University of Alberta

A revision of Scott's technique for scoring molar quadrant wear

by

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ABSTRACT

In this study, the Scott method (1979) of scoring occlusal molar quadrant wear was revised in order to obtain more detailed information regarding molar wear patterns. This was achieved by associating numbered molar quadrants with specific molar cusps rather than visually dividing the occlusal surface into quadrants, as advocated by the original Scott method. The molars examined were excavated at Tell er-Rubʿa (ancient Mendes), Lower Egypt, and date from the Old Kingdom to the Graeco-Roman Period (ca. 3200 B.C. to ca. A.D. 395). Molars were also scored using the Smith (1984) method. Regression equations were then created to determine whether Smith wear scores could be transformed into averaged Scott quadrant wear scores, and vice versa, using the same molar sample.

ACKNOWLEDGEMENTS

This thesis is dedicated to my parents who encouraged me to pursue a Master's degree and always believed in me. Thank you for always being there for me when I needed you. Your love and support has guided me through many tough, challenging times and I hope I have shown you both how very much you are appreciated. A special thanks to my mum who spent endless hours editing and providing suggestions that improved the quality of this thesis. Thanks mum for your unwavering support, encouragement, and love.

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For my parents

In memory of

Olga Zabluda (1923-2008)

&

Edith Wilson (1947-2007)

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CHAPTER 1 – INTRODUCTION

This thesis was undertaken to determine whether the Scott method (1979) used in physical anthropology to score occlusal molar quadrant wear could be revised and improved. The primary objectives of this study are threefold: to 1) to develop a revised Scott scoring method, 2) to measure the degree of dental wear in the Mendes sample using the Smith (1984) and revised Scott scoring methods for scoring dental wear, and 3) to develop a method for transforming averaged Scott scores into Smith scores (and vice versa) so that future comparisons of published wear scores obtained using these methods can be made.

The sample of individuals analysed in this thesis was excavated in the 1960s at Tell er-Rub'a (ancient Mendes), a site in Lower Egypt, by a team led by Donald P. Hansen of the New York Institute of Fine Arts (Hansen, 1965; 1967). Archaeological (Holz, 1969) and written (Holz *et al.*, 1980) evidence indicates that Mendes was occupied continuously for more than 3,000 years and was an important centre of trade and governance in ancient times (Redford, 1988; 2004). The burials excavated from the site date to the Old Kingdom, First Intermediate/Middle Kingdom, and Graeco-Roman periods and consist of non-elite individuals (Lovell, 1992). Molar teeth (n=96) from a sub-sample of twenty individuals were examined and scored. This sub-sample represents all observable molar teeth from the individuals excavated from Mendes and housed in the Department of Anthropology at the University of Alberta.

This thesis consists of six chapters. Chapter 2 will provide an overview of dental anatomy and discuss its relationship to occlusion and wear aetiology. A review of dental wear scoring methods will also be presented, with a focus on the Scott and Smith methods. Chapter 3 introduces the dental materials examined in this thesis, as well as outlines the hypotheses to be tested. The development of the revised Scott quadrant scoring method and motives for creating a modified molar quadrant scoring method will be put forward. Also included in this chapter is a discussion of the statistical methods used to test the hypotheses presented. Chapter 4 will focus on revision of the Scott method, which is intended to provide researchers with additional information regarding patterns of tooth wear by associating each scoring quadrant on the molar occlusal surface with a particular molar cusp. In Chapter 5, molars scored using the revised Scott method from Chapter 4 and those scored using the Smith method will be used to create regression equations. Unlike the Scott method, the Smith method associates a single wear score for the entire molar occlusal surface rather than scoring individual quadrants. Because many anthropological dental collections are scored using the Smith method, it is hypothesized that a regression equation could be developed which would allow Smith scores to be transformed into averaged Scott scores, and vice-versa. This would hypothetically allow researchers to compare one collection against another if one was scored using the Smith method and the other using the Scott method. Chapter 6 will summarize the results drawn from Chapters 4 and 5, as well as assess any problems encountered during data analysis and provide recommendations for future research.

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CHAPTER 2 – DENTAL WEAR

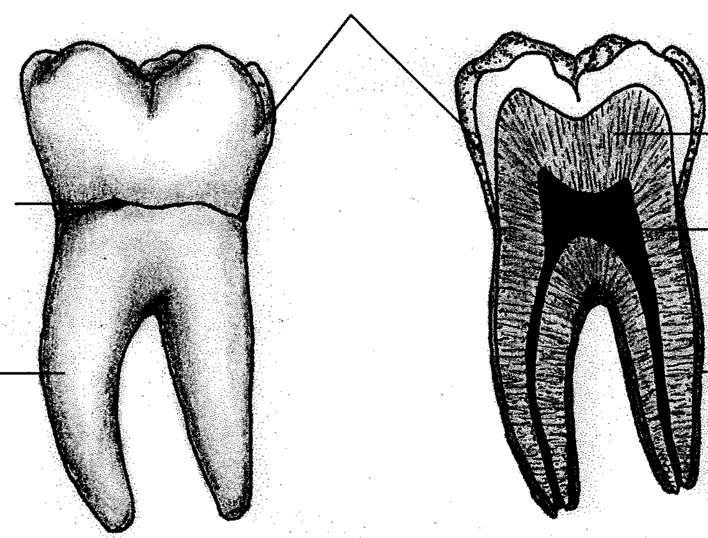
Introduction

In this chapter I describe the relationship of tooth anatomy and occlusion to dental wear, and provide a general overview of both the clinical and archaeological literature regarding the interrelationship between tooth wear and diet, with an emphasis on distinguishing between pathological and non-pathological (*i.e.*, physiological) wear of the teeth. I review the multifactorial aetiology of tooth wear (Grippo *et al.* 2004); describe the forces of attrition, abrasion, erosion, and abfraction; and, discuss the literature on age estimation methods from dental wear. I then survey the literature on macroscopic and microscopic scoring methods used in anthropology and dentistry.

Tooth anatomy

The structure of the human tooth plays an important role in the pattern and severity of dental wear. As illustrated in Figure 2.1, human teeth consist of four main parts: 1) a layer of enamel surrounding the outermost portion of the tooth crown; 2) a bone-like, calcified tissue layer of root cementum surrounding the tooth root below the cemento-enamel junction (CEJ) and forming part of the periodontium; 3) a softer, less dense substance called dentin (*or* primary dentin) covering the entire tooth and situated beneath the crown enamel and root cementum; and, 4) a pulp cavity, the innermost portion of the tooth, made up of both coronal and radicular pulp and housing blood vessels and the apical nerve (Hillson 1996; Turp and Alt 1998). Dental enamel, the hardest substance in the body, consists almost entirely of hydroxyapatite, an inorganic compound that does not regenerate (Aufderheide and Rodriguez-Martin, 1998; Turp and Alt, 1998). Therefore, when the enamel is worn, damaged from injury, or placed under heavy stress, the effects are usually permanent. Anthropologists are thus able to study the teeth in order to analyze the diet, activity patterns, and general health of individuals (Alexandersen *et al.*, 1998). It is important to note that there is a difference in enamel structure between the deciduous and permanent teeth and that this difference may affect the rate of tooth wear (Molleson *et al.*, 1993).

Figure 2.1 – Molar tooth anatomy shown from external and cross-sectional aspects. Left) right M_1 (lingual view) with labeled external tooth anatomy and location of cemento-enamel junction (CEJ; right) right M_1 (mesiodistal cross-section, lingual view) showing external and internal tooth anatomy. (Adapted from Fuller and Denehy, 1984:187, 227.)



Hydroxyapatite and crystalline calcium phosphate, both inorganic materials, make up approximately 70% of dentin weight, while the remaining 30% consists mainly of organic materials such as collagen and dentin-specific proteins (Hillson 1996; Ten Cate 1998; Turp and Alt, 1998). Therefore, dentin wear occurs at a faster rate than enamel wear because it is less calcified than enamel and contains more organic materials. Once the enamel has been breached due to wear, the softer primary dentin developed during the main period of tooth formation will begin to wear away more rapidly than the surrounding enamel (Hillson, 1996; Leek, 1966; Molnar, 1971). Exposure of the dentin is normally occlusally concave in appearance (White and Folkens, 2005). The tooth retains a secondary defense designed to protect the pulp cavity from the effects of enamel and dentin wear: the deposition of reparative secondary dentin (Borrman *et al*, 1996; Brothwell, 1981; Kieser *et al.*, 2001a; Klatsky, 1939; Leigh, 1934; Pindborg, 1970). According to Hillson (1996), secondary dentin refers to the normal deposition of dentin during adulthood as part of the aging process; tertiary dentin is the term he uses to describe dentin laid down to repair damage to the primary dentin. For the purposes of this thesis and in congruence with the majority of the dental and anthropological literature reviewed, the term secondary dentin will be used to describe reparative dentin.

Reparative secondary dentin differs from physiological secondary dentin which is laid down regularly during the aging process (Fuller and Denehy 1984), and can be used to age individuals with when combined with other aging techniques (Gustafson 1947; Gustafson, 1950; Solheim 1992). Reparative secondary dentinogenesis is a reaction to external insults such as caries or dental wear and can be deposited at different rates depending on the severity of the external stimulus (Fuller and Denehy, 1984; Smith *et al.* 1995; Tziafas 1995). Not all individuals will develop secondary dentin, even though their teeth may have experienced severe wear over their lifetime (Scott, 1979a). Analyses of secondary dentin reveal that its mineral content is 8% higher than that of normal dentin and tends to act as a kind of 'second enamel' (Pindborg, 1970; Scott, 1979a). Its deposition is irregular and less permeable than primary dentin (Hillson, 1996). In spite of this, heavy and continuous wear will eventually outpace the deposition of secondary dentin and expose the pulp cavity (Borrman *et al.*, 1996). Exposure of the pulp cavity allows for the entry of bacteria, often causing inflammation and infection (Aufderheide and Rodriguez-Martin, 1998; Borrman *et al.*, 1996; Kieser *et al.*, 2001b; Klatsky, 1939). This has been observed in the molars of individuals from the Old Kingdom, Egypt, where exposure of the pulp cavity led to an apical abscess and subsequent infection of the maxillary sinus(es) (Leek *et al.*, 1986).

Occlusion

Occlusion plays an important role in the rate and severity of tooth wear and, conversely, the degree of tooth wear also affects an individual's occlusal pattern (Hall, 1976). Contact of the occlusal (or chewing) surfaces during function and/or mastication is termed articulation (Turp and Alt, 1998). For the individuals examined in this thesis, it is important to note whether their molars exhibit normal wear patterns due to normal articulation, or whether atypical wear patterns exist attributable to malocclusion. While Hillson (1996) argues that the effects of malocclusion on the overall masticatory system are not significant and that normal dental wear will modify malocculuded teeth, individuals with moderate to severely maloccluded teeth are more susceptible to the dental problems discussed below. In fact, clinical research and anthropological observations have shown that malocclusion affects the entire dental apparatus since it alters masticatory efficiency through abnormal articulation between tooth cusps, often leading to disorders at the temporomandibular joint and alveolus

(Angle, 1899; Bauer, 1941; Darendeliler *et al.*, 2004; Hall, 1976; Klatsky, 1939; Leek, 1986; Ruhl *et al.*, 1994).

Angle (1899) was the first to classify types of malocclusion and describe the criteria identifying normal occlusion. His system is still in use in current clinical and anthropological literature. A normal articular pattern is determined by the position of the upper and lower molars. The paracone (mesiobuccal cusp) of M^1 (referred to as cusp 1 in this thesis) will rest in the sulcus between the protoconid (mesiobuccal cusp; cusp 1) and hypoconid (distobuccal cusp; cusp 2) of M_1 (Fig. 2.3). Because the upper dental arch is larger than the lower, the buccal maxillary cusps extend slightly beyond the buccal mandibular cusps (Turp and Alt, 1998) (Figs. 2.2 and 2.4). Normal dental wear patterns correspond to the normal articular pattern: the protocone and protoconid are often more worn than any of the other cusps (Lovejoy, 1985; Murphy, 1959a; White and Folkens, 2005). This results from the concentration of the majority of force during mastication being placed on these cusps. In other words, occlusal wear on the maxillary molars slopes lingually, while occlusal wear on the mandibular molars slopes buccally (Hall, 1976; Hillson, 1996; Lovejoy *et al.*, 1985).

Malocclusion is divided into three types which are briefly described here. Class I malocclusion describes normal articulation of the premolars and molars, with malocclusion in most cases confined to the anterior dentition. Class II malocclusion (retrusion of the mandible) is divided into two varieties: a) a narrow maxillary arch with prominent upper incisors, and b) malocclusion of one lateral half of the arch with the other half presenting normal articulation (Angle, 1899; Hillson, 1996). Class III (protrusion of the lower jaw) involves mesial articulation of the mandibular dentition

(Hillson, 1996). Therefore, maloccluded teeth result in abnormal relationships between the upper and lower dentition, often causing certain teeth to come into contact with one another and bear more force during mastication than they would during normal occlusion. This results in increased tooth wear at these abnormal contact points, such as has been observed in cases of extreme protrusion of the lower jaw and teeth (Brothwell, 1981), and the edge-to-edge bite pattern characteristic of Class III malocclusion (Leek; 1966; Leek, 1972). Instances of anterior open bite are rare in both archaeological and modern samples (Brothwell, 1981). Cucina and Tiesler (2003) have argued that increased bite force due to malocclusion will accelerate the progression of diseases such as periodontitis, but that malocclusion itself is not the main cause of the disease. It has also been documented that severe tooth wear, caries, and abscesses on one side of the mouth result in the individual favouring that side during mastication (Sheridan *et al.*, 1991). This creates increased strain on the unaffected side of the mouth and often leads to the development of an abnormal occlusal pattern. Severe interproximal tooth wear has been demonstrated to reduce the size of the dental arch (Murphy, 1964), which in turn changes the articulation pattern of the teeth.

The inclination of the posterior teeth and the position of the dental arches also relate to occlusion and the pattern of dental wear. As a general rule, the maxillary molars incline buccally, while the mandibular molars incline lingually (Hillson, 1996). These opposing inclinations form the Curve of Wilson (Fig. 2.2), and complement the movements of the mandibular condyles during the chewing cycle (Fuller and Denehy, 1984). When viewing the dentition from the lateral aspect, the occlusal plane appears to curve superiorly and distally (*Ibid.*). This curvature is termed the Curve of Spee and, together with the Curve of Wilson, forms the Sphere of Monson. The pattern of attrition where lingual maxillary molar cusps and buccal mandibular molar cusps wear more quickly than the other cusps first creates a flat occlusal plane. If molar wear continues, helicoidal plane of wear (or reversed Curve of Wilson) is formed (Hillson, 1996) (Fig. 2.2). The first molars develop this helicoidal plane of wear before the second or third molars, although all molars may exhibit this type of wear pattern in individuals with severe wear (*Ibid.*).

Figure 2.2 - Schematic diagram illustrating the buccal inclination of the maxillary molars and the lingual inclination of the mandibular molars forming the Curve of Wilson. Abbreviations are: buccal (B) and lingual (L). (Adapted from Fuller and Denehy, 1984:35, fig. C.; Hillson, 1996:238, fig. 11.4)

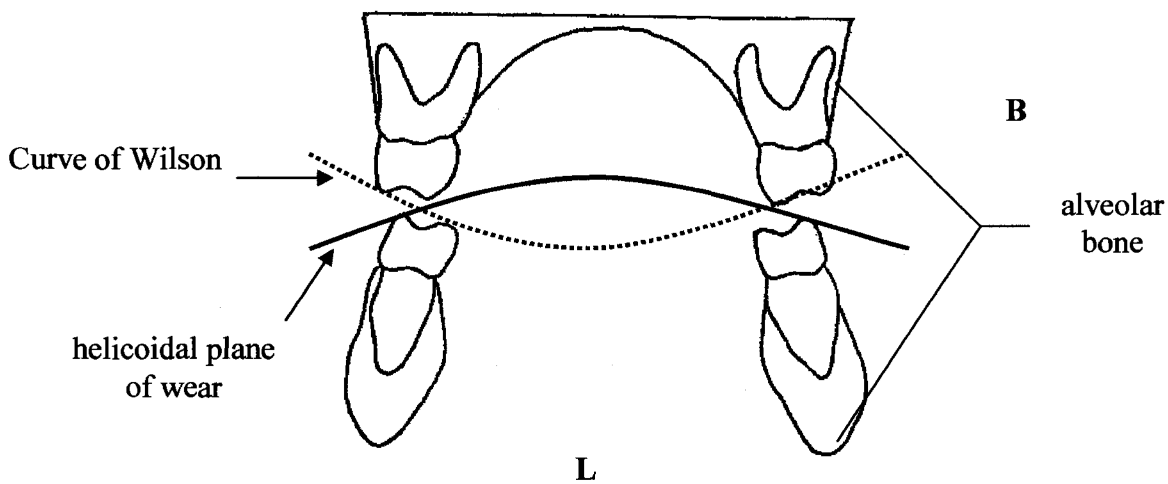


Figure 2.3 - Superior view of normal right M^1 - M_1 articulation. The right M^1 is superimposed on the left M_1. Abbreviations are: mesial (M), buccal (B), distal (D), and lingual (L).

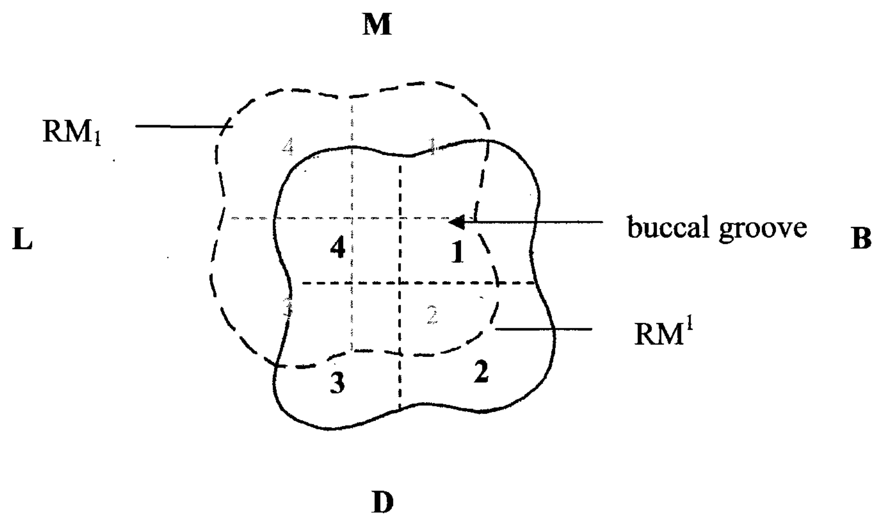
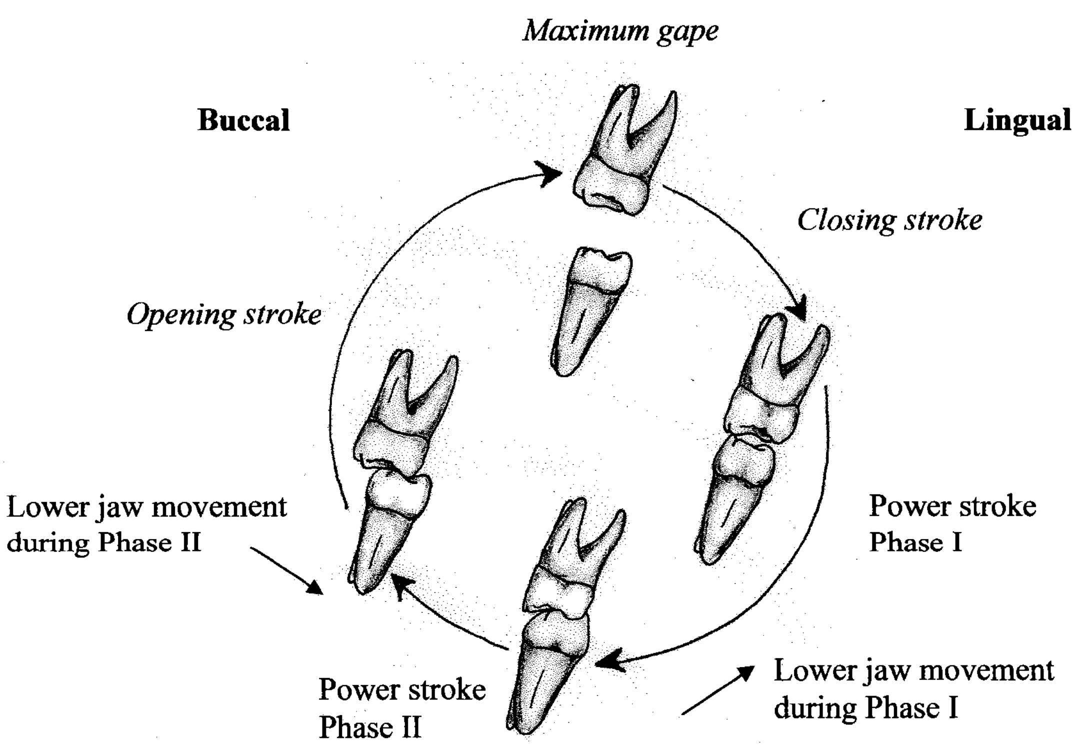


Figure 2.4 - The chewing cycle in molars showing the positions of the upper and lower molars during each phase and the direction of movement of the lower molars. (Adapted from Hillson, 1996:245, Fig.11.7)



There is a paucity of anthropological literature regarding the relationship between malocclusion and tooth wear when compared to the plethora of literature in the field of clinical odontology. Studies have shown that malocclusion was not prevalent in prehistoric and pre-contact populations (Campbell, 1938; Corruccini, 1984; Lucas, 2004; Price, 1936). Severe malocclusion is uncommon in European remains before *c.* A.D. 1500 (Brothwell, 1981). It has been hypothesized that instances of malocclusion have increased throughout history because the human dental arcade has decreased in size due to changes in subsistence, while tooth size has remained relatively constant (Larsen, 1997; Lucas, 2004; Molnar, 1972). Many studies indicate a combination of reduction in masticatory stress from the consumption of softer foods and rapid industrialization caused an increase in occlusal abnormalities in ethnic and aboriginal populations (Corruccini, 1991; Klatsky 1948; Larsen, 1997; Wood, 1971). Pindborg (1970) documented the relative lack of malocclusion in extant Inuit, Bedouin, and Tibetan populations who exhibit severe dental wear due to increased masticatory stress. On the other hand, Leek (1966) noted that Class III malocclusion is quite common in prehistoric and modern African individuals, although he does not state whether these groups show increased or decreased rates of tooth wear or what mode of subsistence they practiced.

