] Jewellery could be found either as adornment on or as in the case of mummified bodies, placed within the folds of the shrouds or even placed within the thoracic cavity, presumably for use in the afterlife. In certain cultures, for example the Egyptian and certain Mesopotamian cultures, the placement of coins on the eyelids of the deceased would later in the decarnated form actually find their way into the bony orbital cavity. This custom may have originated in some cultures that used to blindfold the dead. It relates to the belief that the dead should not see the way in order that the spirit of the deceased will not find its way back to the physical body. There have been a few instances discovered of this ritual in the region of Jericho where coins had been found inside the skull (Craffert 1999:41).

[33] Forensic analysis has as main objective to establish the uniqueness of each individual with the ultimate goal of establishing identity (Skeletal database committee recommendations 1991:11).

palaeodemographical statistics on age, sex and death verifications. Although no established invariable norm is evident in nature, a study of the dentition necessitates a starting point be established, therefore we had to begin with an arbitrary criterion of what an archaeologist would be confronted with in the archaeological field: the macromorphological anatomy of the deciduous and permanent dentitions.

CHAPTER 3

DENTISTS AND DENTISTRY IN ANCIENT EGYPT

Abstract:

This Chapter addresses the question whether a dental profession existed in ancient Egyptian times and were they operative dental surgeons or mere dental pharmacists? The rationale of this Chapter will focus on the author's research which confirms the first theorem although, as in modern times, the dentist may also have been a dispensing practitioner, as well as an operative surgeon. Evidence from archaeological research, principally from the medical papyri, hieroglyphic inscriptions found in tombs, stelae and monuments and lastly physical examination reports of dental conditions in mummies and from dry skeletons are taken into account (Pahor 1995:39). The medical papyri's dental entries will demonstrate that they were mainly focussed on diagnoses and that the science is mostly pharmacopoeial in nature, providing pharmacotherapy and magical incantations but insufficient information on operative treatment. However, all entries on dental matters within the available medical papyri are translated, analysed and presented as evidence for dentistry. The hieroglyphic symbols that are in any way dentally related, whether in the medical papyri or on any other surface relating to dentistry, are analysed and translations offered to elucidate further investigations. Physical evidence of prosthetic and surgical dentistry are presented as further proof.

Key words: Dentists, dentistry, prosthodontics, surgery, Medical Papyri.

3.1 INTRODUCTORY REMARKS

There are reservations among some scholars[34] as to whether the discipline of dentistry existed in ancient Egypt, and whether it links with the observable dental maladies that the entire Egyptian population seem to have suffered from. The innovative question would be whether the population that suffers from life threatening dental diseases and conditions were in any way aided by professional dentists, and if affirmative, then the question has to be asked whether dentistry as a professional service resulted in any alleviation of the condition. Dentistry, in a modern definition, is the practice of preventing, diagnosing and treating diseases of the teeth, gums, and other tissues of the mouth. If not treated, dental health problems can lead to complications in other parts of the body, even death. Hawass (2000:89) revealed the shocking statistics that untreated tooth infections resulted in death 50 percent to 90 percent of the time in Ancient Egypt. Ultimately an infection of this severity in the absence of modern day antibiotics may still be fatal. Craffert (1999:5, 8) mentioned that within the boundaries of the

[34] Nunn (1996:205) quotes Smith & Jones' (1910) disbelief that there were dentists in ancient Egypt; Among other disbelievers are Weinberger (1947:172); Leek (1971:92) and Forshaw (2009b:481).

Roman Empire two thousand years ago, 5 percent of all deaths were caused by dental disease and that life expectancy in the biblical world very low and some scholars estimate that the average life expectancy in the Graeco-Roman Empire was as low as 25 (Craffert 1999:8-9).

Thorough and timely dental care is not only important for maintaining healthy teeth and gums; it is essential to overall human health. The hypothesis is that tooth problems in ancient Egypt existed and the need to treat the malady would be a logical inference.

The available literature and other evidence on the medical and dental professions that forms the basis of this Chapter, and supplies the information used in this dissertation came from a variety of sources. The most informative data would unquestionably be that of the various medical papyri that were largely discovered in the nineteenth century. Next comes textual data in the form of chronicles, a number of nonmedical documents, biblical accounts, mural inscriptions and drawings within mainly burial chambers (Ghalioungui & el-Dawakhly 1965:vii). The radiographic examination of the royal mummies by amongst others Harris and Wente (1980) offered an important contribution.

3.2 PHYSICIANS AND DENTISTS IN ANCIENT EGYPT

The history of medicine and dentistry is so inextricably 'interwoven' that the consideration of one involves the other (Prabhakara 1985:369). Nunn (1994:5) reported the parallel and associated roles of doctors, priests and magicians[35] in health care but claims that all doctors had a relatively low standard of knowledge of pharmacopoeia[36] and a very limited repertoire of operative surgery. However, dentists were grouped amongst physicians as one of the specialities with perhaps similar shortcomings and imperfections (Nunn 1996:114). The disciplines of medicine and dentistry may thus have had a common origin. Chohayeb (1991:66)

[35] Ancient medicine and modern day homoeopathy have much in common in that the patient was treated holistically – body and mind were taken into consideration and the illness was dealt with symptomatically. In ancient Mesopotamia and Egypt, magic and religion were inseparable and medication was administered to the patients while the on-lookers were chanting and dancing (Williams 2009:11).

[36] The analysis of the medical papyri reveals that the Egyptians had a vast pharmacopoeia that included herbal and plant matter, human by-products, animal, insect and also a number of essential minerals. Refering to pharmacopoeia, it is uncertain whether they made use of written texts, or if the information was perhaps passed on during their training and never set to paper (Bouwer 2012:71).

hold that dentists had no training in medicine at medical schools but do not state if they had any other training.

Nevertheless, the doctor had other therapeutic associates at his support, of which the priests were the most important associate who offered tender loving care, an effective placebo effect and magical incantations[37] that provided reliance on the supernatural as well as strengthening credence and laying on hands (Leek 1972a:289). The Egyptians knew that appropriate spells and remedies, illnesses and their causes were mysterious but nevertheless as the work of the gods, caused by the presence of evil spirits or their poisons. Cleansing the body was the way to rid the body of their influence. 'Exorcists', usually priests, used incantations and prayers to the gods - above all to *Sekhmet*, the goddess of healing[38]. The wearing of amulets[39] warded off the evil spirits, probably on the advice of the priests. Lichtheim (1973:30) asserted this religious incantation to the God Amen as follows:

> *Montemhet, 4th prophet of the deity Amen, put his faith in his god he served:*
> *I bow down to your (i.e. Amen's) name*
> *May it be my physician?*
> *May it drive pain away from me*.
>
> (Lichtheim 1973:30)

The physician/dentist is described by Chohayeb (1991:66) as a man of standing in ancient Egypt, a man of culture and education, manual dexterity and a background of training under experienced physicians. In the early dynasties he was a member of priesthood but later dynasties saw him attaining independent professional status. General physicians were subordinate to Chief Physicians, who were usually in the service of royalty (Harris & Wente 1980:114). Reeves (2001:21) pointed out that the Egyptians differentiated between their

[37] Incantations are prayers to the gods - above all to Sekhmet, the goddess of healing. Curses, and threats were often accompanied by the injection of nasty smelling and tasting medicines into the various bodily orifices, and were hoped to prove effective.
[38] The Egyptians believed that disease was caused by supernatural forces that had become ensnared in their flesh. Healing was performed by doctors and magicians – the former made use of herbs and the latter magical amulets amongst others (Bouwer 2012:51).
[39] Many amulets uncovered in Palestine have been Egyptian in style. They were in forms of Egyptian gods (e.g., Osiris and Isis), animals (cats and apes), fruits (lotus and pomegranates), human legs and arms, lunar discs, pierced shells, and signet rings. Amulets were often colored red because blood was vital to life or blue to ward off the evil eye (Elwell & Beitzel 1988:83).

physicians and surgeons on the one hand and the exorcist-healers who were priests of the goddess *Sekhmet* on the other hand.

Not all of Egyptian medicine was based on mysticism (moreover we should never disregard the effect psychotherapy and superstition has on health, even in modern times and more so in today's Third World populations), much of the belief systems on health in ancient Egypt was the result of experimentation and observation, and physical means supplemented the magical ones. From the Ebers papyrus the following is noted: *Magic is effective together with medicine. Medicine is effective together with magic.* Magicians, also known as the *sau* were moreover sorcerers and bone setters. The *sau* dealt with diseases of an inexplicable nature and aided the application of prescriptions with magical incantation (Vinel & Pialoux 2005:7).

Reeves (2001:22) reveals that each physician was a specialist who worked under the auspices of a patron deity; for example *Isis,* the solar goddess was responsible for the liver and *Taurt* was the childbirth goddess. This can be substantiated by Pliny the Elder who quotes Herodotus (5^{th} Century BCE) saying that all Egyptian physicians were specialists: there were so-called doctors of the stomach (gastro entomologists) and eye doctors (ophthalmologist) amongst others. However, Pliny believes that these reports from Egypt in this regard were true but greatly exaggerated (Halioua & Ziskind 2005:13).

Herodotus' book '*Histories'* reflects his admiration for the Egyptian medical profession, the specialisation of the physicians in particular. Herodotus wrote to a Greek audience and therefore was instrumental in their belief that an Egyptian doctor (*ietros*) cured with the help of special remedies. He also used the term *'ietros ton odonton'* Greek for a 'tooth doctor' (Nichol *et al*. 1995:110).

There is ample evidence in the literature that the medical profession was functioning in ancient Egypt. Herodotus viewed a degree of specialisation of Egyptian medical practitioners as follows:

The practice of medicine they (sic) split up into separate parts, each doctor being responsible for the treatment of only one disease. There are, in consequence, innumerable, some specialising in diseases of the eyes, others of the head, others of the teeth, others of the stomach and so on.

(Forshaw 2009b:485)

Herodotus is known to have said that the ancient Egyptians paid great attention to health – in the manner that no doctor was permitted to practice outside his own field of expertise. Practising dentistry had its own dangerous risks: the death of an individual entrusted to the care of a dentist would result in a capital offence of the operator (imply mainly surgical procedures). If however, every possible remedy had been administered according to the governing law, such an operator would then be absolved from blame (Wilkinson 2009:350).

The majority of doctors/physicians were probably designated simply as *swnw*[40] in hieroglyphic script, conventionally pronounced *sewnew* (see figure 3.1) (Nunn 1996:114). Dentists were regarded as one of the medical specialities. Titles of some of the other specialists are: dentists, ophthalmologists, doctor of the eye, doctor of both eyes, man of cautery (a surgeon), doctors of the stomach, 'herdsmen' of the anus, doctors of 'hidden diseases' and in one case a dentist was also named a guardian of the anus, perhaps because suppositories were common treatment in both disciplines, designed to be administered rectally (Halioua & Ziskind 2005:12, 13).

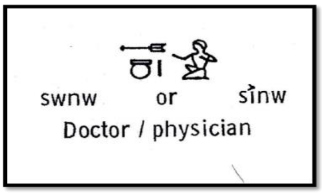


Figure 3.1: Designated title of a physician in ancient Egyptian hieroglyphics. It is often abbreviated to only the arrow. (Nunn 1994:6).

Leek (1969:18) is of the opinion that only philologists can argue what the hieroglyphic symbols represent. He argues that the followers of Junker (1928) believe that the hieroglyphic symbol of an elephant tusk represents a human tooth, whereas followers of Kaplony prefer to translate the elephant tusk as a reference to an office of state. The tusk of the African elephant

[40] After the 27th Dynasty, the word *swnw* had come to mean embalmer as well as doctor (Nunn 1996:115).

(*Loxodonta africana*) measures up to 3.35 metres and weighs approximately 110 kg. Although Leek (1969:18) declines to accept the elephant tusk as the symbol of a human tooth, the author feels that the enormity of a tusk would unquestionably be the ultimate symbol for a tooth, human or otherwise (see figures 3.2 and 3.4 below).

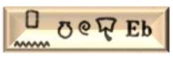
	Pain
	Physician
	Tooth (Ebers)
	Tooth (Ebers & Kahun med)
	Tooth (Ebers)
	Tooth (Kahun veter)
	Cannabis sativa
	Filling (Ausstopfen)
	Chew (Ramaseum)
	Mandible (Ebers)
	Mouse (Ebers)
	Stab/Thrust (Ebers)
	Toothache drug (Ebers)
	Toothache (Edwin Smith)
	Honey

Figure 3.2: A list of relative dental terms translated from the hieratic scripts.

There were doctors who functioned on different levels forming a formally ranked group of specialists or a typical hierarchy (Reeves 2001:21):

The ordinary doctor: *swnw*

The supervisor doctor: *imy-r swnw*

The chief doctor: *wer swnw*

The eldest of doctors: *msw swnw*

The dentist or toother: *ibnh-swnw*

The inspector of doctors: *shd swnw*

The overseer of all the doctors of Upper and Lower Egypt

See in Reeves 2001:22; cf. Halioua & Ziskind (2005:16)

The hieroglyphic writings of the word *swnw* have taken on a number of different forms, as shown below. The rabbit, medicine pot, arrow[41] and quiver are believed to be ideograms. Dentists were mostly designated *ibeh* plus the doctor *swnw* symbol, see figure 3.3 and other dental symbols in 3.4 below (Nunn 1996:119).

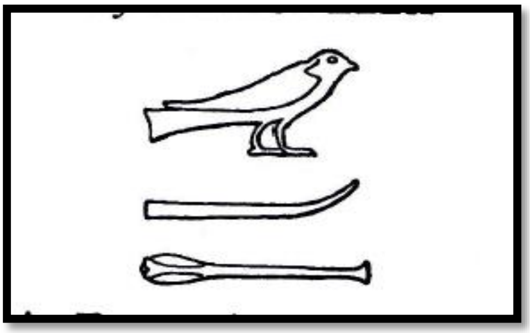


Figure 3.3: Hieroglyphic inscription for a dentist *ibeh* (Leek 1967:51).

[41] The arrow is believed to be an ideogram, implying that the 'arrow man' is skilled at removing arrows from soldiers, often refering to 'injection' (Nunn 1996:115).

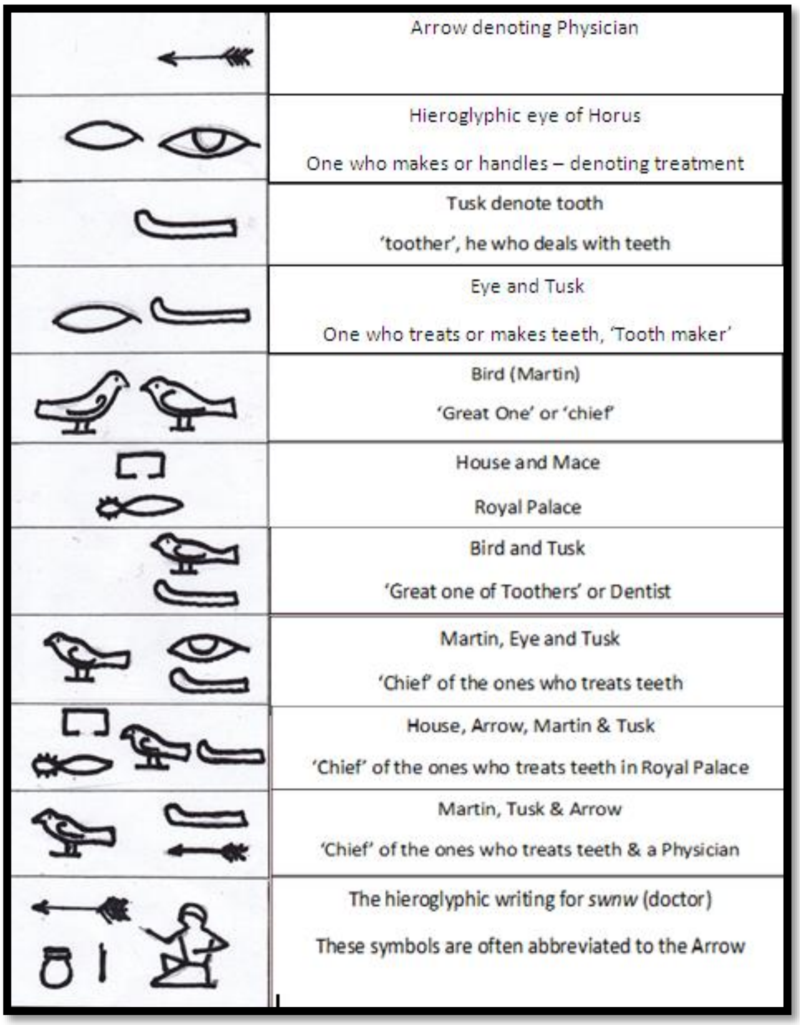


Figure 3.4: A glossary according to Weinberger (1947:176) depicting the dental specialists in the left column and the corresponding transliteration in the right column, Hieroglyphic symbols of the word *swnw* meant physician or doctor after Nunn (1996:115).

Nunn (1996:119) suggested that there were specialists of the Old Kingdom and First Intermediate period who were known to be a dentist and a doctor; and other again regarded only as a dentist[42]. Training schools for physicians, and which may have included dentists as well, are attested by Halioua & Ziskind (2005:22). Medical schools, where the students received training in magic and medicine were usually attached to healing temples. Brooke (1993:23) states that such schools could be found at places like Heliopolis and Sais, while Walker (1993:100) believes that there were more medical schools at Abydos, Amarna, Memphis and Thebes. Nunn, however, maintains that these were not medical schools but rather scriptoria for compiling books on religion. The practice of dentistry was essentially limited to

[42] Some practitioners were involved in more than one speciality. Three examples of dentist/doctors and two of dentist only were described emanating from the Old Kingdom and First Intermediate periods (Nunn 1996:119).

the royal court. The rest of the commoners had to rely on their *swnw's* commonly known as a doctor for their dental needs (Nunn 1996:131). Two of the most famed practitioners, Imhotep, a physician, and Hesi-re, among others, are discussed in 3.2.1 on page 61 ff.

Dentistry was an established profession in ancient Egypt in the early Old Kingdom, as Hesi-Ra is probably archetypal. Clarke (1980:80) is also convinced that dentistry was practised in ancient Egypt although the profession consisted primarily as a form of sacerdotal dental medicine.

The period, starting from Pre-dynastic times through the Pharaonic period, hardly had more than a hundred physicians (including dentists) accounted for in archaeological research (Ghalioungui 1971:94). Silverman (2008: s.v. Ancient Egypt history) reported a population of merely a few hundred thousand in the Predynastic period, which grew to about two million during this period; and three to four million during the Old Kingdom and New Kingdom periods respectively. A supposition of a million[43] is assumed by Cockburn and Cockburn (1980:3) and bearing in mind that the life expectancy on average was below 40 years[44]: it then follows that a population of more than 2 billion inhabitants over a period of 2 000 years may not be implausible at all; all interred in one way or another.

The population increase during the Palaeolithic Period for the world was believed to be at a rate of a mere 0,02 per 1 000 per year, which stayed more or less constant until the 17th Century CE when it increased to 1 per 1 000 and only exploded to 20 per 1 000 since then (Hausen 1964:16).

3.2.1 Imhotep, the first physician

Djer (or Athosis), King of the first Dynasty, is believed to have been the first physician as well as being the King. According to the writings of Manetho, an Egyptian priest of the 3rd Century BCE was the first physician. It is generally not believed to be true as well as highly unlikely

[43] Nunn (1996:10) concurs with Cockburn by reporting a population figure of ca. 1.2 million.
[44] The author believes that the life expectancy was closer to 30 years and concurs with Hausen (1964:16) that the population increases of most ancient populations were very low.

that a king would entertain both roles (Nunn 1994:7). It is therefore plausible that Imhotep should have the honour of being the first physician in history (see figure 3.5 below). It will nevertheless be irrational to believe that in the period from Athosis, the second King of the first Dynasty up until Djoser, the third King of the third Dynasty (a period of more than 300 years[45]) there were no physician in Egypt. It is however, more likely that there must have been other physicians who took care of the Egyptian Kings, as well as the broad population. Until archaeology reveals further evidence of earlier physicians, it will be accepted that Imhotep was the first physician in history (Nunn 1994:9).

Reeves (2001:21) claims that the most famous of all doctors was Imhotep, the vizier, architect and chief physician to King Netjerkhet (Djoser) who ruled during the Third Dynasty (2 686-2 649 BCE) and was known by the Greeks as *Imouthes*, who was later identified with the Greek healing god *Aesculapius*. Imhotep is described by Yahuda (1947:551) as the father of medical art and later deified as the 'Son of Ptah. He was called by the Egyptians 'the benignant God' (*neter menekh*), and addressed as 'the god who bestows life on all men'. Imhotep (*Iry* was the pictogram for the head of the royal court doctors at the Giza during the Fourth Dynasty (2 613-2 498 BCE), had many titles including 'eye doctor of the palace' and 'guardian of the royal bowel movement' (Reeves 2001:22).

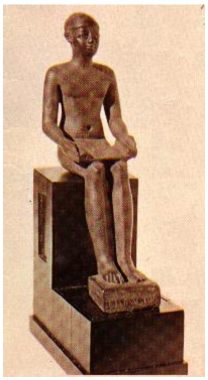


Figure 3.5: Imhotep, the god of Healing. His statue stands today in the Hall of Immortals at the International College of Surgeons in Chicago.

[45] The Egyptian information quoted in this supposition is found in the chronology list of ancient Egypt of David (Kitchen1996:331).

3.2.2 Hesi-re, the first dentist

The Third Dynasty tomb of Hesi-Re was discovered in the 19th Century in the course of an excavation at Saqqara by the Frenchman Auguste Mariette. Eleven wooden panels were found set into the wall at the back of stepped niches, of which 5 were badly decayed and the remaining six are on exhibition in the Egyptian Museum in Cairo (Wood 1978:9). Reisner identified the table scene in the fifth niche (fourth according to Mariette) as the principal offering niche (see figure 3.6 below). It is this scene that most clearly state Hesi-Re as a dentist of high ranking (1936:271). The relief of Hesi-Re seated displays the more complete list of his titles, as well as his name than any of the other surviving reliefs (Wood 1978:12).

Hesi-re[46] (*hsj-r'*) or Hesire[47] was a contemporary of Imhotep, a man of great distinction who carried many exalted titles under the same king as did Imhotep (Nunn 1994:8). In the event that Imhotep is to be acclaimed the first doctor in history, then Hesi-re should then be given the honour of being the first authenticated dentist in history. Hesi-re's claim to fame was inscribed on a *niche-stela*[48] on which his title was inscribed as *wer-ibnh-swnw* (chief of dentists and doctors), thus proclaiming him perhaps ahead of Imhotep as the first authenticated doctor in history (Nunn 1994:8, 1996:124, cf. Weinberger 1947:175, cf. Leek 1967:55).

This remarkable man was a polymath: someone with wide-ranging knowledge of many subjects. His remarkable title was that of 'the greatest (or chief) of physicians and dentist. It is not clear whether he was 'chief' of practising dentist/physician or was he responsible for the administration as such. Hesi-re is mostly known from his mastaba[49] (Egyptian tomb at Saqqara, located to the north of Djoser's Step pyramid). Of the original eleven wooden stelae that once may have stood in the chapel of his mastaba, only six remain. These stelae are sculpted with a

[46] Because vowels did not exist in ancient hieroglyphic writing, scholars have unanimously decided to compromise by substituting any possible vowel in all relevant translations with a short 'e'. In modern transcriptions, a short 'e' is added between consonants to aid in their pronunciation. For example, nfr "good" is typically written "nefer". This does not reflect Egyptian vowels, which are obscure, but is merely a modern convention. Likewise, the ȝ and ' are commonly transliterated as a, as in Ra (Allen 2000:17).

[47] Hesire' is proposed by Forshaw (2009b:481, cf. Weinberger 1947:176).

[48] A reconstruction of the reliefs on the niche-stelae is copiously described by Wendy Wood (1978:15). Some of the titles of Hesi-re in the niche-stelae acclaims a number of the positions he held: 'greatest of the Upper Egyptian ten(s), a probable high provincial administration position, and 'Concerned with the King's property'.

[49] Egyptian tomb: in ancient Egypt, a brick tomb built with a flat base, sloping sides, and a flat roof. Its design inspired the pyramids.

representation of a seated Hesi-re together with carved hieroglyphs presenting his name and extensive titular (Berghult 1999:27).

Figure 3.6: ‘Chief of the Toothers’ as Hesi-re was known, reproduced on a wooden panel showing a rebus or heraldic emblem of a swallow, a tusk and an arrow on the upper right corner, confirming his status as a dentist (Berghult 1999:27).

Wynbrandt (1998:10) described Hesi-re ‘the greatest of those who deal with teeth’ (Chief toother), he was also a director of royal records according to the inscription on the wooden panels in his tomb. His titles written in hieroglyphic are as follows in figure 3.7:

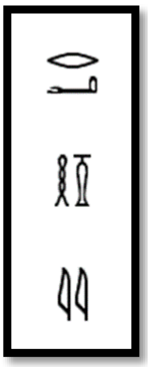


Figure 3.7: The name of Hesi-re (re-Hesy) in vertical column hieroglyphic script (Kamrin 2004:220).

3.2.3 Other references to dentists in Egyptian palaeography

Three other physician/dentists were described by Ghalioungui (1971:91). Ghalioungui bases his notion that the title borne compounded with the '*ibh'*[50] similar to that of Hesi-Re signifying 'tooth', was not the only one to have sported it. The three were:

- Ni-ankh-Sekhmet, who carried the following titles of *wr swnw* = Chief physician, *wr swnw pr-c3* = Palace physician to King Sahure (circa 2 700 BCE) as well as *wr ibhy pr-c3* = Chief of the dentists of the palace of the fifth Dynasty (see also Yahuda 1947:551).
- Khouy[51], Physician of the palace (*swnw pr-c3*), Dean of the physicians of the palace = smsw swnw *pr-c3*, Chief of the physicians of Upper and Lower Egypt = wr *swnw mhw smc* and Chief of dentists = *wr iry ibh.*
- Psametic-Seneb, Chief of physicians (*wr swnw*), Chief of the dentists of the palace *wr ibh(y) pr-c3* and Dean of physicians *smsw swnw* of the twenty-sixth Dynasty.

Two more examples of *iry ibh*, but without the title *swnw* (physician) were:

- Menkaoureankh[52] (*iry ibh*) whose name was mentioned on the same stele as Ni-ankh-Sekmet; It is suggested that he most probably was a dental auxiliary or non-medical dental subaltern, perhaps a dental technician; and Neferiretes, of this *iry ibh* nothing further is known. Weinberger (1947:173), however, attested Pepi-ankh[53] as an *iry swnw,* an eye doctor and dentist.

Dr. Zahi Hawass (2012:1), the secretary general of the Supreme Council of Antiquities of Egypt has revealed the first necropolis ever found that was dedicated to dentists in Saqqara west of the first Dynasty tombs: the first tomb belongs to E-Emery the chief dentist of the king of the fourth Dynasty. The second tomb belongs to Ka-Me-Su, the king of the fifth Dynasty. The third tomb belongs to Sekhem Ka, dentist to a king of the fourth Dynasty. Hawass believes

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[50] According to the dictionary of Egyptian drugs of Von Deines *et al*. (1959:25) the term 'tooth' is written as '*ibh*' (m.gen), whereas '*nḥḏ.t*' denotes 'tooth', the official transliteration of a tooth of a donkey or a pig. All organs of donkeys were designated by 'ᶜ3' including teeth, while that of pigs are transliterated by '*š3j*' (Von Deines & Grapow (1973:43).

[51] Marion (1996:17) appended two more titles to 'Khuwy', namely 'interpreter of the secret art of the internal organs' and 'Guardian of the anus'.

[52] Marion (1996:17) ascribe the titles of Chief dentist and physician of the Palace of the fifth Dynasty to Menkaoureankh.

[53] Blackburn (1977:26) furnished Pepi-Ankh with other official titles namely: physician of the belly of the Pharaoh; guardian of the anus of the pharaoh and surveyor of the physicians of the Pharaoh.

that these dentists received the honour and luxury to build their tombs in the shadow of the Step Pyramid because of their service to the royal house.

An observation that the relatively large amount of data on dentists and the dental profession is that the names of dental professionals, prosthodontics appliances, and the texts known as the medical papyri, derive from the Old Kingdom. Marion (1996:15) is of the opinion that it may perhaps be that the Old Kingdom Period was one of experimenting in all forms of technology. It is believed to be factual that the medical papyri originated from this period and was merely revised[54] in the Middle Kingdom.

3.3 CONFIRMATION OF DENTAL PRACTICES

The evidence of dentists in ancient Egypt is further cemented in the discovery of the medical papyri[55]. The procedures of all medical disciplines were found written on ten medical papyri of which only five contain prescriptions and treatment of dental maladies. The five were the Papyruses Ebers; Hearst; Berlin; Kahun and Edwin Smith. Marion's (1996:15) deduction is that most of the papyri is dated from 1 550 to 600 BCE although most scholars feel, based of palaeographic evidence, that the discovered medical papyri actually date as far back as the Old Kingdom (2 686-2 181 BCE). Ebbell (1937:12) even designates a section in the Papyrus Ebers on the use of the ricinus plant as evidence of an earlier date. He mentions that the contents of this medical papyrus were found in very ancient writings and that a book about the vessels is said to have been discovered in the days of Usaphais, a King in the first Dynasty, more than 3 000 BCE.

The medical papyri verified about 250 different kinds of diseases in total. At least 15 diseases of the abdomen, 11 of the bladder, 10 of the rectum and anus, 29 of the eyes, 6 of the ears, 18 of the skin and 8 of the teeth were among those that diagnosed and treated on specific principles (Reeves 1980:5).

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[54] Ritner (2000:108) pointed out that the medical papyri of this period were merely re-created or copied as indicated by the palaeography of the text which occasional displays grammatical features suggestive of an original date in the Old Kingdom.

[55] For a broader discussion on the above papyri and other medical papyri not mentioned here, the likes of the Chester Beatty Papyrus IV; London Papyrus; Brooklyn Papyrus; Carlsberg Papyrus VIII; Ramesseum IV and V Papyri and papyrus Anastasi, see Reeves (2001:49 to 53).

Referring to the prescriptions or recipes in the medical papyri, Forshaw (2009b:481) disputes that this is evidence of dental practitioners in ancient Egypt and alluded that they, the practitioners, should rather be regarded as pharmacists: referring to the lack of pure physical intervention dentistry opposed to mere diagnoses and prescriptions mentioned in the medical papyri.

3.3.1 Physical evidence of dentistry in ancient Egypt

Odd, bizarre, extraordinary, peculiar, inexplicable and/or mysterious are merely some of the expressions used by some scholars when they are faced with the quandary of the paucity of dental restorative prosthetic evidence in ancient Egypt. Ghalioungui (1971:93) suggested that if professional dental care were to have been given to anyone in the Empire, it would surely have been to the Royal family. However, not one of the Pharaoh's mummified remains which have been discovered shows any sign of dental intervention apart from a number of molar extractions[56]. Ghalioungui's own riposte on this matter is that tradition has it that should an individual be interred with a bodily defect it would create the danger of resurrection in the afterlife with the same defect (1971:93). This, however, would not explain the many severely broken and carious teeth found in mummified royalties. The author's own riposte, as a dentist, on this matter is the fear of dentists, not unlike today, even for, and especially the Pharaohs may have dissuaded them from seeking major prosthodontics work done. The sword of failure that hung over their necks should there be any failures may have played a role in the absence of dental treatment on the Pharaohs.

Removal of loose teeth affected by periodontal disease can sometimes be done with the fingers alone, otherwise the use of forceps or elevators becomes unavoidable. Nunn (1996:204) asserted that no such instruments have ever been found from the Pharaonic period, neither has it been mentioned in any of the medical papyri. However, sturdy jaws have been found where teeth were removed of which no sign of any periodontal disease was present. Nunn therefore

[56] In neighbouring Israel, Asbell (1941:1106) attests that the practice of extracting teeth was frowned upon; the Talmud specifies that tooth extraction should be avoided (*B. Talmud, Pesahim, 113,a*). Nevertheless, the extraction of teeth was performed regardless the prohibition; Preuss is quoted by Asbell (1941:1107) as follows: 'At first, the investing gum was incised. Then the tooth was well-shaken until it was loosened. Then, with *summon periculo evellitur*, the extraction was attempted with the fingers and, if this failed, a forceps was used which was more like a blacksmith's instrument than any surgical appliance'. The author is of the opinion that the same procedure was followed in ancient Egypt.

believes that some method of removing teeth must have been practised unknown to modern science.

To recognise restorative dentistry as the only criterion to identify dentists is erroneous because oral pathology and oral medicine are as much a part of dentistry as restorative dentistry (Clarke 1980:80). However, there are signs of restorative dentistry in the form of fixed prosthetic appliances, and even signs of surgical dentistry was found in ancient Egypt (Weinberger 1947:180). Chohayeb (1991:67) is of the opinion that dentists serving royalty avoided filling cavities. The general philosophy on health at the time was that a healthy mouth meant a healthy body; in the event that any procedural treatment on any royalty should have failed and a limb, eye or tooth was lost, the physician or dentist had to give up that part of his own body to serve as witness to his professional incompetence. The dentist would therefore rather have used conservative treatment as the Ebers papyrus is testimony of (Chohayeb 1991:67).

Evidence of prehistoric dentistry within the Neolithic Period in ancient Slovenia is attested by Bernardini *et al*. (2012:1). A beeswax filling was discovered by using various analytical techniques on the dentition of an individual found to have a number of dental conditions. An exposed area of dentine; a result of occlusal dental wear on a mandibular canine was filled with beeswax. This may have been deemed necessary ante-mortem when relief of toothache[57] or sensitivity was sought. This can certainly be regarded as evidence of a therapeutic-palliative dental filling[58].

Ghalioungui (1971:93) speculates that the treatment prescribed for in Ebers 739 and 740, the word '*ws3*' transliterated into German as '*ausstopfen'* and '*plombage'* which hypothetically refer to a tooth filling material or tooth filling.

[57] Von Deines *et al*. (1973:23) in their amendments to the Ebers' description of toothache attest in a literal translation that having toothache from a periodontal abscess is like being eaten up by the pain.

[58] The interpretation of the evidence obtained by the authors, based on the use of advanced analytical methods supports the hypothesis of an intentional therepeutic treatment, but alternative post-mortem practices are not ruled out.

An equally important and similar discovery was made as described by Jarus (2012: Livescience): A mummy of a wealthy young man was discovered. His teeth were in horrible shape (see figure 3.8 below). He had numerous abscesses and cavities, conditions that appear to have resulted at some point in a sinus infection, a condition potentially fatal. The pain the young man suffered would have been beyond words and drove him to see a dental specialist. Dental problems were not unusual at the time because the coarsely ground grain ancient Egyptians consumed is unhealthy for the teeth. A 3-D reconstruction of the 2 100-year-old mummy's teeth revealed a linen mass that was inserted into a cavity on the mummy's left side between the first and second upper left molars. The linen cloth may well have been saturated with some sort of unknown medication. This linen mass may have acted as a 'barrier' preventing food particles from getting into the cavity and the medication may possibly have relieved the man's pain (Jarus 2012: Livescience).

