THE SIGNIFICANCE OF PALAEODONTOLOGY IN REVEALING THE PALAEODEMOGRAPHY OF ANCIENT EGYPT

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ABSTRACT

Palaeodemography, the means of amassing information from the teeth of the general population, is addressed in this study. Palaeodemography deals with the social characteristics of an ancient population and their development through time, in essence, the lifestyle of a population. The analysis and interpretation of dental data provided by the archaeologist's discovery of human remains, specifically dental remains, will throw light on settlement history, palaeodemography and kinship. 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. The population's health and disease issues are measured by hypoplastic markings in teeth and even sex physiognomics are locked in teeth. Modern technology, in the form of x-rays, has invaluable prominence in the research of mummified and skeletal human dental remains. Non-invasive procedures in examination of bioarchaeological remains have become all important to preserve data for future research.

INTRODUCTORY REMARKS

Palaeodemography is the interdisciplinary study of ancient human vital statistics – mortality, fertility, and migration, information which provides us with insight and provide us with a more profound understanding about the way humans lived their lifestyles within a given period (Buikstra & Konigsberg 1985:316). The term "palaeodontology", on the other hand, merely suggests a study of teeth of ancient populations (Scott and Turner 1988:100). 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 any other oral tissues.

Fekri (1978:49) chose the term "demographic archaeology" to emphasise the archaeological focus that bioarchaeological material provides demographic information. Demographic archaeology is an analytical and interpretive approach within archaeology. Demographic archaeology addresses the key problems of the role of demographic variables in cultural processes throughout ancient populations.

There is a growing tendency among archaeologists to incorporate skeletal studies into their research designs (Larsen 1999:2).[1] 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 the factors were that influenced the lifespan and health of earlier peoples. Palaeodemography specifically 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; and (3) statistics on migrations, their effects, and their relation to economic conditions (Buikstra & Konigsberg 1985:316). The interest in this study is mainly concerned with what the dentition can reveal about the aspects of general palaeodemographics.

[1] 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 by statistics of publications in this regard. On a more positive note, Larsen believes that there is growing evidence of archaeologists incorporating skeletal studies into their research designs.

[2] 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).

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.

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). This method is widely regarded as the method of choice. In the past the ossification processes of long bones were used to determine the age between post-puberty sub-adults and adults. More recently dental aging approaches are preferred (Lovejoy et al. 1985).

The various methods are based on an implicit position of a "biological uniformitarianism". Howell (1976:26) seems well-disposed towards a much earlier model of Simpson (1949:71), by explaining that the term "uniformitarian position in palaeodemography" implies that the human being has not changed in its direct biological response to the environment in the process of evolution. Examples include 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, it has not undergone much intra-species evolution in the demographically relevant biological processes. However, certain other genetically controlled physical traits, such as skin colour, body size or any other feature that is 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,[2] to a period of growth where birth-rates remain high but the death-

2 Diamond (2005: http://www.re.wild.com/mistake.html) claimed that few women in ancient times survived until the age of menopause. This theory is based solely on

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 becomes relevant for modern demographic research.

PALAEODEMOGRAPHY OF ANCIENT EGYPT

The palaeodemographic data of a select Egyptian population group will reveal information of the fitness thereof in relation to its physical and social environment. Masali and 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 imminent 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 reinterpreted it and coined the term "demographically inconvenient populations" claiming that nothing fits the description better than what is studied, as in palaeodemography where all members of a group are dead, which makes the 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 and mummified remains, makes 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 pre-dynastic 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.[3] These authors viewed the

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.

3 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,

population as a young, active population, but sadly not an expanding one, mostly due to low fertility rates, but certainly also from other unidentified reasons in which dental diseases may have played a role.

THE RACIAL HISTORY OF ANCIENT EGYPT

Egypt has a long and involved population history. The geographical location of Egypt, adjacent to several major cultural areas viz. the Mediterranean, the Middle East, the Sahara and East Africa, is partly to blame for the relocation of foreigners into Egypt. In addition, Egypt has experienced several invasions during its long history, including the Canaanites, Libyans, Assyrians, Kushites (Nubians), Persians, Greeks, Romans and various Arab nations. The conquest of ancient Egypt by foreign powers over time has made the affiliation between modern and ancient Egyptians significant, and has become a favourite topic to research (Zakrzewski 2007:502).

The ethnicity of ancient Egypt has been an interest of many anthropologists over a long period. The existence of Egypt as a continuous civilisation for more than five millennia 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 Egypt. Morant reported that Lower Egypt (the northern part) had a population 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 an early mixed population between Caucasoid and Negro races.