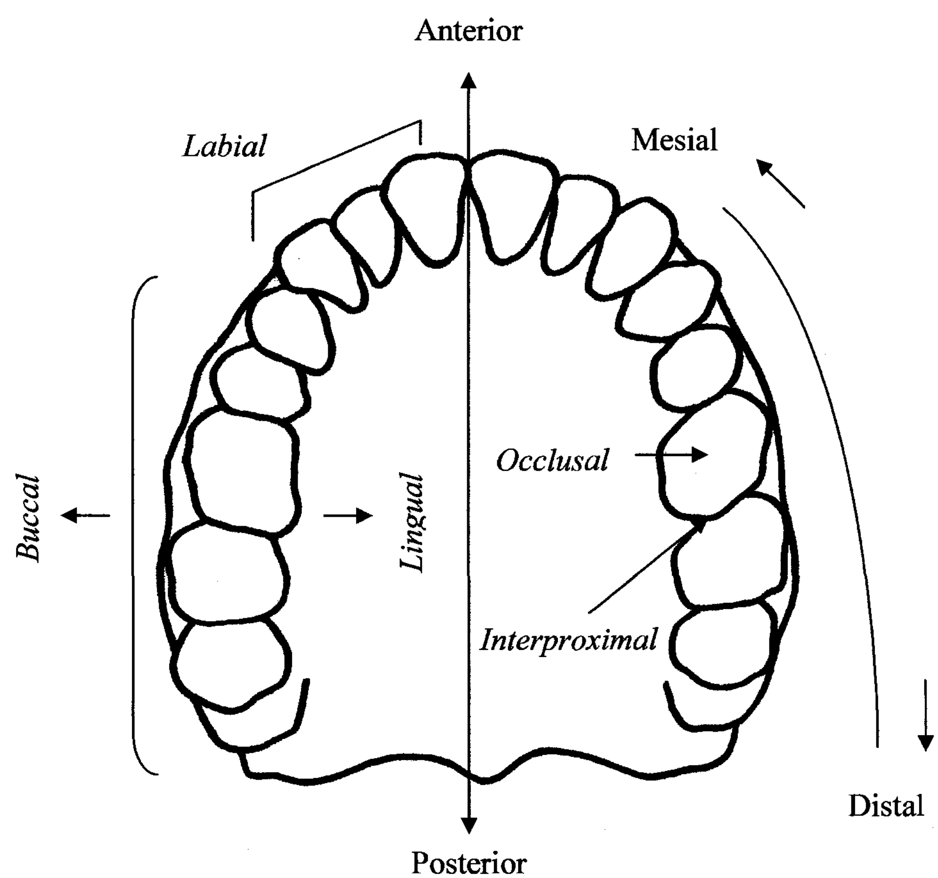
Aetiology of dental wear

Wear can occur on any of the five exposed surfaces of the tooth crown (Hillson, 1996; Lucas, 2004). These five surfaces are the occlusal, mesial, buccal, distal, and lingual aspects of the crown (Fig. 2.5). Interstitial or interproximal wear occurs between teeth, such as between the distal surface of the M^1 crown and the mesial surface of M^2 crown. The majority of dental wear studies have concentrated on occlusal surface wear patterns and rates since they are used to determine dietary status and to estimate age-at-death. The dietary shift from hunting and gathering to an agricultural mode of subsistence has been thoroughly researched in anthropology and studies have shown that overall occlusal molar tooth wear was much more severe prior to this shift (Brothwell, 1981; Davies and Pedersen, 1955; Kaifu, 1999; Leek, 1972; Molnar, 1972; Smith, 1984). The first molars are generally the most affected by wear since they are the first permanent molar teeth to erupt at about six years of age (Buikstra and Ubelaker, 1994; Comuzzie and Steele, 1989; Leigh, 1934; Miles, 1963), and tend to have thinner enamel than the second and third molars (Macho and Berner, 1994). In addition, because they act as the main supportive structure for the dental arcade (Abdel-Fattah, 1996), they endure the most stress during mastication and paramasticatory activities. This pattern is widely observed in contemporary, historic, and prehistoric agricultural populations, although in hunting and gathering populations, where teeth are frequently used as tools by both males and females, the anterior dentition is often more heavily worn than the molars (Borrman *et al.*, 1996; Merbs, 1983).

Sexual dimorphism in molar wear patterns can complicate expected molar wear rates. Longitudinal studies of dental wear among Australian aborigines found that females had significantly lower wear rates on the first molar than males (Molnar *et al.*, 1983). This may be attributed to differential diet, occlusal forces, tooth usage, and cusp morphology between males and females (McKee and Molnar, 1988).

Tooth efficiency is also affected by the wearing away of the occlusal surface. The mammalian dentition is built to withstand a certain amount of wear, but severe wear causes the odontostomatognathic system to become less efficient by interfering with normal occlusal patterns and reducing tooth crown height (Lucas, 2004). Decreased tooth efficiency may jeopardize the individual's health since less efficient food breakdown can mean loss of nutrients or the avoidance of some foods. It has therefore been argued that thickened enamel, especially on the occlusal surface, and an enlarged occlusal surface in hominids are adaptations for resisting wear and high masticatory stresses (Lambert *et al.*, 2004; Lucas, 2004; Schwartz, 2000).

Figure 2.5 – Directional terminology for the dentition including the five locations of tooth wear (*italicized*).



Dental wear has been described as pathological by many researchers in anthropology and dentistry, but it is essential that the distinction between pathological and physiological wear be made in order determine which type of force was responsible for the observed wear pattern (Klatsky, 1939; Molnar, 1972). Reference to attrition as pathological ignores the fact that a certain degree of tooth-on-tooth wear (or attrition) is part of the natural process of ageing and unrelated to pathogens or paramasticatory behaviours.

Attrition

Attrition is defined as natural, physiological tooth-on-tooth contact causing the gradual loss of tooth structure (Klatsky, 1939). Macroscopically, this type of wear produces flat, glossy surfaces or facets on the contact points of the teeth (Lucas, 2004; Molleson *et al.*, 1993). Microscopically, attrition creates polished surfaces with parallel striations oriented along the axes of the movement of the tooth (Molleson *et al.*, 1993). Often, attrition is more detrimental to the teeth than abrasion since teeth are the hardest structures in the human body and hence can inflict heavy wear on each other (Lucas, 2004). Many authors use the terms attrition and abrasion synonymously but in fact they are not caused by the same mechanisms, nor do they produce the same wear patterns.

Abrasion

In contrast to attrition, abrasion is caused by food-on-tooth contact. The severity of wear is dependent upon the nature or 'hardness' of the abrasive particles in food, which consist of silica and calcium salts in plant foods (Lucas, 2004), or windborne abrasives blown into food (Leek, 1966), such as quartzite sand. Quartz is twice as hard as dental enamel, while silica is 1.6 times as hard (Lucas, 2004). Therefore, the higher the proportion of abrasives in an individual's diet, the more likely the individual will demonstrate severe wear. Macroscopically, abrasion creates roughened and pitted areas on the occlusal surface of the teeth unlike a measurable wear plane angle that results from attrition (Molleson *et al.*, 1993). Microscopically, the surface of abraded enamel is rough and irregular, with a low frequency of striations (Kieser *et al.*, 2001b; Lucas, 2004; Molleson *et al.*, 1993).

Abrasion can also be caused through activities such as using the teeth as tools. Merbs (1983) illustrated severe abrasion and frequent loss of the anterior dentition in Sadlermiut Iniut groups and noted that males and females demonstrated differential patterns of abrasion based on activity patterns. Inuit females would stretch and chew hides using their incisors and canines (Borrman *et al.*, 1996; Davies and Pedersen, 1955; Merbs, 1983), while males would use the anterior teeth to stabilize a bow drill or tighten harpoon lines (Merbs, 1983).

Erosion

The erosion or dissolution of dental enamel is a type of corrosive tooth wear thought to be caused by either exogenous or endogenous factors. Exogenous causes of dental erosion include a high dietary intake of fruit, fruit juices or other sweetened drinks (Al-Dlaigan *et al.*, 2001; Bell *et al.*, 2002; Hicks, 1950; Lucas, 2004; Warren *et al.*, 2002). Erosion can also be linked to endogenous factors such as oral pH, salivary production, and gastric reflux (Holbrook and Arnadottir, 2003; Khan *et al.*, 2001; Kieser *et al.*, 2001a). Diseases such as anorexia nervosa and bulimia (Davies *et al.*, 2002; Holbrook and Arnadottir, 2003), as well as congenital abnormalities like Down syndrome, produce higher frequencies of dental erosion when compared to the rate of erosion in the general population due to changes in oral pH (Bell *et al.*, 2002).

Erosion produces a matte surface on the entire exposed area of the teeth when observed microscopically (Kieser *et al.*, 2001b; Lucas, 2004), unlike the striated or pitted surfaces produced from abrasion and attrition. Cupped lesions on the cusps and in fissures of teeth are related to the early onset of dental erosion in juveniles and young adults (Khan *et al.*, 2001). Often, erosion can be diagnosed macroscopically by observing the presence of a narrow outer ring of polished enamel on the lingual surface of the incisors (Holbrook and Arnadottir., 2003), which surrounds a yellowed, cupped lesion.

Alexandersen *et al.* (1998) note the presence of post-mortem erosion of dental enamel and dentin due to acidic burial environments, which produces a brownish staining of the teeth and microscopic etching similar to that found in individuals with pre-mortem dental erosion.

Abfraction

A fourth type of dental wear is known as abfraction or crown chipping. Abfraction may be observed as exfoliation or flaking of the occlusal enamel surface (Pindborg, 1970; Turner II *et al.*, 1991). This type of wear is multifactorial but in the majority of cases it is caused by extreme pressure or force placed on the crowns of the teeth, and differs from minor chipping which occurs with normal dental wear (Turner II *et al.*, 1991) . Abfraction can be caused by mastication of tough foods or the gnawing of bones, as observed in pre-contact Aleut and Inuit populations (Kieser *et al.*, 2001b; Merbs, 1983; Pindborg, 1970; Ryan and Johanson, 1989; Turner II and Cadien, 1969).

Crown-chipping can be caused by using the teeth as tools; for example, in historic and modern contexts non-masticatory crown chipping has been observed in seamstresses who held pins between their upper and lower incisors (Pretty and Addy, 2002).

Pathological disorders of the teeth influencing dental wear

The severity of tooth wear can be intensified by a diverse range of pathological and congenital disorders. For example, individuals with congenital disorders such as Down syndrome exhibit an increased frequency of attrition caused by bruxism and erosion caused by an increased frequency of gastric reflux (Bell *et al.*, 2002). Individuals with hereditary pathological disturbances in tooth formation such as amelogenesis imperfecta and dentinogenesis imperfecta display intensified attrition (Hillson, 1996; Pindborg, 1970; Zilberman, *et al.*, 2004). Amelogenesis imperfecta is characterized by a reduction in the amount of enamel matrix and disturbance of the enamel mineralization process, both of which weaken the occlusal surfaces of the teeth, making them more susceptible to attrition (Zilberman, *et al.*, 2004). Dentinogenesis imperfecta results in transparent or opalescent enamel and the tendency for enamel to chip away from the dentin, creating rapid wearing of the teeth since the dentin is not able to provide the normal supportive basis for the enamel (Aufderheide and Rodriguez-Martin, 1998; Pindborg, 1970).

Age estimation and dental wear

Dental wear has been used to estimate age-at-death in archaeological and forensic contexts (Buikstra and Ubelaker, 1994; Gustafson, 1950; Lovejoy, 1985; Mays, 2002; Miles, 1958; Miles, 1963; Pindborg, 1970; Walker *et al.*, 1991). Most age estimation methods using the dentition record wear on an ordinal scale (Mays, 2002).

Since dental wear is cumulative over time, it is generally assumed by anthropologists that there exists a strong positive relationship between the severity of wear and increasing age (Brothwell, 1981; Cucina and Tiesler, 2003; Lucy *et al.*, 1995; Richards and Miller, 1991; Scott, 1979a; Smith, 1972) (Fig. 2.6). This is, of course, dependent on diet since juveniles with coarser diets will possess greater wear due to abrasion than adults who consume softer, less gritty foods. Other factors such as occlusal relationships and bruxism may also play a role (Warren *et al.*, 2002). To illustrate the relationship between increasing tooth wear and age, let us create a graph using Brothwell's (1981) system for age estimation. In his system, each wear stage corresponds to an age set and these age sets can be numbered in order to plot them on a graph (Fig. 2.7): wear stage 1 (17-25), 2 (25-35), 3 (35-45), and 4 (>45).

Figure 2.6 – The positive relationship between increasing age and increasing molar wear (adapted from Brothwell, 1981:72, fig. 3.9).

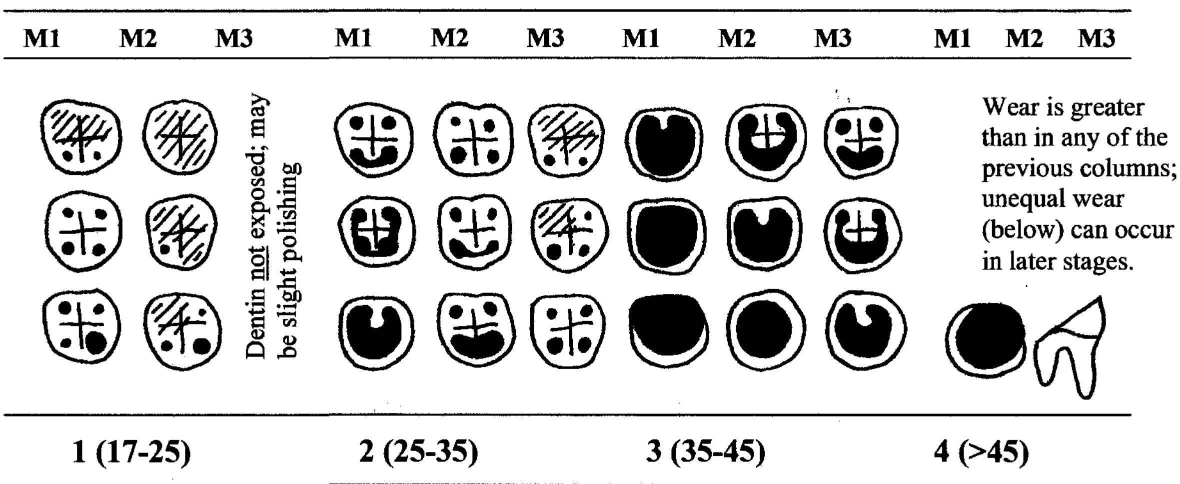
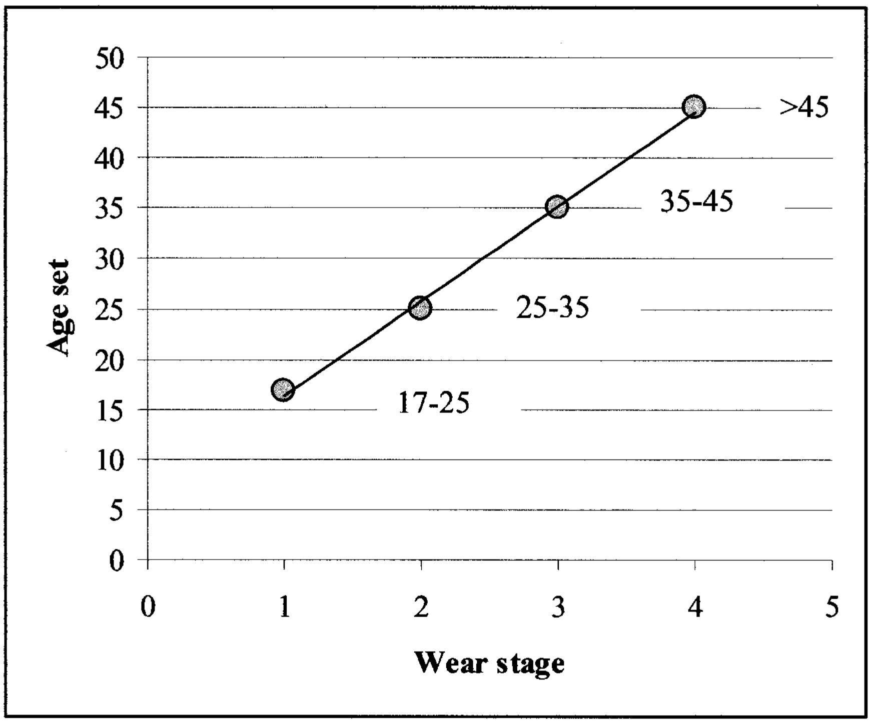


Figure 2.7 - Graphic representation of Fig. 2.7 illustrating the positive relationship between increasing age and tooth wear.



The Gustafson method has been widely used in both anthropology and clinical dentistry (Miles, 1958; Pindborg, 1970) to estimate age from attrition in conjunction with five other criteria: root translucency, cementum thickness, presence of periodontitis, root resorption, and secondary dentin deposition (Gustafson, 1950). In a review of the methods used to estimate age-at-death from dental wear, Mays (2002) states that such 'intuitive' methods are not routinely scrutinized for accuracy and therefore tend to produce large error ranges. He advocates applying root translucency criteria for age estimates using the dentition rather than relying solely on degrees of attrition. Mays' recommendation is obvious when one takes into account the fact that different populations will express varying degrees of wear depending on diet and behaviour. Analyzing root translucency is not usually a viable option for age estimation in the field as it requires the careful sectioning of teeth.

Lovejoy's (1985) analysis of dental wear in the Amerindian Libben population resulted in a 9-phase scoring system for maxillary dental wear and a 10-phase system for the mandibular dentition, preferably used in conjunction with other age estimation methods such as ectocranial suture closure and the appearance of the medial face of the pubic symphysis.

Macroscopic dental wear scoring methods

This section will discuss, chronologically, the history of methods used to score dental wear. The majority of dental wear scoring methods in both anthropology and dentistry are qualitative in their approach, relying on the observer's judgment when comparing observed wear to visual representations of wear and associated values. In anthropology, scoring techniques were mainly used to document the severe wear observed in the skeletal remains of prehistoric populations (Leigh, 1928) and to study the transition from hunting and gathering to agricultural modes of subsistence (Smith, 1972). A major drawback of these early methods is that very few of them provided pictorial representations of the wear stages. The earliest methods employed three to five classifications of wear stages with little to no intermediate classification criteria. This limited the types of statistical analyses which could be used to analyze recorded wear stages (Mays, 2002), and did not permit different types of teeth to be scored individually.