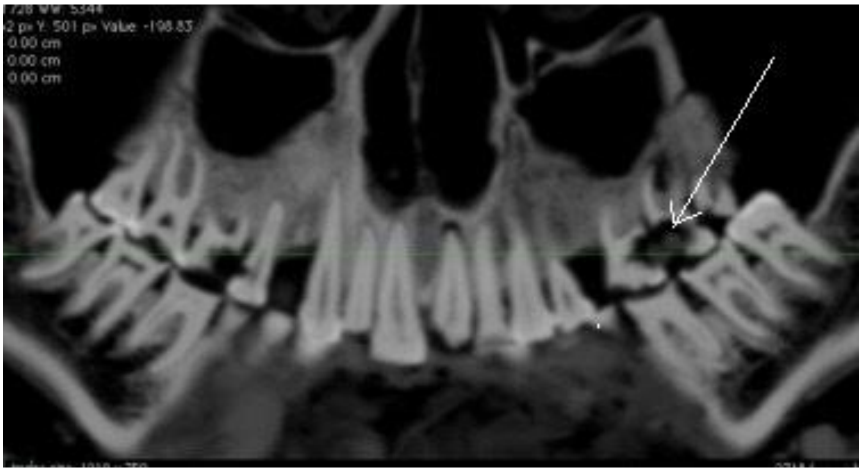

Figure 3.8: A CT scan of 2100 year old mummy reveals much dental pathology, but of interest here is the inclusion of a linen filling placed in the gross carious lesion between the upper left first and second molar teeth (see arrow). Observe the extent of the generalised dental wear as well as carious cavities distal of the upper right second premolar and mesial to the first molar tooth. The upper left central incisor clearly reveals a periapical granuloma whilst only the roots of the upper left wisdom tooth remain (Jarus 2012: LiveScience).

Historically, Duval (1808) in Weinberger (1947:171), held that some royal mummies wore '*sets of artificial teeth [that] were wood carved to fit the roofs of mouths, while the teeth, which were of brass, were generously attached'*. Weinberger also cited Linderer (1851) who attributed to Belzoni (1820) the fact that he, Belzoni, had discovered such prosthetic work in some mummies – no confirmation has unfortunately been found to substantiate such claims.

Weinberger (1947:171) further reveals claims by Belzoni himself of 'sets of artificial teeth, the base is of solid gold and the teeth of ivory' and even 'gold filling of teeth'. Notice should however be taken of the claims of Raymond (1893:632): 'Egyptians were well advanced in the art of prosthetics; teeth filled with gold were found in the mouths of mummies as well as artificial teeth made of sycamore wood'. Rosner (1978:288) opposes this viewpoint; he cites George Ebers[59] speculating that gold covering on teeth and 'bridging' teeth by means of gold wire were affixed post-mortem, probably during the process of mummification. It is a singular fact according to Wilkinson (2009:350) that the ancient Egyptian dentists adopted a method of filling teeth with gold, evidence of which have been obtained from some mummies of Thebes.

Since Weinberger could not confirm these allegations, the author wished to distance himself therefrom although he believes it to be interesting. The axiom of archaeological interpretation of 'absence of evidence in not evidence of absence' comes to mind.

3.3.2 Prosthodontic evidence of dentistry in ancient Egypt

The degree of dental science in the prosthodontic field in the Old Kingdom, IVth Dynasty, is underscored by the discovery in a cemetery at Gizeh by an expedition of the *Wiener Akademie* and reported by Junker in 1914 of two teeth[60] that are ingeniously held together by fine gold wire; one that would probably had been a loose molar that is fastened to a neighbouring sound molar tooth to keep it from falling out, see figure 3.9 below (Weinberger 1947:176). Weinberger undoubtedly believes that seeing that this specimen had disappeared for a number of years and again resurfaced by a discovery years later; that there may have been many more such specimens that had escaped the eyes of dental writers (cf. Hoffman-Axthelm 1970:81).

[59] George Ebers in Geist-jacobi, Geschichte der Zahnheilkunde. Tübigen 1896:9, not handled by author.

[60] The crown of the lower left third molar showed extreme wear and its root resorbed while linked by gold wire to the second molar as support, a method still practiced today (Weinberger 1947:180).

Figure 3.9: An unconventional bridge from the IVth Dynasty (Hoffman-Axthelm 1970:81).

Historic primacy for dentistry intervention arguably resides with the 8th to the 4th Century BCE Etruscans. The Etruscans[61] are widely known as having being well advanced in dentistry. Hoffmann-Axthelm (1970:83) described dentures and other sophisticated prosthetic devices[62] as well as an orthodontic appliance made from adjustable gold bands around adjacent teeth to close a gap caused by the loss of an anterior tooth[63]. Becker (1994:74-79) described the first true bridge in history discovered in Valsiarosa, Etruria from 600 BCE. Guerini (1909) in Weinberger (1947:181) pointed out that the Egyptian and Phoenician dentists were more advanced than the Etruscan dentists; this argument is substantiated by the Egyptian bridge mentioned above that had its inception in the IVth Dynasty (2 575 - 2 467 BCE), almost two millennia earlier.

Many royalties of foreign countries consulted Egyptian physicians, presumably also those who deal with teeth. Homer, in The Odyssey, tells of physicians in Egypt who are wise above human kind for they are the mythical race of Paieon (Halioua & Ziskind 2005:179).

A second prosthetic appliance, the ‘el-Quattra bridge’ dated around 2 500 BCE, was excavated at el-Quattra near Cairo. This dental bridge was not found in situ, but was found amongst scattered remains of skulls elsewhere is described by Forshaw (2009b:483) and also by Harris *et al*. (1975:401) (see figure 3.10 below). The el-Quattra bridge consisted of a maxillary right upper canine, around which a double stranded gilded wire had been wound, finishing in an

[61] Leek (1966:61) is of the opinion that the Etruscan’s knowledge of the practice of dentistry was derived from a more developed civilization, possibly from that of Egypt.
[62] All dental prostheses found in Egypt are considered to be constructed for the afterlife (Nerlich *et al*. 2000:4).
[63] Confirmation of these appliances are found in Baccetti *et al*. (1995:76) and Corruccini & Pacciani (1989:64).

‘eye-loop’ on its distal surface. A separate upper central and lateral incisor was found with similar gilded wire connecting the two teeth. It is believed that the brace at one time was connected to the canine tooth’s eye-loop by some form of hook, perhaps passing palatal to the canine. The central incisor had a hole drilled from the mesial aspect to the distal aspect through which the wire passed, then labially through a groove in the labial aspect of the clinical crown and which then encircling the lateral incisor. All three teeth were rooted, although the root of the central incisor showed signs of root resorbtion. It is thought that the two central incisors were the pontics, the upper right canine the distal abutment, whilst a missing upper left central may have acted as the mesial abutment tooth, thus completing a four unit bridge. Calculus was found on the lateral incisor and the canine, it is therefore claimed that the bridge had been worn for an extensive period of time.

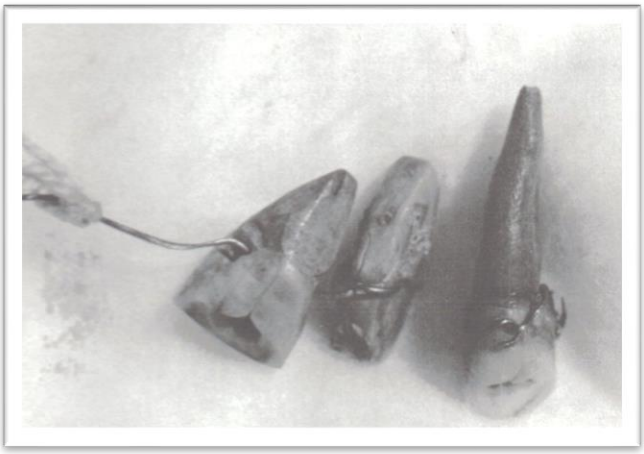

Figure 3.10: An Ancient dental bridge from the Old Kingdom consisting of artificially prepared natural teeth and gold wire (Harris & Ponitz 1980:50).

A third bridge, excavated from Tura el-Asmant, was found in situ, attached to the skull. This bridge was dated to the Ptolemaic period around 332-323 BCE. The bridge comprised of a single pontic, a right maxillary central through which two holes were drilled, from the mesial aspect to the distal aspect. The pontic tooth had been fixed to adjacent abutment teeth of unknown status (Forshaw 2009b:483).

The 'Tura El-Asmant' bridge has been reported in much detail by Iskander and Harris (1977:86-87), naming the bridge found by El-Hetta in the skull of body T-121 the 'silver bridge'[64]. The name refer to the discovery of a pontic tooth (upper right central incisor) attached to the upper left central incisor and the upper right lateral incisor tooth by means of silver wire. The silver wire passes through two holes drilled through the upper right central in a mesio-distal dimension. It is clear that the holes were drilled outside the mouth because of the lack of space intra-orally. The wire attracted interest because it had suffered from complete corrosion and the resultant amorphous silver chloride was completely devoid of any metal. One of the earliest examples of any bridge ever found in Egypt is shown below in figure 3.11.

Figure 3.11: One of the earliest evidences of ancient dentistry is an amazingly detailed dental work on a mummy from ancient Egypt that archaeologists have dated to 2000 BCE. The work shows intricate gold work around the teeth. This mummy was found with two donor teeth that had holes drilled into them. Wires were strung through the holes and then around the neighbouring teeth for support, in: http://www.dentalassistant.net/pictorial-history/

3.3.3 Surgical procedures in ancient Egypt

Apart from the practice of mummification in ancient Egypt which in essence is a quasi-surgical procedure, very few instances of surgical intervention were mentioned in any of the medical papyri. Circumcision was unquestionably performed in the Dynastic Period in ancient Egypt. The surgical procedure of circumcision in a picturesque form was found on one of the reliefs at Saqqarah (Yahuda 1947:557).

[64] Silver, until the 18th Dynasty was much rarer than gold, therefore more expensive. Silver was still valued more than gold even in the Ptolemaic Period (Iskander & Harris 1977:88).

The procedure of the surgical treatment involving a dental abscesses was first raised by Hooton (1917:900). A mandible belonging to a fragmentary skeleton from an Old Kingdom tomb at Giza showed evidence of two holes being drilled[65] on the buccal surface on the right side of the mandible, one between the roots of the second premolar and the first molar at a slightly higher level than the mental foramen (see figure 3.12 below). The other hole was drilled more distally between the roots of the first molar tooth. Radiographic evidence indicated an abscess in the region of the two holes on the roots of the molar tooth. Severe wear of the first molar tooth caused an exposure[66] of the pulp of the molar tooth which undoubtedly led to the abscess on the mesio-buccal root of the first molar.

Caries on the disto-buccal surface of the first molar may similarly have been responsible for the abscess. The following suggestion was posed by Hooton for the holes being drilled in the junction between the alveolar bone and the compact bone of the mandible to alleviate the pain pressure that the abscess caused (see figure 3.12). A hole was drilled in a downward angle of 150 degrees to the sagittal plane which then reached the anterior border of the abscess in order to drain the puss. It is thought that the required drainage did not ensue and another attempt was made by drilling[67] a hole slightly higher up and more distal, between the roots of the molar tooth.

The author is of the opinion that the differential diagnosis of *supernumery foraminae mentalis* is not valid, neither is the natural drainage through the area of least resistance viable because the anterior hole that was drilled went through a thickness of 2,5 mm of sound bone tissue before reaching the infected area, cf. Forrai (2009:189, 190). Others scholars like Leek (1967:56) believe it is quite impossible that the holes are the result of human intervention.

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[65] These holes were bored by the use of some specialised instrument, probably of bronze, for the purpose of draining the abscess present at the apices of the first molar (Asbell 1948:125).

[66] Dental wear patterns fall largely into three main groups, horizontal-, oblique- and concave- wear profiles. It is the concave wear profile that causes the greatest number of pulp exposures, probably because occlusal wear strips the enamel sooner than the other groups (Leek 1972a:291).

[67] Breasted (1930: XIII, XIV, 8, 9 & 53) alluded to specialised instruments of metal, presumably bronze, already in existance in the age of the Edwin Smith surgical papyrus, where mention is made of a 'fire drill'. Hand-held bow drills with flint bits were common tools in ancient time, although no miniature specimen has been found. The author wishes to note the holes that were drilled in the pontic teeth of the bridges mentioned elsewhere, for which no information or explanation has yet been found. Drilling a minute hole through the enamel of a tooth required a highly sophisticated tool.

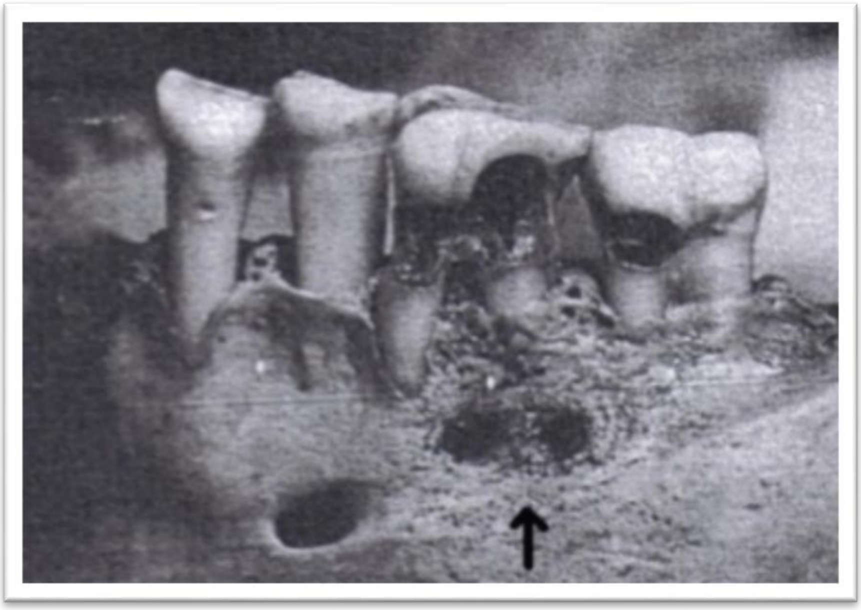

Figure 3.12: Buccal view of lower left premolar/molar area of mandible, two cylindrical holes similar in size and depth below first molar. To the left is the typically positioned mental foramen. Gross caries is visible on the buccal aspect of the first molar with severe periodontal lesion exposing both roots (Hawass 2007:22).

Physical evidence of surgical instruments *per se* has not been found in ancient Egypt. However, inscriptions of surgical instruments were found depicted on the wall of the Twin Temple of Kom Ombo on the Nile. This was the centre for medical care in ancient Egypt. A hieroglyphic relief depicting various medical and dental surgical instruments on the walls of a tomb was thought to be inscribed during the Grecian Period. The relief details medical instruments, including bone saws, suction cups, knives, scalpels, retractors, scales, lances, chisels and dental tools, see relief in figure 3.13 and the explanation of the instruments depicted in the relief in figure 3.14 below (Lichtheim 1973:7).

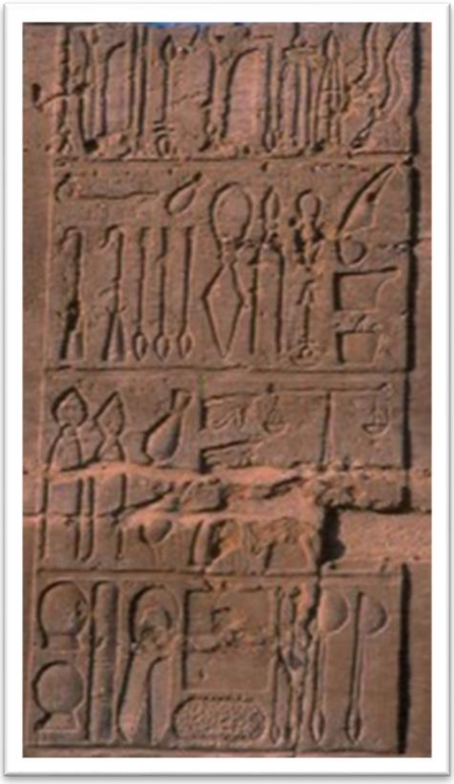

Figure 3.13: Surgical instruments depicted on the entrance of a temple in the Grecian/Roman Period. The image of the incised relief on the wall of the Twin Temple of Kom Ombo on Nile, which was the centre for medical care in ancient Egypt, has a hieroglyphic relief depicting various medical and surgical instruments (Reeves 1980:6).

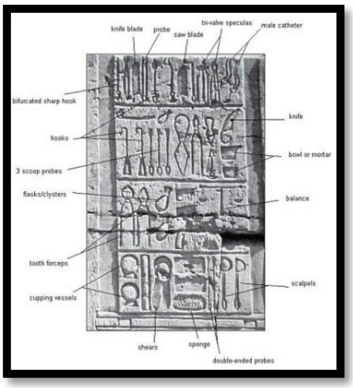

Figure 3.14: Shown above is the legend of the image in figure 3.13 of the incised relief of the Wall of Temple of Kom Ombo[68]. Many instruments are labelled according to the resemblance to known medical devices today, some probably used in the dental field, see dental forceps lower left second row. Others not identified do not have a clear purpose (Nunn 1996:165).

[68] The best preserved temples of ancient Egypt are those that were built in Greco-Roman times: the temple of Kom Ombo has numerous religious inscriptions and a remarkable panel depicting various surgical tools that were used by both the medical and the dental professionals of the time (Lichtheim 1973:7).

3.4 THE MEDICAL PAPYRI

3.4.1 Background to the Medical Papyri

On-going major archaeological exploration in the ancient lands of the Pharaohs for almost two centuries has uncovered enough data for scholars to believe that the ancient Egyptian civilisation was superior to most other civilisations of the period[69]. Since the Egyptians excelled in many fields, such as architecture, astronomy and art to name but a few, it is therefore presumed that they would have been more advanced in medicine, as is evident from certain fields of medicine where Egyptian physicians were even employed by foreign countries[70] (Halioua & Ziskind 2005:179). Woods and Woods (2011:18) report the ancient Greek poet Homer's arguments about Egyptian medical care: '*describing a certain potent drug that the Egyptian doctor gave a Greek queen*' – causing Homer to note that the medical knowledge of the Egyptians leaves the rest of the world behind.

Ebbell (1937:25) pointed out that Greek medicine was by no means as original as once thought to be, it is especially conspicuous in the *Materia medica*; a great number of prescriptions were discovered in *Dioskurides* which are very similar to the Egyptian papyrus remedies, no doubt borrowed from the Egyptians. Egyptian medical science is considered superior to most ancient Middle Eastern countries in ancient times. With regard to the Edwin Smith treatment of injuries to the skull, Ebbell (1937:27) compared it to the description in the Hippocratic writing '*De capitis vulneribus'* and found great similarity. It was also found to be similar in other afflictions. The dispensing of drugs by the Greek physicians was also influenced by Egyptian medicine, for it is only with Egyptian medicine that the Greeks first learnt to quantify specific ingredients in prescriptions (Ritner 2000:108).

Medical science in ancient Egypt was perhaps reactionary to a great degree: Ritner (2000:107) stated that ancient Egypt medicine had been viewed as a quintessentially conservative culture, stubbornly refusing changes made to the wonted medicine of their past. More importantly,

[69] Egyptian physicians were renowned in antiquity and much in demand outside of Egypt. As the Greeks acknowledged, they acquired much of their medical knowledge from Egypt. It can then be argued that certainly the Hippocratic oath taken by modern physicians does originally reflect Egyptian traditions (Yurco 1990: s.v. Imhotep). Greek medicine is by no means original because they have taken much from Egyptian medicine (Temkin 1938:130).

[70] Elmar Edel (1976:38) revealed certain Hettite texts which stated that they, the Hettites, had no medical science and that they relied heavily on Egyptian medicine as well as on Sumerian and Akadian medical texts.

according to Ritner (2000:108), it seems that any updated or altered diagnoses and treatment plans of the original sacred writings were not just frowned upon but totally prohibited, to the extent that death penalties could be the specified punishment because of disrespect in changing a medical tradition. This may be part of the answer to the question why the known medical papyri was based on much earlier data. That there most probably had been some exchange of scientific and medical information between Egypt and Greece, Palestine and Mesopotamia, and contrariwise, is asserted by Riddle (1993:xiv).

The general acceptance is that most of the important medical papyri originated in the Old Kingdom, to the period 3 000 to 2 500 BCE. The Ebers and other medical papyri dated in the Middle Kingdom, were therefore only reproductions of the original medical texts (Nunn 1996:21, cf. Gardiner 1927:5).

3.4.2 The hieratic medical papyri of the New Kingdom

The oldest text on quasi medical matters is that of the *Turin Papyrus 54003* (11th to 12th Dynasties). The Turin papyrus contains magic formulas against three physical vulnerabilities most common amongst the population of the period: eye diseases, snake bites and fish bones (Harris & Wente 1980:54). Surprisingly dental maladies were not among these hazards.

Amongst the hieratic[71] medical papyri that were found as the only surviving written medical and dental reports of ancient Egypt are the following, the ones that contains dental references, mentioned first:

- The Georg Moritz Ebers papyrus (1872), commonly referred to as the Ebers papyrus (containing eleven prescriptions or recipes referring to teeth and periodontal tissues (Joachim 1973).
- The Edwin Smith surgical papyrus (1862).
- The Kahun gynaecological/medical papyrus (1889).
- The Berlin papyrus (early 1900), see Harris & Wente (1980:54).

[71] Hieratic script is a cursive form of hieroglyphic script and is one of three forms of ancient Egyptian writing which was used primarilly on sacred and medical papyri and on wooden coffins. Fragments of papyri dating to the 1st Dynasty showed scripture in this form (Von Klein 1905:1).

- The Papyrus Anastasi (Halioua & Ziskind 2005).
- Other medical papyri that do not mention any dental diagnosis or preparations are amongst others the Chester Beatty papyrus IV, Hearst papyrus, London papyrus, Brooklyn papyrus, Carlsberg papyrus VIII and the Ramesseum IV and V papyri.

Two of the most important medical papyri which contained reference to dental maladies, the Ebers and the Edwin Smith papyri are discussed below.

3.4.3 Ebers papyrus

The Papyrus Ebers belongs to a group of papyri that contains a compendium of miscellaneous medical recipes. The magic content of the P. Ebers is a mere 12 of the 877 recipes (Harris & Wente 1980:54). The misconception that Egyptian medicine was entirely based on magic is refuted by the P. Ebers (3) in the motion that accompanies all drugs with a prayer '*for powerful are spells over remedies*' to be read for all recipes. Another misconception that is contested by Harris and Wente (1980:58) is that remedies such as hyena's tongue or the donkey's tooth[72] are only verbatim in meaning, similar to today's medical terminology such as 'foxglove' and toad's stool' which are common plant names, far removed from the authentic physical animal.

The Ebers papyrus[73] is known as the most comprehensive medical papyrus, dating to circa 1550 BCE (New Kingdom period[74]). It is said that the papyrus was discovered between the legs of a mummy in the Assassif district of the Theban necropolis. The Ebers papyrus is amongst the oldest, most voluminous (containing 877 recipes) and arguably the most important medical papyri of ancient Egypt. The Ebers papyrus was purchased by Georg Ebers at Luxor, Thebes from Edwin Smith, in 1872. It is currently held at the University of Leipzig in Germany. The

[72] Some reference to physical animal anatomical parts such as 'mouse-tail' as an ingredient of a drug are disputed in the dictionary of Von Deines & Westendorf (1961:266). The *pnw* transliteration as mouse, the 'mouse-tail' is possibly a reference to a plant name, presumely an ingredient of a drug. However, an addition to the Ebers Papyrus by Von Deines *et al*. (1973:43) states that a number of other parts of animals that were used in the making of medication for various prescriptions, namely from donkeys and pigs respectively their fat, hair, jaws, teeth hoofs, liver, testicles, bone marrow, blood, eyes, excrement and milk, were commonly used.

[73] The Ebers papyrus was written in circa 1550, but it is believed that this is merely a copy from earlier texts, perhaps as far back as 3 400 BCE. The Ebers papyrus is a 110 page scroll (20 metres in length). The Brugsch papyrus provides parallel passages to the Ebers papyrus and is therefore important for clarification of certain recipes (Ebbell 1937:11, 12).

[74] See Appendix II.

papyrus was found written in cursive hieroglyphic symbols, also known as the hieratic script (Ebbell 1937:12). Below is an excerpt from the original Ebers[75] medical papyrus in figure 3.15.

Figure 3.15: The Ebers papyrus is known as arguably the most important medical papyrus, dating to circa 1 550 BCE (New Kingdom period). The hieratic writing, parts of which are written in red, is in such a perfect condition that at first the entire papyrus was dejected and thought not to be original.

Von Klein (1905:3) suggests that a more accurate date of the papyrus is to be found in the calendar which appeared at the back of the first column of the roll. The following inscription was found: '*in the ninth year of his majesty the King of Upper and Lower Egypt, Amenophis I, the Everlasting'*. He further reveals that the Ebers Papyrus roll was perhaps kept in the Royal Library established at Thebes in 1 670 BCE. The medical papyrus was compiled, revised or rewritten in 1 552 BCE. The text housed 877 remedies, some related to teeth and other oral maladies like toothache, gingivitis, periodontitis and caries (Berghult 1999:27). The most

[75] In historical notes on the Ebers papyrus Griffith (1893:477) cited two foundations of ancient Egyptian pharmacy: empericism and superstition, the latter valueless when faith in superstition passed, while emperical knowledge will leave a 'precious residuum'.

common oral pain was probably pulpitis caused by severe dental wear due to the high consumption of bread contaminated with soil and or quern minerals.

The Ebers papyrus is crucial for palaeodontological research because it has by far the more important prescriptions relating to the oral structures. Von Klein attested the extent of the dental maladies and I quote: '*Diseases of the tongue and teeth (the ailments of the tongue are not specified), but for the teeth there are prescriptions to strengthen them, to make them grow, to heal ulcers of the gums, swellings of the gums and bloody congestions of the teeth*' (1905:7). The following is a classical first English translation by Ebbell (1937:103-104) and followed by a summary of the eleven dental prescriptions taken from the Papyrus Ebers translated by Leek (1967:52-53). The author furnishes his own critique and opinions of the prescriptions based on his knowledge and experience as a practising dentist for 25 years in the latter:

> Ebers LXXXIX:
>
> *The beginning of remedies to fasten a tooth: powder of ammi /, yellow ochre /, honey /, are mixed together, and tooth is filled (?) therewith.*
>
> *Another: scrapings (?) of millstone /, yellow ochre /, honey /, the tooth is filled (?) therewith.*
>
> *To expel growth (?) of purulency in the gums: fruit of sycamore /, beans /, honey /, malachite /, yellow ochre /, are pounded and applied to the tooth.*
>
> *Another to treat a tooth that gnaws against an opening in the flesh: cumin /, frankincense /, d3rt /, are pounded and applied to the tooth.*
>
> *Another to fasten a tooth: frankincense /, yellow ochre /, malachite /, are pounded and applied to the tooth.*
>
> *Another: water /, s3m /, likewise.*

Another to treat the gums with rinsing of the mouth: bran (?) /, sweet beer /, swt dhwtj /, are chewed and spit out, others to expel eating ulcer on the gums (i.e. stomatitis ulcerosa) and make flesh grow: cow's milk /, fresh dates /, manna /, (it) remains during the night in the dew, rinse the mouth for 9 (days).

Another: inst /, fruit of sycamore /, yellow ochre /, sebesten /, gum /, tj3m /, bsbs /, belanites-oil , water, likewise.

Another to strengthen the gums and treat the gums: celery /, dw3t /, sweet beer /, chewed and spit out.

Another remedy to treat "blood-eating" (scurvy) in the tooth: kbw 1 ro, d3rt ½ ro, gum 2 ro, fruit of sycamore 4 ro, inst 1 ro, water 10 ro, (it) remains during the night in the dew, rinse the mouth for 4 days.

Ebers 89, 2-3. For fixing a loose tooth: A mixture of crushed seeds, ochre and honey made into a paste and applied to the tooth, presumably in a manner that would immobilise or splint the tooth by employing surrounding teeth as buttresses. The ochre and seeds is presumed to be fillers with honey the binding factor. The treatment may merely be a mechanical method of splinting a loose tooth, with honey the decontamination factor.

Ebers 89, 3-4 presents a prescription similar to 89: 2-3, but presumably for toothache. Due to the fact that the causative agent for the pain is not specified, periodontal pain is presumed. The pain relief due to pulpal irritation because of caries or for whatever reason does not seem feasible, unless the crushed seeds have anaesthetic or narcotic[76] properties preponderant to the pain-causing effects of honey.

[76] Opiates were used in the treatment of pain, see Merrillees (1962:289).

Ebers 89, 4-6. The prescription seems to be treatment for toothache. A paste of ground-up vegetable and mineral substances, with honey is suggested. A similar argument is valid as above due to the lack of more information given.

Ebers 89, 6-7. A prescription for a septic tooth (literally 'a tooth that gnaws or eats into an opening in the flesh') the ingredients are an astringent concoction of nature: cumin[77], colocynth[78] and frankincense. Cumin (*Cuminum cymminum*) seeds are indigenous to Egypt, they were chewed for gumboils and for sore and abscessed throats (Germer 1993:78). This plant has weak analgesic properties and is used nowadays to treat the common cold (Van Wyk & Wink 2004:407).

Frankincense[79] (*Boswelia serrata*), native to India, (Kramer 2006:49) was used in Egypt during Pharaohnic times as incense, it has, however, many medical uses such as a purgative and a drug to expel worms (Jacob 1993:35). Today frankincense resin is the main components of *boswellic* acids, used for its anti-inflammatory, antiseptic, decongestant and sedative properties (Van Wyk & Wink 2004:69; cf. Kramer 2006:49).

A concoction of colocynth, acacia, dates and honey would prevent pregnancy when a fibre tampon moistened with a herb is inserted in the vagina. It is one of the earliest mentions of contraceptive vaginal suppositories which appear in the Ebers Medical Papyrus (1930). The guide suggests that fermentation of this mixture can result in the production of lactic acid, which today is recognized as a spermicide. Lactic acid is also the waste product when plaque bacteria metabolise carbohydrates (Hillson 1979:150). The bacteria commonly encountered in plaque are strains of Lactobacillus acidophilus and Streptococcus mutans (Roberts & Manchester 1995:46).

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[77] Cumin (*Cuminum cyminum*) is a seedlike fruit, native to the Middle East. The oil of the seed is medicinally used as a disinfectant. The cumin black (Nigella sativa) is medicinally used as a vermifuge, an anthelmintic drug. One cannot help to think of its use against the 'toothworm' (Jacob & Jacob 1992:813).

[78] Colocynth (*Citrullus colocynthis*), is a member of the wild gourd family' also known as bitter apple, the pulp of the fruit dries to a bitter powder.

[79] Frankincense (*Boswellia sacra*), is an important ingrediant of incense. Medicinally it is used as a fumigant, to apply smoke, vapor or gas for the purpose of disinfecting or of destroying pests (Jacob & Jacob 1993:813). Today its resin, the main components of which are boswellic acids, are utilised for their anti-inflammatory, antiseptic, decongestant and sedative properties (Van Wyk & Wink 2004:69; cf. Kramer 2006:49).

Colocynth, a gourd or wild vine - literally, ‘the vine of the field’ is probably is a cucumber, which, because of its leaves, tendrils, and fruit, it bears a strong resemblance to the wild vine. Colocynth may cause colic, at times may cause ‘excite the intestine nerves but has no known influence on oral soft tissue like the gums (Jamieson *et al* 1997: s.v. Colocynth).

Ebers 89, 7 & 9 is a prescription for the fixing of a loose tooth.

Ebers 89, 8 describes a method for fixing loose teeth.

Ebers 89, 8-9 relate to a prescription for treating teeth by rinsing the mouth. In this case two unknown plants should be chewed and spat out. The vehicle is sweet ale.

Ebers 89, 10-11. A prescription for the inflammation of the gums, thought to be a form of stomatitis. The drugs are the homely dates and beans, which are to be exposed to early morning dew, mixed with milk, then chewed as a masticatory and spat out; repeated for nine days.

Ebers 89, 11-12. This seems to be another prescription for the same condition as in 8. In this case the vehicle is oil and water.

Ebers 89, 12-13. A paste is prescribed for ‘making healthy’ the teeth. Two vegetable drugs: mandrake and species of *Potentilla* should be chewed and spat out. The vehicle is sweet ale.

Ebers 89, 14-15 is a prescription for ‘eating blood in a tooth’. This idiomatic expression is understood by Leake (1940:311) to mean ‘scurvy’. Weinberger (1981:111) also mentions Lefebvre’s (1952) translation to imply a diagnosis of pyorrhoea.

Ebers 325, (54, 18-55, 1) mentions fumigants which were common treatments for both vaginal and anal problems; however, Weinberger (1981:110) believes that it was not an uncommon treatment for dental maladies either.

All the above remedies are unassertive external applications. Leek (1967:53) held that the choice of drugs in these and other prescriptions was probably dictated by the belief in their magical rather than their therapeutic value. Most of the prescriptions seem to be for ‘fastening’ loose teeth, or for some malady associated with the gingiva and/or periodontal tissues. Ebers 739 and 743 use the verb *smen* which has the attested meaning of ‘to make fast’ or ‘make to endure’, unquestionably implying loose teeth due to periodontal disease. In Ebers 748 the verb *serudj* is used, meaning ‘strengthen’ or ‘secure’ (Nunn 1996:205). Nunn questions whether looseness as the result of caries is meant but as was shown that caries was not a great factor in ancient Egypt. However, loosening of a tooth due to caries, would imply an abscess with resultant periodontal infection anyhow. The author will show in Chapter 4 that dental wear has direct impact on periodontal diseases leading to periodontal abscesses and subsequently loose teeth.

It is inexplicable beyond comprehension that dental wear *per se* does not feature in any manner in any of the diagnoses and recipes of the Ebers papyrus, neither within any of the other medical papyri ever discovered in ancient Egypt. Dental wear was a health threat that entire populations over millennia had suffered from. Modern dentistry today is well aware of the fact that extreme dental wear still has the potential to cause extreme morbidity and even mortality.

The author has ventured into the following translation from German to English of the recipes mentioning dental structures in the Ebers Papyrus, Anastasi and Hearst Papyrus where the recipes are cited under the heading: mouth, teeth, tongue, in the original translation from the hieratic Egyptian scriptures into German by Von Deines, Grapow and Westendorf in ‘*Übersetzung der mediezinischen texte*’ (1958:65-67).

II E 1. The mouth

The two recipes that were prescribed for painful conditions of the mouth (undisclosed conditions):

1. Ebers papyrus (Eb) 122 (27,7 - 11), similar to the Berlin papyrus 35 (3,8 - 11)[80]. A mixture for prevention of painful conditions in the mouth:

   8^{c}m plant extract, $^{1}/_{8}$; tj^{c}m plant extract $^{1}/_{8}$; ^{cc}m plant extract $^{1}/_{16}$; fruit of ẖ$\frac{c}{c}$ sj.t' bryonia $^{1}/_{8}$; fruit of wacholder w^{c}n $^{1}/_{16}$; grated sycamore $^{1}/_{8}$; išd-fruit $^{1}/_{16}$; colocynth ḏ$\frac{c}{c}$r.t $^{1}/_{8}$; terebinth resin snṯr $^{1}/_{64}$; ocre stj $^{1}/_{32}$; smt $^{1}/_{64}$; wtj.t-teil of sycamore $^{1}/_{8}$; ^{c}mw 20 ro. The ingredients are mixed, exposed to the night dew, pressed and then taken for four consecutive days.