The determination of the relationships between ancient races ideally depends on

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.

the physical characteristics determined by the ontogenetic and phylogenetic development of a species, as revealed in bioarchaeological human remains. According to Berry and Berry (1972:202–203), it depends largely on the non-metrical variations of the dentition and a number of cranial non-metrical traits. The authors however, do not differentiate between Upper and Lower Egypt when they claim that the Egyptians changed very little throughout the pre-dynastic, Old and Middle Kingdom periods, and only changed in the New Kingdom when there was considerable immigration into the upper Nile Valley.

AGE DETERMINATION AND TEETH

Meindl et al. (1989:137) regard the study of human teeth as one of the most important features from which 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 objectives 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 taking into account also the skeletal changes that take place in the pubic symphysis, is the ideal method.

Cameriere et al. (2006:861) have devised a modern approach to age estimation of mummies using dentition. Their estimation of age is based solely on the pulp/tooth ratio method in the upper canines.[4] They use a method that involves the measuring of

[4] 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.

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).

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. 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 or mental developmental abnormalities show little or no dental abnormalities (Garn et al. 1965:243). Methods that are used 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 for 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 method of age determination (Gustafson 1950:45).

The Gustafson method

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

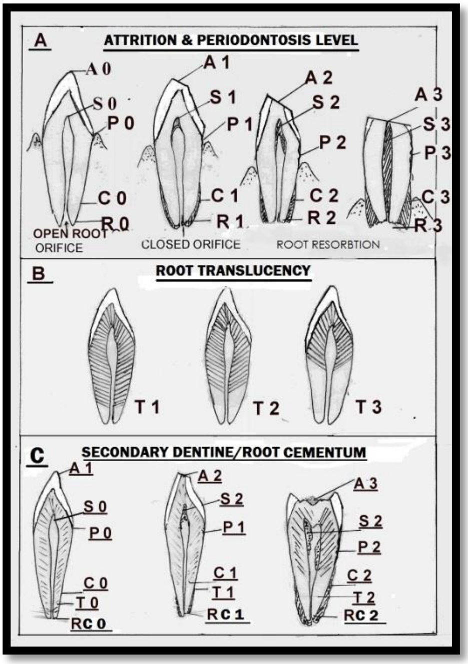

Figure 1: Gustafson's age changes and points scoring system, redrawn from Gustafson (1950:48). A = scores for attrition, secondary dentine, periodontitis, cement, resorption. B = scores for dentine transparencies, C = a practical collage of all six of Gustafson's criteria to make a calculated estimation of the age of the individual. Legend: A = attrition; S = secondary dentine; P = periodontosis; C = cementum layer; R = root resorption; T = transparency of root; Rc root cementum build up. 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.

Pulp/tooth ratio as indicator of age

Kvaal and Solheim (1994:8, 9) introduced a strong correlation with age as determined by a method whereby ratios between the root and pulp measurements were calculated by making use of dental radiographs. Cameriere et al. (2006:861) also proposed a pulp/tooth method to determine age, based on apposition of secondary dentine of upper canines that can be verified by radiographic assessment, providing a non-invasive procedure. The canine tooth is preferred because it is present in more skeletal remains than other single rooted teeth, as well as showing clearer images on x-rays (Cameriere et al. 2006:861). Non-invasive or non-destructive methods for all dental and skeletal investigation procedures should in time to come become obligatory because of the scarcity of human remains due to moratoria being placed on excavation of human remains by many countries already.

Cementum annulation as indicator of age

The annual rhythmic[5] 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 one millimetre in thickness, then examined under a microscope). Premolar teeth are preferred for this exercise because they offer 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.

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5 Annulations are presumed to be formed in human teeth during intrinsic biological rhythms (Charles et al. 1986:312).

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 have been used for decades, but almost none has claimed to be completely reliable. Although the whole skeleton should be taken into 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) is of the opinion 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 mandibular ramus flexure, tooth size, and using DNA in sexual dimorphism. Only the DNA approach is recognised as having possibilities.

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. PCR utilises 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).

The aspiration of scientific sex determination is for a 100 percent success rate in all areas. To attest to this unprecedented aspiration we must simply look at the genetic 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 the 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.

METRICAL ANALYSIS OF THE PERMANENT DENTITION

Statistical analysis of measurements of humans (anthropometrics) in palaeodontology has become an essential tool in the search for understanding the social impact on anthropological research that human remains may have. 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[6] (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) holds 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.

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 cannot 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

6 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 the resultant piece of string is measured.

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. Mays (1997:103) 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 have been described for the entire human skeleton in anatomical literature. There are more than 40 dental non-metrical traits generally used in the ASU-system (Turner et al. 1991:16). 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 hereditary. 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 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 inter-trait 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.[7]

The rationale of non-metrical dental trait data

The value and use of non-metrical traits per se were stated unambiguously by Jackes et

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[7] 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 by foreigners, or instead arose from shifting cultural and technical practices by indigenous peoples (Ullinger et al. 2005:466).