The earliest method for scoring dental wear was published by Paul Broca, the father of French anthropology, in 1879 (Pindborg, 1970) and continues to be used frequently by the clinical dental profession (Felden *et al.*, 2000; Pindborg, 1970). Broca's scoring classification is made up of five stages of dental wear labelled 0 to 4, although it does not include a score for perforation of the pulp cavity. Another of the early scholars to study ancient tooth wear was Ruffer (1920) who conducted analyses using ancient Egyptian teeth. He documented numerous cases of severe wear and pathological conditions associated with the dentition, such as temporomandibular joint disorders. Ruffer believed that the severe dental wear he observed was a contributing factor in the occurrence of lesions associated with periodontitis. When dental wear is severe, it can produce pupal pathosis, a diseased condition, which can then affect the supportive anatomy of the tooth within the alveolus (Kieser *et al.*, 2001b; Ruffer, 1920). Ruffer's study was one of the earliest to propose a correlation between the degree of dental wear and the likelihood of associated pathological dental conditions.

Leigh (1934) also noted the relationship between wear, exposure of the pulp cavity, and periapical osseous lesions. In the late 1920s and early 1930s, Leigh published his investigations on the dental pathology of ancient Egyptians (1934) and pre-contact North American aboriginal populations (1925; 1928). He did not, however, distinguish between the multi-factorial causes of dental wear, but rather attributed all wear of the occlusal surfaces of the teeth to pathological attritional forces produced during mastication. Unfortunately, Leigh's system does not lend itself to quantifiable measurements of dental wear and, according to Klatsky (1939), it is qualitatively deficient and difficult to determine where one stage of wear ends and the next begins. This can be said for most methods which quantify tooth wear as the probability of both inter- and intra-observer error is quite high. Although Leigh indirectly stated that each type of tooth will present varying degrees of wear, his system does not allow teeth to be scored individually according to their degree of attrition. It was not until the 1960s that replicable techniques were developed to quantify tooth wear, the majority of which were created to determine age-at-death from the degree of tooth wear (*e.g.*, Gustafson, 1950; Miles, 1963).

Klatsky appears to have been the first dental anthropologist to separate tooth wear from the realm of dental pathology. He distinguishes between attrition (non-pathological) and the effects of abrasion and erosion (both pathological) of the teeth and views attrition as the normal, physiological wear of the teeth over an individual's lifetime and unrelated to pathological disease conditions (Klatsky 1939). Klatsky's system of scoring dental wear is more descriptive than that proposed by Leigh, although it is nearly impossible to formulate a quantitative analysis of dental wear using Klatsky's methodology. Like Leigh, Klatsky does not create intermediate categories which would allow the assessment of additional degrees of wear and hence the creation of finer distinctions between wear stages, which would provide a more comprehensive presentation of wear data.

The scoring system developed by Murphy (1959a, b) was based on analyses of Australian Aborigine dentitions and written in the wake of the Piltdown fraud. Murphy (1959a) also attempted to answer two questions: 1) what represents the normal human pattern of dental wear; and, 2) how can human wear patterns be distinguished from those of non-human primates? In order to distinguish commonly occurring forms of variants, Murphy developed a system that scores different variants and modal forms of wear on an 8-point scale (Murphy 1959a). For example, when scoring a tooth that displays no wear, that tooth receives a score of 'N'. If a tooth displays wear, it is given a score between 'a' (little wear) and 'h' (complete dentin exposure with no enamel rim). When using his system, the number of teeth in the sample corresponding to each wear score is recorded underneath the matching pattern of dentin exposure depiction. According to Smith (1984), this system was culturally specific and thus difficult to apply to a wider range of population variability. However, this method of recording wear gives a good visual representation of how many teeth relate to each wear pattern. Hinton (1981) adapted Murphy's system to make it more widely applicable to a diverse range of human populations (Smith, 1984). Smith's 8-point scale is similar to Hinton's ordinal wear scale, but doesn't record cupped and rounded wear (Smith 1984).

Molnar (1971) developed a method that scored tooth wear based on the degree of dentin exposure and wear plane angle, both of which were scored on an eight-point scale. In these respects, his method closely parallels those of Murphy (1959a) and Brothwell (1963). However, Molnar also included the degree of visible secondary dentin exposure in wear stages 5-8. He advocates that two criteria must be analyzed when evaluating wear type: 1) direction of occlusal surface wear and 2) the surface form of the tooth (*e.g.*, flat, smooth, concave, or cupped). This method was originally created in order to determine whether differences in type and degree of wear due to diet and food preparation techniques could be observed among and within three North American Indian populations. Canines and incisors were evaluated separately from premolars and molars since Molnar considered his scoring procedure for incisors and canines less precise than his system for scoring molar wear due to the lack of cusps on the anterior teeth.

Molnar's study is considered a seminal work in dental anthropology research. The majority of dental anthropologists today use Molnar's eight-stage scoring method to document the degree of tooth wear and wear plane angle in archaeological dental remains. The only drawback to Molnar's method of scoring dental wear is that it is not as precise as Scott's system (described below) in terms of scoring molar wear. Molnar scores wear on the entire occlusal surface of the molars, rather than dividing the molar into quadrants and determining the amount of remaining enamel in each quadrant.

Leek (1972) examined the relationship between dental wear, temporomandibular joint change, and other odontostomatognathic changes, such as alveolar pathology, in a sample of Egyptian skulls dating from the Predynastic period (*c.* 5000-3150 B.C.) to the 21st Dynasty (*c.* 1075-950 B.C.). Using an inter-site sample of teeth, crania, and mandibles, Leek scored dental wear using an eight-stage system, with a Grade 8 score describing the most severe wear. Occlusal patterns were also analyzed due to their relationship with dental wear and TMJ disorders. He found that severe tooth wear was linked to regressive remodeling at the TMJ and higher frequencies of alveolar pathology. Importantly, Leek noted that pathological conditions at the TMJ and condyles were found to occur bilaterally; therefore, it is unlikely that such conditions were of localized origin and Leek concluded that wear was the major factor in physiological and pathological changes within the odontostomatognathic system.

Smith (1972) examined both juvenile and adult dentitions from the pre-agricultural Levantine Natufian sites of Eynan, El Wad, and Kebara in order to determine whether a correlation existed among rates of attrition, age, and diet. In order to test whether methods of food preparation affected wear rates, she compared the Natufian sample against an extant sample of known dietary status. Since age is a major factor in tooth wear, attrition gradients for each individual were employed rather than mean attrition scores. This was done in order to derive an assessment of the rate of attrition that was independent of age. Smith scored the occlusal attrition of each molar cusp separately on a five-point scale in order to give a better representation of wear patterns and to minimize differences in the rate of attrition between cusps.

Scott (1979a) created a new ordinal dental wear scoring technique to collect data from the molar teeth of three Amerindian populations. Each molar tooth was visually divided into four quadrants, with each quadrant scored on a scale of 1-10 based on the amount of enamel present. Then, the scores for each quadrant were combined to create a score between 4 (4 quadrants with a score of '1') and 40 (4 quadrants with a score of '10') for a single molar. In order to ensure reliability, inter- and intra-observer correlation coefficient and ANOVA tests were conducted. These tests found no significant difference in measurements separated by time and carried out by different observers. Scott then compared wear scores derived from her technique to those obtained using Molnar's 1-8 scale of dental wear. Scott (1979b) also used principal axis analysis to test her scoring method against Molnar's technique. In the first test, she found that in terms of scoring molar wear, Molnar's procedure was not as precise as her own method because her system could score wear by quadrant rather than giving one score for the entire occlusal surface (Scott 1979a). Using principal axis analysis, Scott concluded that her 4-40 system was inherently more precise because it closely approximated an interval scale and provided more insight into variation among molars

(Scott, 1979b). Buikstra and Ubelaker (1994) recommend that Smith's (1984) 8-point scale (described below) be used to score non-molar wear and Scott's to score molar wear.

Numerous researchers analyzing the rate of dental wear in prehistoric populations have employed the methodology articulated by Scott (1979a). They believe Scott's method to be more accurate than Molnar's in terms of scoring the amount of enamel remaining on the molar teeth. An evaluation of Scott's scoring technique was carried out by Cross *et al.* (1986) and they found her methods straightforward, objective, and repeatable. Since Scott's method scores the amount of enamel present in each quadrant of the molar, Cross *et al.* maintain it is inherently more precise than that of Molnar. There are three disadvantages to using Scott's technique: First, it does not score wear plane angle and therefore does not give the researcher insight into the direction of molar wear; secondly, in order to score the incisors and canines one must use another technique; and third, quadrants are not numbered according to cusp nomenclature and it is unclear whether, for example, quadrant 1 refers to the distobuccal cusp or to the mesiolingual cusp. Cross and colleagues note that a modified Scott method may be applied to scoring wear on premolars; however, they do not discuss how this may be done. Many researchers use Scott's technique for scoring molars, but use other methods, such as those set out by Smith (1984), to score the remaining dentition.

For her study of the dentitions of prehistoric and modern hunter-gatherers and agriculturalists, Smith (1984) developed an 8-point scale for scoring wear and assessing wear plane angle. This method was modified from an earlier scoring system created by

Murphy (1959a). Smith found that the wear plane angles of hunter-gatherers were up to 10% less than those of agriculturalists. Despite regional differences in foods, groups practising the same subsistence strategies were found to display similar wear plane angles. Smith's dental wear scoring system is easy to understand and use, both in the field (Lovell, pers. comm., 2006) and in the laboratory, although it does not discriminate among molar quadrant wear severity as does Scott's (1979a) method.

Microscopic dental wear scoring methods

Tooth wear is normally measured by either macroscopically observing gross patterns of wear with the naked eye, or through scanning electron microscopy (SEM) which allows researchers to observe dental microwear. Patterns of macroscopic wear in archaeological dental remains are compared to a series of predetermined wear categories. Gross wear observations cannot be quantified easily, but new methods derived from geographic contour mapping may provide more accurate estimates of gross wear (Lucas, 2004). SEM analysis has been employed by physical anthropologists to study the diets of both human and non-human primates (Kay and Covert, 1983; Molleson *et al.*, 1993; Ryan and Johanson, 1989; Teaford, 1991). Microwear analysis can be divided into two components: the recording of either enamel microwear or dentin microwear. The quantification of microwear features on dentin is more difficult than on enamel as the dentinal surface is soft, heterogeneous, and tends to collect debris easily (Lucas, 2004), and the majority of microwear studies in anthropology focus on enamel rather than dentin.

Microwear can tell us the dominant cause of wear, whether it be attrition, abrasion, or erosion, since each type creates its own distinct markings on the enamel.

An image analyzer system (IBAS) can also be used to measure the length and orientation of each striation to determine the cause of the observed microwear (Lalueza *et al.*, 1996). Attrition will leave parallel striations from the movements of shearing and grinding (Molleson *et al.*, 1993) and polished wear facets that can be seen with the naked eye or under low magnification with oblique lighting (Lucas, 2004). In contrast, abrasion will create roughened and pitted surfaces on the cusps of the teeth and a low proportion of striations (Molleson *et al.*, 1993; Kieser *et al.*, 2001b). Lucas, however, notes that it becomes difficult to distinguish between attrition and abrasion under high magnification SEM since "many facets that look featureless at lower power are actually scratched and pitted when magnified sufficiently" (2004:183). Erosion can be distinguished from both attrition and abrasion since it produces a matte surface without any pits or scratches (Kieser *et al.*, 2001b). Enamel wear from fracturing leaves ragged edges, while dentin is normally indented rather than microscopically fractured through abrasion (Lucas, 2004).

Microwear turnover rates have been studied in both humans (Teaford and Lytle, 1996) and captive monkeys (Teaford and Oyen, 1988) to determine whether diets can be accurately inferred from microwear analysis or whether the turnover is too rapid to create lasting effects. While both studies concluded that it is indeed possible to distinguish abrasive from non-abrasive diets, Teaford and Oyen (1988) caution that observed wear patterns may only represent the last 24 hours of an individual's diet. This is crucial as analysis of microwear in an archaeological dental sample may indicate an abrasive diet due to the presence of pitting, even though abrasion may only have occurred in the past few weeks, or even days.

Conclusion

A review of the clinical, dental, and palaeopathological literature on the aetiology of dental wear shows that not all wear is pathological: attrition occurs as normal, physiological wear over the course of an individual's lifetime. In ancient dental remains, diet appears to have been the primary factor in abrasive tooth wear. This appears to be especially true of individuals in ancient Egypt who consumed a diet high in abrasive material incorporated in foods from cereal processing and windborne sands (Leek, 1986). Consequently, higher rates of abrasion complicate age-at-death estimations, particularly in the case of younger individuals whose teeth are heavily worn as the result of diet, and thus additional methods, such as scoring the degree of ectocranial suture closure and/or the appearance of the pubic symphyseal face, often are used in conjunction with age estimations from dental wear.

Macroscopic and microscopic scoring methods have both benefits and limitations. For example, Scott's quadrant scoring system will yield more precise results than either the Smith or Molnar methods. By examining each molar by quadrants, one can observe the exact location of wear, whether certain aspects of each molar exhibit consistently heavier wear, and whether the molars demonstrate the normal wear pattern (*i.e.*, mandibular molars tend to have heavier wear on the buccal side, while maxillary molars are more worn on the lingual side) (White and Folkens, 2005). When documenting incisor, canine, and premolar wear, Smith's scoring method is commonly used by anthropologists. However, in contrast to Scott and Smith's methods, Molnar's scoring system can provide insight into the degree of secondary dentin exposure. When examining dental wear microscopically, the level of magnification plays a large role in the determination of wear patterns, such as the difference between microwear patterns caused by attrition and abrasion.

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CHAPTER 3 – MATERIALS AND METHODS

Introduction

In this chapter, I review the archaeology and cultural history of Mendes, describe the study sample, and explain the methods used to score dental wear in this study. The data analysed in this thesis was collected from a large sample of human teeth excavated at ancient Mendes, Lower Egypt, in the 1960s by New York University's Institute of Fine Arts under the direction of Donald P. Hansen. The material was shipped to Dr. Nancy C. Lovell, University of Alberta, in the 1990s. Individuals in the Mendes skeletal collection date to the Old Kingdom (2663–2195 B.C.) and First Intermediate (2195–2066 B.C.), Middle Kingdom (2066–1650 B.C.), and Graeco-Roman (332 B.C.–A.D. 395) periods. The collection is currently housed in the Department of Anthropology, University of Alberta.

Site background

Ancient Mendes is located in the eastern central Delta area of northern Egypt on the Mendesian distributary of the Sebennytic Branch of the Nile (Holz *et al.*, 1980; Lovell, 1992), approximately 85 kilometers south of the Mediterranean Sea (Wenke and Brewer, 1996) (Figs. 3.1 and 3.2). In antiquity, its proximity to a major branch of the Nile may have fostered connections between overland and maritime trade routes (Wenke and Brewer, 1996). The Mendesian distributary began to disappear during the time of Ptolemy (Holz, 1969), and had vanished completely by the early 10th century A.D. (Guest, 1912; Hassan and Graham-Campbell, 1997). Two ancient harbours have been uncovered at Mendes (Redford, 2004a) (Fig. 3.3), furthering the hypothesis that trade flourished at this site in ancient times. During the Third Intermediate (1064–664

B.C.), Saite (664–525 B.C.), and Late periods (525–332 B.C.), Mendes was one of the major cities in Egypt (Redford, 2004c; Wenke and Brewer, 1996). It was also the regional capital of the Mendesian nome (Redford, 1988), an ancient Egyptian sub-national administrative division (similar to a province), and was a centre for provincial political government in ancient times. It declined in importance in the first few centuries A.D. (the early Christian era) (Holz, 1969), and the surviving mound or '*tell*' is the largest of its kind in the Nile Delta. Modern-day Tell er-Rubʿa encompasses the tell and the satellite mound of Kom el-Adhem.

Mendes was occupied continuously for more than 3,000 years, from the late Predynastic period (*c.* 3200 B.C.) to the Graeco-Roman period (Holz, 1969). The town was a major cult center by the Old Kingdom Period (Wenke and Brewer, 1996), and evidence suggests that the site was the center of the cult of the holy ram (Hansen, 1965; Harrison, 1978/9; Holz *et al.*, 1980). Hansen (1965) notes that a temple dedicated to the Ram God of Mendes was constructed at the site during the XXVIth Dynasty (Saite period) (Fig. 3.3). King Nepherites I (29th Dynasty), a native of Mendes, made the city his capital during the Late period (Redford, 2004b).

The Greek historian and geographer Strabo (*c.* 64 B.C.–A.D. 24) lists Mendes as an important settlement in the Nile Delta, and the earliest map showing the location of Mendes was drawn by Ptolemy (*c.* A.D. 90–168) (Holz *et al.*, 1980) in a treatise on the geography of the Graeco-Roman world. Subsequent reports of Mendes and its ruins were recorded by numerous 18th and 19th century explorers who visited the area and undertook early, unsystematic excavations (DeMeulenaere and MacKay, 1976). In 1963, the Mendes Expedition of the Institute of Fine Arts, New York University, initiated excavation of Mendes (Hansen, 1965; Holz, 1969; Redford, 2004a), and carried out subsequent excavations until 1980.

The skeletal material evaluated in this thesis was excavated from areas near the temple complex at Mendes and from Kom el-Adhem and belongs to non-elite individuals. The majority of remains date to the Old Kingdom, First Intermediate, and Middle Kingdom periods, with a small number of individuals dating to the end of the Graeco-Roman period (*c.* A.D. 395). Remains excavated at Kom el-Adhem, sometimes referred to as Tell el-Izam (Holz *et al.*, 1980; Wilson, 1982), date to the Graeco-Roman period; this site is a mound situated 100 meters outside the eastern enclosure wall of Mendes.

Figure 3.1 - Map of the Egyptian Nile valley showing the location of Mendes.

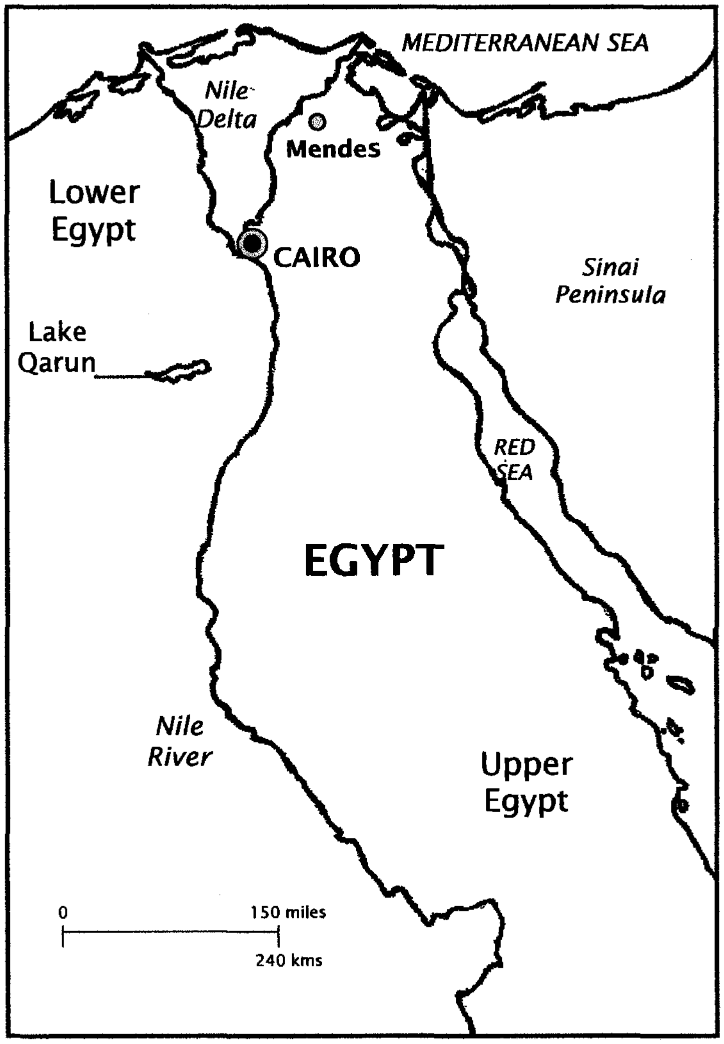


Figure 3.2 - Map of the Egyptian Nile delta showing the location of Mendes.