2. Berlin papyrus (Bln) 76

   A fumigation by smoke to eliminate a condition that changed the one half of the face and the corner of the mouth[81], presumably paralysis. The recipe involves fumigation by/of (ẖt-ds) – tree, paralysis will then be appeased with beer [when]sweat streams from [face] and rubbed by hand.

II E 2. The teeth

II E 2.a General treatment (filling, fastening and parallel recipes).

1. Eb 739 ~ (89, 2-3)

   The remedy or cure to firming up (smn) a [loose] tooth:

   Flour from the germ of Emmer (mjmj), 1 quantity; Ocker (stj), 1 quantity; honey 1 quantity; mixed and made into a paste and the tooth should be filled with the mixture.

2. Eb 740 ~ (89, 3-4)

   Another cure (healing substance) presumably for a loose tooth as above:

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[80] Some recipes described in the Ebers Papyrus are basically the same as that found in the Berlin Papyrus, otherwise refered to in Deines *et al*. (1958:243) as Eb = Bln. Within the Ebers Papyrus there is similarity between a number of recipes, written as Eb ~ Bln (see Appendix I).

[81] This condition is reminiscent of a paralysis due to injury or infection of the facial nerve on one side only, described in medicine as Bell's palsy: the inability to move the muscles on one side of the face, so that the expression of the face is distorted. Bell's palsy is a common facial paralysis, generally temporary and produced by such conditions as neuritis or infection (Microsoft Encarta 2009: s.v. Bell's palsy).

Fine grit from a grinding stone, 1 quantity; ocker (stj), I quantity; honey I quantity; mixed and the tooth should be filled with the mixture.

3. Eb 743 ~ (89, 7-8)

Another cure for the firming up (smn) of a tooth: Terebinth resin (sn<u>t</u>r) 1 quantity; ocker (stj) 1 quantity; malachite[82] *(w3ḏw) 1 quantity; the substances is then pulverised and applied on the tooth.*

4. Eb 744 ~ (89, 8)

And another cure (presumably for a loose tooth again):

Water, 1 quantity; (8ᶜ3m) plant (?), 1 quantity; similar to… (ebenso).

5. Eb 748 ~ (89, 12-13)

Another cure/treatment to firm up/ tightening (festmachen) a tooth:

Celery (m3t.t) 1 quantity; (dw3.t) plant, 1 quantity; sweet beer 1 quantity; a mixture made and given to the person to chew, and afterwards spat out on the ground (given to the earth).

6. Eb 745 ~ (89, 8-9)

Another cure for a tooth with a chewing substance:

(ᶜmᶜᶜ) plant 1 quantity; sweet beer, 1 quantity; (šw.t - ḏḥwti) creeping firefinger-cabbage 1 quantity; mixture should be masticated, then spat out on the ground.

[82] Malachite is a green mineral stone: a green copper carbonate mineral. Use: decorative stones and is a source of copper (Microsoft Encarta 2009: s.v. Malachite).

7. Hearst papyrus ~ (H 8, 1, 7)

(….) if he wants to fall to the earth (soil) - *presumably a very loose tooth, about to fall out of the mouth: germ of Emmer (mjmj) 1 quantity; (ᶜ3m) 1 quantity; Gummi (tree gum)*[83] *1 quantity; should be given to the tooth.*

II E 2b Special illnesses (of teeth)

8. Eb 742 ~ (89, 6-7)

Another treatment for a tooth that is being eaten at the opening of the gingiva (ḥᶜw):

Kummel (cumic & caraway seeds) 1 quantity; terebinth resin (snṯr) 1 quantity; colocynth (ḏ3r.t) 1 quantity; made into a powder and apply onto the tooth.

9. Eb 746 ~ (89,10-11)

Another cure for the elimination of an abscess growing from the gingiva (ḥᶜw) (gum tissue):

Milk of a cow 1 quantity; fresh dates 1 quantity; (wᶜh) fruit (Hulzenfrucht) 1 quantity; this mixture should be exposed to the dew one night, then chewed and swirled around the mouth and should then be spat on the ground.

10. Eb 747 ~ (89, 11-12)

Another treatment: (ins.t) plant 1 quantity; grated sycamore fruit, 1 quantity; ochre (sti) 1 quantity; (išd) fruit 1 quantity; plant gum 1 quantity; (tjᶜm) plant 1 quantity; (b8b8) plant 1 quantity; behen oil 1 quantity; water, the same (presumably) as above.

[83] Gummi (German) translates elastic or rubber. However the author opines rather a sticky plant substance that hardens: a sticky substance found inside some plants, especially trees, that hardens when it is exposed to air and partially dissolves when put in water (Microsoft Encarta 2009: s.v. Gum).

11. Eb 554 ~ (72,14-16)

Elimination of the abscess from a tooth that grows from the gingiva (ḥ^{c}w):

(bsbs) plant 1 quantity; grated sycamore fruit 1 quantity; (ins.t) plant 1 quantity; honey 1 quantity; terebinth resin (snṯr) 1 quantity; water 1 quantity, mixture should be exposed to dew for a night, should then be chewed and swirled around the mouth.

12. Eb 555~ (72, 16-18)

Another treatment:

(tjcm) plant 1 quantity; (ins.t) plant 1 quantity; terebinth resin (snṯr) 1 quantity; (^{c}m^{cc}) plant 1 quantity; Celery (m3t.t) 1 quantity; (nw3n) plant, 1 quantity; root of (tj-šps) cinnamon tree? 1 quantity; (innk) plant 1 quantity; (gjw) Cyprus grass 1 quantity; colocynth (ḏ3r.t) 1 quantity; water and similar (to above).

13. Eb 553 ~ (72, 13-14)

Another treatment for an aggressive abscess of a tooth:

(šps) plant 1 quantity; gum from a tree 1 quantity; honey 1 quantity, oil or fat 1 quantity, abscess should be covered (bandaged) with it.

14. Eb 749 ~ (89, 14-15) similar to papyrus Hearst - H 9 (1, 7-8):

Another remedy for the blood eating condition in the tooth:

(ḳbw) plant $^{1}/_{32}$; colocynth (ḏ3r.t) $^{1}/_{64}$; gum $^{1}/_{16}$; grated sycamore fruit $^{1}/_{8}$; (ins.t) plant $^{1}/_{32}$; water 10 ro. Mixture should be left overnight in the dew, should then be chewed for four days.

15. Eb 741 (7, 2-3)

Elimination of an abscess that is causing pain in a tooth:

Grated sycamore fruit 1 quantity; beans, 1 quantity; honey 1 quantity; malachite (w3ḏw) 1 quantity; ockre (stj) 1 quantity; the products should be milled and pulverised and should be put to the tooth.

3.4.4 The Secondary medical papyri mentioning teeth

- **The Papyrus Anastasi IV[84] papyrus** (Gardiner 1937:48) mentions one of the earliest instances the belief that toothache is caused by a worm. Comment is made of the lament of an Egyptian official who bewails his suffering from toothache: *'…every muscle of his face twitches, the disease has developed in his eye and the worm grows into his tooth…'*. A fragment of the papyrus IV is shown below.

Figure 3.16: Papyrus Anastasi fragment

- **The Edwin Smith papyrus** is the earliest treatise dealing with surgery. It is also viewed by Wilson (1952:76) as a curious mixture of science and superstition. The 'Association of schools of public health's: 'Public Health Report' (1896-1970)' conversely proclaimed the Papyrus Edwin Smith as the only true scientific work among the several Egyptian medical papyri. Below in figure 3.17 is an excerpt from one of the original copy of the Edwin Smith book claiming the papyrus as the first surgical textbook in history.

- The papyrus Smith bears on the recto a treatise on traumatology and on the verso, partly written in another hand, a gynecological remedy, a remedy for the anus, a method of preparing *fenugreek* oil to rejuvenate old people and 8 spells to expell the 'wind of the plague of the year' (Harris & Wente 1980:54). A piece of the original papyrus Edwin Smith is pictured in figure 3. 18 below.

[84] The belief of the cause of toothache is a toothworm is from the prescription (13. 6-13.7) in Gardiner, Late Egyptian Miscellanies of 1937.

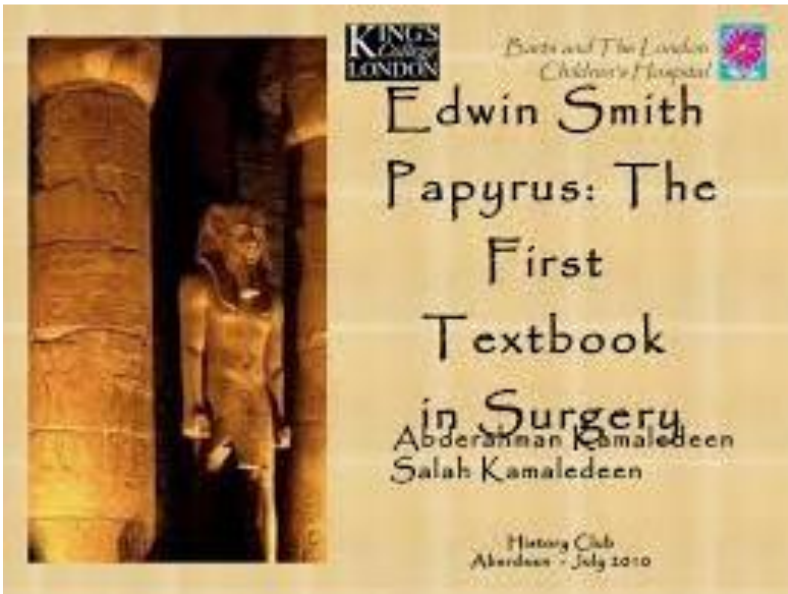

Figure 3.17: The Edwin Smith is regarded as the first textbook on surgery, both medical and dental.

Figure 3.18: Facsimile of the Edwin Smith papyrus, the world's oldest surviving surgical document. The Edwin Smith papyrus was written in hieratic script in Ancient Egypt around 1 600 BCE.

For each case brought to the physician/dentist there is a summary of the diagnosis with an indication of either: 'an ailment I will treat' or 'contend with' or an 'ailment not to treat'. Amongst one of the 48 mainly cranial trauma cases Forshaw (2009b:485) describes the instruction given for the manipulation of a dislocated mandible[85] in the Edwin Smith (Sm Fall 25) papyrus:

'*if you examine a man having a dislocation in his mandible [and] you find his mouth open [and] cannot close it for him, you should place your thumbs upon the ends of the two rami in the inside of his mouth [and] your two groups of fingers under his chin, and you should cause them to fall back so that they rest in their place'* (sic).

This technique cannot be better expounded by a maxillo-facial surgeon today. Von Deines & Westendorf (1958:187) also describe the fracture of a mandible in Edwin Smith (Sm Fall 24) which when palpated with the fingers the bones are found to move under the fingers, you should declare: one with a *ḥsb* fracture of the mandible which has been broken off (*sḏ*) with an open wound; and the temperature feels warm; it is an illness, the man cannot be treated.

Other oral and maxillo-facial procedures in the Edwin Smith papyrus are listed by Chohayeb (1991:68) below with additional references to the translations of Von Deines and Westendorf:

- A case of perforation of the bone of the maxilla and zygoma, of unknown cause, Edwin Smith (Sm Fall 18), Von Deines & Westendorf (1958:184).
- Splinting in the region of the maxilla and zygoma, Edwin Smith (Sm Fall 21), Von Deines & Westendorf (1958:185).
- Compound comminuted fracture of the bone of the maxilla and zygoma, Edwin Smith (Sm Fall 22), Von Deines & Westendorf (1958:186).
- A fracture of the mandible Edwin Smith (Sm Fall 24), Von Deines & Westendorf (1958:188).
- Treatment of a wound to the upper lip: 'probe as far as the column of the nose; stitch the wound; apply fresh meat for one day; apply a combination of grease

[85] Von Deines & Westendorf (1958:187) in their translation of this manipulation refer to both thumbs being positioned 'under' the chin (… deine beiden Daumen unter sein Kinn). Followed by the words after treatment of the dislocation ' one with a dislocation of the mandible: it is an illness that I treat. Then you shall bandage (or strapping or put a dressing) soaked in *imr.w* – mineral, honey every day until it is better.

and honey until recovery'[86],[87], Edwin Smith (Sm Fall 26), Von Deines & Westendorf (1958:187).

- Wound in the region of the chin in Edwin Smith (Sm Fall 27), Von Deines & Westendorf (1958:188).
- In addition the papyrus mentions that swellings due to dental abscesses are to be cauterised with the 'fire drill' and drained, Von Deines & Westendorf (1958:189).

Honey was commonly used to treat infected wounds as long ago as 2 000 years before bacteria were discovered to be the cause of infection. In 50 AD Dioscorides described honey as being '*good for all rotten and hollow ulcers*'. More recently, honey has been reported to have an inhibitory effect to around 60 species of bacteria including aerobes and anaerobes, gram-positives and gram-negative microorganisms (Ahuja & Ahuja 2006:82).

Atta (1999:1191) reported that a common postoperative procedure in ancient Egypt was to apply fresh meat to an open wound for the first day, followed by daily application of lint saturated with grease and honey. Pahor (1995:42) indicated that honey has hygroscopic features and therefore attract an abundant secretion of leucocytes and antibodies to an infected area. In the case of a necrotic wound the surgeon would prescribe the earliest known use of salicin in the form of willow leaves to reduce inflammation and for its antiseptic properties, as well as its analgesic properties. This medication is the forerunner of salicylic acid, a substance used to make modern aspirin.

The ancient operator using the Edwin Smith papyrus was advised to avoid treating an infected fracture: 'when you examine a man with a fractured mandible, find the break with your hand

[86] Fresh meat may provide tissue enzymes and thromboblasts which aids recovery. Honey acts as an antimicrobial by disrupturing the cell walls of microorganisms through increased osmotic pressure (Chohayeb 1991:68).

[87] Honey uses in oral infections: Apitherapy, also known as bee venom therapy, was used in ancient Egypt for many maladies and sometimes specifically for arthritis, probably again for its anti-inflammatory properties. However, there has been one report published in recent times of honey being used in oral surgery, describing a small clinical trial of the placing of honey in the tooth socket before closure of the wound after surgical removal of impacted third molars (see Appendix IV). This modern study showed less pain, less incidence of postoperative complications and less swelling in the honey-treated group than in the untreated control group. The conclusion is that that natural honey showed antibacterial action against anaerobic bacteroides present in dental abscess and osteomyelitis (Ahuja & Ahuja 2006:81).

as it is displaced beneath your fingers; if there is an open wound over the fracture, and the discharge has stopped following, and if he has fever as a consequence; '*this is a disease that cannot be treated'*. The same outlook is described by Wilson (1952:77); if any treatment is beyond the competence of the ancient Egyptian surgeon, who has to conclude in his diagnosis: '*an ailment for which there is no treatment*'. Halioua and Ziskind (2005:9) likewise describe the physical investigation of a possible injury to the upper jaw: crepitation can be felt by a physician with his fingers when examining a fractured maxilla (Edwin Smith 17 & 24).

- The Kahun Papyrus – Dated to circa 1800 BCE, the Kahun Gynecological Papyrus is the oldest known medical text. It was found at El-Lahun by Flinders Petrie in 1889,[3] first translated by F. Ll. Griffith in 1893, and published in *The Petrie Papyri: Hieratic Papyri from Kahun and Gurob.* The papyrus contains 35 separate paragraphs relating to women's health, such as gynaecological diseases, fertility, pregnancy, and contraception.[1] It does not describe surgery. It does however mention teeth. See figure 3.19 below.

Seventeen different conditions and treatments are found on the first page of the Kahun papyrus: such as problems with the eyes, legs and teeth, which despite appearing to be related to general medicine, are linked back to obstetric causes. All seventeen start with the recitation, '*knowledge (treatment) of a woman… (suffering from…)'*, followed by '*say thou with regard to it'* (i.e. diagnose it as…) and then '*make thou for it…'* (prescribe for it …) (Griffith 1893:11).

Papyrus Kahun (Kah 5) contains the following prescription… '*Knowledge of a woman pained in her teeth ibḥ and jaws nḥḏ; she knows not [how to open?] her mouth. Say thou to her it is the itching (?) determinative a toothache tj3.w) of the vulva (uterus?). Do thou for her (thus): you must fumigate her with oil and terebinth snṯr resin in a bowl ḏ3ḏ3 (?), pour iwḥ in her vulva the urine of an ass that has engendered two colts on the day that it has passed it (the urine). If her...is pained from her…shoulder (?) to her...hips'* (Von Deines & Westendorf 1958:269).

Warranted that the prescription is for an unknown complication, disease or ailment, the fact that the prescription specifically indicated the 'urine of a donkey mare that had just given birth', who incidentally, according to modern scientific studies, have high levels of oestrogen in the urine, may have had some bearing on the prescription. Of the most controversial gynaecological drugs today is the use of Premarin®, a modern pharmaceutical drug that provides oestrogens to post-menopausal women. In fact, Premarin® is derived from pregnant mare' urine, or *PMU 222* (Williams 1994*:*1009).

Figure 3.19: The Kahun papyrus fragments

The Carlsberg Papyrus III – was translated by E. Iverson in 1939 and which is currently now housed in the Copenhagen University, this papyrus dates to about the 19th or 20th Dynasty. It deals with ophthalmology on the recto (virtually a replica of the content of papyrus Ebers), and on the verso with obstetric prognostications similar to the papyri Kahun (Nunn 1996:39).

3.5 CONCLUSION

The question posed whether dentistry was practiced in ancient Egypt, and whether the dental profession existed receives a resounding yes as an answer from the author. There is no doubt that the above mentioned medical papyri contain a number of recognisable dental maladies with accurate diagnoses and it was shown that the recipes mentioned are relevant dental treatments analogous to present day dentistry managements.

There seems to be a general consensus amongst anthropology scholars that ample Egyptian literary evidence exists of an established dental profession in ancient Egypt. There are two scholars disputing this assumption, quoting no proof or indubitable records substantiating dentistry. Forshaw (2009a:422) does not commit himself to this question but nevertheless writes about ancient dental hygiene and health factors respectively and concludes that in Pharaonic Egypt dental care was effected by the application of medicaments and not by surgical means, and that there did not exist a separate dental profession. The discovery of the first ever necropolis housing the remains of three dentists at Saqqara may yet be more evidence that dentists did in fact exist in ancient Egypt, however, the availability of this data is still in the early stages and yet unpublished.

There were two diverse titles within the dental profession in general practitioner-levels: one meant ‘one who is concerned with teeth’ and the other meant ‘one who treats teeth’. Marion (1996:17) suggested that the first symbolised a junior or student dentist, while the other was an established dental practitioner. Forrai (2009:188), who agrees that there were dentists in ancient times, also mentions two classes of dentists but differs in her hieroglyphic approach to the meaning and naming the classes: *iryw-ibew*, with the meaning of dentist, is the lower class dentist whilst the elite dentist was referred to as *ir-iryw-ibew*, with the meaning of either great of those who are concerned with teeth, or, *great of dentist* [sic].

Clarke (1980:80) justly argues that one should not only recognise restorative dentistry as a criterion to identify dentists, because oral pathology and oral medicine are as much a part of dentistry as restorative dentistry. Operative dentistry is undisputedly seen in the treatment for a dislocated mandible, and the drilling of holes through teeth[88] and into cortical bone confirms adeptness of an operator that knew what he was doing and obviously why he did what he did.

Ghalioungui (1971:93) however, remarks on the quality of the material and skills of the operators. He wonders how the Egyptian jewellers were able to use magnificent techniques working with for instance gold wire at a much higher proficiency than their dentist counterparts. One could in the same light ask the question how it was possible that the builders of the pyramids were so skilful that their work would never be matched again, even today, with

[88] Gorelick & Gwinnett (1978:38) show that there were indeed drilling phenomena in ancient Egypt. They found perfect holes drilled through ancient seals, probably using a bow drill.

the most modern equipment. The answer to these assumptions may lie in what was important for the people at every given period or tradition.

The principal medical papyri: the Ebers; the Edwin Smith; the Kahun and the Papyrus Anastasi, all of which contain medical and dental recipes, were more than sufficient as the primary source of evidence on diseases in ancient Egypt. 'Time has spared for our admiration a mass of documentary evidence – the so-called medical Papyri' are the words of Nunn (1996:40). Science will forever be grateful that these papyri are still in existence today.

CHAPTER 4

DENTAL DISEASES IN ANCIENT EGYPT

Abstract:

The objectives of this Chapter are to critically survey the literature of dental pathology in general and specifically for the severe dental wear that was ubiquitous in the populations of Upper and Lower Egypt, and thereby identify the cause and effect of the trend. The diseases mentioned and discussed are caries, with special reference to the myth of the teeth-worm, periodontal disease, dental wear and hypoplasias. Most of the oral diseases have one thing in common; pain. Dental pain, from a mild discomfort, to excruciating pain, are being focused on in order to understand the causes and severity thereof. The Egyptians of the period did not seem to have much interest in an oral hygiene regime, with the significance of furthering their susceptibility to other dental maladies. Dental pathology, in all its demeanours, will have a direct and indirect effect on the demography of the population of ancient Egypt.

Key words: Caries, calculus, periodontal diseases, dental wear; dental attrition, dental abscesses; secondary dentine, hypoplasia; molar-incisor-hypomineralisation (MIH).

4.1 INTRODUCTORY REMARKS

The quotation by Philo (20 BCE - 50 CE) below accentuates the importance of teeth in ancient societies; second only to sight, but primarily essential for staying alive:

> *"'Is then,' someone will say, 'a tooth of equal value with an eye?' (202) 'Each,' I would reply, 'is of equal value for the purposes for which they were given, the eye with reference to the objects of sight, the teeth with reference to those which are eatable.' But if any one were to desire to institute a comparison, he would find that the eye is entitled to the highest respect among all the parts of the body, inasmuch as being occupied in the contemplation of the most glorious thing in the whole world, namely the heaven; and that the tooth is useful as being the masticator of food, which is the most useful thing as contributing to life. And he who strikes out a man's eye does not hinder him from living, but a most miserable death awaits the man who has all his teeth knocked out",* in (Yonge 1995:1173 -1174. XXXVI (202).

Teeth are often the best preserved part of the human skeleton, often the only part that survives. Teeth are the most resilient and chemically stable tissues in the body. They provide dental anthropologist/odontologists with a wealth of information about health, diet, stress, occupation, cultural behaviour and subsistence economy (Lukacs 1989:261)[89]. Analysis of dental pathology provides insight on health, disease, nutrition, subsistence and social organisation within selected communities (Işcan & Kennedy 1989:7).

The analysis of teeth in bioarchaeological human remains therefore contributes to the reconstruction of past human behaviour[90]. Human dental and joint diseases are arguably the most commonly occurring abnormalities reported in bioarchaeological excavations of the past, and collectively with other forms of evidence from an archaeological site, they are valuable sources of information about the lifestyle of ancient populations (Roberts & Manchester 1995:44).

Judith Miller (2008:52) attests that in a survey of more than 5 000 skulls from sites in Upper and Lower Egypt; from the Predynastic to the Ptolemaic Periods, a time-span of more than three millennia, research reveals severe dental pathology as the most ubiquitous of dental maladies. Miller points out that whenever there is a statistical variation between certain periods regarding the incidence of dental disease, it can usually be explained by the influence of the diet and methods of preparation of food. It is directly linked to the traditions and culture of a population within a timeframe that directly constitute a certain lifestyle. To elucidate the lifestyle of the ancient Egyptians, a study of the dental status of the population of ancient Egypt is central to this study.

Skeletal or mummified human remains, especially certain physiognomies, will usually confirm racial classification. Chohayeb (1991:69) attests that the Egyptian cephalic index[91] or cranial relationship was dolichocephalic and that there was a tendency of bimaxillary protrusion in a

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[89] Thornton (1995:42) and Harris & Ponitz (1980:45) are scholars who are in accord with the significance that the dentition has on anthropology research.

[90] Alt & Buitrago-Tellez (2004:258) point out that dental anthropology provide views into biological, ecological and cultural aspects of past populations for researchers to understand their individuality, human behaviour, lifestyle and environments. It also elucidates human phylogenic and ontogenic development and evolutionary processes.

[91] The Cephalic Index is a basic measurement of the shape of the skull, used by scientists of the 19th and early 20th centuries in classifying humans. Devised by Swedish anatomist Anders Retzius in the 1840s, the cephalic (or cranial) index expresses the width of the skull as a percentage of the length from front to back. Craniologists distinguished three basic classifications of skulls based on the cephalic index: dolichocephalic (long skulls), with widths of less than 75 percent of the length; mesocephalic (medium skulls), with indexes of 75 to 80; and brachycephalic (broad skulls), with indexes of more than 80 percent (Robson 2011:339).

number of the royal families. Radiographic studies of the facial structures of the royalty appeared to be homogeneous among the Old Kingdom rulers and rather heterogeneous in the New Kingdom period.

The Angle classification of the sagittal relationship between the maxilla and the mandible[92] establishes a class I (neutrocclusion), class II (distocclusion), and class III (prognathism) relationships, as devised by the Katz's modified method, in Brin *et al*. (2000:169). This classification is not only race sensitive but it also refers to a genetic kinship phenomena.

Farrel (1973:558), through cephalometric X-rays, showed that Amenhotep II and Tuthmosis IV had class I occlusions, in contrast to Tuthmosis I, II and III who had bimaxillary protrusions. Other New Kingdom rulers also presented with class II malocclusions. Rameses II, who suffered from severe dental pathology, had a class II malocclusion. Rameses II however, still lived to a ripe old age and reigned longer than any other ruler in ancient Egypt.

4.2 CARIES IN ANCIENT EGYPT

Ortner and Putschar (1981:438) define dental caries as an infectious disease in which progressive destruction of tooth structure is caused by microbial activity on the tooth surface. The destruction of dental hard tissue is the direct result of the lytic activity by bacteria, which are almost exclusively lactobacilli and streptococci. Caries or *caries dentium* is a localised disease characterised by an irreversible and progressive destruction of the hard dental tissue. Caries starts at the enamel surface of the tooth or in case of regressed gingiva, at the exposed cervical or neck of the tooth, which is dentinal in origin. Caries then works its way progressively through the dentine into the pulp cavity in some severe conditions (Powell & Mielke 1985:317). Dental caries was not a common disease among the population of the Predynastic and early Dynastic periods. At the same time periodontal diseases ravaged the dentition of the population and dental wear was extensive and severe in all sectors of the ancient population (see statistics in Appendix IV).

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[92] Depending on the sagittal relations of teeth and jaws, malocclusions can be divided mainly into three types according to Angle's classification method: neutrocclusion; distocclusion and prognatism (Subtelny & Subtelny 1973:350).

Dental caries is an ancient concept that has existed in diverse cultures across the ages. Its history may be traced back as far as the year 5 000 BCE with the legend of the tooth-worm. A Sumerian text in cuneiform script written on a tablet approximately 5 000 years BCE, mentioned tooth decay together with advice of curing toothache (Kovaks 1952:44).

The reason why caries were infrequently observed in ancient Egypt is due to the lack of fermentable carbohydrates in the diet of the general population (Forshaw 2009a:423). Forshaw mentioned statistical values of dental caries among the adult population of between 2,3 persent to 6,14 persent in the Dynastic Period (Forshaw 2009a:424). Thornton (1995:42) concurs that dental caries were low in ancient Egypt and Nubia in early Dynastic periods but stressed that it increased exponentially as a result of dietary changes in later periods. Caries in the Sudan Gebel Barkal area was cited as non-existent in ancient times. Leek (1972a:291) accentuates how rare caries was from the Predynastic Period to the XXI Dynasty when 4 816 teeth were examined by the author and only 39 teeth exhibited simple surfaced carious cavities, or less than 1 persent[93].

Derry (1933:112) quotes Professor Elliot Smith (1924) as had suggested that after the influx of large numbers of aliens in the 4th, 5th and 6th Dynasties of the Old Kingdom, dental caries became extremely common. More than 80 persent of people were believed to have suffered from caries. Any serious scholar in palaeodontology and anthropology would frown upon statistics of this nature and repudiate such statistics as Derry (1933:112) did. He critiquing the claim made by Professor Elliot Smith who claimed that the incidence of caries in the third to sixth Dynasties was more than 80 persent among the Egyptian population; this after Derry had empirically found the figure to be not more than 5.4 persent. The author is of the opinion that Smith erroneously misidentified severe dental wear, which when worn, exposed the pulp cavity, to mimic dental caries. Leek (1972a:291) found the incidence of caries in the Predynastic Period to be less that 1 persent. Hillson (1979:156) found the incidence of caries in the Dynastic Period to be in a range between 0 to 10 persent.

[93] Dental decay in ancient Egypt was almost non-existent among the general population because of a basic diet lacking sugar; however, this does not apply to the royalties because of a much richer diet which including sugars (Halioua & Ziskind 2005:163). The authors found 3 persent of the population in the Predynastic period suffered from tooth decay. The figure changed to 7 persent at the end of the Ramaside Period and up to 20 persent in the Ptolemaic and Christian periods (Halioua & Ziskind 2005:167)(see Appendix IV).

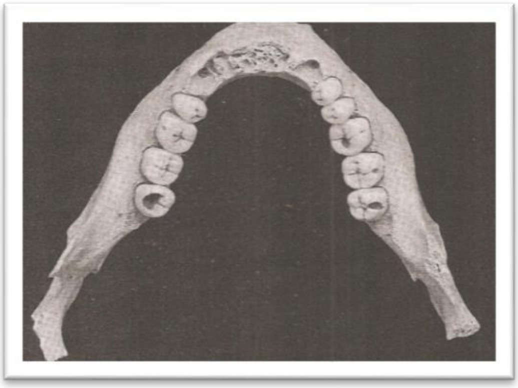

Figure 4.1: Mays (1997:154) presents a mandible of an individual that clearly exhibits an occluso-buccal carious lesion in the lower left third molar, an occlusal lesion in the lower right first molar, and buccal lesions on the second- and third lower right molar teeth.

The Neolithic Revolution saw Egyptians domesticate plants and animals. The introduction of cariogenic carbohydrate cooked food led to an increase in caries incidence. Greene (1969:316, 322) revealed that although the incidence of caries during this period and the Epipalaeolithic period were infrequent, caries were so debilitating as to lead to differential survival and reproduction. The Mesolithic people's teeth were more complex morphologically and therefore more susceptible to dental wear (and less susceptible to caries) while the Meroitic dentitions were less complex in morphology and showed a higher incidence of caries. Lewin (1994:1806) described one of many cases where a CT scan of a Theban mummy of about 3 000 BCE, showed a 'horrendously' large abscess due to caries which most probably was the cause of his death, but admitted that such levels of caries were uncommon.

4.2.1 The tooth-worm

The tooth-worm has, according to popular belief through the ages and in various cultures, caused caries and periodontitis. The tooth-worm was also considered the cause of headaches, probably through referral of dental pain. The gnawing tooth-worm is thought to be responsible for toothache even to this day (Gerabek 1999:1). The Zulu and Xhosa cultures of South Africa still believe that the tooth-worm is the cause of toothache; they even describe rituals and incantations to expel the worm from the tooth (personal communication 2012).

Gerabek (1999:3) alluded to a number of remedies to eliminate the tooth-worm demon used in ancient Egypt. Gerabek mentions the following treatments: medicine obtained from the ingredients of henbane[94] were popular. Henbane oil mixed with wax to form a candle, and then used to fumigate the patient. Myrrh[95] was also used to counter the effects of the tooth-worm and fumigation by means of the henbane seeds, and finally the cauterisation of the tooth-worm by means of a thin wire would rid the individual of the tooth-worm.

An Egyptian source for the tooth-worm was revealed by Kinnier-Wilson (1996:38)[96] who mentioned that the myth or phenomena started in ancient Egypt, which then spread to the rest of the world. A piece of bronze wire firmly lodged in the root canal of an upper right incisor, presumably to close the 'passage' and thereby prevent the tooth-worms from burrowing into the tooth and causing more pain, were found in Israel (Zias & Numeroff 1986:66). Wynbrandt (1998:16) cites the mentioning of the tooth-worm in the sacred texts of the Papyrus Anastasi (about 1 300 BCE).

Asbell (1941:1099), in his study of dentistry amongst the early Israelites who had returned from Egypt after a sojourn of nearly five Centuries there, found them also believing that tooth decay and toothache is caused by a tooth-worm, probably a belief that was brought with them from Egypt. Asbell (1941:1102) describes the reason for using bitter herbs as a preventative measure was that it protected the person against demonic influences, of which the tooth-worm was a manifestation. Another remedy that proved to be efficacious was the ingestion of the eggs of grasshoppers. Asbell (1941:1102) is of the opinion that the tooth-worm had its origin in Babylonia as the poem below demonstrates. The poem probably dates to the early second millennia BCE.

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[94] Henbane (*Hyoscyamus niger*) is a narcotic related to the belladonna. Its effect concerns the blood circulation with a decrease in pulse rate. It is a sedative and shares some similarities with opium. Dried henbane leaves yield three other narcotic drugs namely atropine, hyoscyamine and scopolamine. Drugs of various kinds have been used for many centuries to reduce the distress of surgical operations. Homer wrote of *nepenthe*, which was probably cannabis or opium. Arabian physicians also used opium and henbane (Gerabek 1999:3).

[95] Myrrh (*Commiphora myrrha*) was also used in ancient Egypt for a number of maladies - stops diarrhea, relieves headaches, soothes gums, toothaches and backaches (Aboelsoud 2010:87).

[96] Davis & Janssen (1991:62) and Kinnier-Wilson (1996:38) are both authors who independantly described the existance of the tooth-worm in ancient Egypt.

After Anu had created heaven,
Heaven had created the earth,
The earth had created the rivers,
The rivers had created the marsh,
And the marsh had created the worm –
The worm went, weeping, before Shamash,
His tears flowing before Ea:
"What will you give me for food?
What will you give me to suck on?"
"I will give you the ripe fig and the apricot."
"What good are the ripe fig and the apricot?
Lift me up, and assign me to the teeth and the gums!
I will suck the blood of the tooth,
And I will gnaw its roots at the gum!"
Because you have said this, O worm,
May Ea strike you with the might of his hand!

It is unclear as to whether the Babylonian population discovered their own dental treatment for the tooth-worm, or if this treatment originated from cultural exchanges between Babylonia and Egypt.

The Egyptian physicians are thought to have made more rapid progress in medical knowledge and its application to patients than did the Babylonians, probably because of early specialisation (Brand *et al*. 2003:427). The authors mention that there were perhaps many cures for teeth infested by the tooth-worm, of which the following two cases testify:

If a man (has) a worm in his tooth, you dry out the peel of [...], apply it and he will get better.