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. Hillson (1986:271) also held that one of the more important objectives of using non-metrical trait studies is to assess the relationship between different populations, otherwise referred to as determination of ethnicity. 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.

Dental morphology, Hillson (1986:271) 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[8] comparisons between populations are based on tooth morphology and specifically on the non-metrical traits as an indicator of genetic differences between all levels of social clusters, be it nations, 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 1986:271). 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).

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8 Phylogenetics is the development over time of a species, genus, or group, as contrasted with the development of an individual, which is called ontogeny.

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 (1939:121ff.), 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. 1991:14ff.). The objective 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 Irish (2006:537) more recently used non-metrical data to identify the answer to the age-old question of “Who were the ancient Egyptians?”

Joel Irish’s 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 pre-dynastic times through the New Kingdom period to the Roman period, to compare population distances and relationships.

The physical presence 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) 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 therefore be of tremendous help to bioarchaeological dental, medical and genetic research projects, especially in cephalometric analysis.

THE VALUE AND USES OF PALAEORADIOLOGY IN PALAEODEMOGRAPHY

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, still inferior to that which can be obtained from living individuals today (Nunn 1996:202).

The history of radiology as a tool used by bioarchaeologists goes back to the late nineteenth 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 was the first to appreciate the value of x-ray photography in Egyptian archaeology and published a picture of the lower part of a mummy in 1898 (Fiori & Nunzi 1995:68).

Owing to post-mortem rigidity of muscles, intra-oral x-rays and photography of dental structures is impossible in mummies (Leek 1971:105). Present-day x-ray technology provides 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 discussed above. Some of these changes[9] can be more accurately determined and measured from dental radiographs and specifically from information obtained from an orthopantomogram (panorex) and cephalometric X- rays, as shown in figure 2 below.

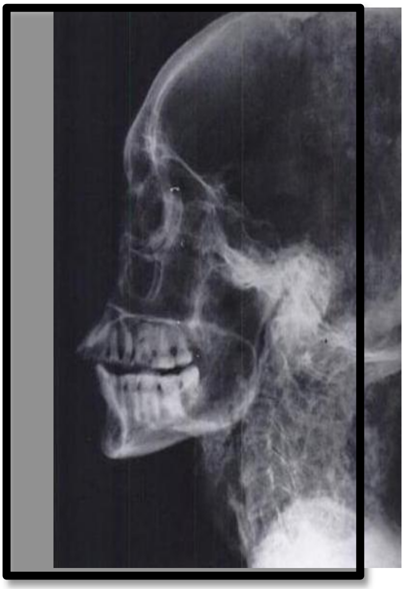

Figure 2: A cephalometric x-ray of the mummy of Queen Ahmose Nefertari, illustrating the maxillary prognathous which was a characteristic of the Royal females of the 18th Dynasty. Note also the level of dental wear (Harris & Wente 1980:63).

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) on a number of Egyptian mummified remains: the crania were evaluated on a Helical CT 1-mm axial scanner and the results confirmed 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 dental pathologies.

Computer-assisted imaging analysis has become indispensable in estimating the age at death of the individual for the use of palaeodemographic research. The greatest

[9] 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.

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.

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.

CONCLUSION

Central to the pragmatics of the definition of archaeology is the understanding of the lifestyles of ancient populations. This entails having a clear notion of the sociocultural, socioeconomical, and socioreligious aspects of life within a specific time/space frame (Greeff 2005:20). This study focused on the palaeodemography of the time, which encompassed the unabridged lifestyle and the health and disease component of the ancient Egyptians.

Palaeodemography looks at the changes in pre-modern populations in order to determine amongst other things the lifespan and health of earlier peoples. Dental data, both statistically and circumstantially relevant, must be inferred from the pursuits of bioarchaeology in most cases. It is the information coaxed from dental remains that provides some of the superior insights into past populations. The scientific approach to palaeodemography relies heavily on information obtained from human dentition. It is widely recognised that, because of the relatively indestructible nature of tooth structures in archaeological human remains, 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 discipline of anthropology the means to understand the human species through providing statistical data regarding the species' demographical information: life expectancy, procreation and sex identifications, and permanence age. This would include identification of populations, groups, individuals, kinship and the migration of people. In the past, age and sexual dimorphism were determined 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 is about interpretation as much as 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 evidence has 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 study 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 various populations, aid in the research into cultural anthropology and 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 to reconstruct the world of the ancient Egyptians, By learning more about the lives of the ancient inhabitants of Egypt, it may help the reader in reconstructing the world of the ancient Egyptians and elucidate their lifestyle (Greeff 2013:112).

Sex determination from oral structures is 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 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 study 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 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.

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 tissues 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 means that no mummified bodies need ever be examined physically again, unless unusual circumstances necessitate otherwise.

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