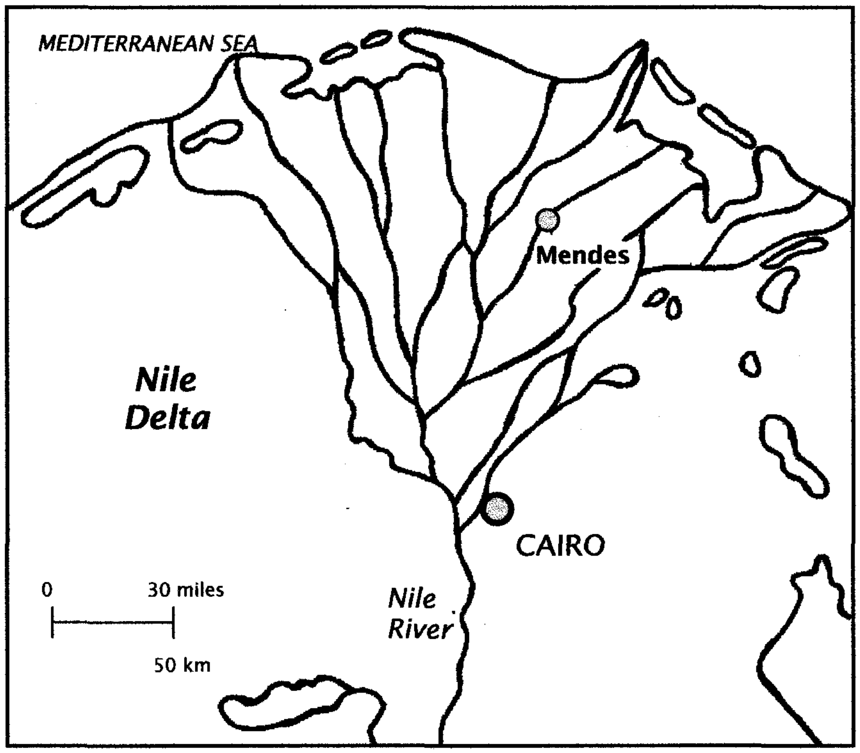


Figure 3.3 - Grid map of the Mendes site showing the temple complex (1), Kom el-Adhem (Hill of Bones) (2), and the two ancient harbours (3 and 4) mentioned in this chapter. (Map adapted from Redford, 2004a:1, fig. 1.)

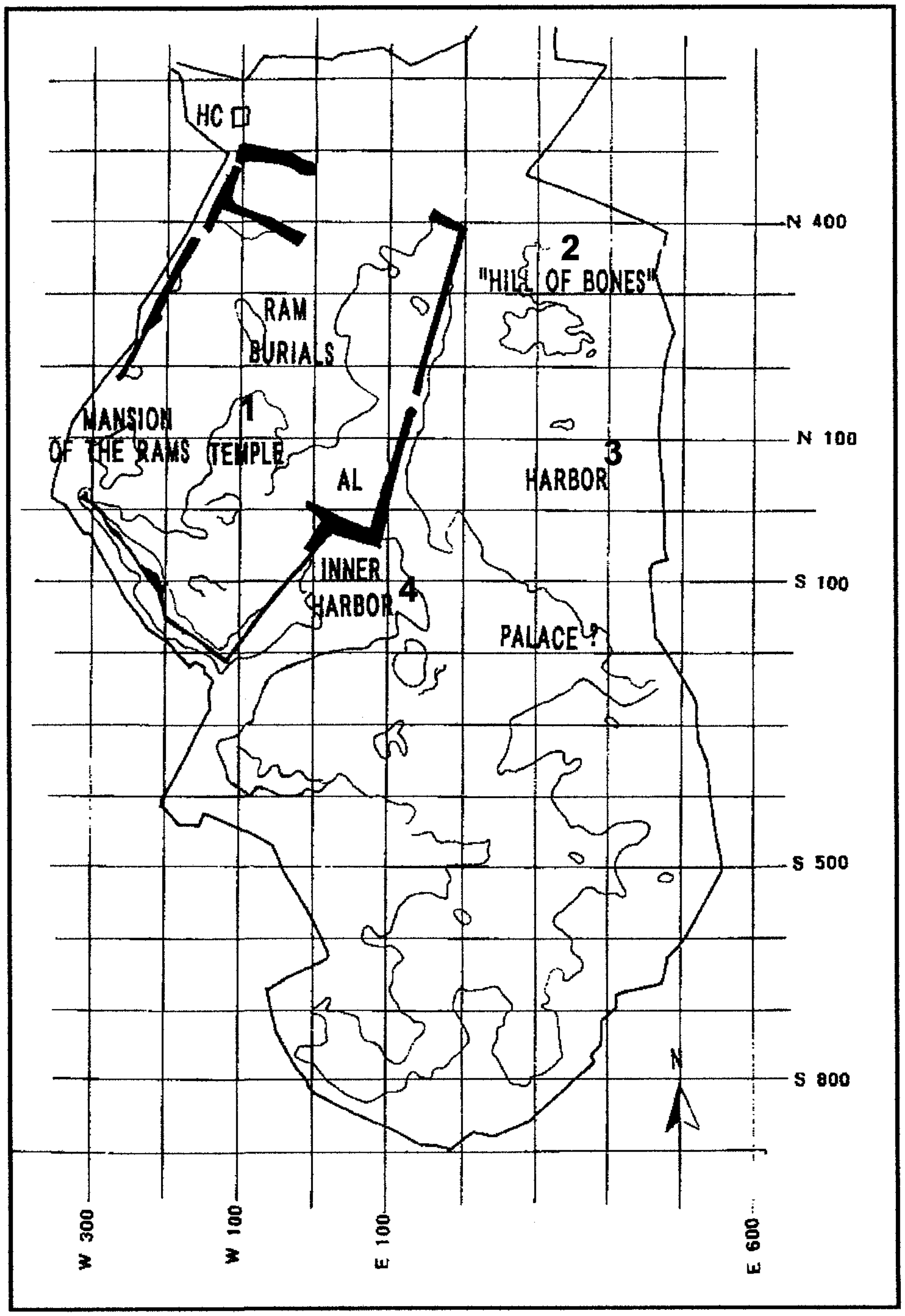


Figure 3.4 - Egyptian chronology divided into periods and dynasties.

	PERIOD DYNASTY	
ca. 5000 B.C. – 3000 B.C.	**PREDYNASTIC**	
	Upper Egypt	*Lower Egypt*
	BADARIAN NAQADA I NAQADA II NAQADA III	AMRATIAN GERZEAN DYNASTY '0'
3050 B.C. – 2663 B.C.	**ARCHAIC/EARLY DYNASTIC** DYNASTIES I – II	
2663 B.C. – 2195 B.C.	**OLD KINGDOM** DYNASTIES III – VI	
2195 B.C. – 2066 B.C.	**FIRST INTERMEDIATE** DYNASTIES VII – XIa	
2066 B.C. – 1650 B.C.	**MIDDLE KINGDOM** DYNASTIES XIb –XIII	
1650 B.C. – 1550 B.C.	**SECOND INTERMEDIATE** DYNASTIES XIV – XVII (Ramesside)	
1550 B.C. – 1064 B.C.	**NEW KINGDOM** DYNASTIES XVIII – XX AMARNA PERIOD (ca. 1360 – 1343)	
1064 B.C. – 664 B.C.	**THIRD INTERMEDIATE** DYNASTIES XXI – XXV	
664 B.C. – 525 B.C.	**SAITE** DYNASTY XXVI	
525 B.C. – 332 B.C.	**LATE PERIOD** DYNASTIES XXVII – XXXI	
332 B.C. – 30 B.C.	**HELLENISTIC** PTOLEMAIC	**GRAECO-ROMAN** PERIOD
30 B.C. – A.D. 395	**ROMAN** IMPERIAL	**GRAECO-ROMAN** PERIOD

Materials and methods

The collection analyzed in this study consists of 20 adult individuals with observable molar dentition that could be scored (Table 3.1). All molar teeth could be scored using the Scott quadrant method; however, all but four molars could be scored using the Smith method. This was due to poor preservation of the molar crown which prevented comparison of the occlusal wear surface with the Smith wear chart. Poor preservation also rendered a number of molar quadrants unobservable and therefore not all molar quadrants could be scored with the Scott method. The remains date to the Old Kingdom, First Intermediate, Middle Kingdom, and Graeco-Roman periods. Age at death was estimated using ectocranial suture closure and relative degree of dental wear. Sex was determined on the basis of cranial and pelvic morphology. Preliminary age and sex determinations were made by Bonne Gustav during the 1976 and 1977 field seasons, but all estimates were reassessed later by Dr. Lovell in Edmonton.

The Mendes skeletal collection contains both isolated teeth and teeth still in occlusion in either maxillae or mandibles. Isolated teeth were identified to tooth number using identification methods outlined in Bass (1995), Hillson (1996), and White (2005). Teeth in occlusion were easily identifiable; however, the maxillary dentition for 4MB1 had previously been reconstructed which necessitated re-identification. In order to ensure intra-observer accuracy in identifying individual isolated teeth, all loose teeth were reexamined for correct identification. It was found that all but 4 teeth that were reexamined matched the original identifications. This resulted in intra-observer accuracy of 96.6%.[1]

The Mendes sample consists predominantly of adult individuals. A total of 20 adults were selected for comparing Smith and Scott wear score methods. 96 adult molar teeth were observed in the Adult sample, consisting of 48 maxillary molars and 48 mandibular molars. The number of observable wear quadrants for the maxillary and mandibular dentition was also recorded. There were 373 observable molar quadrants: 184 maxillary and 189 mandibular quadrants. It is important to note that not all molars could be scored using both Smith and Scott methods. Four molars possessed quadrants which could be scored according to Scott but not enough of the occlusal surface was present to derive a Smith score. This accounts for the discrepancy between total molars observed in the Mendes sample and the total number of molars scored.

Table 3.1 – Number of adults in the Mendes sample according to time period and sex.

Time Period	**Count**	
	Male	Female
Old Kingdom	5	4
FIP/Middle Kingdom	6	3
Ptolemaic	-	2
TOTAL	11	9

Of the 20 adults chosen for analysis, males comprised 55% (n=11) of the sample and females 45% (n=9). The Mendes skeletal collection was originally divided

[1] Inter-observer accuracy is beyond the scope of this thesis. However, it should be evaluated in future applications of the revised Scott method.

into five possible sex categories: male, female, possible male, possible female, and unknown sex. For the purposes of this study and due to small sample sizes, it was necessary to combine the male and possible male categories into a single male category. This was also done for the female and possible female categories.

Table 3.2 – Type, location, and side of observable Adult molars in the Mendes sample. (O) refers to the observed number of molars and (E) to the expected number of molars in the normal adult dentition for the 20 individuals in the sample. Result is rounded to the nearest per cent.

Location	**Side**		**Count**		**O/E x 100**
	Right	Left	(O)	(E)	%
Maxillary	21	27	48	120	40
Mandibular	22	26	48	120	40
TOTAL	43	53	96	240	40

Table 3.3 - Number and type of observed Adult molar teeth in the Mendes sample.

Molar Tooth Type											
RM^3	**RM^2**	**RM^1**	**LM^1**	**LM^2**	**LM^3**	**LM_3**	**LM_2**	**LM_1**	**RM_1**	**RM_2**	**RM_3**
7	8	6	8	8	11	6	11	9	11	6	5

Table 3.4 - Number of maxillary molar quadrants observed in the Adult Mendes sample. (O) refers to the total observed number of quadrants and (E) to the total expected quadrants for the number of observed teeth for the 20 individuals in the sample. Result is rounded to the nearest per cent.

Quadrant	RM^3	RM^2	RM^1	LM^1	LM^2	LM^3	Count		O/E x 100
							(O)	(E)	%
1	7	8	6	7	8	11	47	120	39
2	7	8	6	7	8	11	47	120	39
3	7	7	7	6	8	11	46	120	38
4	6	7	6	6	8	11	44	120	37

Table 3.5 - Number of mandibular molar quadrants observed in the Adult Mendes samples. (O) refers to the total observed number of quadrants and (E) to the total expected quadrants for the number of observed teeth for the 20 individuals in the sample. Result is rounded to the nearest per cent.

Quadrant	LM_3	LM_2	LM_1	RM_1	RM_2	RM_3	Count		O/E x 100
							(O)	(E)	%
1	6	11	9	11	6	4	47	120	39
2	6	11	8	11	6	5	47	120	39
3	6	10	9	11	6	5	47	120	39
4	6	11	9	11	6	5	48	120	40

The Mendes sample was originally divided into seven different age categories. For this study, the categories were broadened in order to verify whether a single adult category could be created, or whether the categories should remain separate when conducting wear score analyses. The age categories compared were: adult (A; n=6), ages 19-45 (n=9), and MA-OA (n=5). Normality was assessed by creating histograms for the Smith and averaged Scott wear scores for each category. Homoscedasticity, or equality of variances, was assessed by running the F_{max} test, where the largest variance is divided by the smallest variance and then the ratio is compared to F_{max} table values (Madrigal, 1999). If variances were equal, a two sample unpaired *t*-test (two-tailed) assuming equal variances was used. When the F_{max} test showed inequality of variances, a two sample unpaired *t*-test (two-tailed) assuming unequal variances test was used.

There was no significant difference within either the Smith or averaged Scott-scored molar sets between the 'Adult' and '19-45' groups and these age categories were then combined into an 'Adult' category (n=14). The wear scores of the Adult group were then compared to those of the MA-OA group (n=5) and significant differences were found between the groups. Therefore, the Adult and MA-OA categories could not be amalgamated to form a single Adult group (n=19) which would have produced a larger sample size and facilitated analysis.

Previous studies have shown that older individuals tend to exhibit more severe dental wear than younger individuals (*i.e.*, old adults vs. young adults) due to the relationship between increasing wear severity and increasing age (Cross *et al.*, 1986; Klatsky, 1939; Lucy, 1995; Mays, 2002; Miles, 1958; Richards and Miller, 1991; Walker *et al.*, 1991). However, this could not be observed in Mendes sample because the sample of only three old adult molar teeth from a single individual does not adequately represent dental wear among older adults at Mendes.

Inventory forms were created specifically for this thesis to record tooth presence or absence and the degree of dental wear. Molar wear was scored using the Smith 1-8 wear scale and the symbol '/' was used when the tooth was either absent or too heavily damaged to score. The Scott 0-10 scale was used to score molar quadrant wear after the occlusal molar surface was visually divided into quadrants and each quadrant was associated with one of the four major maxillary or mandibular tooth cusps (Table 3.7). A score of '0' was used when a quadrant was unobservable due to the absence of the quadrant or damage. Wear scores for each molar quadrant were recorded separately in inventory forms (*see* Appendix). Smith and Scott recording methods are illustrated in table format in this chapter.

The presence or absence of a tooth in the Mendes skeletal collection and its state of development were recorded as a two-digit code. In the recording system, the first digit refers to the presence of the tooth, while the second conveys the state of development (Table 3.6). In addition, three stages of eruption were recognized: 1) completely erupted, 2) partially erupted, and 3) unerupted. The majority of teeth in the Mendes collection were completely formed, isolated teeth that were completely erupted and thus coded 5A.

In order to ensure intra-observer accuracy, scoring using both Smith and Scott methods was repeated on a sub-sample comprising 10% of the original Mendes Young Adult and Adult dental sample. This sample consisted of 12 randomly selected molar teeth from both males and females. It was found that none of the repeated Smith scores differed from the original Smith scores. Of the 47 quadrants that were rescored using the Scott method (one molar had only 3 observable quadrants), 3 quadrants had scores that differed from the original Scott scores. This produced an intra-observer error rate of 6.4% when using the Scott method for this sample.

Table 3.6 - Tooth presence/absence and state of development (adapted from Buikstra and Ubelaker, 1994:49).

Code	Description
1	present in occlusion
2	absent ante-mortem (alveolus resorbing or fully resorbed)
3	absent post-mortem (no alveolar resorption)
4	agenesis/congenital absence
5	isolated tooth (no associated alveolar bone)
A	completely formed
B	root incomplete
C	crown only formed
D	tooth is damaged

Scoring methods

Tooth wear was scored macroscopically on molar teeth using the method devised by Smith (1984). Given that Smith's method discriminates poorly with regard to wear of the molar teeth, especially when wear is low to moderate (Buikstra and Ubelaker, 1994), the Scott system (Scott, 1979) was used in this thesis for scoring surface wear in molars in addition to Smith's method. The Scott system is generally accepted as the preferred method when examining wear of the molar teeth as it assesses not only the overall severity of wear present, but also scores the plane of occlusal wear, or contact area between the upper and lower molars, of the molar teeth. Cross *et al.* (1986) maintain that Scott's scoring method offers a more detailed and objective description of molar wear compared to other methods.

Both left and right sides of the dentition were scored for wear. This was done albeit Smith's (1984) recommendation that only the left side be scored, with teeth from the right side substituted when left teeth are missing post-mortem. For the purposes of this study, both left and right sides were scored so possible differences in wear patterns between the sides could be discerned. In agreement with Campbell (1925), left and right sides should be scored to determine whether wear patterns are similar between sides. Moreover, the marked asymmetry in the Mendes sample with respect to the number of observable teeth per side necessitated scoring both sides of the dentition. Scoring left and right sides is advised by Buikstra and Ubelaker (1994) in such situations.

For this study, it is important to first evaluate whether differences exist between males and females in terms of dental wear for both Smith and averaged Scott wear scores. Differences will be assessed using unpaired *t*-tests (two-tailed) if all assumptions of this test are met. If dental wear is found to be homogeneous between the sexes, male and female scores will be pooled into a single sample. Should statistically significant differences be present, male and female scores will be kept as separate samples. Regardless, dental wear homogeneity or heterogeneity between the sexes will be discussed in the following chapter of this thesis.

Scoring the dentition using the Smith method

The Smith molar wear scoring method allows the observer to quantify and analyse the flatness (or degree) of occlusal wear using an 8-point scale. Molar teeth from 20 adults in the Mendes sample were scored using Smith's method (Fig. 3.6) and recorded on data sheets (*see* Appendix). Differences between male and female wear scores were assessed before the sexes were pooled.

Scoring the dentition using the revised Scott method

Molar teeth from 20 adults in the Mendes sample were scored using Scott's method and recorded on data sheets (*see* Appendix). This thesis employs a modified Scott scoring system in order to score dental wear by associating each quadrant with one of the four major maxillary or mandibular molar cusps. This was done because Scott (1979) suggests that the molars be visually divided into quadrants but does not specify an exact location for each quadrant. Therefore, in order to ensure consistent scoring, each molar is oriented using mesial, distal, buccal, and lingual directions so that the four major cusps can be associated with visually demarcated quadrants on the occlusal surface.

As molars do not consistently display only four cusps, associations between scoring quadrants and molar cusps may need to be modified. Three-cusped mandibular molars are often missing the distolingual entoconid (Hillson, 1996), while five-cusped mandibular molars possess a distobuccal cusp called the hypoconulid. Mandibular molars may display more than five cusps (*e.g.*, a mesiobuccal cusp called the protostylid), while maxillary molars can have more than four cusps, such as the mesiolingual cusp of Carabelli. These additional cusps are often accessory and do not reach the occlusal surface, thereby not incurring significant wear. The distolingual hypocone is often reduced in size in maxillary second molars and may be absent in maxillary third molars, therefore creating a three-cusped molar (Bass, 1995). In this study, for maxillary molars that display three cusps, the score for the missing hypocone will be simulated by adopting the score for the protocone. For three-cusped mandibular molars, the score for the missing hypoconid will be adopted from the protoconid. When more than four cusps are present in either maxillary or mandibular molars, the additional cusp will be visually divided in two and each half will belong to the nearest major cusp. For example, when the hypoconulid is present, half of its score will become part of the score for the entoconid, while the other half will belong to the hypoconid.