If a man (has) a worm in his tooth, you crush 'sailor's excrement' in pressed oil, if the tooth on the right which aches, you pour (the oil) on the tooth on the left and he will get better [sic].

Different theories of the aetiology of caries are known, but the most accepted theory is that the destruction of the hard dental tissue results from acids producing microorganisms, especially those found in an adherent gelatinous film on teeth and gingiva, known as dental plaque. Plaque consists of food debris, salivary proteins, microorganisms and polysaccharides of bacterial origin built up on the teeth in the absence of efficient oral hygiene (Moore & Corbett 1983:140). Malnutrition affecting tooth development causing hypoplasia may also be a cause of dental caries (Ortner & Putschar 1981:439). The diet of the ancient Egyptians excluded to a great extent red meats and sugars – both constituents for the development of calculus and caries respectively – therefore, caries was not a disease of significance that would have had much influence on the lifestyle of the Egyptians. Calculus was, however, still a factor in ancient Egypt where periodontitis was a proliferating disease.

The little evidence of caries in the lands of the Pharaohs did have certain consequences to the individual. The usual aetiology and course of the disease still affected the individual negatively. The origin of dental plaque is on, or in certain areas of the tooth that are not self-cleansing. Dental plaque is a calcium carbonate deposit on teeth and consists of food debris and various other components derived from the saliva, inclusive of bacteria that metabolise carbohydrates resulting in an acidic waste product that would then dissolute dental hard tissue, causing cavities (Mays 1997:149). Caries can give rise to potentially lethal complications. Carious lesions that reach the pulp can lead to infections. An upper molar tooth infection may spread into the spaces within the maxillary bones and cause osteomyelitis. This infection may result in meningitis or cavernous sinus thrombosis, which may be fatal. Lacking modern antibiotic-type of treatment in ancient Egypt, the death rates for the abovementioned acute infections were perhaps 50 to 90 per cent (Calcagno & Gibson 1988:510).

4.3 PERIODONTAL DISEASE IN ANCIENT EGYPT

Subsequent to dental wear, periodontitis is the second most common malady in ancient Egypt (see Appendix IV). Periodontal disease is comparable to most of the other oral maladies with multifactorial causes. Harris and Ponitz (1980:45) attest that periodontitis is commonly caused by calculus and is the single major cause of tooth loss in ancient Egypt. The authors, however, mention a questionable advantage that severe or class III calculus may have: that of acting as a splint to support loose teeth. Clarke *et al*. (1986:182) pointed out that ancient populations did not have the level of sophisticated modern methods of oral hygiene. They are therefore known to have suffered from mild to severe calculus deposits. Despite the presence of substantial calculus in a number of mummies, there was no discernible horizontal loss of alveolar bone of periodontal origin, in more than 90 percent of cases (Clarke *et al*. 1986:178).

Clarke *et al*. (1986:175) compared the incidence of loss of alveolar crestal bone in modern societies to that of ancient societies and found that in ancient Egyptian groups the incidence was 10 percent compared to 30 percent among modern groups. The reason the authors proposed is that in ancient groups the resistance of the progression of gingivitis to more serious periodontitis may be due to the host defence system that operates in the gingival crevice and the gingivae (Clarke & Carey 1985:690). In modern societies, this natural defence system may be compromised by self-induced environmental factors such as stress, smoking and diet.

Reeves (2001:17) point out that periodontal disease was ubiquitous in ancient Egypt; one of the causes according to him was the stresses and strains exerted on the teeth during masticating that lead to severe wear of the enamel of the teeth. Lerato (1970:497) agrees that the reason for tooth loss is due to periodontal disease in ancient societies where severe dental wear and subsequent pulpal involvement is common. There is a strong correlation between severe dental wear and pulpal pathology especially where exposure of the pulp tissue occurs. Subsequently pathogenic microorganisms enter the pulp tissue, which then cause infections and ultimately the formation of periapical dental abscesses[97]. Chazel *et al*. (2005:197, 201) demonstrated that the dietary habits and socioeconomic status of the population influence their choice of the quality and quantity of food intake. These are paramount factors in dental wear in ancient populations, of which Egypt with its wide difference between classes is a good example.

4.4 HYPOPLASIA AND OTHER INSULTS TO AMELOGENESIS

Dental hypoplasia is a quantitative deficiency of enamel. Per definition dental enamel hypoplasia is a deficiency in enamel thickness (even total absence) resulting from a disruption in the matrix formation phase of amelogenesis (Goodman 1991:281, cf. Ash & Nelson 1940:31). These defects commonly result from insults to the highly specialised ameloblast cells at vulnerable stages of amelogenesis or enamel formation during the development stages of

[97] Teeth with periapical abscesses (surrounding the root apex) due to extreme dental wear show wear equal to Brothwell's scale 5 or 6 with most of the occlusal enamel worn away (Greene *et al*. 1967:52) (see Appendix IV).

primary and permanent teeth (Ford *et al*. 2009:382). The risk factors that were responsible in ancient times are similar to modern times and are mainly low socioeconomic status with resultant poor nutritional intake and various infecting agents: parasitic, viral and bacterial (Ford *et al*. 2009:386).

The bioarchaeological record of ancient Egypt can assess whether the transition from hunter-gathering, which proved to have been a relatively healthy lifestyle when nutritional impacts are taken in consideration, to the agricultural way of life, occurred gradually. The analysis of skeletal remains can also reveal whether the shift to agriculture improved the lifestyle of the early farmers and whether it was sustainable. In Starling & Stock's (2007:521) study of early Egyptian agriculturists, they found a poorer quality of life the result in the early Dynastic Period, which then gradually improved in later Dynastic Periods due to major agricultural intensification. The bioarchaeological record relies on information that is commonly garnered from a non-specific stress indicator in the form of enamel hypoplasia.

Lovell (2000:129) published the results of enamel hypoplasia from ancient Mendes in the delta of Egypt to access the impact the socioeconomic environment has on the health status of a sector of the population over a period of 2 000 years. The prevalence for hypoplastic lesions in deciduous and permanent teeth was high. Hypoplasia in the deciduous dentition reflect maternal and neonatal hypocalcaemia, while defects in the permanent dentition reflect nutritional and infectious stresses that are commonly associated with the process of weaning and diseases. The pattern of enamel hypoplasia (EH) frequencies during the various Dynastic Periods of ancient Egypt suggests that episodic stress was more prevalent during the Old Kingdom Period than subsequent periods. The late Old Kingdom period showed deterioration in general health of the population and regular periods of malnutrition (Lowell & Whyte 1999:78).

Enamel hypoplasia (EH) results from developmental disturbances. Malnutrition has historically been viewed as the primary cause of enamel defects. Lovell and Whyte (1999:70) however, mention that the interaction of two factors, namely diet and disease[98] is now thought

[98] Contagious viral diseases, mainly in children, that causes high fever attacks like chicken pox and mumps, are known to cause disruption of the process of amelogenesis, resulting in hypoplastic lesions. Childhood illnesses

to be the major cause. Hypoplastic lesions on anterior teeth compromises aesthetics, causes tooth sensitivity, areas of EH is susceptible to caries and weakened enamel structures are responsive to dental wear. Enamel does not remodel and therefore disturbances of enamel formation can be everlastingly recorded on tooth surfaces (Ford *et al*. 2009:382). EH presents in a spectrum of severity, ranging from a change in translucency, known as enamel opacities, to reduction or loss of enamel known as enamel hypoplasia. Palaeopathological stress markers, of which linear enamel hypoplasia (LEH) of the dentition, is arguably the most reliable non-specific stress indicator[99] (Starling & Stock 2007:521).

Langsjoen (1998:403) metaphorically alluded to hypoplastic enamel lesions as a biological window through which one can observe the long-term consequences of metabolic stresses and it provides a record from which an investigator may infer the time at which the hypoplasia formed and therefore the time of the stressful event that caused the insult (see also Goodman & Armelagos 1985:488). Hillson (2000:272) asserted the great potential in gaining anthropological information from the study of hypoplastic lesions in teeth, above all, the knowledge of what it was like to grow up in ancient Egypt.

EH can mostly be observed on the buccal aspects of dental crowns. Goodman and Armelagos (1985:488) schematised the distribution of the spatial incidence of lesions (figure 4.2 below). Among the incisal and canine teeth of the permanent dentition: 50 - 65 present of hypoplasias occur in the middle third; Hypoplasias in the cervical third: 18 - 30 present, with the remainder 12 - 22 present in the incisal third. In premolars: 50 present occur in the middle third, 25 - 50 present in the cervical third and 0 - 25 present in the occlusal third. Molars show 40 - 80 present lesions in the middle third, 20 - 60 present in the cervical third. Note that the second and third molars are wholly unaffected in most cases (Sarnat & Schour 1941:1991).

coupled with periods of extreme bouts of fever will likely leave hypoplastic lesions. The raised cellular temperature inhibits normal amelogenesis leaving the telltale signs (Van Rensburg 1981:192). Smallpox was a known viral disease in ancient Egypt as the death of Pharaoh Ramses V dying suddenly testifies. His mummified remains bear pustules characteristic of smallpox disease. The first smallpox outbreaks occured in settlements in Egypt around 10 000 BCE (Roberts 2009:98).

[99] The prevalence of LEH was found to be highest in the 'proto-agricultural' (pastoralist) Badari population, with a gradual decline throughout the late Predynastic and early Dynastic periods. This suggests that the period surrounding the emergence of early agriculture in the Nile valley was associated with high stress and poor health, but that the health of agriculturalists improved substantially with the increasing urbanization and trade that accompanied the formation of the unification of Egypt.

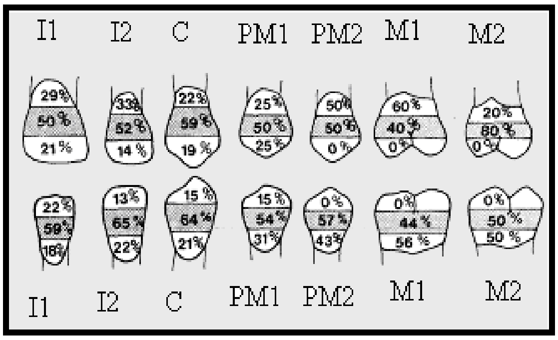

Figure 4.2: The frequency in percentages of EH in the incisal/occlusal, midcrown and cervical crown-third components of the upper and lower permanent crowns, from Goodman and Armelagos (1985:487, cf. Goodman & Rose 1990:89).

There are three distinguished aetiologies for hypoplasia namely hereditary hypoplasia conditions, hypoplasia as a result of local trauma; and systemic metabolic disruption hypoplasias. The hereditary type of hypoplasia is very rare (one present) in modern societies, likely even less in ancient populations (Winter & Brook 1975:16). The second aetiology specify hypoplasia due to trauma or localised infections (i.e. abscesses) according to Hillson and Bond (1997:89). This type results in a defect occurring in only one tooth with the possibility of an adjacent tooth being affected. The third aetiology is known as systemic metabolic disruption hypoplasias, or acquired hypoplasia, which is also known as environmental contributory hypoplasia. This category covers by far the majority of cases found as skeletal non-specific stress indicators[100] (Ford *et al.* 2009:382). These hypoplasias are indicative of not only the health of ancient Egyptian populations, but also of the ecology at the time of the interment of the remains. It follows then that periods of famine or abundance, socioeconomic depression or prosperity and war or peace can be 'read' into the condition of skeletal and dental remains. This information on Egyptian periods of famine can then be used in cross-reference with biblical and extra-biblical sources to establish societal conditions of the past, particularly in the said periods (Roberts & Manchester 1995:167, cf. Greeff 2005:162).

Egypt's greatest resource was the Nile River, providing basically all the water necessary for agriculture. Egypt, as a desert country had little or no annual rainfall. The annual inundation of

[100] Another common non-specific stress indicator is Harris lines (transverse lines), seen in long bones when X-rayed. These lines indicate episodes of intermittend disease or malnutrition and may sometimes be found in remains with hypoplastic lesions. Sandison (1980:30) attests that 30 percent of Egyptian mummies show Harris lines which suggests a generally poor state of health. Papageorgopoulou *et al.* (2011:389) found no association between Harris lines and other non-specific stress indicators including linear enamel hypoplasia.

the Nile provided the river's chief benefit to the land. Each year, with uncanny regularity, the Nile flooded, replenishing the land with silt laden water which results in a thin layer of new soil (Kiser 1944:383). Kiser (1944:385) describes Egypt as nothing more than a deposit left by the Nile in flood, and when cut off from this supply for a single season, the entire population of Egypt would be in the grip of a famine. The waters cover the land along the river's banks from July to September, soaking the fields and depositing a layer of rich silt. When the water levels drop, the Egyptian farmers re-establish the boundaries of their fields and prepare the land for planting. Since all agriculture depended on the annual flood, the Egyptians developed a device, the nilometers to predict its level. A rise of seven to eight meters was ideal: the predictable flooding and controlled irrigation of the fertile valley produced surplus crops, which fuelled social development and culture. A higher flood could be destructive, while a rise of less than six meters could provoke a famine like that mentioned in Genesis 41:53. The availability of food was a perpetual concern because of the recurrent scarcity: droughts were frequent because of the total dependency on the inundation of the Nile River. In the religious beliefs of the Egyptians the spirit of the Nile-flood was the god Ha'pi, the bringer of fertility and abundance, but frequently not (Brisco 1998:8).

Boldsen (2007:65) alludes that linear enamel hypoplasia (LEH) analysis has a causal connection between health events in childhood and the risk of dying at an earlier period. LEH formation and the risk of dying are influenced by a common factor – poor health at an early age predisposes poor health throughout life. This phenomenon may reflect in a population like Egypt where a large percentage of the population died within the first decade of life. Armelagos *et al*. (2009:270) concur and add that individuals who display two or more hypoplastic lesions died, on average ten years earlier than those devoid of enamel hypoplastic lesions did. No difference has been found between the sexes *vis-à-vis* the prevalence of hypoplasia, however, adults have a higher prevalence of linear enamel hypoplasia than juveniles because LEH that is caused by systemic stresses appear more in the permanent dentition than in the deciduous dentition (Griffin & Donlon 2009:S99).

A new type of enamel malformation[101], closely related to enamel hypoplasia, has been identified within the past decade (Weerheijm 2003:114 & 2004:9). The author has speculated for a long time about the possibility of a condition that would cause ‘softening’ of enamel, to the extent that within a family one sibling may have ‘soft’ enamel with little outward signs of enamel disturbances while the other siblings have little or no problems with their teeth. Molar-incisor-hypomineralisation (MIH) may prove to be the reason. MIH is characterised by noticeable demarcation of the lesion often with indented defects on the enamel surface and some degree of change in its translucency, with the area presenting shades of white opacity, yellow or brown in colour (Ogden *et al*. 2008:166). MIH enamel is soft, porous and poorly delineated from normal tooth tissue. The hypomineralised enamel was found to have from three to fifteen-fold higher protein content than normal. MIH is thought to be acquired via a multifactorial systemic disturbance of the process of amelogenesis on the cell level. There seems to be a link to illnesses during infancy and teeth dissociated from fluoride, although the primary cause of MIH remains a mystery (Mangum *et al*. (2010:1160).

Jenkins (1978:262) simply labelled this degree of malformation as ‘gross hypoplasia’, perhaps already misdiagnosed MIH. MIH is related to hypoplasia in that it is shaped during the developmental stages of the enamel (amelogenesis). The aetiology may also be similar: bouts of malnutrition, disease and fever are suspected but not yet proven. MIH that affects molar teeth displays cuspal enamel lesions and incisors and canines show episodes of linear enamel hypoplasia (LEH). Molars are described by Ogden *et al*. (2008:166) as decaying so rapidly during eruption that it clearly surpasses the effects of common hypoplastic lesions, more closely related and referred in the literature as non-fluoride enamel opacities, internal enamel hypoplasia, non-endemic mottling of enamel, opaque spots, idiopathic enamel opacities, and ‘cheese’ molars lesions (Weerheijm 2004:9). Crombie *et al*. (2009:81) attest that there is currently insufficient evidence to establish aetiological factors relevant for MIH. It is the opinion and theory of the author that MIH may have existed in ancient Egypt.

The population of ancient Egypt was distressed by extreme dental wear. A supposition of generic MIH of the population cannot be ruled out. A non-empirical proposal is made that MIH

[101] Ruffer in the ealy 20th century had already speculated that dental wear depended largely on the nature of the diet, the relation of the mandible to the maxilla (the bite) and the density of the tooth substance, implying enamel structure weakness (Ruffer 1920:348).

initially causes weakening of the occlusal enamel surfaces of molar and buccal surfaces of incisor teeth which underscores the early wear of teeth, with further rapid deterioration and breakdown[102] of the teeth caused by the common aetiological factors of tooth wear (Discepolo & Baker 2011:22). Once dental wear has reached the softer dentine structure of a tooth, wear takes place at a rapid pace. Fagrell *et al*. (2010:215) clearly state that teeth with MIH have significantly lower hardness values in the hypomineralised enamel compared to normal enamel. Permanent molar teeth displaying occlusal MIH in bioarchaeological human remains would prove to be underrepresented because of the extreme dental wear phenomenon; little or nothing of occlusal enamel of the crowns usually remains to be found, even in some subadult's molars. MIH of incisor teeth will likewise be infrequent in human remains because single rooted teeth are generally lost in jawbones post-mortem. Multirooted teeth are held in place solely by the curvatures of the roots and/or the divergences of the roots regardless of not having any periodontal membranous tissue (Van Beek 1983:56).

Since MIH is a phenomenon of the infant and juvenile dentition[103], research has to concentrate on infant and juvenile bioarchaeological remains. Unfortunately, statistical tables drawn up for most archaeological sites clearly show an abnormality regarding the number of infant's and children's skeletons to draw inferences from. Brabant (1967:897) speculates that children's skeletons[104] are generally less numerous in all anthropological collections. However, Bouwer (2012:226) argues that the ancient Egyptians are known to have rendered respect to neonates. Foetuses and even the placenta was deemed important to avail necessary respect. At the eastern Necropolis of Deir el Medina, the lowest slopes were reserved for burial of infants and children. Numerous small pits were found, some circular and some square, cut into the rock to about 40 – 90 cm deep. It was here that Meskell (2000:429) discovered amongst the grave pits burials of neonates, placentas and foetuses.

[102] The rapid breakdown of enamel structures in MIH exposes the dentine and therefore causes chronic pulpitis and moderate to severe pain (Discepolo *et al*. 2011:22).

[103] Prolonged breastfeeding may reduce enamel defects such as Deciduous Molar Hypomineralisation (DMH) attest but Crombie *et al*.(2009:80) point out that amelogenesis is highly susceptible to relatively minor changes in the environment such as any childhood illnesses. Elfrink *et al*. (2012:551) report that there is a shared cause (environmental) of DMH and MIH and that DMH is likely to be a predictor of MIH.

[104] Rösing (1983:153) and Saunders (2000:136) are both knowledgable on subadult bioarchaeology, and both are of the opinion that there are generally a scarcity of subadult skeletons in most archaeological excavation sites.

Palaeodemographers who are confronted by such a marked and extended anomaly of paucity of immature remains have been divided in opinion. Most scholars would without argument accept the scarcity of infants in cemeteries (Guy *et al*. 1997:222). Some, like Acsádi and Nemeskeri (1970:62) refused to admit that infants' bones may be less well-preserved in the earth than those of adults. They proposed that children were interred in shallow graves, which would have been more exposed to for instance the act of ploughing. Erosion of soil would then also play a role by perhaps washing the remains away. The problem encountered with this proposal was perhaps the location of some cemeteries. These were areas where erosion could not have taken place. Simple pit graves were a common feature in the Iron Age I period but are difficult to find unless discovered accidentally (Faust 2004:175). Most Bedouins are today still buried in shallow graves (Goldstein *et al*. 1976:622). Roberts (2009:58) pointed out that the bodies of infants (birth to end of first year), and children (2 years to puberty), are much smaller and their bones less dense than that of adults, and will therefore 'disappear' more quickly. She mentioned that the bones of the elder with osteoporosis will also be more susceptible to faster decay. Infants were normally not buried with the rest of the population, which may also add to the scarcity of children's skeletons (Meindl & Russell 1998:377).

Other possibilities were argued to solve the mystery of the disappearance of infant remains: infanticide was suggested and even poor people would get rid of infant bodies in secret (Guy *et al.* 1997:224). Infant bodies were sometimes placed in earthenware jars and interred under the floors of homes (Matthews 1991:130). Le Roux (1995:109) stated that this process should not be considered a normal Israelite burial ritual but would probably be a Canaanite idol burial-ritual, who often interred an infant beneath the foundations of a dwelling to gain favour from Molech. Le Roux (1995:109) quoted Joshua 6:26: *Then Joshua charged them at that time, saying, 'Cursed be the man before the Lord who rises up and builds this city of Jericho; he shall lay its foundation with his firstborn, and with his youngest he shall set up its gates'.*

Although no mention is made of infanticide in honour of the deity *Molech* (*Moloch*) in the Egyptian pantheon, it is known that nearby Carthage under the influence of the Phoenicians, practiced infanticide in the late Dynastic periods (Stager & Wolff 1984:33). Excavations of the *Topheth* cemetery at Carthage have led certain archaeologists and historians to conclude that ritual of infanticide was maintained for at least five centuries (ca. 700–200 BCE) among the Carthaginians (Schmitz 1992:363)

The rational answer to the question of the paucity of infant remains may lie in blaming taphonomic processes that may be responsible for the disappearing of whole skeletons. For many decades scholars realised that statistical tables were erroneous since they were aware that the headcounts of infants were abnormally low or sometimes even totally unaccountable for (Guy *et al*. 1997:224). Angel (1969:430) believed that infant remains disappeared more readily than adult remains and that he even rectified his palaeodemographic statistical curves according to this conjecture, which he credited, but was unable to demonstrate.

4.5 DENTAL WEAR IN ANCIENT EGYPT

Klatsky (1939:73) viewed dental wear as a natural biological phenomenon and not as a pathological condition of enamel, unless it is a feature of the pathological softening of enamel such as *amelogenesis imperfecta* or molar-incisor hypomineralisation. Therefore, should dental wear be accepted as a natural phenomenon, then a study of worn teeth should reveal some record of the past (Molnar 1972:511). This type of study would also reveal the type of diet, the way in which food is prepared, as well as social or cultural uses and abuses of teeth.

4.5.1 General remarks on dental wear in Egypt

Scott and Turner (1988:109) alluded that dental wear has only two components: attrition (that which results from direct tooth-on-tooth contact), this component would include bruxism, which is the pathological process of grinding the teeth during sleep. Davies *et al*. (2002:12) defined bruxism as the grinding of teeth during non-functional movement of the masticatory system, in other words, it is a mandibular parafunction. The wear in bruxism is usually uniform when opposing teeth are affected. In cases where periodontal support is compromised, hypermobility of teeth may result. Other effects of bruxism are sensitivity to thermal stimuli, loss of vertical height and fracturing of unsupportive enamel. The aetiological models proposed by Davies *et al*. (2002:13) are structurally a malocclusion in the maxilla-mandibular relationship and secondly a psychological model, unproven in ancient populations, but highly probable in modern societies. There are no mention made in research material regarding bruxism *per se* in ancient Egypt but specific reference was found in Kinnier-Wilson's (1996:137) description of a Mesopotamian case (see page 140).

The other component is abrasion (produced by teeth making contact with a foreign material like food objects) and abrasives that are added to food (i.e. during food preparation). Abrasion is due less to the food people eat than to the abrasives incorporated in it during preparation. Moorrees (1957:133) epitomised dental attrition simply as the frictional wear of the teeth, and abrasion as the result of abrasive food material.

Dental wear has a multifactorial aetiology. Tooth wear is a slow process in most cases and the gradual loss of dental enamel happens through three distinct processes: abrasion, attrition and erosion. Addy and Shellis (2006:17) have shown that the three components of tooth wear, i.e. abrasion, attrition and erosion have been proven rarely to act alone but would rather interact with each other. The most important interaction is the potentiation of abrasion by erosive damage to the hard tissues. The science of dental wear, friction and lubrication is known as tribology, which recognises the variety of mechanisms by which wear can occur. Abrasion or corrosion is defined as the chafing or rubbing away of tooth surfaces caused by a foreign substance, for instance mineral particles in food. Erosion is the loss of tooth substance due to a chemical process (Smith & Knight 1984:435, 436). Davies *et al*. (2002:16) segregate the different types of tooth surface loss: the flattening of cusps or incisal edges and localised facets on occlusal or palatal surfaces would physically indicate a primary attrition aetiology. The loss of tooth surface caused purely by abrasion has sharply defined margins and a smooth, hard surface. The lesions with sharp edges would become rounded and shallow if there is an element of erosion present. The distinction between attrition and erosion is defined by the latter, which present with well-demarcated wear facets on the occlusal surface. Dental wear is excluded when the affected areas cannot be brought into contact in natural occlusion (Klimet & Borkowski 2002:54).

Dental wear can also be seen as a gradual and progressive wastage manifestation of the enamel cusps of the posterior teeth initially, before the anterior smooth enamel surfaces also undergo wear. Although the progression of wear is a tedious process, it is irreversible and may eventually destroy the whole tooth crown. Dental wear is a condition that affects the dentition of the primary dentition, as well as in the permanent dentition. Ancient Egypt was a country with a clearly demarcated dualistic social system with a thin layer or veneer of bureaucracy on top and a vast layer of craftsmen and peasants below. Its entire population was nonetheless uniformly affected by the dental wear and attrition conditions; even the kings and pharaohs could not escape this devastation of tooth structure (Allen 2000:31). Degrees of dental wear are to be seen in most Egyptian skeletal and mummified human remains (see statistics in Appendix IV).

Certain clinical features (see figures 4.3 to 4.6 below) when examining human remains' teeth may be regarded as diagnostic of pathological tooth wear are found listed by Smith and Knight (1984:436-437), and are as follows:

- Pulp exposure
- Exposure of secondary dentine
- Exposure of dentine on the buccal of lingual surfaces
- Cupped incisal or occlusal surfaces
- Wear in one arch more than in the other
- Reduction in the length of incisor teeth so that the length is out of proportion to the width

Figure 4.3: Various degrees of dental wear of a section of the mandible, typical of ancient and modern Egyptians (Harris & Ponitz 1980:45).

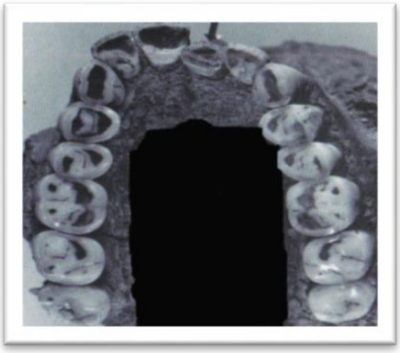

Figure 4.4: Typical dental wear dentine islands of upper arch of the maxilla showing classical wear patterns on most teeth bar the wisdom teeth (Miles 1963:2000).

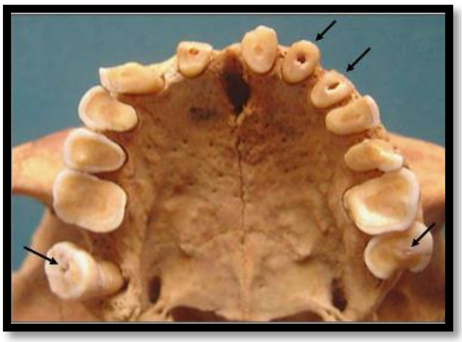

Figure 4.5: Severe dental wear in an individual with an abrasive diet. Pulp chamber exposure visible on teeth numbers 22 and 23. Pulp defence by secondary dentine evident on most other teeth.

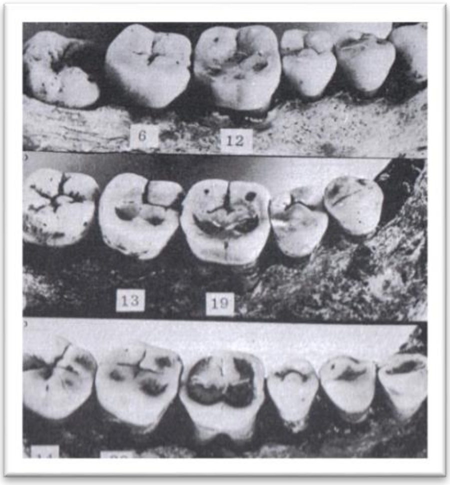

Figure 4.6: A display of successive wear patterns read from top to bottom according to the classification of severity (Miles 1978:459).

4.5.1.1 The rationale of dental wear

Dental wear is one of the most devastating conditions affecting the tooth crown. Severe dental wear was the cause of various oral diseases and was detrimental to the general health of the population of Ancient Egypt. Hawass (2000:89) revealed the shocking statistics that untreated tooth infections resulted in death 50 percent to 90 percent of the time in Ancient Egypt. Antithetical to this hypothesis is the advantageousness of dental wear on dental and temporomandibular joint function. Dental wear is an excellent tool in the conjecture of the palaeodiet of Ancient Egypt, and in the all-important palaeodemographical aspects of age determination and life expectancy to infer population censuses of past civilizations.

4.5.1.2 Diet and dental wear

Walker *et al*. (1991:169) discussed the importance of tooth wear in making inferences about diet, food preparation techniques and habitual activators involving the teeth, as well as an important source of data on the age structure of prehistoric populations. They also indicated that the demographic information provided by tooth wear varies according to the abrasiveness of the diet. Most ancient peoples consumed tough grit contaminated food.

In ancient times, tooth wear was the result of the population's diet and the abrasive materials added to the diet, resulting in flat occlusal surfaces at a relatively young age (Sicher 1953:408). Due to their diet and the dental wear result it had, ancient people soon reached a score of five on Molnar's scale (see figure 4.8 on page 110). The most common and trusted method used to estimate age at death is probably the pubic symphysis when that part of the pelvis survives (Aykroyd *et al*. 1999:59). Teeth on the other hand, have a better survival chance than the pelvis and, therefore, are now widely used as a method to estimate age, especially dental wear rates on molar teeth, are probably the method of choice. Aykroyd *et al*. (1999:58) point out that the rate of wear is influenced by many factors, especially the type of diet, which varies for each population studied. Brothwell (1965:68) cautions that age estimation from teeth should not be done within different archaeological periods and in different areas. However, it is fortunate that the rates of wear does not differ much within most of the Dynastic Period in Egypt, but extreme caution should be taken not to compare the hunter-gathering period to that of the agricultural period.

4.5.1.3 Estimation of age and dental wear

Dental wear has also been incorporated, along with several other dental criteria in multiple regression methods, to establish age in human remains (Dalitz 1962:20; Maples 1978:764). Dental wear is one of the more important age related changes according to Solheim (1988:299); it can easily be viewed using a microscope and on a clinical basis, by visual estimation to establish age. It is even feasible for the field archaeologist in situ to estimate the age of the human remains. The extent of attrition is difficult to measure; therefore, most researchers rely on specific scoring systems (see scoring methods of Molnar (1972:511) and that of Gustafson (1950:47).

Dental wear has been used to assess human age in archaeological remains. Sometimes dental wear has been used as the sole criterion for age, but lately has ideally been incorporated along with other dental and skeletal criteria in multiple regression methods in the estimating of age (Solheim 1988:299). Once dentine becomes exposed, the clinical appearance is determined by the contribution of the aetiological factors. If wear is primarily attrition, then dentine tends to wear at the same rate as the surrounding tooth enamel. Erosive lesions cause cupping on the surface of the tooth. When erosion affects the palatal surface of the upper maxillary teeth, there is often a central area of exposed dentine surrounded by a border of unaffected enamel. The progression of dental wear can be seen in the scoring systems of Hillson and Molnar below.

The scoring system devised by Hillson (1996:232) is shown in figures 4.7 and 4.8 below. The rating technique of wear diagrams for different teeth is chosen. It is aptly mentioned by Hillson that the various methods of scoring show little or no intra- or inter-observer variability; therefore, no bias should be expected from researcher analysis. Molnar (1971:178) added categories representative of wear direction profiles:

- Oblique (buccal-lingual direction)
- Obligue (lingual-buccal direction)
- Oblique (mesial-distal direction)
- Oblique (distal-mesial direction)
- Horisontal (perpendicular to long axis of the tooth)
- Rounded (buccal-lingual direction

- Rounded (mesial-distal direction)

The principal axis analysis of dental wear data is based on the importance of the rate of wear rather than the amount of wear that is primarily age related. This method avoids earlier methods of analysis, correlation and regression. Scott's (1979:203) principal axis equation is determined using the slope of the dental wear that indicates the rate of wear; high slopes indicate rapid wear. The Molnar's 1-8 scoring system is used in the above technique.

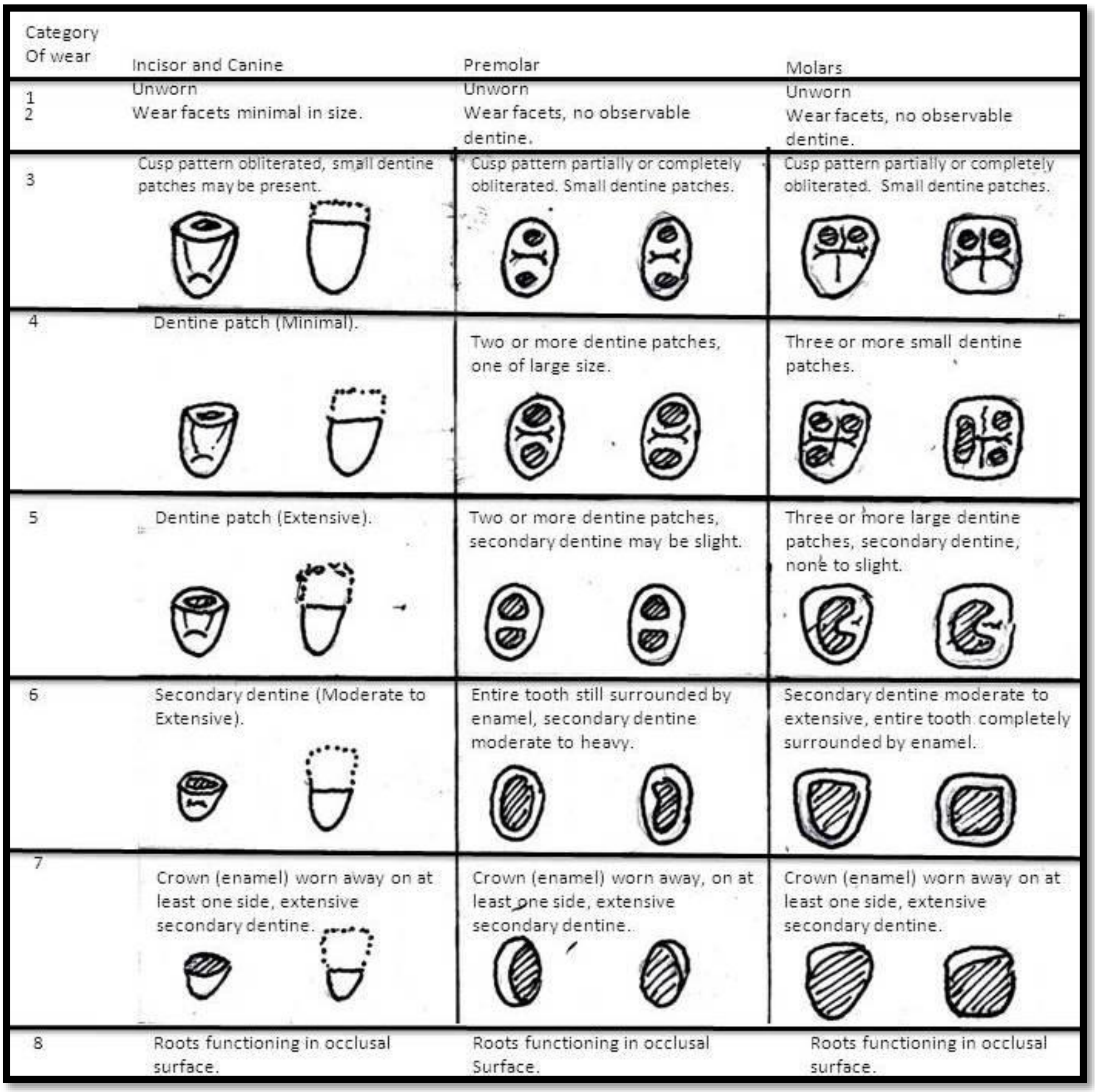

Figure 4.7: The Molnar 'three' dimensional scoring system for dental wear redrawn from Molnar (1971:179): A 1-8 ordinal scale based upon the number of dentine patches and the amount of secondary dentine present on the occlusal surface of a tooth.