Tribosphenic cusp names (Osborn, 1907; White and Folkens, 2005) were used when scoring wear by cusp and correlated to the quadrant number so that other researchers can replicate the scoring method precisely (Table 3.9, Fig. 3.5). The nomenclature for molar cusps was originally developed by Osborn in 1888 and applied to the dentition of Eocene mammals (Gregory, 1922; Lucas, 2004). This molar cusp terminology does not reflect evolutionary patterns (Lucas, 2004), although its use is prevalent in the literature. Humans possess a tribosphenic molar tooth form; this form evolved in therian (live-bearing) mammals sometime during the Cretaceous period (Butler, 1972). Tribosphenic maxillary molars have three main cusps known as the protocone, paracone, and metacone. In some mammalian lineages, a fourth cusp called the hypocone appeared independently (Lucas, 2004). Mandibular molars are divided into the distal talonid basin and the mesially located trigonid: the talonid basin is made up of the hypoconid, hypoconulid, and entoconid, while the paraconid, protoconid, and metaconid make up the trigonid (Alt *et al.*, 1998; Butler, 1978; Fleagle, 1999). Extra cuspules (small cusps) such as the cusp of Carabelli, located on the lingual side of the tooth, can occur on the molar teeth (Hillson, 1996), but are not usually large enough to reach the occlusal plane.

Table 3.7 – Modified Scott scoring system employing molar quadrant number and corresponding cusp name.

Maxillary molars		**Mandibular molars**	
Quadrant	*Cusp name*	*Quadrant*	*Cusp name*
1	Paracone	1	Protoconid
2	Metacone	2	Hypoconid
3	Hypocone	3	Entoconid
4	Protocone	4	Metaconid

Figure 3.5 - Stylized maxillary and mandibular molars showing demarcation of Scott scoring quadrants. Abbreviations are mesial (M), buccal (B), lingual (L), and distal (D).

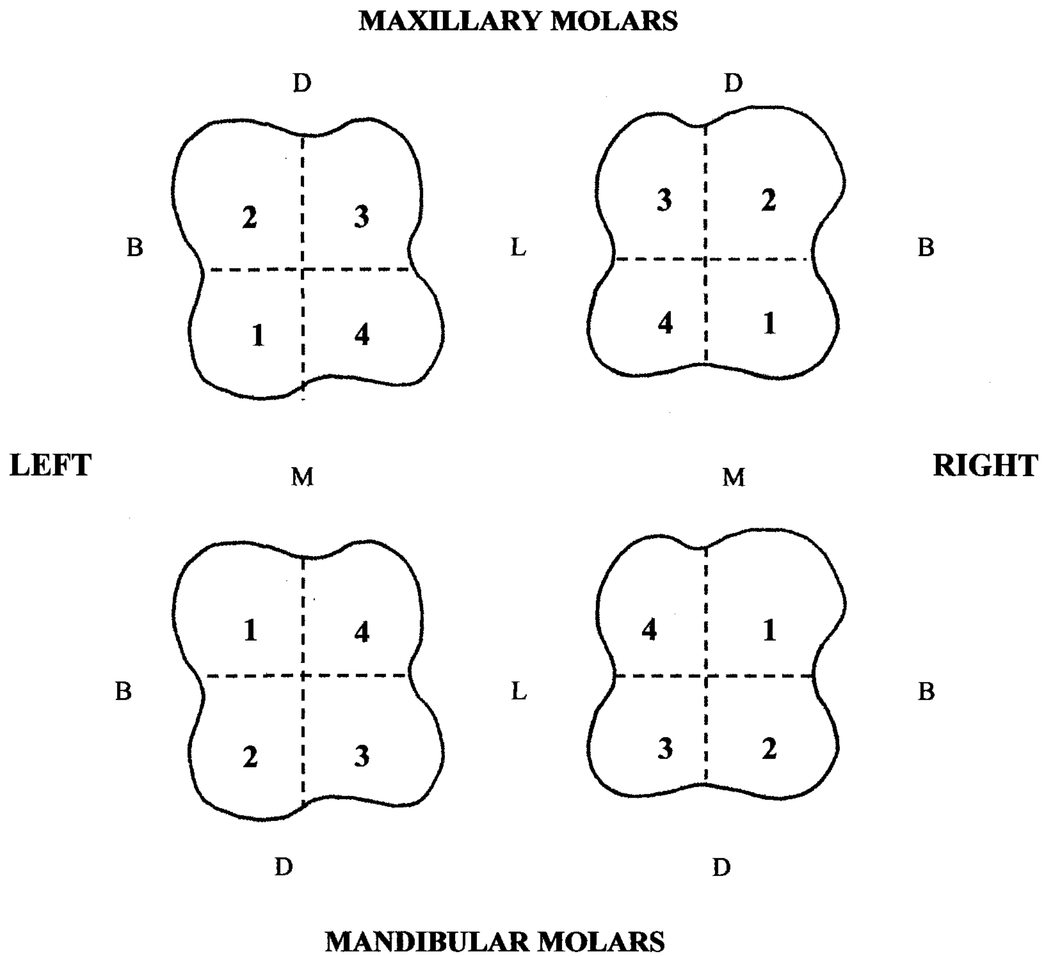


Figure 3.6 - Depiction of Smith (1984) 8-point scoring system for molars. Drawings by Natalie Shykoluk (after Smith, 1984:46, fig. 3).

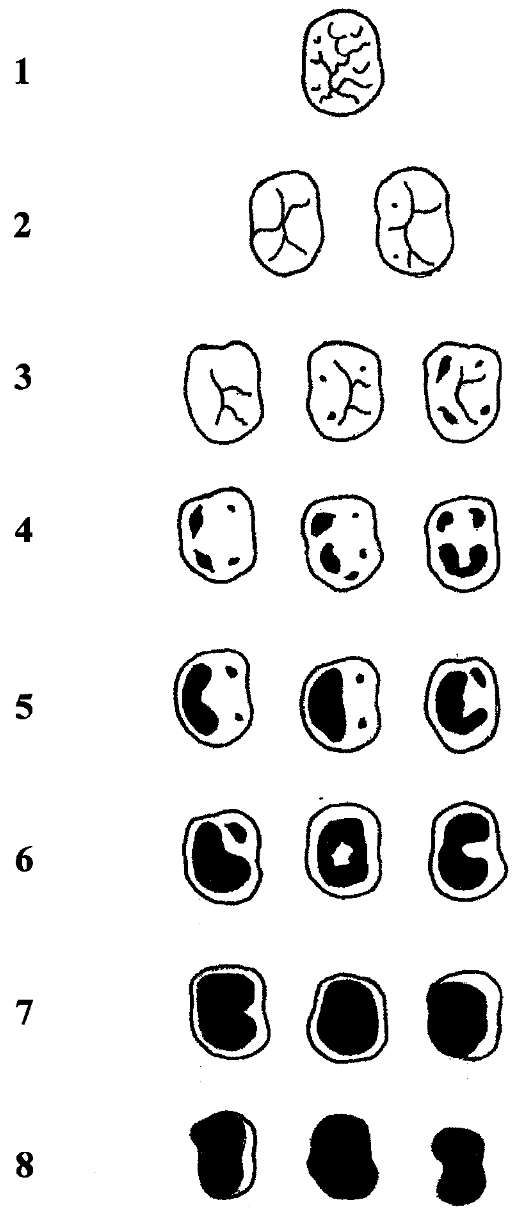
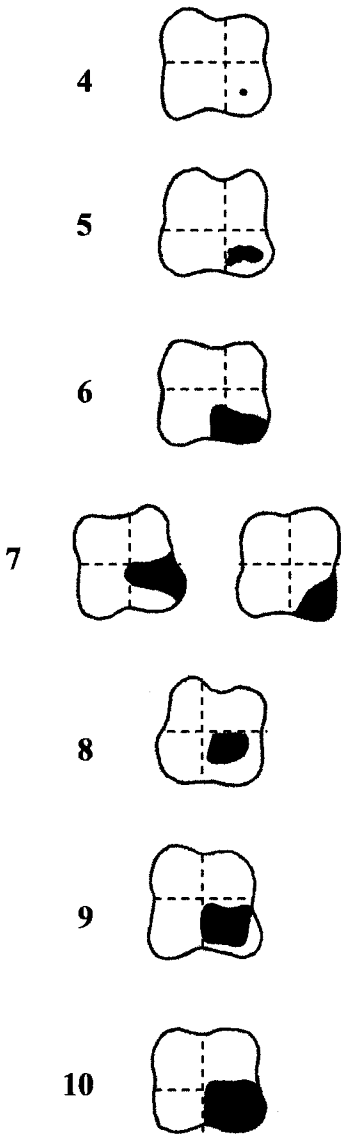
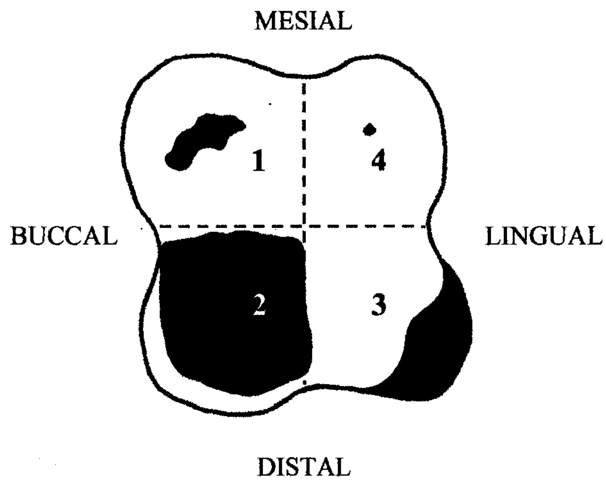


Figure 3.7 - Stylized molars showing Scott quadrant wear scores. Wear score illustrations are correlated with descriptions to the right of each molar. Illustrations for scores 0 to 3 are not shown. Drawings by Natalie Shykoluk (after Scott, 1979:214, table 1).



Score	Description
0	No information available (*i.e.*, tooth unerupted, not occluding, antemortem/postmortem loss, etc)
1	Wear facets very small or invisible.
2	Large wear facets but large cusps still present and surface features (*e.g.*, noncarious pits, crenulations) very clear. Some pinprick dots of dentin exposure may be present but should be ignored; quadrant retains *much* enamel.
3	Any cusp in quadrant which is rounded rather than clearly defined (*see* score 2). Cusp becoming obliterated but not yet worn flat.
4	Quadrant area worn flat horizontally; no dentin exposure other than a pinprick-sized dot.
5	Quadrant area worn flat, with dentin exposure ¼ of quadrant or less.
6	Dentin exposure involves more than ¼ of quadrant but still much enamel present. If the quadrant is visualized as having three sides, the dentin patch is surrounded on all three sides by enamel.
7	Enamel found on only two sides of the quadrant.
8	Enamel on only one side (usually the outer rim), and enamel is thick to medium on the remaining edge.
9	Enamel on only one side and very thin, resembling a strip. Part of enamel edge may be worn through at one or more places.
10	No enamel on any part of quadrant—dentin exposure is complete. Wear extends below the CEJ into the root.

Figure 3.8 - Stylized right maxillary molar showing examples of Scott quadrant wear scores 4, 5, 7, and 9.



Quadrant	Wear Score
1	5
2	9
3	7
4	4

Statistical testing methods

Z-scores were not used because the purpose of this study was not to compare a sample mean with a hypothetical population. Rather, samples were compared in various groupings against each other by using either a paired or unpaired *t*-test. In order to run the unpaired *t*-test, the data must conform to three assumptions: the data in the sample must have been collected randomly (*i.e.*, each member in the population had an equal chance of being selected to become part of the sample), the sample must be normally distributed, and variances of the two samples must be equal (Khazanie, 1997; Madrigal, 1999). For the paired *t*-test, the sample must have been randomly generated, the distribution of data in the sample must be normal, and variances must be equal (Madrigal, 1999). Histograms were created in SPSS 10.0 for each sample being tested to verify that the data approximated a normal distribution.

The F_{max} test was run to check for homoscedasticity between the groups being tested. The null hypothesis of homogeneous variances was accepted if $F_{calculated} <$

$F_{critical}$ and the *p*-value was greater than 0.05. If *p*-values are ≤ 0.05, the null hypothesis is rejected and variances are assumed to be heterogeneous, even if $F_{calculated} < F_{critical}$ (Madrigal, 1999). F_{max} tests were run before *t*-tests were carried out. If variances were equal, a two sample unpaired *t*-test assuming equal variances (two-tailed) was used. When the F_{max} test showed inequality of variances, a two sample unpaired *t*-test assuming unequal variances (two-tailed) was used.

Scott scores were also examined to detect any consistent differences in wear severity among scoring quadrants. This was done in order to determine if buccal wear was consistently more severe than lingual wear for the mandibular molar dentition, and vice versa for the maxillary molars. If wear is found to vary significantly from the normal occlusal molar wear pattern, malocclusion or activity-induced wear could be explored as possible factors. Also, these analyses could show whether one molar quadrant was always more worn than the other three quadrants.

Scott and Smith wear scores: testing linear relationships

A linear relationship was observed between averaged adult Scott molar wear scores and adult Smith molar wear scores when the data points were plotted on a scatterplot. Linear regression was used to test this apparent relationship employing the Microsoft Excel 'trendline' function. Sample regression equations for each tooth type (*e.g.*, M1s, M2s, and M3s) were created following the equation $y = \mathbf{a} + \mathbf{b}x$. One set of equations was designed for transforming Scott scores into Smith scores and the other for transforming Smith scores into Scott scores. The sample regression line best illustrates the relationship between *x* and *y* for the population being studied. It is important to state that a given value for *x* will not always give the exact value for *y*. In this study, the *overall* linear trend for x and y is examined, taking into account random error.

For the first set of equations, Smith scores (scores between 1 and 8) were placed on the y-axis and Scott scores (scores between 0 and 10) on the x-axis. This was done for each tooth type, resulting in three scatterplots and three separate equations. A linear regression trendline was then drawn through the points. The regression equations created by Excel for transforming averaged Scott scores into Smith scores are as follows: adult M1s, $\mathbf{y_{M1} = 0.8569x + 0.0874}$; adult M2s, $\mathbf{y_{M2} = 0.7005x + 0.7990}$; and, adult M3s, $\mathbf{y_{M3} = 0.6250x + 0.7292}$. Therefore, when a Scott score (x) is entered into the equation, the outcome is a Smith score which must be rounded to the nearest integer. For example, let us compare the Scott and Smith scores for the left M_1 4MB1 (Mendes, adult male). 4MB1 has an averaged Scott score of 8.25 (cusp 1 = 9; cusp 2 = 9; cusp 3 = 7; cusp 4 = 8) and a Smith score of 7. If we plug the Scott score into the regression equation above, we get $y = 0.8569(8.25) + 0.0874$, resulting in a Smith score of 7.16. When this score is rounded to the nearest integer, the calculated Smith score is 7, the same score determined using the Smith method for that molar.

To create the second equation, averaged Scott scores (scores between 1 and 10) were placed on the y-axis and Smith scores (scores between 0 and 8) on the x-axis. Again, a linear regression trendline was then drawn through the points. In order not to cause confusion with the previous set of equations, we can rewrite the regression equations as $\mathbf{x = a + by}$. The regression equations created by Excel for transforming Smith scores into averaged Scott quadrant scores are: adult M1s, $\mathbf{x = 0.9965 + 1.0995y}$; $\mathbf{x = 1.1278 + 0.0885y}$; and, $\mathbf{x = 1.2037 + 0.1327y}$. As with the previous equation, let us use the same example (LM1, 4MB1) to test this equation to see whether pursuing further inquiry would be valuable. When fitting the Smith score to the regression equation above, we get $x = 0.9965 + 1.0995(7)$, resulting in a Scott score of 8.69. Recall that the original averaged Scott score was 8.25, a difference of 0.44 from the calculated Scott score.

In order to establish the validity of using the first regression equation to transform averaged Scott scores into Smith integer scores, all averaged adult Scott molar wear scores for the Mendes burials will be inserted into the equation. The Smith scores (y) will then be compared against the Smith scores previously calculated using the Smith method (z). The second regression equation will be tested by inserting all adult Smith wear scores for the Mendes burials and creating expected Scott scores. When only one or two quadrants are observable or a Smith score cannot be obtained due to breakage, this method cannot be used and the molar will not be included in regression calculations. The paired t-test (two-tailed) will be used to determine whether the differences between the Smith scores (y) and the actual Smith scores (z) is significant at $\alpha = 0.05$. All transformed scores will be arranged in table format in the Results chapter of this thesis.

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CHAPTER 4 – REVISION OF SCOTT'S MOLAR WEAR SCORING METHOD

Introduction

Dental wear can provide researchers with a wealth of information regarding the health and diet of past peoples. More specifically, molar wear patterns can provide information about occlusal patterns (*i.e.*, normal vs. abnormal wear patterns), diet, age, and activity-induced wear. Since Broca published the first systematic method for scoring dental wear in 1879 (Pindborg, 1970), many additional methods of recording molar wear have been developed and then refined in dentistry (Gustafson, 1950; Klatsky, 1939; Miles, 1958) and anthropology (Lovejoy, 1985; Molnar, 1971; Murphy, 1959; Ruffer, 1920; Scott, 1979; Smith, 1984).

The Scott (1979) method for scoring occlusal molar wear was analyzed in this study. Cross *et al.* (1986) maintain that Scott's method offers a more detailed and objective description of molar wear in comparison to other scoring methods that score occlusal wear. Scott's method visually divides the molar occlusal surface into four quadrants and measures wear by scoring the amount of enamel remaining in each quadrant on a scale of 1 to 10. The four quadrant wear scores are then combined to obtain a score out of 40. Because the scores are additive, occlusal wear patterns and directionality of wear, such as differential cusp wear resulting in oblique or flat molar wear, may be masked. In addition, by visually dividing the occlusal surface into quadrants without first orienting the molar tooth, each quadrant is not consistently associated with a particular cusp or area of the tooth.

While it is true that Scott's scoring method offers a more detailed and objective description of molar wear compared to other methods which only score overall wear of the occlusal surface (Cross *et al.*, 1986), the Scott method can be improved in order to give consistent, detailed, and replicable results. The objective of this study is to revise the Scott method in order to make it possible to discern differential cusp wear patterns and directional wear for the molar teeth. This will be achieved by associating each quadrant with one of the four major maxillary or mandibular molar cusps. A dental sample from 20 individuals will be used in the testing and analysis of the revised Scott method. Individual quadrant wear scores will be reported (*i.e.*, not combined for a score out of 40 for each molar), a technique which will alert the researcher to patterns of cuspal wear, as well as any abnormal wear scores that may be the result of intra-observer error.

Materials and methods

The data set analysed in this study was collected from a large sample of human teeth excavated from the temple complex and at ancient Mendes and nearby Tell el-Izam, Lower Egypt, in the 1970s by New York University's Institute of Fine Arts under the direction of Donald P. Hansen. This collection was shipped to Dr. Nancy C. Lovell in Edmonton, Alberta, and is currently curated in the Department of Anthropology, University of Alberta. The dental sample examined belongs to non-elite individuals and dates to the Old Kingdom (2663–2195 B.C.), First Intermediate (2195–2066 B.C.), Middle Kingdom (2066–1650 B.C.), and Graeco-Roman (332 B.C.–A.D. 395) periods.

Ancient Mendes is located in the east central Delta area of northern Egypt. The site was occupied continuously from the late Predynastic to the Graeco-Roman period (Holz, 1969), a period spanning over three millenia. It was one of the major cities in Egypt during the Third Intermediate (1064–664 B.C.), Saite (664–525 B.C.), and Late

(525–332 B.C.) periods (Redford, 2004; Wenke and Brewer, 1996). During the Old Kingdom (2663–2195 B.C.) period, Mendes became a major center for the cult of the holy ram (Hansen, 1965; Harrison, 1978/9; Holz *et al.*, 1980; Wenke and Brewer, 1996). Modern-day Tell er-Rubʿa encompasses the surviving mound (or *tell*) at Mendes and the satellite mound of Kom el-Adhem, sometimes referred to as Tell el-Izam.

In total, the combined study sample consists of 96 molars from 20 adult individuals. This translates into 48 maxillary and 48 mandibular observable molars. 184 maxillary molar quadrants and 189 mandibular molar quadrants were scored, totaling 373 observable adult molar quadrants (Table 4.1). Student's *t* tests showed no significant differences between any of the mean male and female Scott mean wear scores for any of the quadrants compared in this study. Therefore, adult males and females were pooled when examining differences among molar quadrant wear were examined. Also, individuals in the Mendes sample were originally divided into three age categories: adult, middle adult, and old adult. No significant differences were found when each category was compared with the other using the *t* test; also, mean quadrant wear scores were not significantly different among age categories when analyzed with one-way ANOVA.