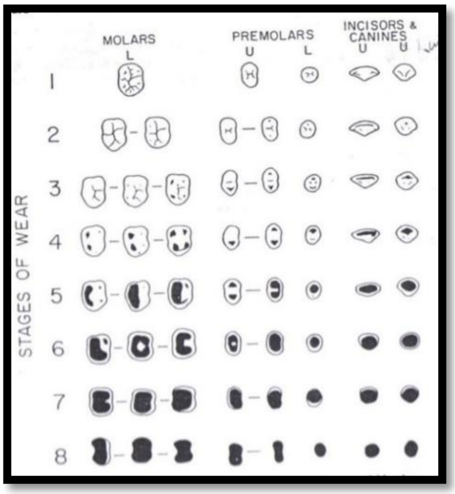

Figure 4.8: Degree of dental wear scoring on mandibular molar 1st, 2nd & 3rd teeth, premolar, canine and incisor mandibular and maxillary teeth are shown in eight categories depicting occlusal wear stages. The molar teeth are depicted with the loss of enamel structures corresponding to each molar tooth of the analogous stage of wear. (Hillson: 1996:232).

The author suggests that ancient people had an 'expiry' date closely related to the phenomenon of severe attrition. The low life-expectancy statistics may, to a great extent, be due to a loss of chewing function and a high mortality rate due to dental infections. This observation might put pay to the belief in the mammoth ages claimed for certain biblical and extra-biblical characters[105] in various religious texts.

The gradual wear of the enamel due to mainly the mastication processes on the occlusal surface (attrition) is used to access human age in archaeological materials, sometimes even being the sole criteria for age (Miles 1963:261) when no other part of the skeleton is in a condition to comply. Teeth act and react with the environment in a physical way. Enamel that does not remodel at all, as skeletal bone does, this fact has a positive aspect for palaeodontologists as the degree of wear when examined can provide a significant contribution to age estimation techniques (Langsjoen 1998:393). The rate of wear relates to the abrasive nature of the food and the amount of wear is a function of age (Molleson & Cohen 1990:363, cf. Smith 1972:233).

[105] While life expectancy was generally low in ancient cultures, there are exceptional cases recorded like that of the Genesis characters in the Bible. Without criticizing the biblical writers, one should note that the 'Sumerian King List' mentioned by Arnett (1985:156) recorded King Alulim lived an incredible 28 000 years and King En-men-lu-Anna 43 200 years!

Table 4.1: Life expectancy table for populations living in ancient times in the Southern Levant and other Mediterranean countries.

Life expectancy	Author	Area & period
40 years ♀♂	Arensburg (1985:27)	Egypt
30 years ♀♂	Brothwell (1959:16)	S. Levant
20 years ♀♂	Aykroyd *et al*. (1999:57)	S. Levant
20 years ♀♂	V d Heever & Scheffler (2001:40)	S. Levant
30 years ♀♂	Nunn (1996:22)	Egypt Predynastic
30 years ♀♂	Miles (2001:977)	S. Levant
32 years ♀♂	Rathbun (1981: abstract)	S. Levant
19 years ♀♂	Diamond (2005:3)	S. Levant post-agricultural
18♀26 ♂years	Molto (2001:81)	Dakhleh Egypt
30 years ♀♂	Masali & Chiarelli (1972:162)	Egypt Predynastic
25 years ♀♂	Masali & Chiarelli (1972:162)	Egypt Dynastic

The following scholars reported life expectancy statistics for the Mediterranean countries. Due to a number of reasons, life expectancies were very low as seen in the following reports: The statistical table of Puech *et al*. (1983:618) reveals 10 percent of ancient human remains as over 50 years old, while 61 percent of the sample of 603 skeletal remains died before the age of 30. Life expectancy at birth and in adults is uniformly low in the Roman Period at the Dakhleh oasis area (18.5 - 26.5 years at birth and 17 - 21 years in adults) suggesting stressful living conditions (Molto 2001:81). The following table serves only to elucidate the low life expectancy of the population in ancient times in Egypt and neighbouring countries. Table 4.1 is by no means a comprehensive study on the topic.

4.5.1.4 Dental wear amongst the ancient Egyptian population

One of the most remarkable dental characteristics of the ancient Egyptians is the magnitude of dental abrasion on the cusps of teeth among most of the population. This form of dental wear is a predisposing cause of considerable dental disease and sepsis. The macroscopic appearance of dental wear proffered gives an account of the enormity of dental disease, the diet and the morbidity and perhaps the mortality thereof (Puech *et al*. 1983:617). The authors conclude that the expanse of dental wear, the teeth of Predynastic subjects, show a greater degree of wear than those of Dynastic individuals. The differing rates during successive periods clearly reflect improved food preparation.

Nunn (1996:202) reported on Leek's statistics of mild to severe dental wear of all mummies and skeletons examined from the XII to the XXV Dynasties. A modest decrease of dental wear occurred between the fourth millennium BCE and the first millennium. Dental wear is also a prominent feature found in every one of the 40 skulls examined by Smith (1986:23) from the period 1 069 - 715 BCE. All teeth with the exception of newly erupted ones found in bioarchaeological material of every Dynasty in ancient Egypt exhibited wear of the cusps, with consequent pathology (see dental wear statistics in Appendix IV).

The ability of teeth to survive better than bone tissue in bioarchaeological locations permits the study of oral diseases and dental wear in particular as biological indicators of the health of the living individual and age at death within a population model. Mummified human remains are generally found intact and are therefore ideal research material, albeit unfortunately mostly elitist in nature. For an all-inclusive research sample, the lower classes that were interred in menial graves should, where possible, be included. Tooth assessment is generally supported by the skull and post-cranial material when present. Dan Brothwell (1959:59) pointed out that it was particularly fortunate that teeth are situated in the skull. The explanation is that in the past archaeologists were far from particular about what part of the skeleton was thrown away, provided it did not yield one of the standard measurements. This resulted in many post-cranial remains being thrown into dustbins after initial examination. Tooth remains and the jaws were thus saved as part of the cranium and today odontological aspects of anthropology have inspired much interest.

Arensburg (1985:27) mentioned the temporo-mandibular joint pathology frequently found in the osteological remains in ancient Egypt, which he believed to be related to extreme dental attrition. Leek (1972a:289) found 92 percent of the adult population in ancient Egypt to have suffered from a reduction in crown height found of between 1 and 4 mm. This phenomenon occurs only in severe dental wear cases.

4.5.1.5 Positive attributes of dental wear

There is however, a positive side to tooth wear: Bailit (1975:129) suggests that approximal wear on tooth crowns is desirable for good occlusion as modern human beings have more malocclusions because of the lack thereof. Sicher (1953:406) poses the question whether wear of teeth has a positive function and whether nature sacrifice tooth substance in aid to achieve an increase in functional potentiality? Furthermore, if the wear of teeth is supplemented by adaptive, reparative, regenerative changes (secondary dentine), is it to nullify the loss of dental tissues? To both questions the answer is not a clear yes or no, as worn teeth (flat occlusion surface)[106] during function protect the temporomandibular joint (Sicher 1953:408), and Solheim (1992:193) reasons that secondary dentine seems only to a minor extent to be influenced by dental wear.

Rose and Ungar (1998:349) describe these processes of protection against immanent problems as works of art and a wonder to stand in awe of. Approximal wear is described as an indication of the magnitude of masticatory forces, resulting in a mesial force vector, consequential to mesial drifting of molar and premolar teeth (Hinton 1982:103). In the discussion of caries in individuals, it was noted that dental wear destroys not only the cusps of teeth but also eradicates the occlusal fissures, thereby preventing areas where plaque usually forms and thus prevents occlusal caries, therefore an advantageous process.

4.5.1.6 The temporomandibular joint and dental wear

Dental wear is not a dental disease per se, but can predispose a person to other dental pathological conditions, noted among: caries, periodontal diseases and temporomandibular

[106] Neiburger (2000:16) mentioned the lack of malocclusions, caries, and temporomandibular joint problems of the population of Mesopotamia which is the direct result of a flat plane occlusion, due to severe dental wear.

anomalies (Roberts & Manchester 1995:52). The wearing down of tooth structure during mastication is a natural process[107] (Rose & Ungar 1998:349). Functional wear is not only normal, but is also essential to the maintenance of dental health. Unworn molar teeth may be detrimental to normal masticatory function; cusps may interfere with the unconscious swallow reflex and it may be the primary factor in the aetiology of temporomandibular dysfunction (Kirveskari 1979:316). Smith and Knight (1984:435) suggest that all dental data obtained from human remains samples should be used to set maximum levels of acceptable tooth wear for every group investigated; only beyond these levels, the condition should be regarded as pathological.

Temporomandibular joint degenerations affected 40 present of the specimens studied by Richards and Brown (1981:293), and were associated with both the rate and extent of tooth attrition. Age, unaccompanied by tooth wear, is not significant in the progress of this disease. Degenerations affected the temporal joint surface more frequently than the condyle, particularly in the lateral and central regions of the articular eminence. Another factor that was probably responsible for temporomandibular joint degenerations was the ever presence of sand. Patterns of degenerative joint disease in ancient populations illustrated a breakdown in the physiological adaptability of the masticatory system resulting from increased occlusal stress consequent upon progressive tooth wear. Under these conditions, the teeth and the temporomandibular joints enter a ‘wear-out’ phase of occlusal function, which usually commences in early adult life and becomes more severe as the conditions continue.

Functional tooth wear is compensated by continual vertical eruption of the teeth as seen in many ancient Egyptian dental research material. This results in the intermaxillary functional occlusal space to be reduced (free space). This alters the temporomandibular joint intracapsularly (Murphy 1958:178). In turn, this eventually causes widening of the mandibular angle (Loth & Henneberg 1996:473). This phenomenon serves as a differential diagnosis when the angle of the mandible is the appraisal for the sex in skeletal remains.

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[107] Molnar’s (1972:511) viewpoint is that if dental wear is a normal by-product of human being’s contact with their environment, then the study thereof should reveal a record of the diet, food preparation methods and social habits (cf. Sicher 1953:401).

Although a large proportion of dental wear may be attributed to the diet of the ancient Egyptians, it is likely that the process was intensified by other factors. Factors such as the common edge-to-edge Class III[108] malocclusion, which is prevalent of a large part of the population, inherent to attritional wear, with accompanying changes in the temporomandibular joint (Leek 1972a:291, cf. Leek 1966:60). Secondary edge-to-edge relationship caused by occlusal and interproximal wear is the more common result of dental wear. Without intercuspation, teeth are free to migrate, usually in an anterior (mesial) direction. This notion of tooth migration is considered natural and necessary to provide the third molars space into which to erupt, and generally result in the relief of crowding of teeth (Hylander 1977:302).

Egyptologists have long since described the wearing down of the dentition as ubiquitous in every Predynastic and Dynastic skull. The severity of dental wear that was found in the skull of the 18th Dynasty Pharaoh Amenophis III, currently housed in the Cairo Museum made bioarchaeologists realise that if the wear of the Pharaoh's teeth reached such dimensions, what is to be expected in the rest of the underprivileged of the time? The King would most certainly have had a better diet than the rest of the population (Leek 1966:60). In his studies of the ancient Egyptian population, Thornton (1995:43) also described gross levels of occlusal wear as well as the pathological consequences thereof among all levels of society, in the form of dental abscesses and ante-mortem tooth loss.

4.5.1.7 The effects of dental wear and the significance thereof

Associated with the gradual loss of tooth material are certain anatomical relationships between the teeth and jaws. Teeth undergoing certain changes apart from loss of its enamel covering: structures within the tooth are under threat (pulp tissue) with the resultant effect a change in the general oral health of the individual.

There are noticeable changes that occur in the dental arch dimensions, vertical facial dimensions, relationship changes between the mandible and the maxilla and atypical migration

[108] Primary class III occlusion is one of the three types of occlusion, the relationship of the upper and lower dentition when the jaw is closed, in this classification an edge to edge relationship of the incisor teeth are seen (Leek 1966:60). Secondary edge to edge relationship of the jaws are the result of teeth drifting into such a position because of occlusal and interproximal wear.

of teeth among adults in high dental wear environments like ancient Egypt. Newman (1999:731) reports compensatory changes in the vertical dimension of the jaws in response to the loss of occlusal enamel covering. The upper border of the inferior alveolar canal is a fixed reference point from which vertical changes in the mandible is measured. The relationship between this upper border of the inferior alveolar canal as a reference line and the occlusal surface (occlusal plane), the cemento-enamel junction, the alveolar crest and the root apices of the second lower premolar and the three lower molar teeth remain constant throughout the life of the individual. Johansson *et al*. (1993:398) report other factors associated with occlusal wear in high-wear environments. Other factors are:

a) The significantly higher wear profile among the male population compared to that of females.
b) An increased biting force found in men.
c) Decreased occlusal tactile sensitivity, also resulting in increased biting force.
d) Less crowding found within the dental arches.
e) Cephalometric changes of the jaw relationship where signs are seen in the retroclination of the maxillary incisors, as well as a greater interincisal angle. Most of the above changes can only be explained by dietary abrasion and by certain lifestyles where teeth are used as tools.

Lastly, dental wear has the result of compensatory tooth eruption to counteract the loss of occlusal tooth material. Passive eruption of the teeth keeps pace with the continual loss of tooth material; therefore, no change in facial height should occur in the living entity (Hylander 1977:303).

4.6 ACHES AND PAIN OF THE ORAL CAVITY IN ANCIENT EGYPT

> *For there was never yet a philosopher that could endure the toothache patiently.*
>
> (William Shakespeare 1564-1660)

The first graphic mention made of a sufferer of toothache was perhaps the tale of a Sumerian deity, the Earth god *Enki*, whose sister asked him: '*My brother, what hurts you*?' upon which his answer was: *'zú-mu ma-gig'*, my teeth hurt me! (Kinnier-Wilson 1996:38). In the research of 3 000 mummies Patel (2010:11) found that 18 percent suffered from what is known today as painful dental conditions consequential of periodontal disease, dental caries and abscesses[109]. *Celsus*, a first Century Roman writer, lists toothache as amongst the worst agonies of humankind (Rosner 1978:285).

The effect of dental disease in ancient Egypt is clearly seen in the written word: citations such as *'pain in the teeth*, and a '*tooth that gnaws into an opening in the flesh*' were most certainly uttered by sufferers of dental disease because these words were mentioned in the surviving medical Papyri (Leek 1969:289). Leek (1966:60) however, refutes the general opinion that severe dental pain was inconceivable in ancient Egypt because no mention was made in any of the medical papyri.

There are numerous causes of painful experiences within the oral cavity. Pain due to caries in ancient Egypt did not play a big role because caries was not commonplace among the general population. Pain should certainly have been a problem because of the rapid and intense wear of teeth that caused exposure of the pulp (Rose & Ungar 1998:349 cf. Leek 1966:61). Leek (1967:53) mentions periodontal lesions, which invariably leads to the loosening of the affected teeth with the sequelae of inflammation and severe pain in the surrounding gingival tissues.

An unconventional reference to a condition that relates to toothache is mentioned by Bouwer (2012:225) in her research of obstetrics and gynaecology of ancient Egyptian women, found in a classical article of Griffith quoting the Papyrus Kahun which contains the following prescription… '*Knowledge of a woman pained in her teeth and jaws; she knows not [how to open?] her mouth. Say thou to her it is the itching (?) determinative a tooth) of the vulva. Do thou for her (thus): kap her with oil and incense in a bowl (?), pour on her the urine of an ass that has engendered two colts on the day that it has passed it (the urine). If her... is pained from her… shoulder (?) to her... hips'* (Griffith 1893:11).

[109] The author is of the opinion that the statistical information of Patel on dental pain does not include the pain that originates from dental wear, which may vary from slight to excrutiating pain whenever the enamel of a tooth has been worn away whenever the laying down of secondary dentine is lagging behind increasingly faster wear patterns.

Bouwer (2012:225) warranted that the prescription is for an unknown complication, disease, or ailment, mention that the recipe specifically chose the urine of a donkey mare that had just given birth to twin foals. This may perhaps be because the mare would have high levels of oestrogen in her urine, which may have some bearing on the prescription.

Stevens (1975:950) relates to the parallel recipe that Griffith described above but only in a feasible later translation as follows:

Kahun: recipe 5: *instructions for a woman suffering in her teeth and her gums that she cannot open her mouth. You should declare about her: 'This is acute pains of the womb" you should prescribe for it: … (lost) … then fumigate her over oil and frankincense in a d'd'-bowl, and pour into her vagina the urine of an ass who has created his fellow the same day as he passed it. If however she is suffering in her pubic region as far as her clavicles and as far as her buttocks, this indicates an incurable disease'*. Kahun added in recipe 33*: 'to prevent toothache in a woman who has conceived: beans ground up with [ ] … for her teeth until the days of giving birth. This is a cure for toothache that has been really successful countless times'* [sic].

Although the Kahun papyrus deals with mainly gynaecological matters, it does refer to yet another toothache incident:

> Kahun; Kah 33 (3, 25 - 26)
>
> *Not allowing that a woman having toothache […]:*
>
> *Beans, should be milled […] at her tooth (nḥḏ.t) on the day that she will bear a child.*
>
> *[that is] the elimination of the toothache. Really divine, a million times* (Von Deines *et al*. 1958:287).

A remarkable treatment for sleep bruxism that causes pain in the temporomandibular joint, was described in the Babylonisch-Assyrische Medizin (BAM) texts, presumably of Mesopotamian origin, and presented by Kinnier-Wilson (1996:137), translated is as follows:

'If a man grinds (or, 'grates') his teeth in his sleep, you will take a human skull, wash and anoint it with oil, and for seven days it shall be kept in place at the head of his bed. Before he lies down he shall kiss it seven times and lick it seven times – so he will recover'. Bruxism, like

extreme dental wear has at times negative influence on the temporomandibular joint. Severe headaches and referred earache pains are common consequences (Magnusson & Carlsson 1978:86).

A similar repulsive treatment features in a prescription for painful periodontal disease recorded by Blackburn (1977:29): Egyptian peasants in ancient times should split the body of a living mouse[110] and then lay the halves while still warm along the gums of a patient. The bleeding would stop. The superstition of ancient Egyptians regarding toothache, led them to turn to the local mice, which they regarded as protected by the deity *Re* and capable of fending off death. A common remedy for toothache involved applying half of the body of a dead mouse to the aching tooth while the body was still warm (Forrai 2009:188).

The mouse had been one of the sources of therapy in ancient Egypt. Mice were regarded as 'Givers of Life'. There is a connection between the inundation of the Nile River, source of life, and the belief that mice were spontaneous products (*abiogenesis*) of the Nile mud after each inundation (Dawson 1924:83). Occasionally the presence of mice bones in the alimentary canal of children proves that small rodents had been eaten after being skinned, as treatment in difficult situations (in extremis), but not revealed what the situation is (Smith 1923:50). Other uses of mice as treatment for various maladies that are mentioned in the Medical Papyri are found in the Ebers, Hearst, and in magical papyri. Within these papyri there are amongst others: treatments for rheumatoid arthritis, for various hair disorders, to drive out *sesmi* (some unknown infantile ailment), applied to scorpion stings and helps to stop dribbling of the mouth. The ash of a mouse mixed with honey cure earache, or when rubbed on the teeth, is a mouth refresher (Dawson 1924:84).

There is no indication that the sufferers of pain in ancient time used any specific drugs to dull toothache apart from what the recipes described in the medical papyri. However, the use of opium could well have filled the gap between professional treatment and private use. Opium trade between Cyprus and Egypt in the 18th Dynasty was well documented in the many Cypriote base-ring pots discovered in Egypt (Merrillees 1962:289). Reeves (1984:317) infers

[110] The Egyptian mouse would probably have been of the genus Acomys.

that the Edwin Smith papyrus' mention of a drug referred to as *spn* or *spnn* translates as poppy, which probably refers to *Papaver somniferum*. Opium from the Eurasian poppy *Papaver somniferum* is a narcotic drug known for its pain relief, physiognomies and sleep inducing properties. The alkaloids of the drug namely morphine, codeine and others, are not known to have existed in ancient Egypt. Merrillees (1962:292) is of the opinion that the population did not only wear an amulet in the form of a vessel modelled on the unripe seed capsule of the *Papaver somniferum* to ward off evil-causing maladies, but also for its pharmacotherapy properties. In summary Merrillees named opium's probable uses in Pharaonic times as:

- A sedative for wounds and necrotic wounds in the breast
- A sedative for an abscess with a prominent head
- A sedative for exanthema of the scalp
- A dusting powder is to be mixed with other drugs for scalp problems
- A sedative for a child

Opium may well have been the panacea for all common illnesses, an indispensable medicament in ancient Egyptian households. Merrillees (1962:292) named the other maladies that opium would have been taken orally were: diarrhoea, dysentery, cold shivers, fits of fever, asthma, chronic coughs, rheumatism, diabetes and pains of all kinds. Opium must certainly have been the drug of choice in toothache because dental pathology was ubiquitous among the ancient Egyptians.

Apart from their pharmaceutical knowledge, the ancient Egyptians made inroads in the study of anaesthesiology. There is ample evidence to suggest that 'primitive man employed digital compression of the carotid arteries to produce anaesthesia' (Zorab 2003:826). Instead, the ancient Egyptians advanced the science, using both hemp[111] (Cannabis sativa) and poppy juice to induce drowsiness in patients, which would eventually result in loss of consciousness. An interesting use of herbs in Egyptian medicine is their role as analgesics, i.e. to relieve pain. Cannabis was one such medication which was administered by mouth, rectum, vagina, topically and via fumigation. Through research and collaboration in the field, researchers

[111] This association of shemshem with cannabis or hemp, is derived from its association with rope making and basketry, as well as medicine, leaving researchers like Dawson (1934:44) to identify hemp with cannabis.

agreed that the Egyptian hieroglyphs pronounced '*sm-sm-t*' or '*shm-shm-t*' literally translates into 'The Medical Marihuana Plant' (Bouwer 2012:70).

Dental wear was ubiquitous in ancient Egypt. When the occlusal enamel and underlying dentine are worn away by the tough gritty foods, the pulp of the tooth is in danger of being exposed to the oral environment. Once this happens the pulp becomes infected and abscessed which eventually leads to tooth loss. Not only will the individual experience excruciating pain and the health dangers of an active infection, but also once the tooth is lost, the ability to chew and eat will be lost. All of this potentially contribute to premature death (Rose & Ungar 1998:349).

Pain due to pulpitis is the topic of Alt *et al*. (1998:250): pulpitis is an acute or chronic, local or generalised inflammation of the pulp. It is typically accompanied by a sharp or dull, sometimes throbbing pain with moderate to severe intensity. Pulpitis is usually associated with caries; conversely, in ancient Egyptian context the prevalent causes of pulpitis and subsequent periapical lesions appear to have been a dental pulp exposed by excessive dental wear (Taylor 1963:101).

The symptoms of an acute osteomyelitis[112] are similar to those of an acute infection, with severe pain and a raised temperature being the most prominent features. Teeth in the affected area are tender to percussion and become loose (Alt *et al*. 1998:262). Dental abscesses usually erupt to the labial side of the mandibula or may cause severe complications in the maxillary sinuses. Forrai (2009:189) is confident that the Ancient Egyptians suffered from various extensive, severe and painful dental diseases. She also states that it could hardly have been alleviated, or relieved, by the treatments or prescriptions made available in the medical Papyri. She did

[112] Osteomyelitis is a term applied to any inflammation of bone or bone marrow, usually caused by infection from such microorganisms as Staphylococcus aureus, various streptococci, Mycobacterium tuberculosis, as well as, several fungi. The microorganisms generally reach the bone through the bloodstream from localised infection or even from infection elsewhere. Occasionally osteomyelitis occurs by direct infection after surgery, after a compound fracture, or as a result of trauma. Osteomyelitis, especially bacterial, presents as an acute disease. Common symptoms include chills followed by fever, with acute pain and swelling above the site of inflammation. The inflammation begins in the marrow cavity and causes softening and erosion of the bone structure, often with the formation of pus-containing abscesses, which soon spreads over the entire bone, with consequent death of the hard portions of the bone (sequestrations) and in ancient time may have caused the death of the individual (Vorhaus 2009: s.v. osteomyelitis) (see Appendix IV).

however; mention that the bark of the willow tree may have been suggested in one of the recipes, mixed with ground beans may have been the forerunner of aspirin (Forrai 2009:190).

Weinberger (1981:110) mentions the use of ground kidney beans in another prescription. It was to be placed on a woman's tooth (*nhdt*) 'on the day on which she gives birth': as a 'preventative of toothache; true and a million times excellent!' There is little evidence the ancient Egyptian had any idea as to the aetiology of toothache. The papyrus Anastasi IV mentions the following incident of an Egyptian official on an outpost, describing the suffering of a colleague:

'*I am staying at Kenkenente, unequipped, and there are neither men to make bricks nor straw in the neighbourhood… I spent the whole day watching birds… There is a gnat at sunset and the n=midge at noon; the sand-fly stings and sucks and sucks at every vein… A mns-scribe is here with me, every muscle of whose face twitches, the wštt-disease has developed in his eye and the fnt-worm into his tooth. I cannot leave him to his fate'* (Anastasi 12, 6 - 13, 7) (Weinberger 1981:110).

The author is a dentist with reputable experience in the diagnosing and treatment of toothache and tooth hypersensitivity, and wishes to make the following observations on tooth sensitivity. There is lack of insight of scholars on the extent of dental hypersensitivity, unless they have experienced it first hand, proves to influence their judgment on dental pain the ancient Egyptians. In the 'Molnar dental attrition scoring system' (see page 122) hypersensitivity may be initiated at the score of 3 where the dental attrition or wear has merely exposed one minute 'dentine island'. Hypersensitivity (pain) to contact (food) and temperature (hot and cold) on such exposed dentine areas can, at times, be the source of excruciating pain. This newly exposed area compels a great number of patients with this malady to seek urgent dental treatment in modern times. Hypersensitivity of various degrees may be experienced in an on-going manner as the wearing down of tooth substance continues throughout the Molnar scoring stages 4 to 9. Sensitivity continues as long as the pulp has not died down and the wearing away of enamel stays ahead of the formation of secondary dentine.

Dental wear is often referred to as a normal physiological process; however, even with the self-adapted protective measure of the formation of secondary dentine, the psychological process becomes a pathological problem (Senawongse *et al*. 2008:14). With a population who commonly suffered from extreme dental wear like the ancient Egyptians; it would make sense that they were perhaps a rather melancholic society – unless they had some form of treatment with efficacy not yet known to science.

4.7 ORAL HYGIENE IN ANCIENT EGYPT

Epidemiology is the study of disease origin and the spread thereof: the scientific study of the causes and transmission of disease within a population, inclusive of the pattern of the disease's aetiology, progression or development of the disease, and the developmental characteristics of a specific disease. The prevention of disease, by preservation of health and cleanliness is defined as 'hygiene'.

The effect of social customs and habits on oral health satisfies the anthropologist concerned with bioarchaeology – the primary reason that scientists are interested in oral diseases of ancient populations is so that we may determine new methods for preventing oral diseases and in defining the effects that harmful cultural habits have on the dentition (Davies 1963:209). The practice of oral hygiene within a cultural structure of a population determines the oral health of that population to a great degree. The social custom of cleaning teeth is as old as humankind itself, however, some epidemiological studies have shown that the prevalence of caries is substantially low in people who do not clean their teeth at all, and is high in people who do clean their teeth (Davies 1963:216).

The Egyptian understanding of dental hygiene was primitive. The Ebers papyrus describes recipes for gargles as part of a preventative dentistry prescription. Blanchard (2003:28) mentioned some of the irrational pharmaceutical concoctions used as gargles; that of including powdered mouse bones and the ashes of burnt rabbit fur to concoctions.

Gurudath *et al*. (2012:225) revealed that the ancient Egyptians were making a tooth powder consisting of powdered ashes of ox hooves, powdered and burnt eggshells, and pumice. The earliest known reference to a toothpaste was found in a manuscript from ancient Egypt, wherein a prescription of a mixture of powered salt, pepper, mint leaves and iris flowers is advocated.

The Romans used toothpaste formulations based on human urine. Since urine contains ammonia, it is probably effective in whitening teeth (Gurudath *et al*. 2012:226).

Davies (1963:216) attested to the use of tooth powder (*ovdontovtrimma*) at various sites in Egypt, primarily from the *Fayyum* region. A number of popular prescriptions (recipes) written in Greek for toothache and other dental disorders were found dating from the second century of the Common Era. Dental cleaning sticks were in use in Dynastic times and are still in use by many people in India and Africa today.

The use of toothpicks for cleaning teeth was known in ancient Egypt, but unlike other societies, they did not resort to dental chewing sticks, which are for cleaning teeth and massaging the gums. The use of toothpicks in conjunction with dietary grit inevitable led to interproximal grooving, associated with dental pathology (Berryman *et al*. 1979:211). Odontologists make the diagnosis of interproximal grooving when examining the dentition and grooves are found in the area of the enamel/cementum junction between upper molar teeth. This may imply that some form of dental hygiene was practiced in Egypt from Predynastic through Dynastic times because interproximal grooving can possibly be blamed on toothpick habits (Formicola 1988:668).

The Babylonians used chewing sticks about 7 000 years ago. The most common source of chewing sticks is *Salvadora persica*, a small tree or shrub whose stems and roots are spongy (see figure 4.9). The source may differ from country to country, as well as regions within countries. Chewing sticks are crushed between the teeth to form fibres not unlike that of a toothbrush. The stick would then be used to dry-rub (brush) the enamel surfaces in a circular motion with mild pressure but over a long period. The Chinese were also amongst the first people to use the chewing stick as a toothbrush to clean the teeth and massage the gingival tissues. Chewing sticks are commonly made of plant limbs or roots, with one end beaten into a soft fibrous condition and used for scrubbing and brushing the teeth. Chewing sticks are still in use today, especially people of the Islam religion, therefore inclusive of modern-day Egypt (Almas & Al-Lafi 1995:206). Sadhan and Khalid (1999:81) identify the *miswak* as a chewing stick; different types of chewing sticks are used around the world, but the most commonly used plant in the Middle East is from the Arak bush (*Salvadora persica*). The pharmacological and therapeutic aspects of the *miswak* play a positive role in plaque control, but negative since it may be a contributory factor in causing gingival recession, tooth wear, bleeding gums and thereby compromising periodontal health.

Figure 4.9: A chewing stick - used as a toothbrush (Almas & Al-Lafi 1995:206).

Dixon (1969:435) defines a masticatory as any substance that is chewed to increase saliva and which is then not digested and therefore nutritional, gustatory, narcotic and medicinal effects may occur concomitantly. Forshaw (2009a:422, 423) also mentions the use of masticatories (quids) as oral disinfectants and mouth refreshers. The Egyptians were probably the first to invent breath refreshers, designed for the sole purpose of defeating bad breath. These masticatories are the products of a mixture of frankincense, myrrh and cinnamon together with honey. The resultant paste is then shaped into pellets and dried. The expelled residue is known as a quid. Upon examination of these quids, scientists can determine blood groups from the saliva remaining in the bite-marks. The expectorated remains of masticatories have immense value as a source of information on the day-to-day activities of the ancient Egyptians.

Other recipes of masticatories found in the Papyrus Ebers are referred to as little pellets (*ipp.t*) which are used as mouth deodorants in order to sweeten the breath in the same way that frankincense was chewed. Natron[113] of non-plant origin was also a masticatory substance (Dixon 1969:445). In the section of the Ebers papyrus (Eb No 852) dealing with dental medicaments, masticatories *hpʽ* are mentioned.

The noun derived from the verb *hpʽ w* (masticatory) indicate the spitting out after being chewed. When in the case of the verb *hpʽ* being prescribed with milk in the recipe, it would indicate the swilling round of the liquid in the mouth, medicinally used as a mouthwash (Dixon

[113] Natron is a light-colored mineral: a white, yellow, or gray hydrous sodium carbonate mineral. The source of natron lies within salt deposits and soda lakes. A common use for natron in ancient Egypt was for funerary practices and specifically for embalming practices (Silverman 2008: sv Natron).

1972:441). One Ebers recipe mentions a fumigator to sweeten the inside of a house or clothing, the basis of which consisted of *cntyw*-gum-resin and Pistachio-resin (nut kernel of the Pistachio tree). This recipe was also prepared and made up into pellets (*ipp.t*) which women are known to use as a mouth deodorant to sweeten their breath (Dixon 1972:441). The papyrus plant stems (raw, roasted or boiled) were also chewed, the residue then spat out. This masticatory was probably enjoyed for the sweet taste and can therefore be classified as a nutrient. The papyrus plant was considered one of the three most useful aquatic food plants in Egypt in ancient times (Dixon 1972:442).

4.8 DIET AND DENTAL DISEASE IN ANCIENT EGYPT

Among ancient people, dental wear appears to be a natural phenomenon; however, the degrees and kinds of wear seem to vary from population to population. Molnar (1971:175) suggests that the variability is conceivably related to certain material aspects of culture such as diet, food preparation techniques and tools used and abused in the processes. The relationship between some dietary factors to dental health has long been researched. There are a number of other factors that influence the diet *per se* that should be taken into account in any population's social structure: these are the religious customs; the socio-economic status; customary taboos and fads; and urbanisation (Davies 1963:212). The kinds and degrees of dental wear are prominently related to the culture of a population, especially when taking into account that diets vary across cultures, as do food preparation. The same is observed within a culture during transitional phases over time and within socioeconomical fluctuations (Molnar 1972:513).

Lukacs (1989:261) mentioned that the oral cavity functions primarily as a food processor. Composition and consistency of foods therefore determine, to a large degree, the health or morbidity of the individual. Due to the close relationship between teeth and diet, the dental structures have incorporated a variety of characteristics that reflect what had been placed in the mouth and presumably had been consumed, through caries and metabolic disrupted hypoplasias (Goodman & Rose 1991:279).