The quadrant scale method for scoring molar wear was developed by Scott (1979) and originally applied to three North American aboriginal dental samples. First, the occlusal surface of the molar tooth being scored is visually divided into four quadrants. Then, the amount of observable enamel in each quadrant is scored on a scale from 1 to 10 based on descriptions and illustrations given by Scott for each of the ten possible wear score categories. Quadrant wear scores for each molar are then combined to derive a total wear score between 4 and 40. For example, if quadrants 1 to 4 were scored as 2|3|5|6, the total combined wear score would be 16. Scott devised this ordinal scoring method in order to conduct analyses using the principal axis technique which enabled her to examine rates of molar wear distinct from age. Scott (1979) states that it is preferable to study the rate of dental wear rather than the degree of wear because the strong correlation between age and increasing wear severity prevents the accurate analysis of the degree of tooth wear alone. Also, scoring occlusal wear by quadrants and using the 4 to 40 system of combined quadrant scores tends to generate lower variances and smaller confidence limits when conducting quantitative analyses (Benfer and Edwards, 1991; Pastor, 1992; Scott, 1979).

This study is not concerned with determining the rate of wear or the application of the principal axis technique to the Mendes sample. Rather, it is hypothesized that the revised Scott method proposed in this study will provide a more comprehensive overview of occlusal wear patterns and degree of wear among and between molar cusps. Consistent, accurate scoring and detailed recording of molar quadrants will also alert the researcher to any anomalous wear scores, whether they are a result of abnormal cuspal wear or intra-observer error. With the revised Scott method, each quadrant should occupy an invariable location on either the maxillary or mandibular occlusal surface. This is accomplished by first orienting each molar as it would appear in the maxilla or mandible. In doing this, each quadrant can be associated with one of the four major maxillary or mandibular tooth cusps (Table 4.2).

Table 4.1 - Number of maxillary and molar quadrants scored in the Mendes sample.

TOOTH	QUADRANTS				TOTAL
	1	*2*	*3*	*4*	
RM^3	7	7	7	6	27
RM^2	8	8	7	7	30
RM^1	6	6	7	6	25
LM^1	7	7	6	6	26
LM^2	8	8	8	8	32
LM^3	11	11	11	11	44
TOTAL	47	47	46	44	184
RM_3	4	5	5	5	19
RM_2	6	6	6	6	24
RM_1	11	11	11	11	44
LM_1	9	8	9	9	35
LM_2	11	11	10	11	43
LM_3	6	6	6	6	24
TOTAL	47	47	47	48	189

Table 4.2 - Modified Scott scoring system employing molar quadrant number and corresponding cusp name and location.

Maxillary molars			**Mandibular molars**		
Quadrant	*Cusp*	*Location*	*Quadrant*	*Cusp*	*Location*
1	Paracone	Mesiobuccal	**1**	Protoconid	Mesiobuccal
2	Metacone	Distobuccal	**2**	Hypoconid	Distobuccal
3	Hypocone	Distolingual	**3**	Entoconid	Distolingual
4	Protocone	Mesiolingual	**4**	Metaconid	Mesiolingual

By associating each scoring quadrant with a particular molar cusp and listing scores for all quadrants in table format, quadrants can be compared consistently among maxillary or mandibular molars, or between buccal and lingual cusps. Few researchers report each quadrant wear score in the literature reviewed. However, a previous study by Pastor (1991) does present Scott quadrant score data in table format, although does not indicate whether each quadrant consistently occupies a specific location on the molar occlusal surface. The revised method presented in this study allows for comparison among dental collections or inter-observer analyses of the same collection as scores can be easily replicated.

In this study, quadrant wear scores were not combined to derive a possible total wear score out of 40 as recommended in Scott (1979). By keeping cusp scores separate on data recording sheets, it is possible to observe patterns of wear among or between cusps, determine whether wear scores follow expected patterns of wear for normal occlusion, and detect the presence of anomalous wear patterns (see Table 4.3 for an example of data presentation). If anomalous patterns are exposed when cusp scores are kept separate, they may be correlated with paramasticatory activities (*i.e.*, behavior not related to the act of chewing food for ingestion), deviations from normal occlusal patterns of cusp-on-cusp wear, differences in enamel thickness among molar cusps, or evaluated for possible errors associated with the data collection process itself (*i.e.*, intra-observer error). As discussed by Hillson (1996), the mastication of food occupies a small fraction of an individual's day, while other more intense paramasticatory forces such as using the teeth as tools and for food preparation, or the pressures exerted during clenching and grinding of the teeth (*i.e.*, bruxism), occupy the majority of an individual's waking and resting hours. Individuals who have been diagnosed with bruxism often display abnormal paramasticatory cycles and mandibular protrusion (Faulkner, 1989), which may result in abnormal intercuspal contact points between the upper and lower molars.

Table 4.3 - Scott quadrant wear scores for RM1 in the Mendes sample. The mean wear score for each quadrant is listed at the bottom of the table. Calculations are rounded to two decimal places.

RM_1	QUADRANTS			
	Buccal		*Lingual*	
Burial #	**1**	**2**	**3**	**4**
4MB1	9	8	7	7
4MB2	8	6	5	5
5MB12	10	10	9	9
5MB16	6	6	5	6
5MB21	8	8	7	7
5MB26	7	7	6	5
5MB3	9	9	4	6
5MB38	6	6	5	5
5MB39	8	7	6	6
5MB42	9	8	8	9
6MB3	6	7	6	5
MEAN	7.82	7.45	6.18	6.36
COUNT	11	11	11	11

With regard to differences in enamel thickness among molar types, Kono *et al.* (2002) report that enamel is thickest on the buccal surfaces of mandibular first molars and the lingual surfaces of maxillary first molars in response to functional demand. Overall, it has been shown in a study by Macho and Berner (1994) that enamel is thinnest on the occlusal surface of the first molars compared to the thickness of enamel on the second and third molars. Interestingly, with regard to the first molars, the protoconid (the mandibular cusp which normally displays the heaviest amount of wear and loading stresses) was found to have strikingly thin enamel (Kono *et al.*, 2002). Atypical wear patterns observed in the Mendes may be the result of abnormal occlusion and/or paramasticatory activities such as bruxism or activities which employ the teeth as tools, although the latter is more often observed when examining wear of the anterior dentition (Hillson, 1996).

Figure 4.1 – Stylized maxillary and mandibular molars showing demarcation of Scott scoring quadrants. Abbreviations are mesial (M), buccal (B), lingual (L), and distal (D).

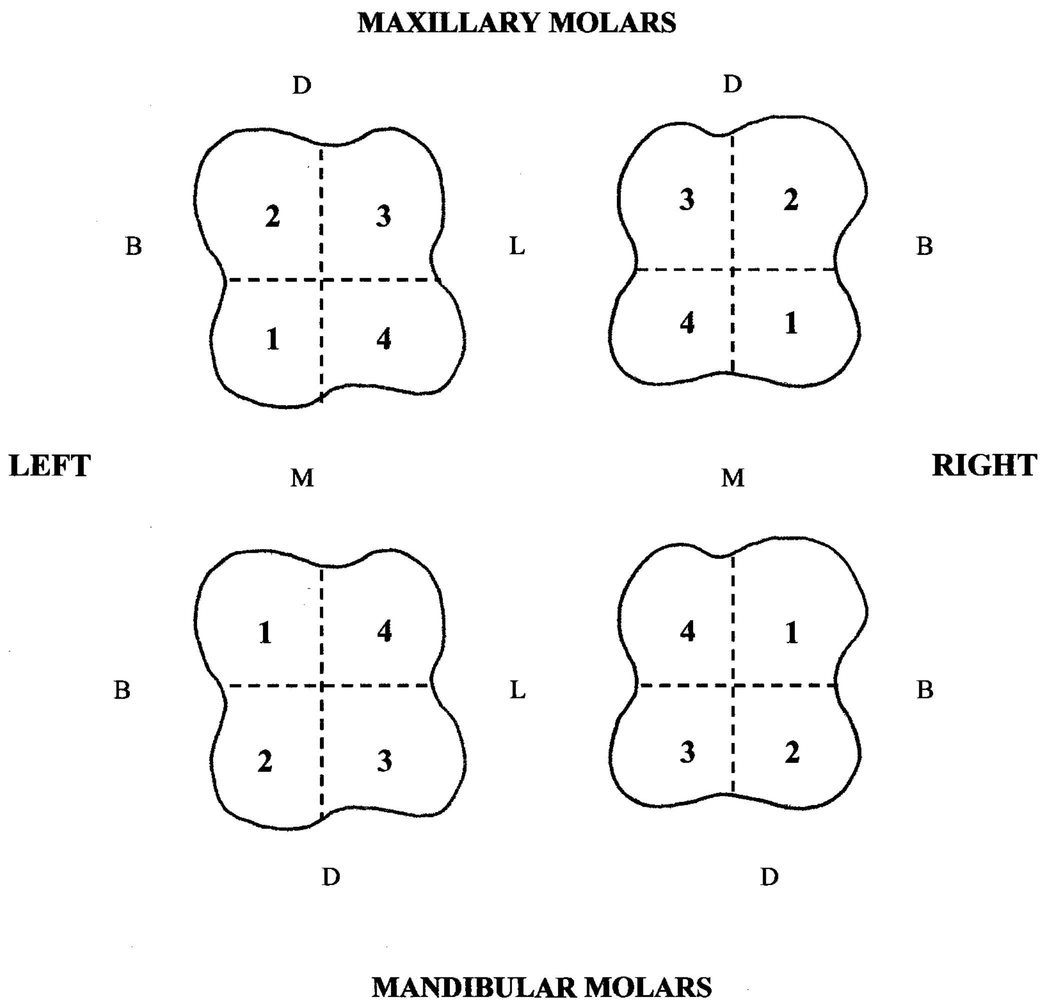
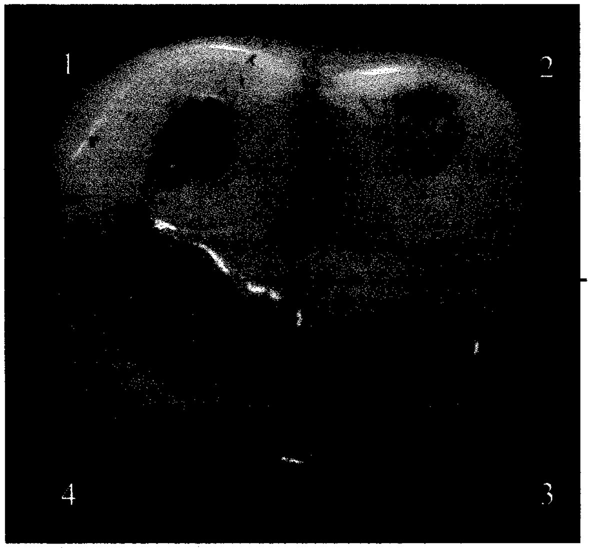


Figure 4.2 - RM^1 with four cusps showing the demarcation of Scott scoring quadrants. Note that lingual maxillary cusps are more heavily worn than their buccal counterparts.

Buccal

Mesial



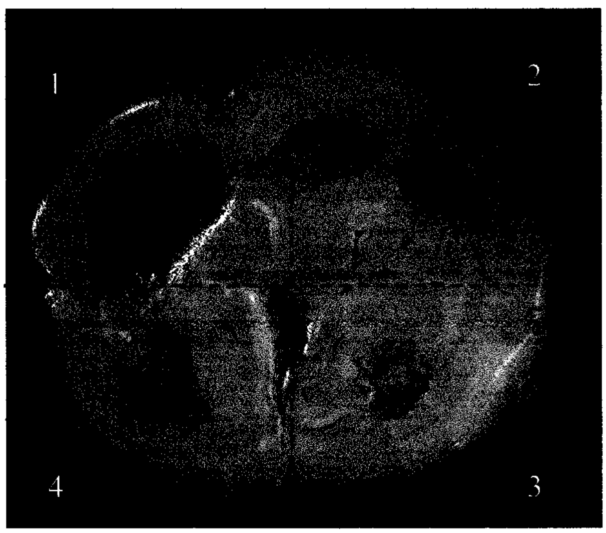
Distal

Lingual

Figure 4.3 – RM_1 showing a five-cusped occlusal surface divided into Scott scoring quadrants. Note that buccal mandibular cusps are more heavily worn than their lingual counterparts.

Buccal

Mesial



Distal

Lingual

Student's *t* tests will be administered to evaluate differential patterns of mean wear between the buccal and lingual cusps of the first and second molars using the revised Scott method. Previous research has shown that maxillary lingual cusps and mandibular buccal cusps are generally more worn than their counterparts due to occlusal surface contact during the masticatory cycle (Hillson, 1996; Kay and Hiiemae, 1974; Smith, 1986; White and Folkens, 2005). However, because the degree of difference between mean wear scores is not known, it is assumed in this study that no difference exists between mean lingual and buccal cusp scores (*i.e.*, two-tailed test; H_0: $\mu_1 = \mu_2$, where μ refers to the sample mean). Prior to performing *t* tests, assumptions of this test will be met by assessing homoscedasticity (*i.e.*, equality of variances), normal distribution of data, and random sampling. Homoscedasticity is assessed through the F_{max} test, where the larger variance is divided by the smaller variance, resulting in an F ratio which is then compared to F critical values in the F_{max} table values (Madrigal, 1999). If variances are found to be heteroscedastic, the *t* test will not be used and only basic statistics will be presented, along with a discussion of the visual observations of wear that were recorded when the molars were scored using the revised Scott method.

Wear scores for maxillary lingual quadrants 3 and 4 will be pooled and compared with combined maxillary buccal quadrants 1 and 2 for each tooth type. This will be done separately for first and second molars. For the lower dentition, wear scores for mandibular lingual quadrants 3 and 4 will be pooled and then compared with combined wear scores for mandibular buccal quadrants 1 and 2 for each tooth type. Mean buccal and lingual quadrant wear will also be compared between M^1s and M^2s, as well as between M_1s and M_2s using the *t* test. Quadrants for the maxillary and mandibular third molars will not be examined for differences between buccal and lingual wear because their quadrants were notably less worn than first and second molar quadrants and presented dissimilar wear patterns to those observed for M1s and M2s. The lack of severe wear present on third molars in this sample could be due to the fact that they are the last to erupt, generally from age 18 onwards (Bass 1995); in addition, their occlusion may differ from that of other molars due to their position at the widest part of the dental arch (Smith, 1986; Tobias, 1980). Third molars also tend to exhibit less lingual tilting than either M1s or M2s (Hall, 1976; Osborn, 1982). Consequently, they can be subject to different cuspal wear patterns and wear severity than the first and second molars. Results are assumed to be significant if $p < 0.05$, without referring to *t* values; when $P > 0.05$, calculated *t* values will be compared against critical *t* values. Descriptive statistics, F_{max} results, and $t_{calculated}$ values will be presented in table format.

Variance among quadrant wear scores will be examined using single-factor (one-way) ANOVA. This test was chosen because it allows for comparison of means among samples, in this case mean wear scores for four quadrants, whereas the *t* test can only compare the means of two samples. Before tests are administered, the assumptions of homoscedasticity (*i.e.*, equality of variances), independence of variates, normal distribution of data points, and random sampling will be evaluated. The F_{max} test is used to assess homoscedasticity and produces an F ratio by dividing the largest variance by the smallest variance. Means for maxillary M1 quadrant wear scores were compared, as were means for maxillary M2 and M3 quadrants. This was repeated for mandibular M1s, M2s, and M3s. Tooth types were not compared against one another in terms of quadrant wear scores because previous research has shown that the pattern of normal molar wear is such that M1s are the most heavily worn, followed by M2s and M3s. This pattern was similarly observed in the Mendes sample when mean wear scores for each tooth category were compared. Null hypotheses for all ANOVA tests carried out in this study will assume that no significant differences exist among mean quadrant wear scores for any of the molars examined (*i.e.*, one-tailed test; H_0: $\mu_1 = \mu_2 = \mu_3 = \ldots \mu_k$). As the *F* distribution is one-tailed, *F* scores cannot be greater than 0. Results are assumed to be significant if $F_{calculated} < F_{critical}$.

The one-way ANOVA test will also be used to assess whether the mean Scott wear scores for each molar tooth type differ significantly. Mean wear scores for maxillary M^1s, M^2s, and M^3s will be compared separately from mean wear scores for mandibular M_1s, M_2s, and M_3s. It is expected that the revised Scott method would yield higher mean wear scores for M1s than for either M2s or M3s. This is because the first permanent molars erupt at about 6 years of age, before the second and third permanent molars, and therefore experience the most wear over an individual's lifetime (Buikstra and Ubelaker, 1994; Comuzzie and Steele, 1989; Leigh, 1934; Miles, 1963). In addition, M1s endure the most stress during mastication and paramasticatory activities because they act as the main supportive structure for the dental arcade (Abdel-Fattah, 1996). It was hypothesized that mean Scott wear scores would not differ significantly between left and right molars, or between maxillary and mandibular molars. However, it was decided that these hypotheses should be tested for each molar tooth type using the *t* test. Descriptive statistics as well as the results of ANOVA tests, *t* tests, F_{max}, and $F_{calculated}$ results will be presented in table format at the end of this chapter.

In order to ensure the reliability and validity of the revised Scott method, scoring using the revised method was repeated on sub-sample comprising 10% of the original Mendes adult dental sample. The basis of statistical testing relies on the validity and reliability of the sample. Validity refers to the inherent accuracy or precision of a method (*e.g.* using a ruler that measures in millimeters rather than one that measures only in centimeters), whereas reliability refers to the extent to which measurements or observations can be repeated by different observers (Madrigal, 1999). The sub-sample consisted of 37 randomly selected adult molar quadrants from all tooth types, 10% of the total sample of 373 observed molar quadrants. Of the 37 quadrants that were rescored using the Scott method, 2 quadrants had scores that differed from the original Scott scores. These two scores were then corrected in the original wear score data set. This produced an intra-observer error rate of 5.4% when using the Scott method in this study.

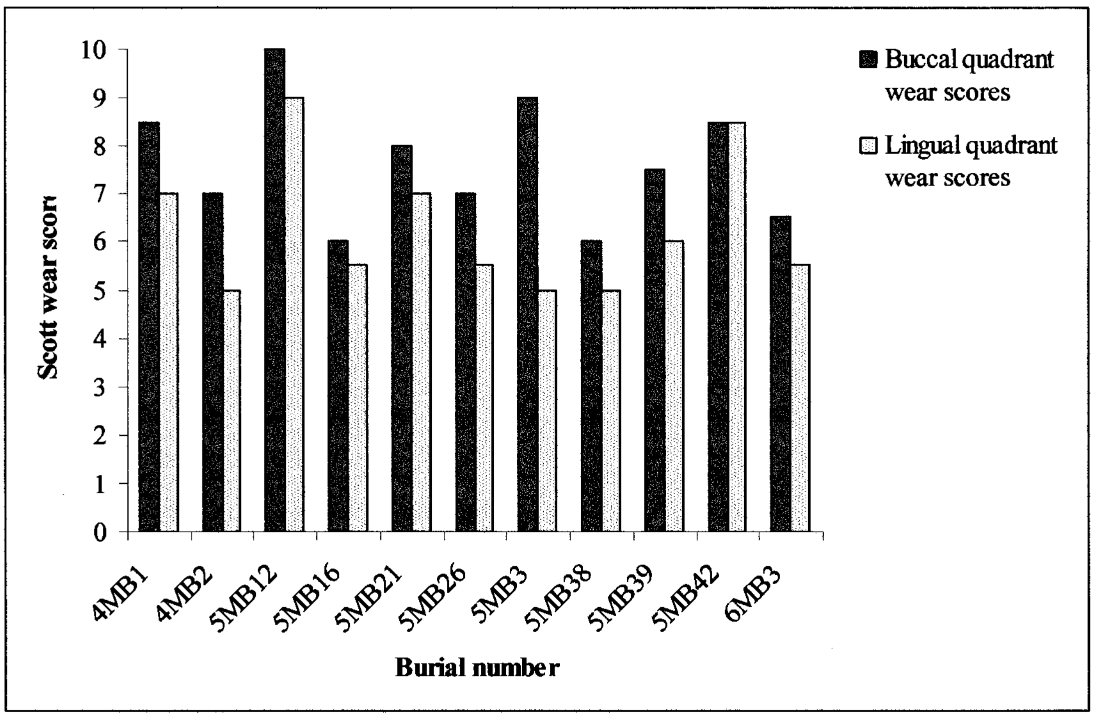
Results

Analysis of buccal and lingual wear patterns using the revised Scott method

Visual comparisons of buccal and lingual quadrant wear scores and basic descriptive statistics initially suggested that there were significant differences between lingual and buccal scores for both maxillary and mandibular first and second molars. For maxillary molars, the mean wear score for lingual quadrants 3 and 4 was consistently greater than the mean wear score for buccal quadrants 1 and 2. However, when means were compared for each tooth using the *t* test, no significant differences were found between mean lingual and mean buccal wear for either maxillary first or second molars. Mandibular first molar (RM_1s and LM_1s) buccal and lingual quadrants were significantly different as indicated by the *t* test. Buccal and lingual quadrants for the mandibular left second molars (LM_2s) were also significantly different; however, no significant difference was found between buccal and lingual quadrants for the mandibular right second molars (RM_2s). Recall that neither maxillary nor mandibular third molars were included in analyses of mean buccal and lingual quadrant wear differences.