Teeth are exposed to every part of the diet that enters the digestive system. The influence that the diet has on the dentition should as expected, act as reliable indicators for the diet eaten during a lifetime (Hillson 1979:147). During the development of the dentition, teeth are affected by dietary factors. The reconstruction of diets in antiquity is a complex process.

There is a need for clarifying dietary terminology through definitions as revealed by Rose *et al*. (1991:283): (1) diet is that which is eaten, (2) nutrition is the measure of the physiological adequacy of the diet, and (3) subsistence is the procurement of the dietary material. The nutritional quality of the diet during the early developmental years exerts a powerful influence upon the normal dental maturation. Gilbert and Mielke (1985:286) suggested that the quality of adult enamel provides a memory in the form of a permanent record of childhood stress episodes. Goodman and Rose (1991:290) cautioned that enamel hypoplasias are not always perfect assays of nutritional status and that correct diagnosis should be made between hypoplasia due to systemic and non-systemic factors. Lovell and Whyte (1999:69) found that stress episodes occurred most commonly between the ages of 3 and 5 years in the Late Iron Age in Egypt. Hypoplasia lesions in deciduous teeth would suggest that physiological stress had already occurred *in utero*. Skinner and Goodman (1992:161) reported the pervasiveness of enamel hypoplasia in the permanent dentition of selected samples: hypoplasia statistics for Egypt and the Southern Levant were compared to that of Mesopotamia during the periods of the Metal ages and the Roman period, and were found to be dissimilar.

Relevant to this study of hypoplasia is the percentage of hypoplasia that affected individuals – Egypt and the Southern Levant: 70 percent (n = 282) and Mesopotamia: 17 percent (n = 327). This data compares well with those of *cribra orbitalis*[114] in the same period and region. Edwards (1995:785) asserted that iron deficiency anaemia (*hypoferraemia*) produces cranial vault and orbital roof lesions in childhood (*porotic hyperostosis*[115] and *cribra orbitalis*), and remarked that it had been shown that chronic blood loss stimulates marrow hyperplasia and that dietary insufficiency alone causes notably less of a hyperplasia response. Roberts and Manchester (1995:60) found a strong association between enamel hypoplasia and *cribra orbitalia* in an ancient Nubian population. Jerome Rose (2006:73, 76) analysed the bioarchaeological human remains at the excavation of Tell Amarna during the period of the

[114] *Cribra orbitalis* can be seen as heralding a disease but is not disease per se. *Cribra orbitalia* is a well-recognised non-specific stress indicator (Nathan & Haas 1966:171).

[115] Iron deficiency as indicated by the high childhood prevalence of porotic hyperostosis (94 percent) is found to be *Cribra orbitalia* is a bone condition that consists of lesions that originate from anaemic related conditions, hyperendemic in the Dakhleh area (Molto 2001:81).

building of the new city of the Pharaoh Akhenaten between 1 350-1 330 BCE. Rose (2006:76) found 23 percent of the working class population reveal the condition of *cribra orbitalis* due to a diet not adequate in iron, producing anaemia. Unfortunately, no records of dental hypoplasias were preserved for research purposes. Neiburger (2000:16) suggested that the ancient Mesopotamians also suffered from chronic malnutrition, probably caused by famine during the beginning of the second millennium in Ur, home of the biblical Abraham. The Sumerian population was short-lived and suffered from severe dental wear (95 percent); periodontal disease (42 percent) and caries (2 percent). Research at the Kellis cemeteries in the Dakhleh oasis area revealed stochastic results of all dental maladies of the Late Roman Period. Results show high porotic hyperostosis due to anaemic considerations. Caries, as expected in later periods of ancient Egypt, had increased dramatically in the adult population, an overall prevalence of 20.7 persent (Molto *et al*. 2003:357).

4.8.1 Diet of the ancient Egyptians

Food is an important issue for archaeologists because it reflects the social, economic, and even the religion of a society or population. The food ingested by different cultures has a marked effect on their health and nutrition. Archaeological interest in reconstructing palaeodiets has mainly focussed on two areas according to Samuel (1997:579): one is the raw ingredients of the culture's sustenance and the methods by which these resources are obtained; the other is the medicinal and nutritional experiences of ancient populations that bioarchaeologists reconstruct by looking at the formation, structure and chemistry of teeth and bones. The health of a population can be assessed when all these data are available.

The Egyptians called their country *Kemet,* meaning 'the Black Land,' a reference to the dark, fertile soil that remained after the Nile floodwaters had receded. They also used another term, *Deshret,* or 'the Red Land,' a designation for the desert sands that burned under the blazing sun (Nunn 2002:7). The annual flooding of the Nile River[116] (inundation) between the months of June and September makes the Nile Valley one of the most fertile areas known in the ancient

[116] Elwell & Beitzel (1988:664) see Egypt as the gift of the Nile, without it Egypt cannot exist. The Nile deposits a layer of rich silt every year as it overflows its banks. The cultivated area on both sides of the Nile is on average only about 13 Km wide today, and only 4 percent of the land is arable while 96 percent is desert.

world (Elwell & Beitzel 1988:664). It is also then true that Egypt, as a country is nothing more than the deposit left by the Nile River, apart from the development around the various oases.

A comprehensive study of the diet and food supply in Egypt during the Stone Age revealed a diet based on hunting, fishing and harvesting molluscs. In the Neolithic Age emmer wheat (*Triticum dicoccum*) and barley (*Hordeum hexastichum*) were the basic diet of the period; later inhabitants ate bread and porridge after they became agriculturalists. Dynastic Period's diet comprised of vegetable products, bread and less proteins. Some of the more common diets comprised edible tubers, edible parts of papyrus, dates, figs, jujubes and seeds of the lotus plant, mostly indigenous plants.

The Old Kingdom Period's basic diet was based on bread, vegetables, fruits, fish, milk and cheese with a clearly reduced intake of meat during this period. Various forms of leavened bread and beer (malt) were discovered in the tombs of less privileged state workers (Saffiro 1972:297, 301). As for the New Kingdom, the Harris papyrus uncovered the tradition of a diet of meat and fish, cooked or simply smoked and salted. Bread during this period was leavened and oil was used only by the wealthy. Beer was confirmed by its presence of residues in jars which still contained traces of malt (Saffiro 1972:303). The variety of foods in the diet of the population of Dakhleh[117] during the Ptolemaic and early to late Roman periods is described by Molto (2001:91) as unleavened bread, dates, figs, onions, sorghum, barley, wheat, cheese, chickens and pigeons. Tombs of the ancient Egyptian nobilities have yielded lists of foods, and sometimes tables laden with food for the afterlife were often depicted in frescoes. The undisturbed tomb of Kha and his wife Merit, a Theban tomb of the XVIII Dynasty in the period of Amenhotep III (1 390-1 352), has provided unique physical samples of the food placed in the tomb to be consumed in the afterlife. The ritual offerings for the deceased included numerous examples of bread in a variety of shapes. There are wine jars, jars of fat, oil, flour, meat and fish. A vase of roasted and salted birds, preserved fruit and two large sacks of doum palm nut. Vegetable substances include peppergrass (*Lepidium sativum*) and *cumin* or

[117] The carbohydrate rich agricultural diet of the people from Dakhleh during the above periods resulted in moderately high levels (11.0 percent) of dental caries whilst the tenacious presence of sand in the diet was responsible for the high rate (9.5 percent) of antemortem dental fractures (Molto 2001:81).

Cuminum cyminum) that was used as a flavouring agent (Saffiro 1972:302, 303; cf. Nunn 1996:18).

One of the principal modes adopted by the ancient Egyptians for preventing illness shows their attention to a dietary regimen to have regular bowel movements. The Egyptians were well aware that the majority of diseases result from indigestion and excess eating. They used various remedies for constipation, used emetics and other simple means of relieving the system, which some persons were in the habit of repeating every two or three days (Wilkinson 2009:351). 'Those who lived in the corn country' as Herodotus termed it, were particular about their health and would follow a dietary regimen submitting to a regular course of 'treatment' of some form of fasting for three successive days every month. Their conviction was that stomach irregularity caused illnesses, and following this, if preventives were ineffectual, they had recourse to suitable remedies as many recipes for stomach ailments were widely suggested in the various medical papyri (Wilkinson 2009:351). Aboelsoud (2010:88) suggested that the medicinal properties of many herbs used for these maladies grew in the desert, particularly between the Nile and Red Sea. Many of these medicinal herbs are still known to the Arabs today; though their application has unfortunately been lost or improperly recorded and preserved. Garlic was an essential part of their diet, in addition to it being an excellent healing agent. Fresh cloves were peeled, mashed and macerated in a mixture of vinegar and water. This linctus was then used to gargle and rinse the mouth, or taken internally to treat sore throats and toothache (Aboelsoud 2010:88).

Food selection is subject to the socio-economic status, prohibitions and trends of a period and development of a sector of the population. These factors determine the physical characteristics of the sustenance. In figure 4.10 below, a flowchart, devised by Davies (1963:212), sets out dietary habits and effect on dental structures and diseases. The physical effect on the teeth would therefore depend or be determined by the socio-economic status, the religious custom, certain prevailing traditions and the development of a sector of the population, roughly divided into an affluent society and the underprivileged. As mentioned earlier, the prevalence of caries in both the Predynastic and Dynastic periods were relatively low among the common people and higher amongst the royalties who had more access to refined carbohydrates like sweet sticky foods. Bread was the staple food of the general population and was clearly the main cause of severe dental wear because of the ever present inorganic inclusions.

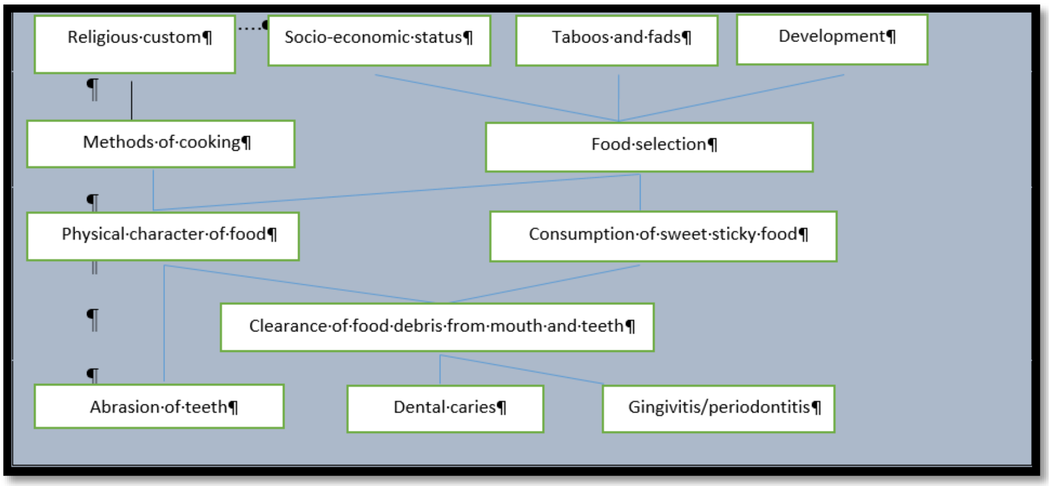

Figure 4.10: Flowchart of dietary customs and social practices, and the effect on dental structures and diseases (after Davies 1963:212).

Walker *et al*. (1991:169) discussed the importance of tooth wear in making inferences about diet, food preparation techniques and habitual activators involving the teeth, as well as an important source of data, on the age structure of prehistoric populations. They also indicated that the demographic information provided by tooth wear varies according to the abrasiveness of the diet. Most ancient peoples consumed tough grit contaminated food.

The customary methods of cooking in ancient Egypt have resulted in the incorporation of sand in the food. This has been shown to result in the extensive abrasion of teeth. Occlusal surfaces wear down below the maximum circumference of the tooth enamel; the interproximal circumferential enamel is destined to break away, creating an interproximal space where food becomes impacted which inevitably results in periodontal disease (Davies 1963:214). Dixon (1972:435) mentioned the effect that the habit of chewing vegetable masticatories has on enamel, a custom that is mentioned in the Papyrus Ebers. Dixon (1972:437) quotes Theophrastus: '*All natives in Egypt chew papyrus*[118] *uncooked, boiled or roasted. They extract the juice by chewing, and then spit out the quid*'.

118 The Cyperus papyrus is a perenial plant, extant in the marshy habitat of the Nile river. The pith of the stem, rich in phytolithes, was boiled and eaten. Plants produce tiny mineral objects called phytoliths while they grow.

4.8.2 Bread as staple diet in ancient Egypt

Egyptian bread justifies being deliberated on, separate from the general remarks on diet in ancient Egypt. Bread has been documented as the contributory cause of dental wear among the population of ancient Egypt. Ancient Egyptian methods of baking bread in the Deir el-Medina area of the New Kingdom (1 550 to 1 307 BCE) are described by Samuel (1996:488-490) as commonly made of coarsely milled wheat, well kneaded into dough with often inclusions of chaff and unintended inclusions such as grit (see bread baking in figure 4.11 below). Investigation by optical and scanning electron microscopy revealed that a portion of malt with yeast was added to the mixture. This resulted in a mixture of coarsely ground cooked and uncooked malt, resulting in a large proportion of starch and chaff remained in the bread, favourable for causing severe dental wear.

Diet and the health factor of teeth are interrelated in a positive as well as in a negative way. Bread as the staple diet of the Egyptians in all Periods, was largely responsible for the epidemic proportion of various dental diseases. One of the principal problems is the way in which the Egyptians ground their flour[119]. It appears that the process of grinding wheat into flour was speeded up when a 'handful' of fine desert sand was added to the grinding process. Both wheat and sand would then be reduced to powder by the grinding stone wheels, or alternatively, by millstones and stone pestles[120]. Egyptian flour was customarily made from emmer wheat (*Triticum dicoccum*) that yielded a particularly sticky dough, which would then adhere to teeth, hastening the tooth decay process. The sand formed an abrasive powder that rapidly abraded away the tooth enamel, eventually exposing the pulp to infections with dire consequences (Saffiro 1972:298).

Phytoliths is a major factor in the cause of dental wear, at first microwear but can later cause severe wear as the chewing of quids become a habit (Puech *et al*. 1983:628). Scientific classification: Papyrus belongs to the family Cyperaceae. It is classified as Cyperus papyrus.

[119] Dough was kneaded on a stone on the ground as seen in figures 4.13 and 4.14 below. By the time of the Middle Kingdom, the stone was placed on a table for easier access of the worker. When larger quantities were needed, it was placed in large tubs and kneaded under-foot.

[120] Grinding stones excavated in Upper Egypt in the Predynastic period consist of igneous rock (basalt, granite) and metamorphic rocks (marble, quartzite) from the Dokkan volcanics located in the Wadi Hammamat. These grinding tools were extremely hard and unlikely to have left much microstructures in the final product. Later periods probably used local limestone for grinding stones which were known to have left much micro-inclusions in the flour (Mahmoud & Bard 1993:241, 245).

The Greeks called the Egyptians *Artophago*, an epithet used to describe them as 'eaters of bread'; probably because of the amount of bread they ate (Wilson 2001:93). Further evidence of the excessive intake of bread[121] is found on a stele commemorating an expedition of Seti I (1 309-1 291 BCE) wherein the following bread ration for the troops became evident: daily ration of bread per head; 1 860 gram. This relates to 4 483 kcal, more than adequate for the daily provision of calories (Hillson 1979:154).

Figure 4.11: Wheat made into bread was one of the main foods eaten by both rich and poor ancient Egyptians. The picture shows the bread-making process.

Bread baking sees dough being fashioned into flat, round loaves, and baked on hot stones or on the outside of a mud oven. Bread was baked in many different shapes and sizes, as various hieroglyphic symbols for bread attest. The hieroglyph alphabetical 't' is symbolised by a loaf of bread (see figure 4.12 below). Leavened bread was only introduced at around 1 500 BCE. During the Old Kingdom there were at least 15 types of bread; by the New Kingdom that number had risen to over 40 types. The introduction of leavened bread shows an improvement in the taste and digestibility of this basic food. The making of bread was closely associated with that of beer (Saffiro 1972:300). The bread for the rich was sweetened with the addition of honey, spices or fruit in the dough. Bread for temple offerings was often covered with cumin seeds and bread for magical and liturgical rituals were crafted into human or animal shapes.

[121] Ruffer held that the soldiers under Seti received four debens of bread, two bundels of vegetables and a roast of flesh daily; at Silsileh every worker at the sandstone quarries received the same and the King's bodyguard received five minae in weight of bread and vegetables and double rations of roast meat in addition to arysters of wine (Ruffer 1920:355). Reeves (1984:313) mentions that site workers of the pyramids were given radishes, onions and garlic to help ward off bacteria.

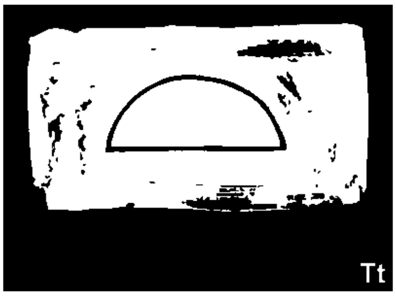

Figure 4.12: The bread loaf ideogram above is transliterated as ‘t’.

Figure 4.13: A primitive granite quern a simple stone mill used for grinding grain by hand (Leek 1972b: plate XXIX, 1).

Figure 4.14: An Old Kingdom limestone statuette of a woman making dough on the floor (Leek 1972b: plate XXIX 2).

4.9 CONCLUSION

Various dental diseases were discussed in this Chapter, all relative to the understanding of the health of the individual and of the population as a whole. Dental caries tended to be an uncommon condition in ancient Egypt as a whole, albeit a condition which slowly evolved in prevalence from the Prehistoric Period to the Roman Period to a more universal dental disease. The generally accepted aetiology of the disease is sugar, a product uncommon in the early Dynasties, but which in later Dynastic Periods increased when sugar was introduced to the New Kingdom. The aetiology of caries was not understood at the time until the tooth-worm was erroneously blamed as the causative factor, a concept proved to be preposterous to the modern scientific understanding of the causative factor for caries. However, the myth and legend live on in the uninformed Third World populations, who, to this day, believe the tooth-worm to be the malefactor that eats into the tooth.

Periodontal disease is arguably the most common disease in the world today, surpassing caries as the most common disease. In ancient times caries played a minor role, whilst periodontal disease was rampant in most societies and the aetiology and pathogenesis of this disease proves to be multifactorial. The theory claiming that periodontal disease was the predominant causative factor for losing teeth in ancient Egypt was later shown that not to be the case. Periodontal infection in the form of periodontitis is a very painful condition with many aetiologies. In summary of the process of periodontitis, the following: dental wear is probably the most common inducement factor of periodontitis. In extreme wear cases, the roof of the pulp chamber is breached; pulpal infection ensues, the result is the onset of pulpitis within the coronal part of the pulp. The infection then spreads and an abscess develops. The abscess spreads though the root apex into the periodontal ligament, causing periodontitis, an extremely painful condition, which ends up in the loosening of the tooth because of the onslaught upon the support system of the tooth, with eventual exfoliation or loss of the tooth. A further complication may be the spread of the infection within the surrounding alveolar bone spaces, a condition known as osteomyelitis may develop which when reaching the sinus cavity adjacent to the apex of the roots of maxillary teeth, may even cause the demise of the individual.

Enamel hypoplasia (EH) is a quantitative deficiency of enamel and is often termed an 'non-specific indicator of stress'. Hypoplastic lesions are seen by scholars as a window through which the history of disease of an individual can be seen. This is because the lesions that hypoplasia leaves on the tooth enamel are the result of an onslaught upon the developmental stages of the enamel (amelogenesis). Hypoplastic lesions are etched then into the enamel permanently. Such lesions are recognisable as furrows (linear hypoplasia) or pits in the enamel. These lesions are unsightly and are weak spots where caries may develop or where dental wear progresses. Molar-incisal-hypominaralisation (MIH) is similar to EH and is discussed as a possible cause of widespread dental wear because of the softening of the enamel surface on teeth.

The lack of effective oral hygiene was perhaps instrumental in the aetiology of many maladies of the oral cavity including caries, periodontal diseases and other infectious conditions of the soft tissues of the mouth. The relatively little communiqué in the literature of the time, nor any other type of communication referring to dental pain is still an unresolved issue. The pain from the dental maladies that the author assumed the general population would have suffered from evoked so little attention in the media of the time. This phenomena should infer that a civilisation which was otherwise so highly developed in science, to have had dentists to alleviate their continuous suffering and morbidity in ways unknown to modern science. The answers to the question whether the treatments advocated in the medical papyri to resolve painful dental conditions, lay modern dental science to ridicule their means and methods. It still may prove to be sufficient evidence of good dentistry if empirical studies in this regard follows this dissertation. There may still be an answer to be found if and when all the constituents of the recipes presented in the medical papyri have been identified and put to the test.

Severe dental wear in ancient Egypt was ubiquitous to the point of perhaps being an important factor determining the health and wellbeing of an entire population, with no regard of persona. It is hypothesized that the royalty of the land suffered from dental pathology to a greater degree than the average population due to a diet of more carbohydrates and sugars. Dental pain may have resulted in constant morbidity[122], and may even have been instrumental to the mortality of the sufferer. This hypothesis rests squarely on scientific research and information that is available for modern day society – with the difference being that an individual presently would have the opportunity for treatment for the malady from highly specialised hands. In comparison, the only known treatment in ancient Egypt was what the medical Papyri proposes, primarily that of the Ebers Papyrus. Although a number of prescriptions addressing dental maladies could be considered as supportive to alleviating certain basic symptoms, it would still be regarded by modern scientific standards as extremely primitive.

Apart from the fact that a good diet is essential to good overall health, the general diet of the Egyptian population in ancient times is reflected in a number of ways: good healthy teeth are substances of note only as far as statistics are concerned, and then only as reference points to compare not so healthy teeth with. Unhealthy teeth are of more interest to science. Hypoplasia and molar-incisor-hypomineralisation are two conditions that discloses the actual lifestyle situation of a delineated environment at a specific period, within a socioeconomic culture. In short; it should be able to reveal even times of wars and famine.

Bread is the principal predisposing cause of dental wear in a population known to have had bread as their staple diet across all sectors of society, even among the royalty of the land. Bread, however, were contaminated with a number of inclusions, ranging from sand to quern minerals, that in turn were directly responsible for the extreme dental wear that a great percentage of the population suffered from.

[122] The quotation 'like a bear with a sore tooth' implies anger or irritation – a monarch with a sore tooth may very well negatively influence his decisions and even the course of history.

CHAPTER 5

TEETH AND PALAEODEMOGRAPHY IN ANCIENT EGYPT

Abstract:

Demography is the interdisciplinary study of ancient human mortality, fertility, and migration. Palaeodemography in this Chapter deals with social characteristics of a population and their development through time. In an attempt to analyse and interpret the data provided by the archaeologist's discovery of human remains, in this case dental remains, will throw light on settlement history, demography, economic and political relationships. The internal shifts and strains caused by population migration are vital for understanding the social lifestyle of ancient Egypt. To determine the age at death of individuals, dental wear is but one of the changes that occurs in the process of natural aging and provides one of the most accurate means to determine the age of an individual. Palaeodemography simply refers to demography of ancient populations. Modern technology, in the form of X-rays, has invaluable prominence in the research of mummified human remains. Non-invasive procedures in examination of bioarchaeological remains has become all important to preserve data for future research.

Keywords: Palaeodemography, dental wear, age at death, life expectancy, non-metrical dental trains, palaeoradiography.

5.1 INTRODUCTORY REMARKS

Larsen (1999:2)[123] believes that there is growing evidence that archaeologists are incorporating skeletal studies into their research designs. This is the case where many of these scientists are drawing inferences about diet, nutrition, health, disease, demography, physical behaviour and lifestyle of the past. Demography is specifically concerned with mortality, fertility and migration of a population. More specifically, palaeodemography looks at the changes in ancient populations in order to determine what it was that influenced the lifespan and health of earlier peoples. However, palaeodemography may include among others the following: 1) analysis of the population based on age, parentage, physical condition and ethnicity; (2) changes in the population because of birth, marriage, and death; (3) statistics on migrations, their effects, and their relation to economic conditions (Buikstra and Konigsberg 1985:316). Our interest in this

[123] Larsen (1999:1) is shocked by the disregard some archaeologists have concerning human remains, some openly stating that 'burials on historical sites are much more trouble than they are worth'. This attitude seems to be the same in certain circles of archaeologists in many countries, judging statistics of publications in this regard. On a more positive note, Larsen believes that there is growing evidence that archaeologists are incorporating skeletal studies into their research designs.

Chapter is mainly concerned with what the dentition can reveal about the aspects of general palaeodemographics.

Buikstra and Konigsberg (1985:316) aptly define Palaeodemography as the study of vital rites, population distribution, and population density in extinct human groups, especially those for which there are no records (birth date, date of demise and sex). Roth (1992:175) is convinced that palaeodemography is a valid, specialised sub field of demography, despite several controversies that have raised doubts among a number of scholars, in particular by Bocquet-Appel and Masset (1982:321) concerning the validity of palaeodemography as a scientific endeavour.

Humankind has a special interest in its own species and because, for various other reasons, including forensic ones, the assessment of age in Homo sapiens demographical studies has great practical value (Miles 1978:455). Palaeodemography in the southern Levant, of which Egypt forms part of, is no different to any other region in the world.

Howell (1976:25) pointed out that palaeodemographical methodologies in determining sex and age are indirect techniques based on known age patterns of skeletal and/or dental growth and/or wear and/or sex-specific dental morphological characteristics. Dental age in juveniles and subadults is measured by tooth eruption using the developmental method of Schour and Massler (1944)[124]. This method is widely regarded as the method of choice. The age between post-puberty subadults and adults is calculated by using the ossification of long bones in the past. More recently dental aging approaches are preferred.

The various methods are based on an implicit position of a 'biological uniformitarianism'. Howell (1976:26) seems well disposed with a much earlier model of Simpson (1949:71) by explaining that the term 'uniformitarian position in palaeodemography' implies that the human

[124] The Schour and Massler (1941) chart expounding the dental development through illustrations is most useful in archaeology and anthropology. It is especially the classical tooth developmental chart of Schour and Massler (1941:1153) that was later updated that provided the best universal dental 'development at a glance' information for the field archaeologist. The estimation of age in infants is far easier owing to the possibility of judging the degree of tooth-germ natural mineralisation (Vlcek & Mrklas 1975:203). See developmental chart of Schour and Massler in Appendix III.

being has not changed in its direct biological response to the environment in the process of evolution. An example is spermatogenesis, length of gestation, degree of helplessness of the offspring, rates of maturation and senility over time. For about 40 000 years of Homo sapiens' existence, the species has not undergone intra-species evolution in the demographically relevant biological processes, while certain other genetically controlled physical traits such as skin colour, body size or any other features that are sensitive to environmental influences, may undergo considerable changes under selective pressures.

Engels (1984:386) explains that a demographic transition is an era in which the population of a society changes from a general stable position of balanced levels of births and deaths[125], to a period of growth where birth-rates remains high but the death-rate diminishes. The population will become stable when the transition effect is completed. This will occur when the declining birth rate becomes lower than the death rate. It is then that the comparison between the various chronological periods of the Kingdoms of ancient Egypt become relevant for modern demographic research.

5.2 PALAEODEMOGRAPHY OF ANCIENT EGYPT

The demographic data of a select Egyptian population group reveals information of the fitness thereof in relation to its physical and social environment. Masali & Chiarelli (1972:161) held that there should at least be an equilibrium of fertility, mortality, life duration and life expectancy, which would then form the basis of this population's environmental adaptation and development.

Roth (1992:175) discussed the parameters of a palaeodemographic study by identifying small non-literate groups who lack Western calendric systems and compared the data to 'demographically convenient' populations. Roth then construed the term 'demographically inconvenient populations' and claims that nothing fits the description better than what is studied as palaeodemography: where all members of a group are dead, and who makes the

[125] Diamond (2006: s.v. Palaeodemography) claimed that few women in ancient times survived until the age of menopause. This theory is based solely on palaeodemographical statistics which endeavour to estimate age at time of death in ancient skeletons. These estimates rest on the assumption that recovered skeletons are unbiased samples of an entire ancient population and that age at death can be accurately determined.

determination of their age and sex extremely inconvenient due to lack of skeletal material. However, the accumulation of large collections of human remains, namely dry skeletal remains and mummies, make ancient Egypt a fascinating field for demographical research and is likely to provide data for understanding the lifestyle of the ancient Egyptian population (Masali & Chiarelli 1972:161).

The ancient Predynastic and Dynastic Egyptians, like many other ancient populations, had a short average life span (Masali & Chiarelli 1972:167). The population therefore consisted mainly of young adults[126]. These authors viewed the population as a young active population but sadly not an expanding one, mostly due to low fertility rates, but certainly also by other unidentified reasons, in which dental diseases may have played a role. They also believe that the Dynastic population's lifestyle was not very hard, compared to other ancient populations.

Johnson and Lovell (1994:427) reported a classical illustration of the use of non-metrical dental morphological data when they investigated the differences between the individuals buried at Naqada near the Valley of the Kings in Lower Egypt. The author's main interest in the above-mentioned study was to illuminate some of the fundamental aspects of the social differences and their antecedents. Johnson and Lovell (1994:431) based their research on tooth morphology to add to palaeodemographical data and reached the conclusion that Cemetery 'T' represented an elite burial ground, a possible royal cemetery, where the other two nearby cemeteries differed markedly in status. Further research by Prowse and Lovell (1996) in the same area, centred their research on the origin of the ancient Egyptian population after the unusual rapid social and political changes that occurred in Upper Egypt during the Predynastic Period (5 000 to 3 050 BCE). Their conclusion is similar to that what Petri earlier called 'the new great race' which was indeed the elite 'T' cemetery, the one that differed much from the other two nearby cemeteries. Prowse and Lovell's (1996:238) studies contended that non-metrical cranial and dental traits are superior to skeletal metrical traits because of the apparent lack of correlations

[126] Woods and Woods (2011:14) attest that ancient healers were indeed skilled in treating simple injuries and illnesses, but were unable to treat the more complicated injuries, infections and diseases, it therefore meant that people died at an early age. They also confirmed that many women died during childbirth, at a young age.

with age and sex between individual traits, minimal influence of environmental factors, and relative ease of scoring[127].

5.2.1 The racial history of ancient Egypt

The land currently known as Egypt has a long and involved population history. This is partly due to its geographical location at the crossroads of several major cultural areas: the Mediterranean, the Middle East, the Sahara and East Africa. In addition, Egypt has experienced several invasions during its long history, including the Canaanites, the Libyans, the Nubians, the Assyrians, the Kushites (Nubians), the Persians, the Greeks, the Romans and the Arabs. The conquests of ancient Egypt by foreign powers over time have made the affiliation between modern and ancient Egyptians significant, and has become a favorite topic to research (Zakrzewski 2007:502).

The racial issue of ancient Egypt has been an interest of many anthropologists over a long period. The existence of Egypt as a continuous civilisation over a very long span of time, more than five millennia to be more accurate (equalled only by China), has been the focus of researchers. The general consensus today is that ancient Egypt very soon became a civilisation of mixed races after the flourishing unification of Upper and Lower Egypt came into being, drawing foreigners to seek refuge there. Batrawi (1946:136-137) quotes Morant (1925) who had biometrically researched the crania, inclusive of the dentitions, of human remains in a number of ancient cemeteries throughout the expanse of the land Egypt. Morant reported that Lower Egypt (the northern part) had a population entirely unaffected by any influences foreign to their country for the period from Early Dynastic to Ptolemaic times; this Morant states must be unparalleled in the history of the world. The situation was different in Upper Egypt, where research of the crania revealed a mixed population between Caucasoid and Negro races.

[127] Jackes (1992:189) explained that palaeodemographical studies that are based on human skeletal remains, seek to reconstruct basic biological and social aspects of human life in the past, population structure, life expectancy, mortality, and fertility rates. The first step in such a study is to establish the distribution of ages at death. He also proposed that this procedure should become a mandatory part of any anthropological report on any mummified body or of dry bone remains in any cemetery site. Few ancient populations could provide the quality and quantity of human remains compared to that of ancient Egypt.

The determination of the relationships between ancient races ideally depends on the physical characteristics determined by the ontogenetic and phylogenetic development of a species, as revealed in the bioarchaeological human remains. It also depends largely on the non-metrical variations of the dentition and a number of cranial non-metrical traits according to Berry and Berry (1972:202-203). The authors do not differentiate between Upper and Lower Egypt when they claim that the Egyptians changed very little throughout the Predynastic, Old and Middle Kingdom Periods, and only changed in the New Kingdom when there was considerable immigration into the Nile Valley.

5.2.2 Age determination and teeth

Meindl *et al*. (1989:137) regard the study of human teeth as one of the most important features to obtain information about mortality and longevity in earlier human populations. Lucy *et al*. (1995:425) agree that dentally based age at death estimation offers significant advantages over skeletally based age estimations.

Through the comparison of dental and skeletal data amongst archaeological sites, and over time, researchers are able to differentiate between historical mortality rates and modern mortality rates. One of the primary objects is to achieve this through various techniques of adult age assessment. In discussing various ageing techniques, Maples (1978:764) held that improvements on the classical Gustafson dental technique to establish age offered considerable accuracy, and may be the technique of choice. Brothwell (1989:307) proposed that a multidisciplinary approach, not only dental but also that of the skeletal changes that takes place in the pubic symphysis.

Cameriere *et al*. (2006:861) have devised a modern approach to age estimation of mummies using the dentition. Their estimation of age is based solely on the pulp/tooth ratio method in the upper canines. They use a method that involves the measuring of the tooth width, height and pulp area by using special dental radiographic computer software. The results the authors claim are particularly promising for age estimation on the older age-group mummies of Egypt (Cameriere *et al*. 2006:863). The authors conclude that this method is more reliable in human remains for the estimation of age at death than the estimation of age in a living person. Pulp/root ratio studies using ‘cone beam computed tomography’ (CBCT) on incisor teeth resulted in this method being claimed one of the best to determine age from human remains (Star *et al*. 2011:S77). It is unfortunate that upper single-rooted anterior teeth are often lost in post-mortem finds (due to anterior teeth having single conical roots), single teeth may however, still be found in the vicinity of the skull, mostly when the skull and the rest of the skeleton is still in its original interment position as mummies usually are. Teeth may also get lost in their handling from excavation site to a laboratory (Hillson 1996:24, 56).

Dental development is widely regarded as the most accurate means of determining age at death in individuals who have not reached dental maturity (Brickley 2004:21). Most anthropologists recognise that dental development provides the best evidence for age at death in children. Dental development is a more accurate method than bone development as it is less variable because it is much less affected by endocrinopathies or other developmental insults than other parts of the skeleton (Smith 1991:143). The Schour and Massler (1940) chart expounding the dental development through illustrations, is most useful in bioarchaeology and anthropology research (see Appendix III). This chart should be one of the tools of a field archaeologist when examining immature skeletal remains for dental information in situ (Greeff 2009:286). Children affected by severe abnormalities affecting sexual maturation, stature, bone age (even mental developmental abnormalities) show little or no dental abnormalities (Garn *et al*. 1965:243).