Due to the fact that quadrant wear scores were examined in table format and scores were not combined for each molar tooth, any anomalous or unexpected scores could be studied. The RM^1 for individual 5MB12 (adult female, First Intermediate /Middle Kingdom period) was scored 10|9|9|9 for quadrants 1, 2, 3, and 4, respectively. We would expect that buccal quadrants 1 and 2 for maxillary molars would score lower than lingual quadrants 3 and 4. The molar for this individual was reexamined and rescored but the same scores were generated. Individual 5MB42 (adult male, Old Kingdom period) also exhibited unexpected quadrant wear scores for the first and second maxillary molars and one mandibular molar. The wear scores are as follows and their order reflects quadrant 1, 2, 3, and 4: RM^2, 5|4|4|6; LM^1, 9|9|8|9; LM2, 5|4|4|6; RM_1, 9|8|8|9. Quadrants for these molars were also reexamined and no differences were found between the original and rescored quadrants. The cause or causes of these apparent deviations from the type of expected lingual and buccal wear are difficult to pinpoint because there are numerous factors other than mastication which can affect the severity of dental wear. These individuals may have had thinner enamel on the cusps that showed abnormal wear which could have contributed to a faster rate of wear than the surrounding cusps. Or, they may have had malocclusion of the upper and lower dentition and/or bruxism which caused irregular contact points among the molar cusps. If occlusion could be reconstructed with the presence of the mandibles and maxillae, it may be possible to determine causes of anomalous molar quadrant wear patterns.

Figure 4.4 - Bar chart illustrating the differences between buccal (quadrants 1 and 2) and lingual (quadrants 3 and 4) quadrant wear scores for RM_1 for the labeled individuals from the Mendes sample.



Patterns of wear among molar tooth quadrants

Dental and anthropological studies have shown that the lingual cusps of the maxillary molars and the buccal cusps of the mandibular molars are the most heavily worn molar cusps. This creates a pattern whereby occlusal wear on the maxillary molars slopes lingually, while occlusal wear on the mandibular molars slopes buccally (Hall, 1976; Hillson, 1996; Lovejoy *et al.*, 1985) (*see* Figs. 2.4 and 2.5). This pattern of wear creates what is known as the helicoidal plane of wear, or a reversed Curve of Monson. The protocone (mesiolingual maxillary cusp) and protoconid (mesiobuccal mandibular cusp) are often more worn than any of the other molar cusps (Lovejoy, 1985; Murphy, 1959a; White and Folkens, 2005). This wear pattern corresponds to the normal occlusion of the maxillary and mandibular molars during the chewing cycle (Hillson, 1996).

In this study, it was expected that lingual maxillary quadrants 3 and 4 (the hypocone and protocone) and mandibular buccal quadrants 1 and 2 (the protoconid and hypoconid) would display the heaviest wear. It was found that, during the scoring process and through simple descriptive statistics, this was more often than not the case for both adults in the Mendes sample. Lingual quadrant 4 exhibited the highest mean wear score for all maxillary molar quadrants. This was expected as the protocone is generally the most worn of all maxillary molar cusps (White and Folkens, 2005). It was found that buccal quadrant 2 was consistently the least worn among all maxillary molars when mean wear scores among quadrants were compared. Among mandibular molar tooth types, buccal quadrant 1 displayed the highest mean wear score for RM_1, LM_1, LM_2, and LM_3. Mean wear scores were highest for RM_2 buccal quadrant 2 and, surprisingly, lingual quadrant 4 for RM_3. The latter may be the result of one missing data point for quadrant 1 as this quadrant for the RM_3 individual 5MB1 could not be scored due to lack of preservation of the entire occlusal surface. Had this quadrant been present, the mean wear score for quadrant 1 may have surpassed that of quadrant 2. Regarding result for RM_2, it appears that quadrant 2 for individuals 5MB14 and 5MB21 scored higher than quadrant 1. However, since both buccal quadrants 1 and 2 for RM_2 possess higher mean wear scores than those of lingual quadrants 3 and 4, the pattern of wear is well within the expected pattern of heavier buccal versus lingual wear for the mandibular molars.

ANOVA tests were run for all tooth types in order to assess the degree of variance among wear quadrants for each tooth type. Variation among mean wear quadrant wear scores was significant at $\alpha = 0.05$ for RM^1, with an F ratio of 3.54 (cv 3.07). None of the remaining maxillary molars examined showed significant differences among mean quadrant wear scores. This was interesting because it was expected that certain cusps would either be significantly less worn or more worn compared to other cusps, creating increased variation among wear scores. It is therefore assumed that wear among quadrants for maxillary molars, except quadrants for RM^1, does not differ significantly with regard to degree of wear. With regard to the mandibular molars, only wear scores for RM_1 quadrants displayed significant variation, with the F ratio of 3.54 being greater than the critical value of 2.84. Nevertheless, when buccal quadrants are combined and compared to combined lingual quadrants as shown above, mean scores are consistently higher buccally (mandibular molars) and lingually (maxillary molars), even though these differences are not statistically significant at $\alpha = 0.05$.

Comparison of wear among molar tooth types

It was expected that M1s would exhibit higher mean Scott quadrant wear scores than M2s or M3s. This was indeed the case for the maxillary molars, with the mean overall wear score as follows: RM^1, 6.29; RM^2, 4.96; RM^3, 2.68; LM^1, 7.82; LM^2, 5.09; and LM^3, 3.11. With respect to the mandibular molars, the pattern of decreasing mean quadrant wear from M1, M2, and M3 is observed is also observed: RM_1, 6.95; RM_2, 5.25; RM_3, 3.13; LM_1, 6.76; LM_2, 5.00; and LM_3, 3.67. One-way ANOVA was used to test the whether mean quadrant wear scores for each molar tooth type were indeed significantly different.

Right maxillary molars were significantly different at $\alpha = 0.05$ when mean scores for each molar tooth type were compared. ANOVA resulted in a P value of 0.00, with an exceptionally high F ratio of 12.34 and a critical F value (cv) of 3.52. Left maxillary molars could not be examined for differences among mean wear scores for LM^1, LM^2, and LM^3 because the F_{max} test indicated that the variances were heteroscedastic. Having equal samples sizes mitigates the effect of unequal variances; in the Mendes left maxillary molar sample, the samples sizes are unequal and therefore we can assume that the variances are indeed heteroscedastic. For future testing, it may be possible to employ a one-way ANOVA with unequal variances test developed by Rice and Gaines (1989), which is an expansion of the Behrens-Fisher *T* test.

For the mandibular right molars, mean wear scores were significantly different at $\alpha = 0.05$, with $P = 0.00$ and an F ratio of 15.00 which was far greater than 3.52 (cv).

Mean wear scores were also significantly different among mandibular left molars, with $P = 0.00$ and an F ratio of 9.70 (cv 3.42). When examining mean quadrant wear scores for the lower left molars, it becomes apparent that some mean scores for LM_2 were in fact greater than the lower mean scores for LM_1. For example, the mean wear score for LM_2 for individual 5MB12 was 8.00 and the highest among mean scores for that tooth type. It exceeds the lowest mean score recoded for LM_1s of 5.33 which belonged to individual 5MB16. These differences become masked when the mean scores are pooled for each molar tooth type. When the rest of the skeletal material for those individuals is examined, it may become apparent that the individual with severe molar wear (female, age 28-54) is older than one with slight to moderate molar wear (male, adult), even though both individuals were placed in the adult category as it was previously determined that no significant differences existed among adult age categories.

Examination of side differences among maxillary and mandibular molar quadrants

The Student's *t* test was again used to analyze whether quadrant wear score differences were significant between left and right mean buccal wear scores, as well as between left and right mean lingual wear scores. Side differences were examined for each molar tooth type. Among maxillary molars, there were no significant differences between left and right molars with regard to either buccal or lingual wear scores. This indicates that the left and right maxillary molars did not experience differential wear.

If quadrant wear scores had been combined to obtain a score out of 40 for each molar tooth and then these scores examined statistically, differences between left and right sides may in fact be significant. However, the purpose of this study is to illustrate the benefits of allowing quadrant scores to remain separate so that different types of information may be obtained in comparison to using a combined Scott score or Smith (1984) score which provides a wear score for the total occlusal surface.

Conclusion

In scoring the molar occlusal surface using the Scott quadrant system, we are able to determine whether one or more cusps are consistently more worn than others. This can tell us if wear corresponds to normal molar patterns for maxillary and mandibular molars: maxillary molars normally display heavier wear on their lingual cusps, while mandibular molar are more heavily worn on their buccal cusps (Hall, 1976; Hillson, 1996; Lovejoy, 1985; Murphy, 1959a; White and Folkens, 2005). In the Mendes adult sample, maxillary lingual quadrants 3 and 4 were significantly more worn than buccal quadrants 1 and 2 for M1s, M2s, and M3s. For the mandibular molars, buccal quadrants 1 and 2 were significantly more worn than lingual quadrants 3 and 4. Moreover, the protocone (maxillary quadrant 4) and the protoconid (mandibular quadrant 1) displayed the more severe wear of all the quadrants scored. These results correspond to the findings of previous studies.

It has been shown that when scoring the molar teeth using the revised Scott quadrant method, the molar tooth must be oriented properly before quadrants can be visually determined. If the tooth is not oriented properly, quadrant scores for each molar cannot be compared among individuals or replicated by other researchers. Quadrants must therefore be assigned to the four major molar cusps to ensure scoring accuracy. This allows researchers to compare buccal and lingual wear patterns to determine whether they correspond to normal occlusal wear patterns or if other factors, such as using the teeth as tools or bruxism, were responsible for abnormal types of wear.

The results gathered from this study are specific to the sample of molar teeth in the Mendes collection. In addition, due to the comparison of categories consisting of small sample sizes, it is acknowledged that the wear observed in the samples may not be indicative of overall adult wear patterns in Lower Egypt during the Old Kingdom, First Intermediate, Middle Kingdom, and Graeco-Roman periods. A separate study was undertaken which examined differences among molar wear patterns at Mendes and results can be found in Chapter 5 of this thesis.

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CHAPTER 5 – COMPARISON OF TWO MOLAR WEAR SCORING METHODS

Introduction

In the late 19th century, Paul Broca, the famous French physician and anthropologist, published the first systematic method for scoring dental wear based on the degree of dentin exposure (Pindborg, 1970). During the last century, new and more detailed methods that score occlusal dental wear severity have been created and refined, allowing researchers to associate the degree and/or pattern of wear observed in dental remains with diet (Molnar, 1971; Leek, 1972; Smith, 1972; Smith, 1984), age (Brothwell, 1981; Gustafson, 1950; Lovejoy, 1985; Mays, 2002; Miles, 1963), and other factors such as food preparation techniques (Grilletto, 1977; Harar, 1993; Leek, 1966; Molnar, 1971).

In this chapter, the Smith (1984) method and the revised Scott quadrant molar wear scoring method (see Chapter 4) are applied to a sample of adult teeth, creating two sets of data. Some researchers employ the Smith method for scoring molar wear, while others prefer to use the Scott quadrant method, a disparity that discourages a direct comparison between wear scores from different skeletal collections. The purpose of this study is to create regression formulae that would allow the researcher to transform Smith scores into averaged Scott quadrant wear scores, and vice-versa, facilitating the comparison of wear severity between molar teeth that are scored by the two different scoring techniques.

Materials and methods

The data analysed in this study were collected from a large sample of human teeth excavated at ancient Mendes (modern Tell er-Rubʿa), Lower Egypt, in the 1970s by New York University's Institute of Fine Arts under the direction of Donald P. Hansen. This collection was shipped to Dr. Nancy C. Lovell in Edmonton, Alberta, and is currently housed in the Department of Anthropology, University of Alberta. The dental material in the study sample dates to the Old Kingdom (2663–2195 B.C.), First Intermediate (2195–2066 B.C.), Middle Kingdom (2066–1650 B.C.), and Graeco-Roman (332 B.C.–A.D. 395) periods and belongs to non-elite individuals recovered from areas near the temple complex at Mendes.

Ancient Mendes is located in the east central Delta area of northern Egypt and was occupied continuously for more than three millennia, from the late Predynastic to the Graeco-Roman period (Holz, 1969). Mendes became a major center for the cult of the holy ram during the Old Kingdom period (Hansen, 1965; Harrison, 1978/9; Holz *et al.*, 1980; Wenke and Brewer, 1996), and Hansen (1965) notes that a temple dedicated to the Ram God of Mendes was built in the XXVIth Dynasty (Saite period). During the Third Intermediate (1064–664 B.C.), Saite (664–525 B.C.), and Late (525–332 B.C.) periods, Mendes was one of the major cities in Egypt (Redford, 2004c; Wenke and Brewer, 1996). During the Late period, King Nepherites I (29th Dynasty), originally a native of Mendes, made the town his capital city (Clayton, 1994). According to Holz (1969), Mendes declined in importance during the first few centuries of the Common Era.

<u>Sample composition</u>

The paired Smith and Scott-scored study samples consist of 63 molars each from 15 adult individuals. This translates into 27 maxillary and 36 mandibular observable molars (Table 5.1). One hundred and ten maxillary molar quadrants and 143 mandibular molar quadrants were scored, totaling 253 observable adult molar quadrants (Table 5.2).

Table 5.1 - Number and type of paired Smith and Scott-scored Adult molar teeth.

Molar Tooth Type											
RM^3	RM^2	RM^1	LM^1	LM^2	LM^3	LM_3	LM_2	LM_1	RM_1	RM_2	RM_3
5	3	3	3	5	8	6	8	6	8	4	4

Table 5.2 - Number of molar quadrants observed in the Scott-scored Adult sample.

Molar Tooth Type											
RM^3	RM^2	RM^1	LM^1	LM^2	LM^3	LM_3	LM_2	LM_1	RM_1	RM_2	RM_3
20	12	8	18	24	28	24	32	24	28	20	15

Previous studies have found that increasing age and wear are strongly positively correlated (Brothwell, 1981; Cucina and Tiesler, 2003; Scott, 1979), although this correlation is dependent on diet. For example, juveniles with coarser diets will tend to display more severe wear due to abrasion than older adults who consume softer foods containing few gritty particles. Consequently, higher rates of abrasion may complicate age-at-death estimations, particularly in the case of younger individuals whose teeth are heavily worn as the result of diet. In ancient dental remains, diet appears to have been the prominent factor in abrasive tooth wear. This is especially true of individuals in ancient Egypt who consumed a diet high in abrasive material incorporated in foods from cereal processing and wind-borne sands. Bread was a staple in the diet of ancient Egyptians (Aldred, 1998) and its high content of particulate matter, introduced as windblown sand and/or during cereal processing using grinding stones (Leek, 1986), may be linked to the severe wear observed in the dental remains of these individuals. This connection between coarsely ground flour, quartz from grinding stones, and attrition has been discussed in previous studies (Brothwell and Brothwell, 1969; Melcher *et al*., 1997; Ruffer, 1920). Although the individuals in this study belong to three separate time periods, the overall diet of Egyptians did not change significantly for more than three thousand years until the Graeco-Roman period (Redford, 2001). Therefore, it is assumed that differences in molar wear severity are due solely to age and not diet.

In order to ascertain whether wear scores from different age groups could be pooled to create a larger sample size, each set of scores (Smith and averaged Scott quadrant scores) were compared separately between the 'Adult' (A) and 'Middle Adult-Old Adult' (MA-OA) groups. This was done separately for Smith and averaged Scott quadrant wear scores. Due to small sample sizes for molar tooth types in the MA-OA group, it was not possible to test wear score differences between the two groups. No significant difference was found between the two samples; therefore, MA and OA scores were pooled to create a larger sample size against which to compare scores from the Adult group.

Molar wear patterns and wear severity between males and females can complicate expected molar wear rates. Molnar and his colleagues (1983) found that, among Australian aborigines, females had significantly lower wear rates with respect to the first molar than males. This difference can be attributed to differences in diet, disparate occlusal forces combined with cusp morphology, and tooth usage between males and females (McKee and Molnar, 1988). Therefore, differences between adult male and female molar wear scores were examined separately for each set of scores generated by the two methods.

In order to determine whether adult males and females could be pooled into a single adult group, male and female Smith-scored molars were compared for each molar tooth type using the two-sample (two-tailed) unpaired t test. Averaged Scott quadrant wear scores were also compared between males and females for each molar type. Before running t tests, F scores for assessing equality of variances were calculated for each of the data sets being tested and histograms gauging whether the data were normally distributed were constructed. The distribution of data points in a histogram should approximate a normal curve in order for the data set to be thought of as normally distributed. When an F test indicated inequality of variances, a two-sample (two-tailed) unpaired t test for inequality of variances was administered.

It was found that no significant differences ($\alpha = 0.05$) existed between the sexes for any of the molars analysed. Therefore, male and female wear scores were pooled for the Adult age group. Because the MA-OA group comprised only one male and four females, wear score comparisons could not be conducted between the sexes. Due to the small size of the sample and the fact that the mean wear score for each molar tooth type was much higher than for the Adult group, scores for the MA-OA group would not be pooled for any of the analyses carried out in this study.

Smith-scored sample

Occlusal molar surface wear was scored on a scale of 0 to 8 according to the method developed by Smith (1984)for the teeth of prehistoric and modern hunter-gatherers and agriculturalists. Many researchers choose to employ Smith's dental wear scoring method because is easy to understand and apply in field and laboratory settings (Lovell, pers. comm., 2006). However, the method does not discriminate among molar quadrant wear severity as does the quadrant system developed by Scott (1979).

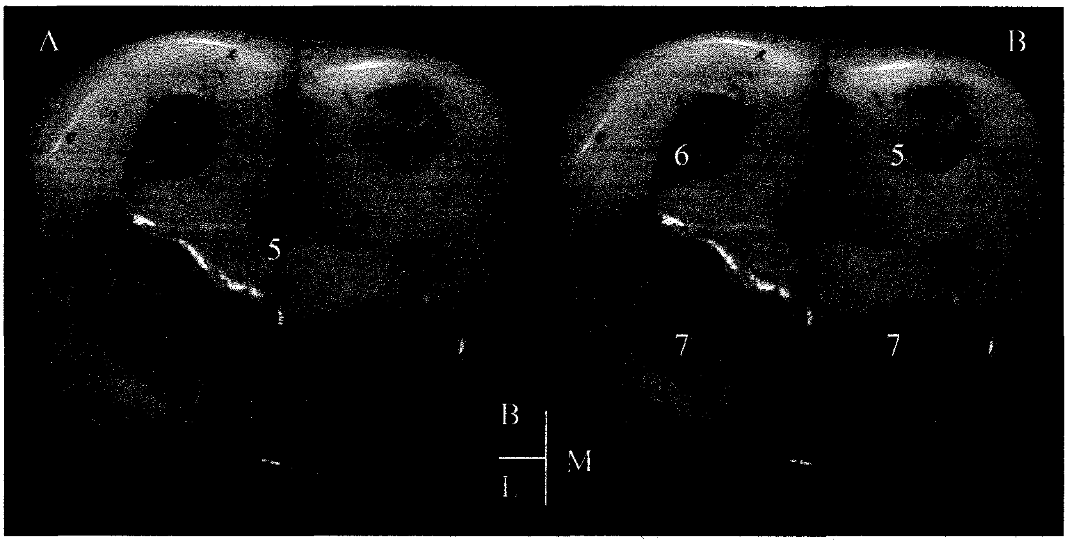
Scott-scored sample

Molar wear was scored according to the revised Scott quadrant method developed in Chapter 4 of this thesis. The original Scott molar wear scoring technique was developed from the analysis of the molar dentitions of three Amerindian populations. This ordinal method visually divides the occlusal molar surface into quadrants and then scores them on a scale of 1 to 10, depending on the amount of enamel remaining. Scores for each quadrant are then combined for a total score between 4 (4 quadrants with a score of '1') and 40 (4 quadrants with a score of '10') for each molar. In other words, scoring using the Scott method is performed without assessing the anatomical orientation of each molar quadrant and its main purpose is to sum quadrant scores for each molar to obtain a total score out of 40.