Other methods to determine age at death using mature dental structures include the following:

- Racemisation of aspartic acid in dentine as an indicator of age, for both immature and mature human dental remains (Schroeder 1991:184).
- The mandible as indicator of age, only mature dental structures (Gustafson 1966:105).
- Tooth root colour as indicator of age, only on late mature structures (Ten Cate *et al*. (1977:83).
- Cementum annulation as indicator of age, also on late mature structures (Douglas *et al*. 1989:278).
- The Gustafson and other methods of age determination (Gustafson 1950:45).

Gustafson's (1950:47) classical method of age determination in human remains is widely acknowledged as one of the basic tools to determine age at death for individuals today (see figure 5.1 below for the Gustafson scoring system).

Gustafson's method employed the following tooth structures to attain relatively good estimation of age at death of the individual. Gustafson used all tooth structures that are subject to change with age, namely:

- Translucency of the root (root transparency or sclerotic dentine)
- Attrition of enamel (dental wear)
- Secondary dentine apposition within the pulp chamber
- Periodontosis, level of gingival margin versus the level of alveolar crest
- Root cementum build-up
- Root resorption

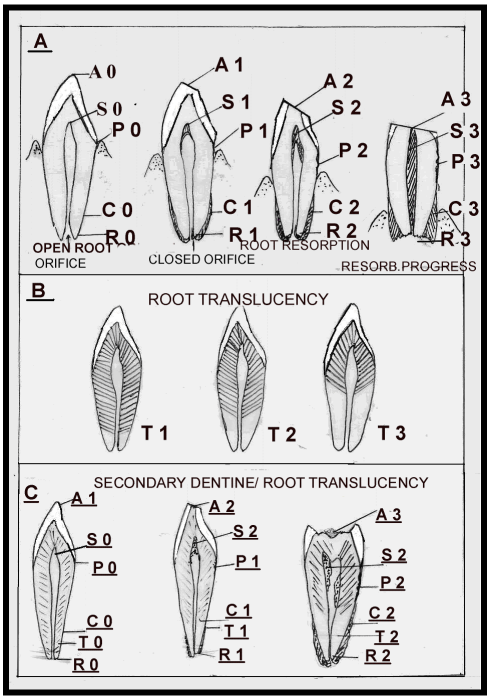

Figure 5.1: Gustafson's age changes and points scoring system, redrawn from Gustafson (1950:48). A = scores for attrition, secondary dentine, periodontitis, cement, resorption. B = scores for dentine transparencies, C = a practical collage of all six of Gustafson's criteria to make a calculated estimation of the age of the individual. Legend: A = attrition; S = secondary dentine; P = periodontosis; C = cementum layer; R = root resorption; T = transparency of root. The age changes in the tooth (scoring) are seen by the numerical 0, 1, 2, and 3 which depicts the severity thereof; 0 or zero depicting the absence of the change; 1, 2 and 3 indicate the severity.

Boldsen (1991:217) suggests that the critical part of the application of dental wear as a means of age determination is the establishment of a standard that is always specific for any time period, the area and the population group being studied.

5.2.2.1 The mandible as indicator of age

Gustafson (1966:105) added the use of the mandible as an indicator of age. Gross changes in ageing are linked to the angle between the body of the mandible and the ramus. In adolescence, he demonstrated, the angle is obtuse. In adulthood, the angle is orthogonal, whilst in aged people the jaw angle returns to being obtuse again. This observation is by no means scientific but rather an indication as to what major assemblage the mandible belongs.

5.2.2.2 Racemisation of aspartic acid in dentine as an indicator of age

Schroeder (1991:184) has shown that an age determination of individuals between the 5th and 70th year of life is possible from the chemical determination of the degree of racemisation of aspartic acid in dentine. This procedure is expensive but the resulting age estimation is very reliable.

Racemisation is the conversion to a racemic compound, the process of converting in this case, aspartic acid from an optically active compound or mixture to a compound that does not reflect or absorb light. Aspartic acid is an amino acid that is produced by living organisms; the formula is $C_4H_7NO_4$ (Young 2010: s.v. Racemisation). The *L-amino* acids present in bone and teeth undergo slow racemisation at a rate proportional to the temperature. At about 370^o Centigrade, aspartic amino acid residues in tooth enamel and dentine undergoes *in situ* racemisation at a rate which corresponds to an enrichment of *D-aspartic acid* content of approximately 0.1 percent per year (Masters *et al*. 1976:280). The authors proved dentine suitable as a reliable indicator of age. Masters (1986:179) reported that the post-mortem conditions are crucial to the accuracy of age determination, especially exogenous temperatures such as exposure to extreme heat as found in cremations.

5.2.2.3 *Tooth root colour as indicator of age*

Ten Cate *et al*. (1977:83, 85) demonstrated that there is a normal but marked difference in the colour of the roots of teeth with ageing as a result of a progressive yellowing of the root surfaces. They therefore believed they could use the difference in the colour of the root to determine the age of the individual. Ten Cate *et al*. (1977:85) then visually selected the teeth in age groups. Using a colour densitometer to determine the colour of the teeth, they soon realised that the human eye is much more sensitive and better able to assess colour - better than any optical instrument yet devised (Ten Cate *et al*. 1977:86).

5.2.2.4 *Cementum annulation as indicator of age*

The annual rhythmic[128] growth of cementum that occurs in layers on the roots of teeth throughout life, relates to the age of the individual. These layers are added yearly, not unlike tree-rings (Charles *et al*. 1986:312). Growth layer groups (GLG) in cementum appear in cross-section as alternating wide and narrow layers of different optical density, due to hyper- and hypo-calcification, referred to as 'annulations'. Douglas *et al*. (1989:280) reported that there is a complex underlying physiology involving nutritional, climatic, genetic, functional and regulatory factors present. To facilitate this procedure, the use of demineralised sections is necessary (acid treated roots are demineralised and sliced to about a millimetre in thickness, then examined under a microscope). Premolar teeth are preferred for this exercise because it offers more replicable results (Charles *et al*. 1986:316, 319). The usefulness of the cementum annulation technique as a method of determining age in humans is questioned, it is an expensive exercise, unreliable, cumbersome and is very much a tooth destructive method.

5.3 SEX DETERMINATION FROM ORAL STRUCTURES

The human being is a dimorphous species. The rationale of the determination of the sex of skeletal remains in archaeological excavations is necessary for data and information regarding palaeodemography (Milner *et al*. 2000:475). Various physical anthropological methods to determine the sex of the remains of a human being had been used for decades, but almost none has claimed to be 100 percent reliable. Although the whole skeleton should be taken into

[128] Annulations are presumed to be formed in humans during intrinsic biological rhythms (Charles *et al*. 1986:312).

account when determining the sex of human remains, sexual dimorphism is most pronounced in the pelvis, skull and long bones, in that order (Brown 1998:3). The pelvis is widely recognised as the single most reliable sex determination feature, showing functional adaptation for childbearing, and is therefore used predominantly in determining the sex of adult individuals (Gustafson 1966:90).

Gustafson (1966:91) stated that it is practically impossible to determine sex from the teeth alone, because of the variability in dental structures. The modern approach therefore seems focused on a multifactorial oral and multidisciplinary approach. A number of recognised techniques are as follows:

5.3.1 Mandibular ramus flexure in sexual dimorphism

Loth and Henneberg (1996:473) described the ‘new’ trait to indicate sexual dimorphism as a flexure observable in the dorsal (posterior) surface of the mandibular ramus. These authors later regarded this flexure as the only consistent dental indicator of sexual dimorphism because distinct flexure at the level of the occlusal plane is found only in adult males, and of course the lack thereof in females (Loth & Henneberg 1998:91). Loth and Henneberg (1998:92) concluded that although the posterior border of the ramus can be flexed in other places, they were adamant that the only flexure that counts for adult sex diagnosis is that part which is located at the specific level of the occlusal plane.

5.3.2 Tooth size in sexual dimorphism

Sexual identification of human remains becomes important in populations where sexual dimorphism is small or even unknown. Of all the methods to determine sex from skeletal remains, the dentition is the most unlikely to produce great success rates (Brace et al. 1991:36), however as has been stated repeatedly; there are times when teeth are the only surviving structures of an individual. Oxnard (1987:65) sarcastically pointed out that teeth do not bear recognisable gonads. Consequently it is virtually impossible to sex detached teeth. Using tooth-size assessment should only be made on the basis of pooled samples of males and females.

5.3.2 Using DNA in sexual dimorphism

Ancient DNA (aDNA) is a relatively new field in which the tools of molecular biology are being applied to archaeological materials. The discovery of the polymerase chain reaction (PCR) is one of such tools. It allows the retrieval of infinitesimal amounts of DNA and its amplification from biological samples; even when molecules are damaged and degraded, it may still provide enough DNA strands to perform PCR (Greenblatt & Spigelman 2003:v).

To understand the aspiration of the science sex determination, the aim is probably for a hundred persent success rate in all areas. To attest to this unprecedented aspiration we must simply look at the genetically studies of Pill and Kramer's work on determination of the sex of an individual. Pill and Kramer (1997:673) have shown that it is possible to determine the sex of an individual by using the PCR and amplify the region of ZFX and ZFY gene from DNA in human tissue. They chose to extract pulp tissue from freshly extracted teeth for this experiment. The result was a remarkable 100 percent accuracy in numerous trials. Pill and Kramer (1997:674) demonstrated that the same results could also be expected when DNA was extracted from crushed dentine substance from ancient teeth, but have to date not succeeded.

5.4 METRICAL ANALYSIS OF THE PERMANENT DENTITION

Statistical analysis of measurements of humans (anthropometrics) in palaeopathology, palaeoepidemiology, palaeodemography and palaeodontology has become an essential tool in the search of understanding the social impact on anthropological research that human remains may have. Pietrusewsky (2000:375) explained that measurement and description of skeletal remains as a paradigm focus on the investigation of human population structures and past biological relationships, including the assignment of unknown specimens to reference groups.

Dental wear should be included in odontometric analysis because the amount of wear is measurable. Interproximal or approximal dental wear will affect the mesio-distal measurement of the tooth as well as the overall length of the mandible and/or the maxilla, and should be carefully determined[129] (Howells 1969:312). Odontometrics can also be used to describe racial affinities. Races with large teeth are distinguished from races with small teeth, using the tooth index as criteria. Rosenzweig (1970:1423) hold that there is no doubt that odontometrics has a valuable contribution in establishing biological differences between sexes and human populations. The size of teeth of the ancient Egyptians is important to distinguish between the Nubian and Caucasian populations.

5.5 NON-METRICAL DENTAL VARIATIONS

Non-metrical variation does not imply not measuring any dental feature; only that it is difficult and impractical to define measurements that can consistently be reproduced. Non-metrical features include presence/absence of teeth, size and number of cusps, shape of grooves in molar occlusal surfaces, presence of pits and form of ridges to name but a few (Hillson 2005:262). The minor variations in human dental morphology are useful in historic, palaeodemographic and forensic contexts (Scott & Turner 1997:4).

The term non-metrical is generally taken to encompass any minor anomalies of skeleton or dental morphology not normally recorded by measurement. Non-metrical traits are recorded as being either present, or absent, or scored, according to the degree of development of the feature (Mays 1997:102). Mays defined dental traits as a heterogeneous bunch of anomalies, devoid of any sign of a disease condition. Saunders (1989:95) asserted that there are more than 400 non-metrical traits (variants) that has been described for the entire human skeleton in anatomical literature. In one of the classifications of non-metrical dental variants, Mays (1997:103) described the two fundamental categories of dental traits, namely that of the variations in the number of teeth and the variations in the form or shape of tooth crowns.

Non-metrical dental traits are characteristically heritable. Hillson (2005:273) reported that twins and family studies reveal a strong heritable component of several dental traits (Sofaer & MacLean 1972:811). Recording of non-metrical variations in skeletal remains can be

[129] The practical method to determine the length of a dental arch is to work on a stone model of the dentition: a piece of string is laid on the occlusal surface of the teeth, measuring from the distal surface of the last tooth on the one extreme to that on the other side – then measure the resultant piece of string.

accomplished either directly from the dentition, or from casts made from impressions taken, viewed in a laboratory, and finally saved for future reference.

Criteria for the selection of dental traits for kinship analysis must be high in heredity and low in population trait frequency, must have a distinct trait expression and low dependency on age and sex as well as having small intertrait correlation. Dental traits should be singled out as the method of choice for kinship analysis (Alt & Vach 1995:111). Non-metrical traits have been extensively researched and are used in the identification of kinship among royalties in ancient Egypt[130].

5.5.1 The rationale of non-metrical dental trait data

The value and use of non-metrical traits *per se* were stated unambiguously by Jackes *et al*. (2001:97) as being more accurate than the measurements of crania or what can be inferred from gene frequencies, often more feasible, cheaper and simpler than studies of ancient DNA. The internal shifts and strains caused by population migration are vital for understanding the social lifestyle of ancient Egypt. The migrational information aids in validating the data for palaeodemographical studies.

Hillson (1986b:271) also held that one of the more important objects of using non-metrical trait studies is to access relationship between different populations, otherwise referred to as determination of ethnicity. Dental morphology, he pointed out, is a convenient and easily recorded aspect of phenotypic human skeleton variation. It has the advantage of being available to be studied in both living individuals and in archaeological material because dental morphology has a genetic as well as an environmental component that controls it. Tyrrell and Chamberlain (1998:549) pointed out that dental non-metrical traits are expressed very early in tooth development and are therefore not subject to skeletal remodelling. Functional constraints ensure that dental structures are under relatively strong stabilising selection. The value of phylogenetic comparisons between populations are based on tooth morphology and specifically

[130] The Late Bronze Age-Early Iron Age transition in the southern Levant indicates the emergence of a new ethnicity. The question remains, however, whether changes in the material culture are the result of an invasion of foreigners, or instead arose from shifting cultural and technical practices by indigenous peoples (Ullinger *et al.* 2005:466).

on the non-metrical traits as an indicator of genetic differences between all levels of social clusters, be it villagers, tribes or races (Palomino *et al*. 1977:61).

Non-metrical variants prove valuable in the estimation of the frequencies of combinations of relationships of teeth, in short, the genes of a population. The relative proportions of the variants are used to calculate a genetic distance between populations. The more genes held in common, the more closely related they are (Hillson 1986b:271). Hillson however, warns that it must be taken into account that there is a complex relationship between genetics and the environment, involving many genes. Therefore, the degree of genetic control in archaeological material becomes implicit when comparing the dental morphological distance with distances determined from blood groups, geography, linguistics and history (Cavalli-Sforza *et al*. 1988:6002).

The importance of non-metrical studies was realised by Brothwell (1965:93) who, at the time, criticised earlier workers in archaeology and anthropology for concentrating all their attention on the physical measurements of all skeletal bones and teeth. It has become increasingly obvious, he stated, that one field that offers promise is the study of non-metrical characters. Risdon (1939:121 ff.) for example, has done extremely valuable work on the statistical nature of the bioarchaeological material excavated at Lachish (Tell Duweir) in Israel by means of craniometrical studies, but has neglected the dental non-metrical features at his disposal.

The Arizona State University (ASU) system was developed mainly for the purpose of identifying non-dental traits in the quest to characterise and individualise groups of people as well as to differentiate between groups and even races by certain unambiguous dental traits (Turner *et al*. 1991:14 ff). The goal of the ASU inventory system is to impart and introduce replicable, graded distinctions by defining sets of variants, which are commonly observed within archaeological dental remains. This system has successfully been used in various studies; (Irish 1996:129; Irish & Turner 1997:141-146) and more recently used to identify the answer of the age-old question of ‘Who were the ancient Egyptians’ (Irish 2006).

Joel Irish’s (2006) findings are deemed effective in the estimation of the synchronic and diachronic biological relatedness used to test the viability of several hypotheses on the population of ancient Egypt (Irish 2006:539). Irish used 22 non-metrical dental traits on 15 groups along the entire length of the Nile River over periods that ranged from Predynastic times through the New Kingdom Period to the Roman Period to compare population distances and relationships.

The discussion of the non-metrical crown, groove and root traits, form the basis of the ASU system. The selected standard variation scale of the trait is expressed in percentage frequencies of traits within a geographic region in the way of subsections: a) low frequency groups, (LF); b) intermediate (low or high) (IF, LIF or HIF); and c) high frequency groups (HF) and for the regions mentioned including its abbreviated form (Scott & Turner 1997:178-235). Greene (1972:315) for example, implied that through migration, hybrid groups might be identified and established. In differentiating between population groups living in Upper ancient Egypt, Greene (1972:317) found that the Meroitic, X-Group and Christian populations are closely related, and proved that the groups are of equal distance from both the Caucasoid Egyptians and the Negroid West Africans. This might imply that Nubian groups were hybrids of Negroid and Caucasoid races. Harris *et al*. (1975:554) proposed that because these Nubian groups are socially and geographically a stable isolated people, who have lived in the Nile valley for thousands of years, they could be of tremendous help to bioarchaeological dental, medical and genetically research projects, especially in cephalometric analysis.

5.6 THE VALUE AND USES OF PALAEORADIOLOGY

Teeth and jaws are highly resistant to post-mortem deterioration especially so in the dry climate of Egypt, and unlike soft tissues are generally free from damage during mummification. Radiographs taken of such excellent preserved dental remains of mummified individuals are however, inferior to that which can be obtained from living individuals today (Nunn 1996:202).

The history of radiology as a tool used by bioarchaeologist goes back to the late 19th century. Soon after the discovery of X-rays by Roentgen in 1895, it was recognised as an important diagnostic medium in the study and display of bioarchaeological findings. Petrie first appreciated the value of X-ray photography in Egyptian archaeology and published a picture of the lower part of a mummy in 1898.

Owing to post-mortem rigidity of muscles, intra-oral x-rays and photography of dental structures is impossible (Leek 1971:105). The present-day X-ray technology provide results previously never attained, but more importantly in a manner that is totally non-invasive and non-destructive to the biological material and structures under investigation.

Age-related changes in the dentition are one of the more important research topics in palaeodontology. Teeth provide several useful data about an individual's age as was seen above. Some of these changes[131] can be more accurately determined and measured from dental radiographs and specifically from information obtained from orthopantomogram (panorex) and cephalometric X-rays as shown in figure 5.2 below.

Figure 5.2: A cephalometric X-ray of the mummy of Queen Ahmose Nefertiry, illustrating the maxillary prognathous which was a characteristic of the Royal females of the 18th Dynasty. Note also the level of dental wear (Harris *et al*. 1986:63).

[131] Changes in the pulp index indicate aging and the best example of accuracy is for instance to measure the infinitesimal deposits of secondary dentine within the dental pulp by utilising the non-invasive technology of computer tomography.

Computer tomography (CT) is an indispensable tool in the evaluation of the anatomy of Egyptian mummies because it can non-invasively generate large amounts of data. The use of CT is exemplified by the work done by Hoffman and Hudgins (2001: abstract) on a number of Egyptian mummified remains: the craniums were evaluated on a *Helical CT 1-mm axial scanner* and the results were confirmation of severe dental wear on a number of the mummies without unwrapping the bodies. The relationship between the upper and lower jaws can also be determined, as well as other dental pathologies.

Azzopardi *et al*. (2000:93) described the use of scanning electron microscopy (SEM) as an important tool in the evaluation of dental microwear. SEM is used for monitor surface microwear[132]. X-ray microradiography provides a tool to measure thickness of enamel, and is sensitive to changes of the mineral content thereof. Computer programmes that facilitate surface mapping of enamel wear are available. The method is termed *profilometry,* which in the laboratory is used in tooth-wear profile-mapping (Azzopardi *et al*. 2000:93). Studies of dental microwear have shown qualitative and quantitative differences related with specific diets, also used in dietary research in Egypt (Puech *et al*. 1986:507).

Computer-assisted imaging analysis has become indispensable in estimating age at death in individual for the use of palaeodemographic research. The greatest contributions in predictions of age are dental wear and root translucency. The rationale of computer-assisted image analysis is to avoid the bias, which is inherent in observer subjectivity (Valenzuela *et al*. 2002:386). In later research, Miles (2001:973) found that progressive root translucency is evidently related to age and is more accurate than any of the other five features in the Gustafson method of age estimation, contrary to other methods mentioned that are also claimed to be the best method. Lovejoy (1985:54) is of the opinion that tooth wear is the best indicator of age with the least bias in the under-estimation of age. However, both authors agree that a multifactorial method of estimating age is still the method of choice.

[132] Dental microwear research also elucidates dietary substances like silica phytoliths (Danielson 1998:303).

With the use of multislice computerised tomography[133] (MSCT) on the dental status of three Egyptian mummies, Gerloni *et al* (2009:58) were able to generate multiple planes, which in turn is able to generate three-dimensional (3-D) stereolithographic reconstructions. Although radiography produces information on mineral tissues, computerised tomography images will also visibly show soft tissues and internal cavities with remarkable clarity. The resultant CT images were able to exhibit various degrees of dental and periodontal diseases. CT images also shows that the mummies had low caries rates and that all three mummies had fully erupted wisdom teeth, all images were acquired with non-invasive techniques (Alt & Buitrago-Téllez 2004:258-263). Thali *et al*. (2003:15) see the results of the scanning of lifeless mummies far superior to that of scanning living individuals due to the absence of motion and the fact that there are no limits to the radiation dosages.

There are specific CT hardware and software programmes for the use in dentistry, *viz.* the *Dentascan* programme (Thali *et al*. 2006:113-119). The programme software allows reconstruction of images comparable to conventional panoramic dental radiographs. The images show all hard- and soft tissues of the oral cavity. This, and other features of this screening tool, are ideal for scanning Egyptian mummies. Cameriere *et al*. (2006:862) made use of radiographs that are digitized by a scanner and images recorded in a computer file. The images can then be processed, using computer-aided drafting (CAD) technology.

An ancient Egyptian mummy skull was examined using computer assisted tomography (CT). In this skull three of his teeth were found in the cranial cavity (not shown). They had been retained after their loss caused by periodontal disease, and were inserted into the cranial cavity via a trans-sphenoidal hole, probably during the process of mummification. The 3-D image shown below in figure 5.3 shows in remarkable clarity three teeth that the authors believe were sowed in the fauces to grow in the afterlife (see right arrow). The age and sex of the mummy was determined by the teeth and found to be between 25 - 35 years old and that of a male person. The CT scan reveals poor dental condition with dental diseases in the form of caries, tooth loss, periodontal disease and severe drifting or movement of teeth.

[133] The *16-slice CT scanner* that was used is a Aquilion 16; Toshiba Medical Systems Europe, Zoetermeer, Netherlands. Both 3D and orthogonal-plane reconstructions were created along a curved view of the entire mandible and maxilla (Gerloni *et al*. 2009:58).

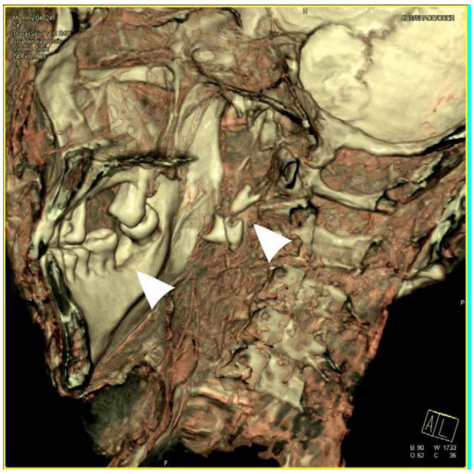

Figure 5.3: Left lateral view of mandible using a 3-D CT scan. Drifting teeth (left arrow) and tooth spaces in the right part of the dentition. Fragments of roots of teeth in the fauces (right arrow) (Harbort *et al*. 2008:4).

Tooth development (ontogenesis) is one of the better methods of determining physiological maturity, or in palaeodontology terms the determination of the age of an individual who had died in ancient times (Saunders 2000:142). Dental microstructures and their regular rhythmic periodicity throughout tooth incremental growth have been studied for more than a century. The resultant interior and exterior incremental features of the enamel yields development standards, including ages of crown completion, tooth eruption and root completion. Through the employment of 2-D and 3-D non-destructive approaches namely by the X-ray Synchrotron Microtomography (SR-mCT) system, age at death in fossil juvenile hominid dentitions can now be accurately determined to within days after development had started (Tafforeau & Smith 2008:224).

An example of the value of computed tomography can be seen in the CT scan of the dentition of the female mummy Djedmaatesankh. Her dental profile revealed the following information: three teeth are missing, the right maxillary canine is impacted, severe attrition is present, periodontal disease and caries are rampant, and 24 of the 28 teeth present in her mouth show exposure of dental pulps. Eighteen teeth are afflicted by periodontal lesions, of which five teeth may have contributed to the large secondary infected radicular cysts, seen on the resultant scan. One of the cysts had displaced the maxillary antrum and enlarged the maxilla in a lateral dimension (Melcher *et al*. 1997:329). Peter Lewin (1994:1806) earlier described the above abscess as a ‘horrendously large dental abscess’, an inch in diameter! With no antibiotics, it must have caused equally horrendous pain and with the spread of the infection, Djedmaatesankh had probably died from it.

The X-rays of Rameses II revealed that he had such a severe abscess in his lower jaw that it has confidently been claimed that he died from it. The rest of his teeth were also badly abscessed, evidentially sufficient to believe that the King suffered much and probably lived a morbid life. The King had a mouthful of rotting stumps, which was all that remained of most of his teeth. This would have prevented him eating a healthy diet (Melcher *et al*. 1997:330).

The dento-facial structures of another Egyptian mummy, at first not identified, was radiographically evaluated with computer tomographic scans. The measurements on 'Lady' Udja were closely related to the cephalometric standards. The dental findings on the 'Lady' include noticeable generalized dental wear of the dentition, an extracted lower first molar, and impacted maxillary third molars (Thekkaniyil *et al*. 2000:11). 'Lady' Udja was later established to be a male.

Radiographic imaging facilities sometimes become a necessary tool in the field when faced with human remains that are too fragile to be handled. Conlogue *et al*. (2004:254-255) suggested that in such circumstances a facility is required that is portable so that it can be placed close to the excavation site or the storage unit. Conlogue *et al*. (2004:255) stated that four requirements for an on-site facility are: a radiographic unit (ideally a mobile unit capable of a 55-kV output), a dark room, an image receptor system and a skilled radiographer. A fifth component not mentioned by the authors, is a generator to supply the necessary electrical power.

The history of the use of radiology for examining Egyptian mummies has seen the technology move from the original discovery of x-rays to the latest 3-D rendering of CT images. Over time, the discipline has moved from the clinical realm, to the highly sophisticated analysis of human remains (Gardner *et al*. 2004:234). These authors describe the cooperation of anthropologists, archaeologists, radiologists and computer engineers, as an obligatory team that can greatly improve current knowledge of anthropology.

5.7 CONCLUSION

Central to the pragmatics of the definition of archaeology is the understanding of the lifestyles of ancient populations. This would entail having a clear notion of the sociocultural, socioeconomical, and socioreligious aspects of life within a specific time/space frame (Greeff 2005:20). This study is focused on the health and disease component of the ancient Egyptians. All the social aspects mentioned above may have an influence on the lifestyle of the individual.

Palaeodemography looks at the changes in pre-modern populations in order to determine amongst other, the lifespan and health of earlier peoples. Dental data, both statistically relevant and circumstantial, must be inferred from the pursuits of bioarchaeology in most cases. It is the information coaxed from dental remains that provides some of the better insights into past populations. The scientific approach to palaeodemography relies heavily on information obtained from the human dentition. It is widely recognised that, because of the relative indestructible nature of tooth structure in archaeological human remains, the dentition makes excellent research material (Humphreys 1951:16). Human dental remains that had been subjected to cremation, putrefaction, or even to external taphonomic forces, may still be used for scientific evaluation (Bang 1993:55).

Palaeodontology offers the anthropology discipline the means to understand the human species through providing statistical data regarding the species' demographical information: life expectancy, procreation and sex identifications, and age at death. This would include identification of populations, groups, individuals, kinship and the migration of people. The past saw age and sexual dimorphism determination mainly from skeletal remains, in particular from the pelvis and the cranium. Modern research with the utilisation of multidisciplinary techniques, incorporate the mandible and the dentition (Milner *et al*. 2000:475). Due to the durability of the enamel of the tooth crown, one could expect to find a number of good quality teeth in most bioarchaeological excavations, even when the rest of the skeleton is in pitiable condition, or only fragmentary, and of no more research value (Coppa *et al*. 1998:371).

Modern archaeology as well as palaeodontology are about interpretation as much as of discovery. The archaeologist's prime tasks are excavation and collection of artefacts from the human past, but these artefacts are mute; they do not speak for themselves; the evidences have to be interpreted. Only through interpretation is meaning assigned to any archaeological finds. Without interpretation, archaeology is no more than treasure hunting (Bunimovitz & Greenberg 2004:19). This Chapter dealt mostly in the interpretation of excavated human dental structures for demographical purposes.

Age determination plays a great role in all branches of bioarchaeology, including forensic pathology; not only for identification, but also to place the remains in temporal and cultural context for statistical palaeodemographical studies. It was also argued that dental trait analysis could define the various populations, aid in the research into the cultural anthropology, the palaeodemography, and elucidate the natural sociocultural environments of the inhabitants. By learning more about the lives of the ancient inhabitants of Egypt, it may help in reconstructing the world of the ancient Egypt and lay bare the ancient context that may elucidate the life that people lived in ancient times, to the modern reader through expounding the social world of ancient times.

Sex determination from oral structures are generally not popular among scholars for the reason that the pelvis has proven to be the most reliable method in sex determination of human remains – not only historically but also in modern times. The problem however, arises when the post-cranial human remains do not exist or the pelvis is in a poor state of repair. As mentioned earlier, teeth and other oral structures may be the only parts left of the human remains, and then only do the methods stated in this Chapter become of great value to determine the sex of the individual.

Radiographic technology has remarkably improved the science of bioarchaeology within the boundaries of ancient Egypt. In the past, mummies were unwrapped in order to examine the mummified human remains, often with dire consequences to the mummified body. The investigation and examination of the bodily structures had invariably led to a form of modern-day autopsy, where the body was physically ripped apart, even decapping the skull. The result, more than often, lacked proper osteology examination, nor soft tissue scrutiny.

Dissimilarly, with the introduction of modern X-ray technology, there is no need at all to unwrap the body. The X-ray technology of today produces ultra-clear images of hard and soft structures of the body, in a non-invasive, non-destructive manner, leaving the mummified body virtually untouched by human hands or tools that in the past left the body mutilated. The utilisation of radiography has a result that no mummified bodies need ever be examined physically again, unless unusual circumstances necessitate otherwise.

The art and science of mummification was a phenomenon that ensured preservation of the human remains, enabling bioarchaeologists a platform to observe and analyse human remains by making use of unending modern techniques. Modern non-invasive techniques will ensure that future improved techniques can be employed in research procedures, unlike the destructive processes of the past.

CHAPTER 6

CONCLUSION

6.1 INTRODUCTION

Archaeology, the science of material culture, involves the recovery, study, and interpretation of the material remains of the past. The written sources that scribes left behind are the product of the upper social levels. However, the archaeological evidence has the potential to illuminate all levels, but particularly the lower echelons. The scribes of ancient Egypt were perhaps extremely selective about what they recorded; however, archaeology is sometimes capable of supplementing the information they either lacked or failed to include.

This dissertation involved a multidisciplinary approach to dentistry in ancient Egypt. The approach gained a more comprehensive view of dentistry in all its facets by engaging three main disciplines in a study of this nature: palaeodontology, history, and archaeology. A critical stance is adopted towards the literary sources on data from all three of these disciplines in order to glean as much information on dental data as possible. The exceptionally dry desert climate of ancient Egypt and the burial customs combines to give interesting information of the daily lives of these people.

6.2 RESEARCH OVERVIEW

Chapter 2 explains palaeodontology as a substantive discipline, inaugurated by, but discernible from palaeopathology. Palaeodontology as a discipline is defined within the context of this dissertation. However, both disciplines are closely related. In bioarchaeology, teeth are equally as part of the whole body, as are the eyes (ophthalmology), or the stomach (gastroenterology). However, due to the special place that teeth occupy within physical anthropology and related sciences by virtue of its indestructible nature, palaeodontology has digressed as a distinct entity.

An introduction to macro- and micro- dental morphology aimed to promote an understanding of the basic anatomy of teeth and its supporting structures. Only by being acquainted with the standard anatomy of the dentition, can one recognise dental anomalies. The macromorphology or anatomy of teeth serves to identify teeth in dimensional context within the jaws (shape, size and position). Knowledge of the micromorphology or histology of tooth structures serves to understand and recognise the effect various diseases have on the microstructures of teeth, amongst others; caries, pulpitis, periodontal diseases and enamel hypoplasias. Tooth development (odontogenesis) is one of the better measures to determine physiological maturity, or in palaeodontology terms, to determine the age of subadult human remains.

Palaeobiochemistry of the oral structures concludes Chapter 2 by revealing the interaction that the environment has on the dental tissues. The diet of an individual has direct influence on the chemistry of the teeth and surrounding supportive structures. Palaeobiochemistry involves amongst other DNA research. Pulp tissue DNA is used to determine sex and the mineral content of teeth has proved to be useful in radiocarbon dating procedures.

The focus of Chapter 3 is the question of whether a dental profession existed in ancient Egypt. Palaeographic data in the form of hieroglyphic inscriptions were gleaned from various inscriptions, translated, and the result verifies the existence of dentists. The progenitor confidently identified as Hesi-re is recognised as the world's first dentist. Further confirmation of dentistry comes from a number of prosthodontic appliances in the form of dental fillings and bridges. Dentists are known to have performed surgical procedures. Surgical intervention by means of holes being drilled in the bone opposing a presumed dental abscess to relieve the pressure, is further evidence. The discovery of a number of guidebooks on medical matters in the form of the medical papyri dated from the Old Kingdom Period has various references to the treatment of dental maladies. One such reference in the Kahun papyrus describe in detail the treatment of a dislocated mandible. Such treatment falls into the category of surgical intervention. Further research on the medical papyri reveals a number of pharmacopoeia recipes on treatment of a number of dental maladies, mostly on periodontal diseases.

Dental diseases that perturbed the ancient Egyptians are the subject of Chapter 4. Although evidence of dental caries is observable in a number of excavated skeletal and mummified human remains, statistical evidence reveals that caries were not pervasive among the Egyptian population. The reason is probably the lack of refined sugars in the diet of the ancient Egyptians. The myth of a tooth-worm as the cause of caries has no scientific base although the belief still exists among primitive cultures today. The same does not apply to periodontal disease. Periodontal disease affected most of the adult population. One of the aetiologies of the disease is the severe dental wear that was common in the mouths of most ancient Egyptians. Dental wear was ubiquitous among all people in ancient times. Egyptians, because of its desert environment and cultural diet, were affected more than most other populations. Dental wear is not a disease *per se*, but leads to a number of dental maladies, however, this phenomenon was the predisposing cause of significant dental diseases and indiscriminate morbidity of the population.

Dental hypoplasia is a quantitative deficiency of enamel and is often termed a 'non-specific indicator of stress.' Enamel hypoplasia is another dental phenomenon that is not a disease *per se*, but merely a sign of earlier insult on the health of the individual. The aetiology of enamel hypoplasia is believed to be various diseases and malnutrition among the age group of between birth and 6 years. Hypoplastic lesions occur in the form of pits, lines and furrows on especially labial surfaces of mostly canine teeth, but other teeth as well. In severe cases hypoplasia may lead to complete absence of tooth enamel, especially true for the condition known as *amelogenesis imperfecta*. It is metaphorically alluded that hypoplastic enamel lesions are biological windows through which one can observe the long-term consequences of earlier metabolic stresses. It provides a record from which an investigator may infer the time at which hypoplasia occured and therefore the time of the stressful event that caused the insult.

All the maladies mentioned in this Chapter invariably lead to pain – of various degrees. Although pain is rarely mentioned in the literature of ancient Egypt, the author is of the opinion that dental pain had an influence on the lives of those that were affected by toothache. Oral hygiene rarely features in the literature of the ancient Egyptians and therefore may not have helped to allay dental diseases.

Diet plays an important part in dental health and diseases. It is mainly through the cultural diet of the ancient Egyptians that most of the dental maladies was caused. Their dependence on bread as a staple diet was perhaps their dental downfall. The bread they ate contained abundant minerals that were directly the causative factor in the severe dental wear experienced by most members of society.

Demography is the interdisciplinary study of ancient human death, fertility, and migration. Palaeodemography does not differ in principle. Chapter 5 assesses the role that teeth play in the gathering of information to establish a palaeodemographic representation of ancient Egypt.

The deterioration of oral structures due to mastication over time leads to the science of aging human remains. The amount of dental wear on teeth reveals the age of the individual. Dentally based age at death estimation is one of the most important disciplines to obtain information about mortality and longevity in earlier human populations and offers significant advantages over skeletally based age estimations. Wear is specific to a number of factors, amongst others; sex, environment and diet.

Sex determination of human remains is necessary to add to the data needed to establish a palaeodemographical image of ancient Egypt. However, dental structures are not the object of choice to determine sex; the likely choice would be the pelvis. Teeth only become important should the other osteological structures be incomplete or are in such a poor condition that sex determination is not possible. Non-metrical dental traits are characteristically heritable. Recording of non-metrical variations in human remains are accomplished either directly from the dentition, or from casts made from impressions taken, observed in a laboratory, and finally saved for future reference. The internal shifts and strains caused by population migration are vital for understanding the social lifestyle of ancient Egypt. The migrational information aids in validating the data for palaeodemographical studies.

From a meagre beginning, X-ray technology has in little more than a century advanced to the point where non-invasive bioarchaeological human remains exploration has become possible. Modern radiographic technology is non-destructive and has been responsible for creating high definition images of mummified human remains without the necessity of unwrapping the bodies. As a result this has saved the human remains from destruction during examination and has ensured quality biomaterial for future exploration. Through the employment of recent 2-D and 3-D non-destructive approaches of X-ray synchrotron microtomography (SR-mCT), the microscopic field of bioresearch is now possible.

6.3 ON ACHIEVING THE GOAL OF THIS RESEARCH

In order to achieve the goals set for this study, answers to the following questions have been sought, based on an integration of the information gleaned from the discussions in the preceding chapters.

6.3.1 A dental profession in existence in ancient Egypt

Palaeographic research revealed hieroglyphic scripts that attest the existence of Hesi-re and other dentists. Wooden panels lined the burial chamber of Hesi-re’s third Dynasty tomb. The inscriptions on one of the panels proclaimed Hesi-Re as a dentist of high ranking (chief of dentists and doctors), thus also proclaiming him ahead of Imhotep as the first authenticated doctor in history although the latter is officially recognised as the first physician.

It was proffered that dentistry was a specialised branch of medicine during the Dynastic Ages. The names of other dental practitioners were recently discovered in a tomb next to the Stepped Pyramid at Saqqara. We also have evidence that oral surgery was practised in a papyrus Kahun description of the manipulation of a dislocated mandible. Prescription drugs were part of dental treatment. Prosthodontic appliances in the form of dental bridges, tooth fillings and the simplest form of retentive prostheses were being used in treating pyorrhetic and pathologic conditions. According to Talmudic decisions, the extraction of teeth must have been a common practice in neighbouring Israel. Contrary to archaeological findings, Weinberger (1948:49) believe evidence exist that in Egypt teeth were also extracted.

The various hieratic medical papyri were scrutinised to find evidence of dental recipes. These were then dissected and translated to acquire further information on the existence and work of dental practitioners of the time. The recipes found in the medical papyri that deals with teeth are evidence that dentists did feature in the diagnosing and treatment of dental maladies.

Although it is reasoned that the ancient practitioner was merely a dispenser of drugs, it must be said that modern dentist to a degree still engage in pharmacotherapy.

6.3.2 Resource material availability

Dan Brothwell (1959:59) pointed out that it was particularly fortunate that teeth are situated in the skull. The explanation is that in the past, archaeologists were far from particular as to which part of the skeleton was thrown away, provided it did not yield one of the standard measurements. This resulted in many post-cranial remains being thrown into dustbins after initial examination. Dental remains and the jaws were thus saved as part of the cranium and today odontological aspects of anthropology have garnered much interest. This phenomenon only refers to skeletal human remains. Mummification preserves the entire body and therefore, in most cases, the teeth are protected from environmental onslaughts. Unfortunately, mummification was only for the royalty and the rich. The remainder, the poor, were buried in the sand. Although these bodies buried in the sand were well preserved by natural mummification due to the dry climate, very few bodies of this nature have been recovered.

The discovery of the greatest source of medical information, the medical papyri, has perhaps been one of the greatest medico-archaeological discoveries of all time. A number of these papyri, of which the papyrus Ebers is the largest and best known, was in such impeccable condition that scholars initially believed it to be a bad forgery. Other papyri were in less perfect condition, some in fragile condition, or merely fragments. However, the information therein revealed the recipes for the treatment of a host of medical and dental diseases and conditions. These recipes proved to be the most important window through which the medical scientific domain could find access to the health and disease of the ancient world. There are, unfortunately, only a mere handful of references to dental recipes, but even so, the ones that were available are of utmost importance to the discipline of dentistry. Evidence that dentistry was practiced in ancient Egypt are amongst the benefits of the discovery (see table of medical papyri in Appendix I).

Although no mention is made to the specific dental conditions in the medical papyri as we know them today, we can, without much imagination, identify most of the dental conditions discussed in the recipes of the medical papyri. There are quite a number of substances named in the various recipes that have not yet been positively identified. This, perhaps, is a field that will require investigation in the future. The most disturbing manifestation in the medical papyri is the lack of information provided regarding any specific treatment for dental wear. Dental wear was the most ubiquitous dental malady among the population of ancient Egypt for most of the three millennia of its existence. One would expect some kind of treatment for the sensitivity and pain that dental wear undoubtedly had caused; treatment in the form of analgesics to relieve the symptoms occasioned by the malady. It is still not known whether opium and marijuana were used as an analgesic for everyday maladies, or only in surgical procedures.

6.3.3 The extent of dental diseases in ancient Egypt

Dental diseases are pervasive in every known population, in all periods throughout the prehistoric- and historical eras wherever archaeological excavations have uncovered human remains. However, the prevalence of certain dental diseases does vary from one population to another, depending on the cultural diet and environmental influences. Caries is one of the most common dental diseases worldwide but has not been very predominant as a disease in ancient Egypt due to the lack of sugar in the diet over much of the Dynastic Period. The incidence of caries seems to have been more prevalent among the royalties and more affluent people because of their richer diet. Caries increased in the Hellenistic and Roman Periods due to an increase of sugar that has become available to the masses.

Dental wear was an omnipresent condition that perhaps affected close on 100 percent of the Egyptian population. Dental wear *per se* is not a disease but a condition that is contributive to a number of dental maladies. Dental wear was shown to be the direct cause of periodontal disease, tooth abscesses, temporomandibular disorders, and was even shown to be the reason of great morbidity within the population. The reason for the greater morbidity was due to constant pain when the wearing down of the enamel has reached the softer dentine, which is rich in nerve endings.

Dental infections usually went unchecked in individuals who were compromised by immunosuppressive conditions, mainly the young and old individuals of the society, sometimes the infections led to their demise. There were no antibiotics, as we know it today. However, a number of the medical papyri recipes mention a number of antiseptic and antibacterial substances that could be used as treatment for various maladies, of which honey is the best know substance. One can then deduce that the medical and dental fraternity were well aware that an insalubrious substance was the cause of the malady, millennia before microorganisms were discovered.

6.3.4 Restorative and surgical procedures in ancient Egypt

One can perhaps understand the negativity of certain scholars when faced with the question whether dentistry was practiced in ancient Egypt. It is human nature to always want to see physical evidence. Restorative and prosthodontic dentistry have been comprehensively discussed in Chapter 4, but in retrospect, the evidence may be insubstantial for the inquisitive mind. There are only a few confirmations of prosthodontic and restorative treatments described for the lack of more examples. It is justifiable then that it can be argued that for a period of three thousand years, and supposedly for a population of millions, only a handful of identifiable restorations and appliances had been offered as evidence for the existence of a dental profession, is inadequate. One should keep in mind that the important axiom of archaeological interpretation is the absence of evidence is not the evidence of absence. It is however, undeniable that the bridges described do exist.

6.3.5 Primitive medical and dental disciplines

One cannot deny that modern medicine and dentistry has taken great strides through ongoing research, development of drugs, surgery, radiography and radiology, but likewise, one cannot argue that Egyptian medicine in its time was relative to the period, less advanced and unscientific in its approach, which is to be expected.

The research question of ‘to what extent does ancient Egyptian dentistry compare with the overall development of knowledge and science’ during the same period is relevant to this study because of the primitive state of affairs in the medical and dental disciplines in comparison to the highly sophisticated sciences of astronomy and architecture of the same period.

Pink (2005:50) argues the fact that man has not progressed as much as we think we did. To test this theory one should compare the products from the various fields of human enterprise of today with those of three or four thousand years ago. It is true that modern science has not reached the technology of the designers and builders of the Pyramids at Giza (Al Jizah). Pink (2005:53) further states that recent examination of some mummies has revealed the fact that the Egyptians were ahead of *us* even in medicine and dentistry; while physically, *we* compare unfavourable with the ancient Egyptians. The statement of Pink on medical and dental science compel the author to disagree in principal because this dissertation should clearly have shown how primitive the ancient Egyptians were, *especially* in the field of medicine and dentistry. The physical condition of the ancient Egyptians could not have been that good if their life expectancies are taken into consideration. One would expect that with the Egyptian elaborate practice of embalming and their knowledge of anatomy of the body including the oral cavity, they should have been more proficient in the medical sciences.

The lack of sophisticated operative dentistry and medical surgery techniques compares poorly in light of their knowledge concerning astronomy, chemistry, geography, and mathematics (Achtemeier *et al*. 1985:274). In geodesy (the measurement of the Earth's surface) and associated sciences, the Egyptians had attained a perfection that has never been surpassed; so that even our most modern instruments cannot detect any errors in their measurement and levelling skills.

In conclusion then: it remains a fact that in relation to the modern science of medicine and dentistry the compeer in ancient Egypt was primitive in all respects. It is not only primitive compared to modern science but also primitive in comparison to the other sciences of ancient Egypt of the same time. There seems to be no explanation to this phenomenon except that in recent history the science of dentistry of only a hundred years ago also seems very primitive to that of today. Taking into account that for the period of hundreds of years prior to the eighteenth century the skill of the jewellers were phenomenal whilst there were hardly any advancement in dental fillings, inlays, or dental bridges.

6.4 THE SIGNIFICANCE OF THIS STUDY

The author is confident that this dissertation put paid to the opinion that dentistry as a profession did not exist in ancient Egypt. The dentist as a professional was aware of some aetiologies of selected dental diseases, very much the same situation as the physicians of the time. The dentist was shown to have diagnosed a number of diseases, albeit erroneous at times. The dentist then treated these diseases in ways that modern dentistry may not approve of, being rather primitive in comparison to modern dentistry, but perhaps in a manner that satisfied his patients. Going forward with the knowledge imparted in this dissertation may be of great value to primitive populations around the globe that still today live in similar situations as the ancient Egyptians did 5 000 years ago.

Unchecked dental wear and attrition is still a reality in many African and Near Eastern countries today, including Egypt. Third World countries with similar topography and cultural geographic features that house artificial entities such as nations and settlements, may also suffer the same fate as that of the Egyptians in Ancient times. In the event that these peoples have an analogous diet, the assault on important dental anatomical and physiological conditions and disease will be similar to that of Ancient Egypt. Intervention is therefore suggested; starting with improved methods of food preparation together with an awareness programme on the dangers of mineral inclusions in their diet.

The significance of dental wear in ancient populations is locked up in the fundamental definition of archaeology which is the scientific study of past human culture and its focus is on the holistic lifestyle of past populations (Boshoff 2007:3). Archaeology also focuses on material remains (as fossil relics, artefacts, and architectural remains) of past human life and activities; in short, the remnants of the culture of a people. Every excavated object is examined by specialists to create an overall picture of an archaeological site; from the Temples and palaces down to the pollen spores. Human bioarchaeology in effect would be the archaeology of life, of biology and of past populations. Bioarchaeology explicates the cultural studies of human anthropology (Mich *et al*. 1996: s.v. archaeology). Archaeology studies past human behaviour through the examination of material remains of previous human societies. These remains include the fossils (preserved bones), skeletal remains and mummies of humans, food remains, the ruins of buildings, and all human-made artefact items such as tools, pottery, and jewellery. From their studies, archaeologists attempt to reconstruct past ways of life. Archaeology is an important field of anthropology, which is the broad study of human culture and biology, commonly referred to as bioarchaeology. Archaeologists concentrate their studies on past societies and changes in those societies over extremely long periods (Fagan 2009: s.v. Archaeology).

6.5 FUTURE RESEARCH QUESTIONS

The field of Egyptology is constantly expanding as new evidence is brought to the fore. There are endless reports of excavations in the field, documented measurements and drawing of field sites. One could argue that the knowledge of Egypt is inductive, simply by virtue of its reliance on archaeology. It is not just what we see that provides us with information on advancements in the field; it is also the questions we ask.

The influence that dental diseases have on the morbidity and mortality of the population of ancient Egypt may prove to be a debating question. Diet and dental disease are intricately connected. Periods of famine reaching biblical proportions occurred not only in biblical times but also throughout Egyptian history. These periods may perhaps be recognisable in the hypoplastic lesions and other insults to amelogenesis in ancient Egyptian individuals. Periods of famines and wars caused severe food shortages and metabolic diseases, which can perhaps be charted and compared to historical literature. Khwaileh (2009:2) reports that infectious diseases increased as a result of on-going wars in the Dynastic Periods in Upper and Lower Egypt. The lower social classes were more prone to suffer from famine in ancient times.

Berghult (1999:27) reports that Clement of Alexandria (circa 200 AD) mentioned that the written knowledge of the ancient times were held in the famous Alexandrian library. This knowledge was gathered in 42 genre of papyri, of which the last six contained all the medical writings. The remedies or prescriptions in Ancient Egypt were unique and the author believes future research may possibly uncover new medical papyri, which will then provide the medical and dental disciplines with new answers about ancient diseases and the health care of that period, which will ensure an even better understanding of the ancient medical and dental disciplines.

The future of palaeodontology rests squarely on development and implementation of new technologically advanced tools and methods to aid bioresearch (Smith & Hublin 2008:170). Technologically advanced tools are not a futuristic dream anymore; they are a reality of our times. DNA technology has identified the causative agents of a number of pathological conditions in ancient Egypt, and is used in the determination of sex and kinship of individuals. The Egyptian burial custom of mummification is unique and renders itself ideal grounds for DNA investigation. The future of DNA research may well be that selected skeleton or part thereof could be genetically scanned to determine not only the cause of death, sex and diet, but also what other underlying diseases the individual was suffering from.

The author concurs with Hughes (2011:59) that the security of archaeological artefacts is a major issue in the world at the moment, especially in the Middle East. There is a constant danger of artefacts being lost to war, rioting, theft and fire due to political unrests. An example of this occurred February 2011 when two mummies were destroyed in the Cairo Museum during the anti-government protests. X-ray CT scans combined with photography are the best way of 'saving' bioarchaeological artefacts for posterity. However, access to CT scanners for archaeological research will continue to be a problem. Clinical CT scanners tend to be too expensive for exclusive archaeological use – the initial purchase cost is high and there is the issue of the cost of on-going maintenance and repair.

In conclusion: there has in recent years been a growing interest in palaeopathology, assimilating palaeodontology (Roberts & Manchester 1995:1). The study of this discipline has proven to elucidate evolution, development and progression of various diseases, as well as other demographic information required to explicate the everyday life of ancient populations, and how human beings have adopted to changes within their environments. In ancient Egypt, our palaeodontological research has primarily provided evidence regarding the state of general health of the population, but with the combination of the bioarchaeological and cultural information (the biocultural approach), it has become an important tool in our recognition and understanding of the lifestyle of the progenitors of one of the greatest civilisations the world has known.

APPENDIX I

COMPARISON BETWEEN MEDICAL PAPYRI THAT DISTINGUISHES DENTAL TISSUES

Table 2: Comparison of medical papyri that distinguishes teeth and other oral structures. Adapted from Bouwer p 213.

PAPYRUS	Kahun medical	Edwin Smith	Ebers	Anastasi
Date	1 850 BCE	1 550 BCE	1 500 BCE	1 900 BCE
Condition	Highly fragmented	Good	Excellent	Fragmented
Discovered	Illahoun Fayum	Theban necropolis	Theban necropolis	Memphis
Present location	University College London	New York Academy of Medicine	University museum, Leipzig	British museum
Content	Gynaecological, mathematics & dental	Medical, surgery & dental	Medical & dental	Didactic excerpts & hymns, dental
Knowledge base	Medical & main dental	Medical & dental	Magico-medical & dental	Medical & little dental
Author	Unknown – copied by Usertesen II	Unknown	Unknown	Scribe Inina
Tomb owner	Unknown	Physician	Unknown	Unknown
Writing system	Hieratic	Hieratic	Hieratic	Hieratic
Original or copy	Copy	Copy of older text	Copy of older text	Copy

APPENDIX II

Table 3 Timeline: Chronology of ancient Egypt according to Nunn (1996:10-12).

DATE (BCE)	PERIOD	HIGHLIGHTS OF PERIOD
200 000 years BCE.	Palaeolithic Period.	Hunters, fishermen & gatherers.
10 000 years BCE.	Mesolithic/upper Palaeolithic Period.	Early signs of settlement, agriculturists grinding cereals with stone implements.
6 000 years BCE.	Neolithic Period.	Pasturelands & agriculturists mixed with hunter gatherers, in region of Fayum lake. Husbandry: barley & emmer. Beer common. Pottery.
4 500 – 3 000 years BCE.	Chalcolithic Period.	The use of copper became more prevalent
4 000 years BCE.	Predynastic Period; Late Neolithic.	Flint tools still in use. Medical science undeveloped.
3 100 years BCE.	Proto-Dynastic Period, beginning of recorded history.	Narmer, king of upper Egypt.
3 100 – 2 686 years BCE.	Old Kingdom Early Dynastic period.	3 Dynasties identified. Kings ruled from Aswan to Delta. Beginning of writing. Bronze Age proper. Stepped pyramid of Djozer at Saqqara. First recorded physician i.e. Imhotep & Hesi-re.
2 686 – 2 181 years BCE.	3rd – 6th Dynasties.	Great achievements i.e. Pyramids at Giza; a time increased interest in mathematics, astronomy, transport & government administration. Period of escalation of physicians, magic & science and of writing the Medical Papyri (i.e. Ebers & Edwin Smith); countless tombs of officials.
2 181 – 2 040 years BCE.	1st Intermediate Period.	General instability leading to a decline in all social sectors.
2 040 – 1 795 years BCE.	Middle Kingdom.	Period of great splendour; classical papyri scriptures; medical papyri of i.e. Kahun & Ramesseum.

? – 1 550 years BCE.	Intermediate Period.	Loss of central governmental control. Invasion of the Hyksos for more than a 100 years.
1 550 – 1 069 years BCE.	New Kingdom; 18th – 20th Dynasties.	Egypt again an international power. Population ca.3 million All kings buried in the Valley of the Kings at Thebes. Heretical Pharaoh Akhenaten (Amenhotep IV 1350-1336) results heretical change in state religion and in the Amarna Period where art flourished. Tutankhamen returns to orthodoxy. Hebrews still in Egypt and beginning of the Ramses Period.
1 069 – 656 years BCE.	3rd Intermediate Period.	Period of rule under Libyan & Nubian rule. Invasion of Assyrian forces 671-667, only to fall to the Babylonian Empire at the end of Psalmmeticus I's reign (664-610 BCE) and again later when Cambyses conquered Egypt in 525 BCE (Porten 1995:16). Start of the Greek medical schools.

The concept of 'Ancient Egypt' in this dissertation refers to the period from circa 4 000 to 300 BCE. Ancient Egyptian chronology[134] has to be established (and not yet precisely) by making use of a variety of sources. These include: a) ancient lists of kings, sometimes giving their supposed span of reign; b) genealogies giving sequences of people and rulers; c) original documents citing regnal years of kings, and archaeological evidence of such; d) synchronisms between Egyptian and independently dated foreign rulers; e) and astronomical calculations based on phenomena of the sun, moon, or stars mentioned in ancient texts; and f) the annual cow census; g) finally, and most often used by scholars, there is the *Aegyptiaka* or 'Egyptian History' by Manetho (an Egyptian priest of the 3rd century BCE), written in Greek under Ptolemy II.

[134] There is no consistency, neither standardisation as to the exact chronology of Ancient Egypt. Two authors' chronologies of the New Kingdom were chosen randomly to illustrate discrepancies and are as follows: (1 550 [or 1 539] to 1 295 BCE) (Kitchen 1996:328) and 1550 - 1069 BCE (cf. Nunn 1996:11).

The writings of Manetho embodied in its narrative various successions of kings and reigns. These are grouped in “Dynasties” or families (real or otherwise), with summaries of years of each Dynasty, and of longer periods of several dynasties. Except for a few citations in Josephus (first century CE), Manetho’s original work is now lost. At an earlier date, a basic list of the kings, Dynasties, and periodic summaries had been gathered into an Epitome. This summary of the ‘king’s list’ survives in three versions: in the writings of Africanus (3rd century CE); Eusebius (4th century CE); and George the Syncellus (ca. 800 CE). The original thirty Dynasties presented by Manetho are still retained in history books to this day because they provide convenient groupings of Egyptian rulers for historical purposes. However, the names and figures in the embodiment have clearly suffered considerable corruption in the course of centuries due to repeated hand-copying, and sometimes at the hands of would-be manipulators of ancient chronology. This is clear from the variant names and numbers evident in Africanus, Eusebius, the Syncellus, and Josephus, when compared with first-hand older Egyptian sources, especially from the reigns of individual kings. It is therefore true that Manetho provided only an outline framework. To be find more accuracy in the chronology of ancient Egypt, Manetho’s data should be used critically in conjunction with older and original sources (Kitchen 1996:325).

APPENDIX III

DENTAL DEVELOPMENT CHARTS

Table 3: Dental development charts by Schour and Massler (1941:1154).

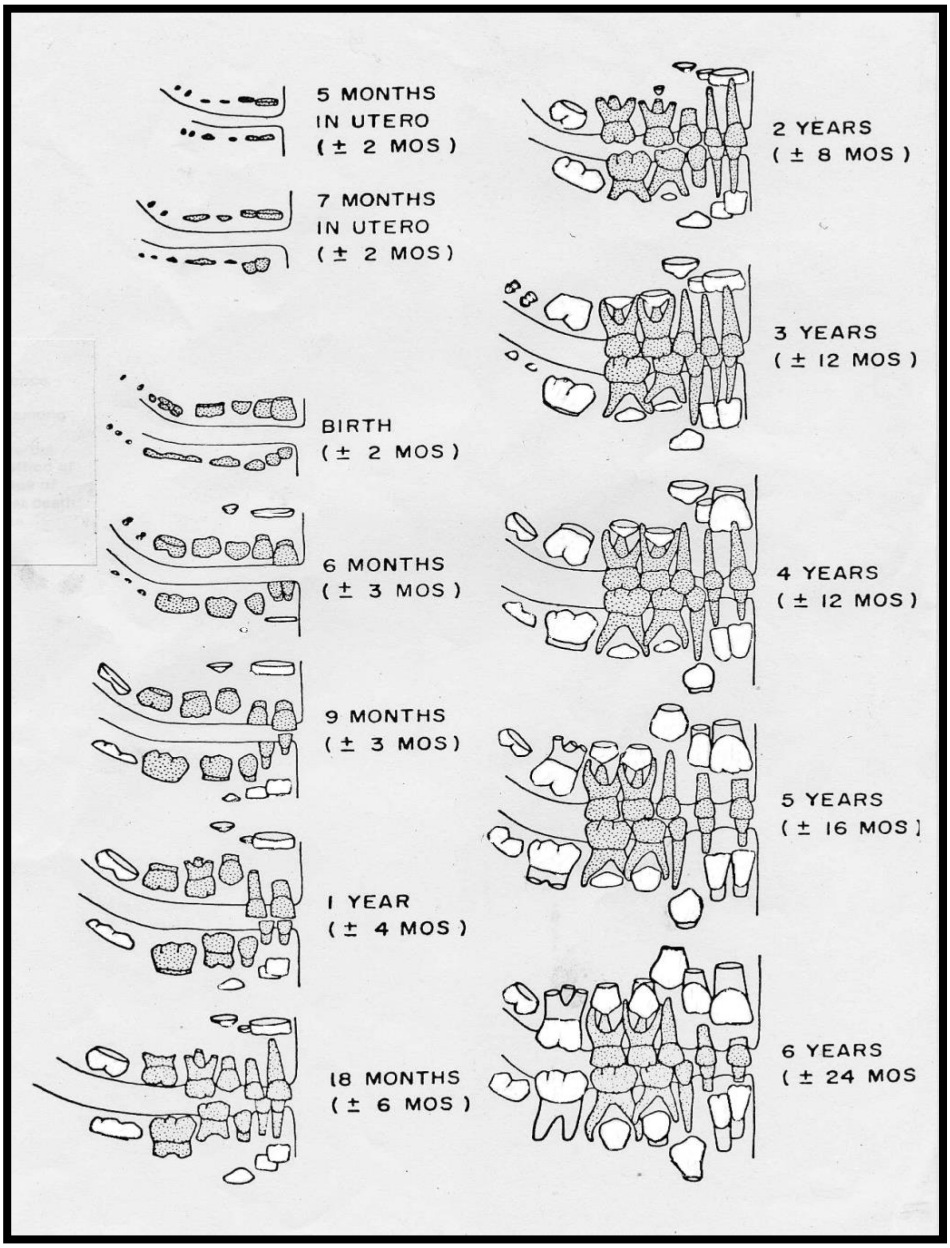

CHART I: The development of the dentition is according to the classical chart of Schour and Massler (1941:1154), and updated by Buiksra and Ubelaker (1978:112). It shows the primary and mixed dentitions between the ages of 5 months in utero up to 6 years of age. The deciduous teeth are shown in grey and the crowns of the permanent dentition are shown in white. Note that calcification of the crown-tips of permanent teeth starts before birth at about 6 months in utero (± 3 months). The mixed dentition period lasts from about 6 years through 10 years.

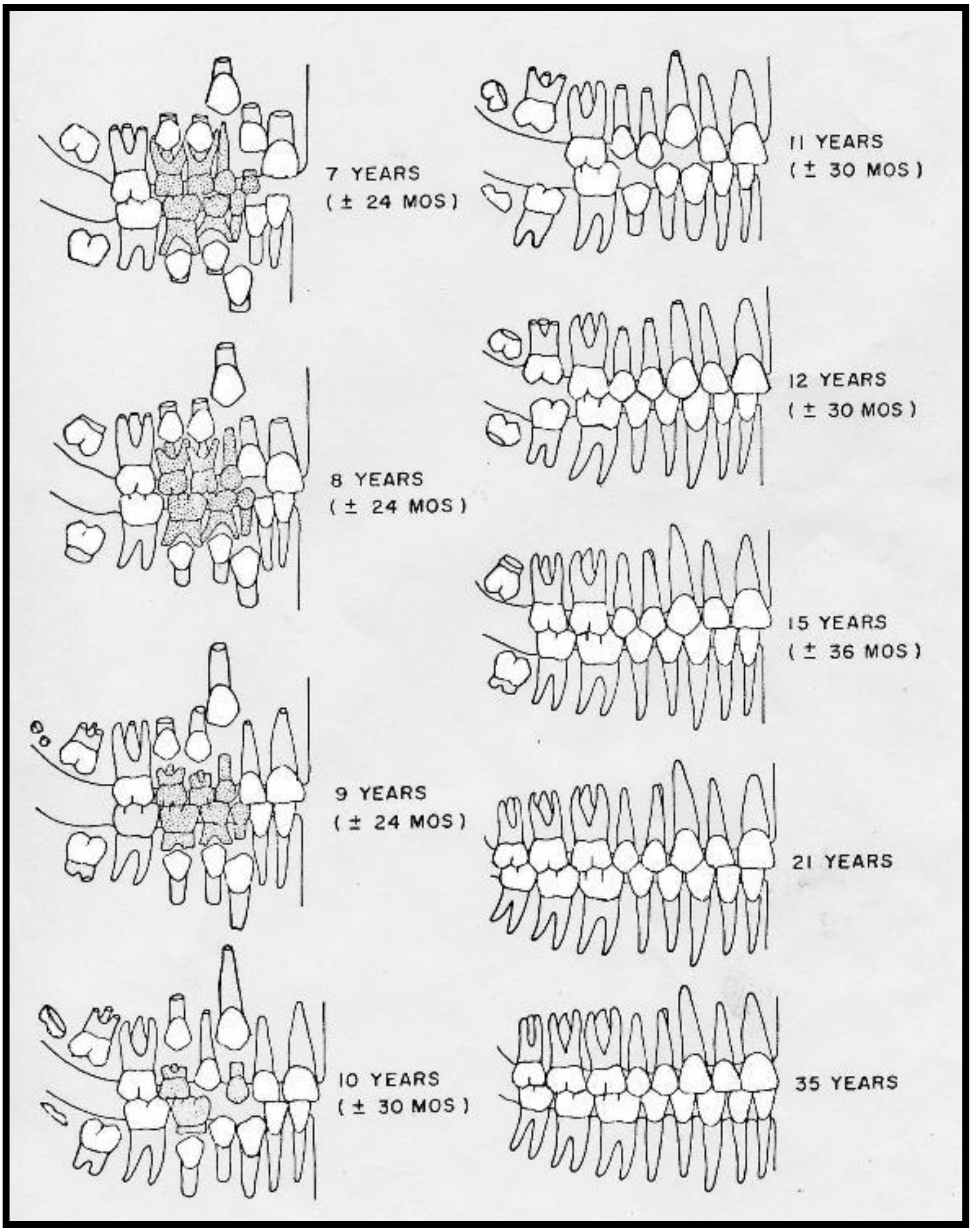

CHART II: The second chart of the development of the dentition based on the classical chart of Schour and Massler (1941:1153) and later updated by Ubelaker (1978:113) shows the mixed and permanent teeth between the ages of 7 years and 35 years. The deciduous teeth are shown in grey and the permanent dentitions are shown in white. Note that as from about the age of eleven, there are no more deciduous teeth present.

APPENDIX IV

STATISTICAL INFORMATION RE DENTAL DISEASES

In Sidmant Dyn. IX; Qurna Dyn. XI; Qâw Dyn. IV-XVIII; Hierakonpolis Pre- & Early Dynastic; Tarkhân Dyn. I & II.

Table 5[1]: Frequencies of dental caries in some earlier human populations (Adults only).

Approx. time	Series	Author	No. of teeth examined	No. with caries	% caries
70 000 – 35 000 BCE.	European Neanderthal	Brothwell 1959	259	0	0
35 000 – 10 000 BCE.	M. Carmel (Skhul) & European Upper Palaeolithic groups	Brothwell 1961	523	5	1.0
	Rhodesian Man	Carter (1928)	13	11	
10 000 – 30 000 BCE.	European and North African Mesolithic	Pequart, Boule, & Vallois (1937)	1 148	88	7.7
30 000 – 10 000 BCE.	French Neolithic	Hartweg (1945)	11 717	379	3.2
	German Neolithic	Brinch & Moller-Christensen (1949)	1 589	27	1.8
	Swedish Neolithic	Holmer & Maunsbach (1958)	6 402	91	1.4
	Danish Neolithic	Christophersen & Pedersen (1939)	3 612	56	1.6
	British Neolithic	Brothwell (1962)			
	Predynastic	Brothwell & Wood	1 151	36	3.1
	Egyptian	Robinson & Carr	1 742	40	2.3
	Greece (3000 – 1000 BCE)	Angel (1944)	1 404	116	12.1
			1 498	135	9.0
	Crete (1 750 – 550 BCE)	Carr (1960)	884	38	4.3
	China (1 766 – 1122 BCE.)	Mao and Yen (1959)	29 999	918	3.1

[1] Reproduced from D.R. Brothwell 1963:271-278, in Leek 1966:59-64.

Table 6: Teeth present.

Name of	Hierakonpolis Pre- & Early Dynastic	Tarkhân Dyn. I & II	Qâw Dyn. IV-XVIII	Sidmant Dyn. IX	Qurna Dyn. XI
Maxillae	95	114	128	48	48
Mandibulae	27	32	129	42	33
Possible number of teeth	2 056	2 302	4 112	1 440	1 296
Teeth present	518	1 150	2 320	479	349
Teeth lost ante-mortem	137	129	269	39	49
Percentage lost ante-mortem	6,7%	5,6%	6,5%	2,8%	3,8%

Table 7: Dental wear.

	Hierakonpolis	Tarkhân	Qâw	Sidmant	Qurna
Number of teeth	518	1,150	2 320	479	349
Number of teeth showing dental wear	385	1 003	2 184	422	326
Percentage	74%	87%	94%	90%	93%
Pulp exposed by dental wear	12	16	41	17	23
Abscess due to dental wear	12	20	113	31	25

Table 8: Caries and consequent pathology.

	Hierakonpolis	Tarkhân	Qâw	Sidmant	Qurna
Single surfaced cavity	7	8	23	1	-
Double surfaced cavity	-	8	25	1	3
Apical abscess	-	8	5	2	-

Table 9: Periodontal and alveolar conditions.

Area of alveolar destruction	Hierakonpolis	Tarkhân	Qâw	Sidmant	Qurna
Buccal lesions	33	28	46	11	10
Labial lesions	1	8	3	-	-
Periodontal abscess	12	3	7	-	-

Table 10: Absence and impaction, lower wisdom teeth.

	Hierakonpolis	Tarkhân	Qâw	Sidmant	Qurna
Absent 8 / 8 Lower third molar impaction	8	6	12	5	4

Table 11: Osteopathology.

	Hierakonpolis	Tarkhân	Qâw	Sidmant	Qurna
Dental cysts	7	-	14	8	3
Dental osteomyelitis	16	11	10	4	1

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