The revised method stipulates that the molar in question be oriented in order to correlate each quadrant with one of the four major maxillary or mandibular tooth cusps (Table 5.3; Figures 5.1 and 5.2). Each quadrant score is presented in table format so that patterns of occlusal wear can be detected. However, to facilitate regression analyses, Scott quadrant scores for each molar were also summed to get a score out of

40 and then divided by four, thus giving an average overall Scott quadrant wear score for that molar tooth (as done in Scott's original method).

Figure 5.1 – The RM[1] from individual 5MB39 (Mendes) scored using the a) Smith and b) Scott methods. Application of the Smith method resulted in a score of 5, while a mean score of 6.25 was derived from summing the 4 quadrants and dividing the total by 4. Directional abbreviations are B (buccal), L (lingual), and M (mesial).



Researchers analyzing the rate of dental wear in prehistoric populations often apply the methodology developed by Scott (1979) because it scores the amount of enamel remaining on the molar teeth. Cross *et al.* (1986) found Scott's methods straightforward, objective, and repeatable. Also, since Scott's method scores the amount of enamel remaining in each quadrant of the molar, Cross *et al.* argue that it is inherently more precise than other molar wear scoring techniques. This is because more information is gathered by scoring quadrant wear rather than overall occlusal wear. Yet, there are disadvantages to using Scott's original method. For example, quadrants are not numbered according to cusp nomenclature, which prevents consistent scoring among molar cusps and analyses of cusp wear patterns. Also, Scott's method does not score wear plane angle and cannot give the researcher insight into the direction of molar wear. It is generally accepted that Scott's technique may be used to score the molar teeth, but since it doesn't score the remaining teeth, the anterior dentition must be scored using another method, such as that proposed by Brothwell (1981) or Smith (1984).

Figure 5.2 – Stylized maxillary and mandibular molars showing demarcation of Scott scoring quadrants. Abbreviations are mesial (M), buccal (B), lingual (L), and distal (D).

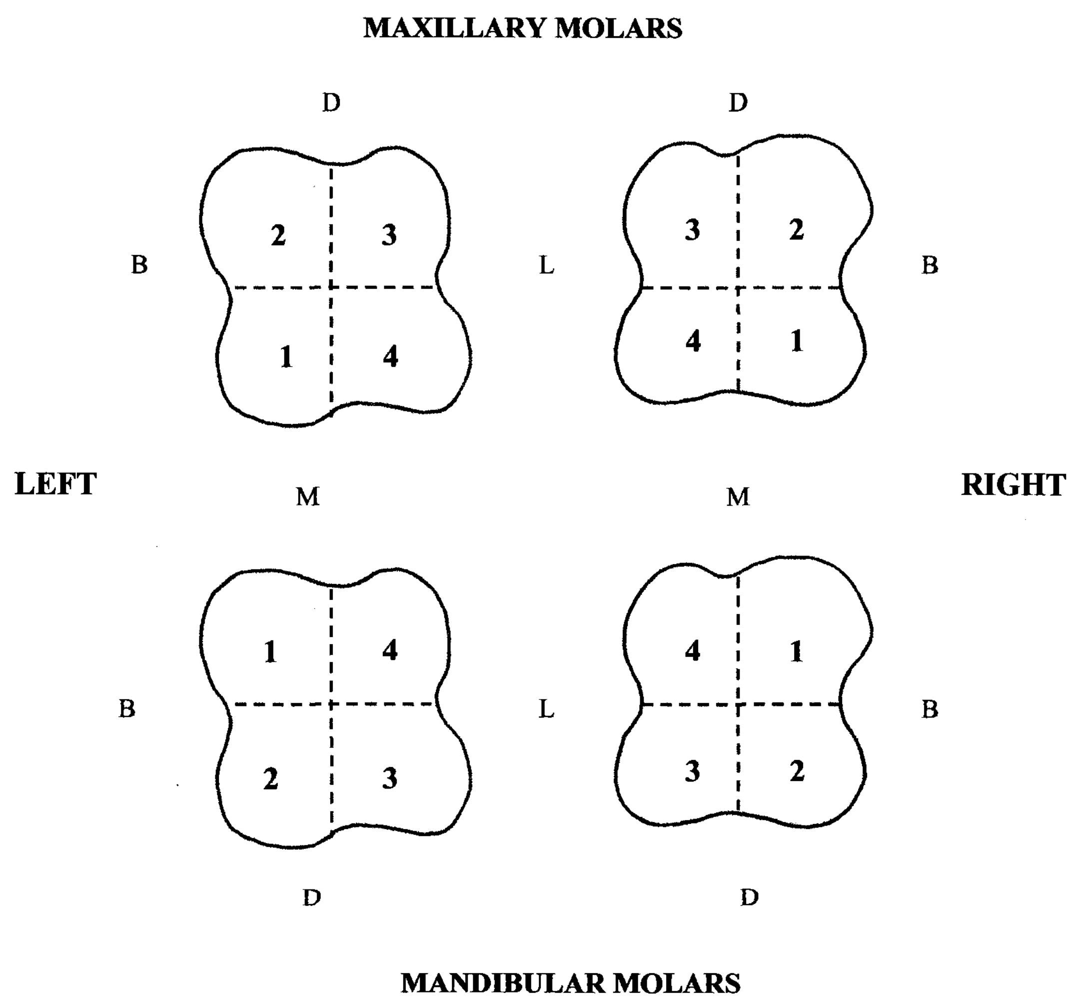


Table 5.3 - Modified Scott scoring system employing molar quadrant number and corresponding cusp name and location.

Maxillary molars			**Mandibular molars**		
Quadrant	*Cusp*	*Location*	*Quadrant*	*Cusp*	*Location*
1	Paracone	Mesiobuccal	**1**	Protoconid	Mesiobuccal
2	Metacone	Distobuccal	**2**	Hypoconid	Distobuccal
3	Hypocone	Distolingual	**3**	Entoconid	Distolingual
4	Protocone	Mesiolingual	**4**	Metaconid	Mesiolingual

Creating a regression equation for the comparison of Smith and averaged Scott scores

Linear regression was used to establish whether: 1) observed averaged Scott molar quadrant wear scores (x) could be transformed into approximated Smith wear scores (y), and 2) if averaged Scott quadrant wear scores (y) could be estimated using Smith scores (x). Two sets of regression equations are generated for each molar tooth type (*i.e.*, first, second, and third molars) because previous studies (Brothwell, 1981; Buikstra and Ubelaker, 1994; Hillson, 1997) have shown that wear score severity among molar tooth types is significantly variable.

In humans, the normal pattern of molar wear is determined by the sequence of eruption for each molar tooth type. First molars erupt at approximately six years of age, while the second and third molars erupt at around 12 and 18 years of age, respectively (Ubelaker, 1989). According to Benfer and Edwards (1991), this means that by the time the third molars erupt, the first and second molars will already demonstrate approximately 12 and six years of wear. Aetiology of decreasing wear severity from the first to the third molars can be linked to two factors: the sequence of molar tooth eruption and the fact that the first molars endure the most stress during mastication and paramasticatory activities because they act as the main supportive structure for the dental arcade (Abdel-Fattah, 1996). Using the Mendes sample, differences in molar wear rates among molar tooth types are illustrated in Figures 5.3 and 5.4.

Regression equations were created by plotting averaged Scott wear scores against Smith wear scores, and vice versa, for each tooth type, calculating the regression equation which best fit through the data points. When three or more quadrants were unobservable, that Scott score was removed from analysis, along with the paired Smith score. *F* tests for assessing homoscedasticity of variances between observed and estimated Smith scores were run. Once the scores for both methods were plotted and regression equations calculated, the R^2 value (goodness of fit or correlation coefficient) was examined.

Figure 5.3 - Scatterplot showing the distribution of averaged Scott molar quadrant wear scores for M1s, M2s, and M3s in the Adult Mendes sample.

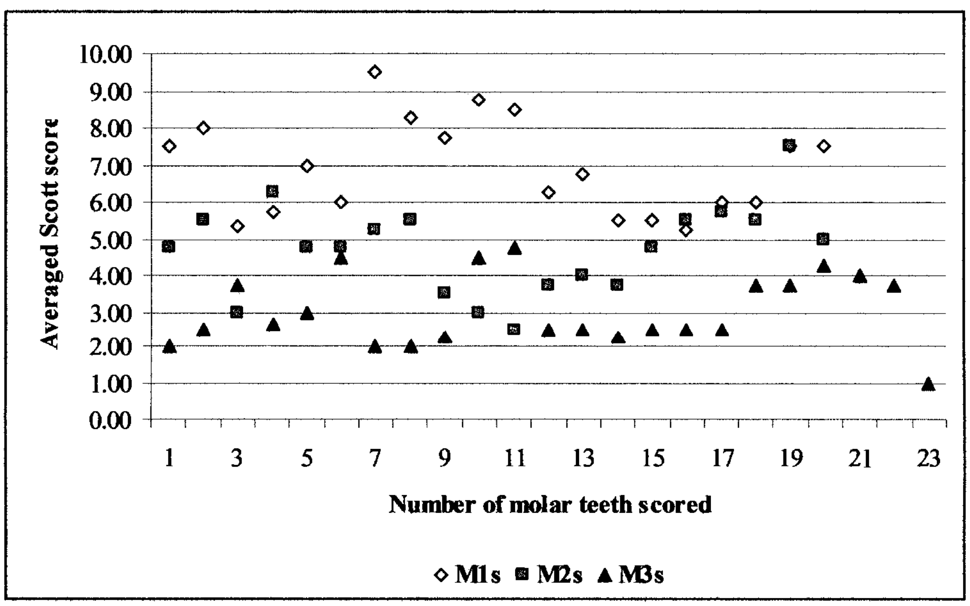
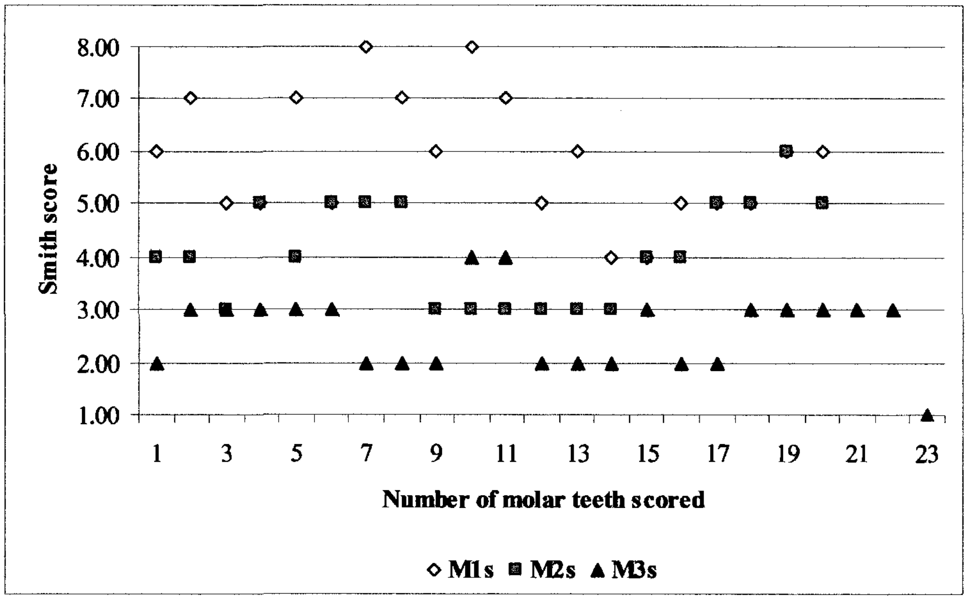


Figure 5.4 – Scatterplot showing the distribution of Smith wear scores for M1s, M2s, and M3s in the Adult Mendes sample.

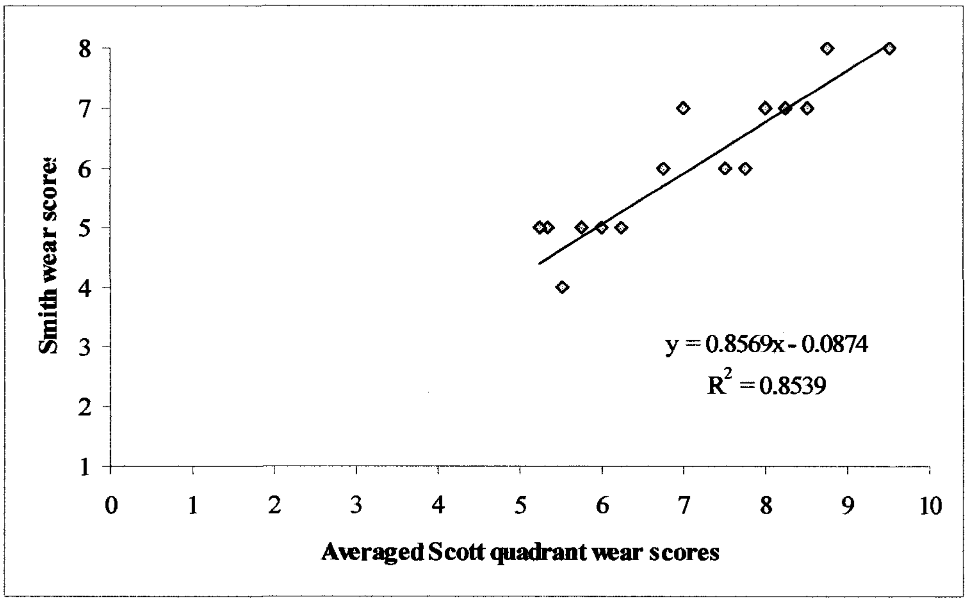


Results

M1s – Averaged Scott quadrant wear scores to Smith wear scores

For maxillary and mandibular first molars, the equation y_{M1} **= 0.8569*x* + 0.0874** was derived by plotting Smith scores on the *y*-axis and averaged Scott wear scores on the *x*-axis. Each averaged Scott quadrant wear score was then inserted into the equation to produce an estimated Smith score. This estimated Smith score was then rounded to the nearest integer. The mean difference between estimated and observed Smith scores was 0.33 and the difference was not significant at $\alpha = 0.05$, with $p = 0.9902$. Consequently, it can be assumed that, for maxillary and mandibular molars in the Mendes sample, this equation can accurately estimate Smith wear scores using observed averaged Scott quadrant wear scores.

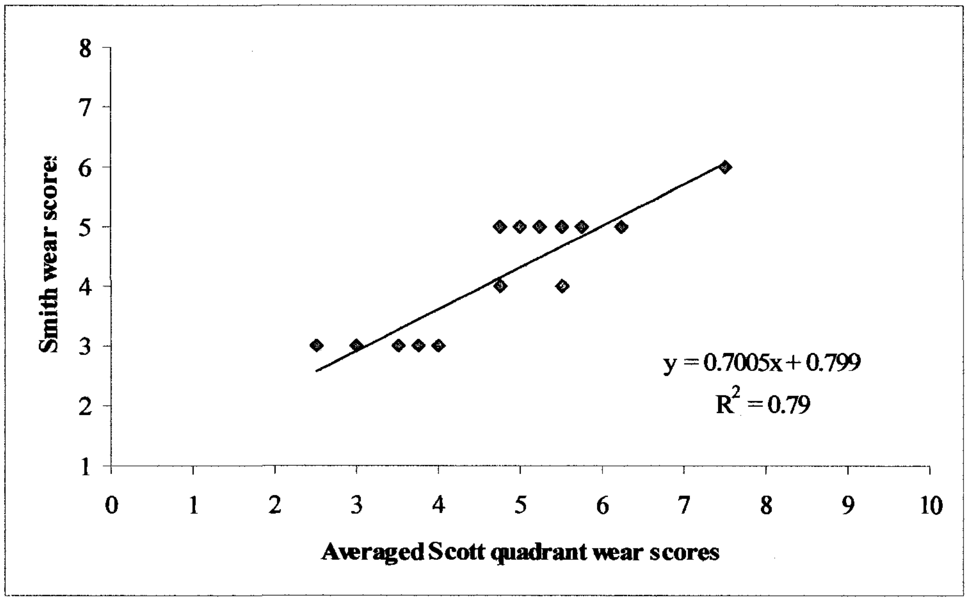
Figure 5.5 - Scatterplot illustrating the correlation between averaged Scott M1 quadrant wear scores (*x*) and Smith M1 scores (*y*). A regression line is drawn through the points and R^2 given. R^2 is an expression of the total variation of *y* explained by *x* on a scale of 0 to 1 (Madrigal, 1998).



M2s - Averaged Scott quadrant wear scores to Smith wear scores

Plotting the Smith and averaged Scott quadrant wear scores for maxillary and mandibular second molars resulted in the regression equation y_{M2} = **0.7005*x* + 0.7990.** The calculated mean difference between estimated and observed Smith wear scores was 0.34. This difference was not significant at the 0.05 level, with $p = 0.9948$. The M2 equation generated does completely not explain the relationship between *x* and *y* (as $R^2 = 0.79$); however, for the Mendes sample, it is possible to estimate Smith M2 scores using averaged Scott M2 quadrant wear scores.

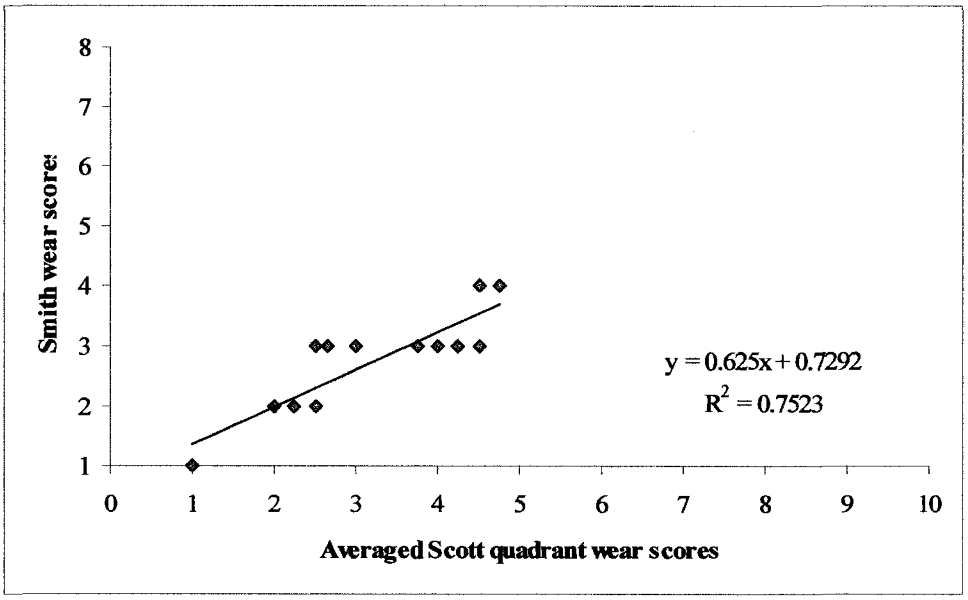
Figure 5.6 - Scatterplot illustrating the correlation between averaged Scott M2 quadrant wear scores (*x*) and Smith M2 scores (*y*). A regression line is drawn through the points and R^2 given. R^2 is an expression of the total variation of *y* explained by *x* on a scale of 0 to 1 (Madrigal, 1998).



M3s - Averaged Scott quadrant wear scores to Smith wear scores

To create an equation for M3s, maxillary and mandibular Smith and averaged Scott quadrant wear scores were plotted, resulting in the regression equation $\mathbf{y_{M3} = 0.6250x + 0.7292}$. The mean difference between estimated and observed Smith wear scores was 0.28 and, at the 0.05 level, the difference was not significant ($p = 0.9954$). This allows us to say that third molars in the Mendes sample scored using the Scott method can be transformed into estimated Smith scores with relative accuracy.

Figure 5.7 - Scatterplot illustrating the correlation between averaged Scott M3 quadrant wear scores (*x*) and Smith M3 scores (*y*). A regression line is drawn through the points and R^2 given. R^2 is an expression of the total variation of *y* explained by *x* on a scale of 0 to 1 (Madrigal, 1998).

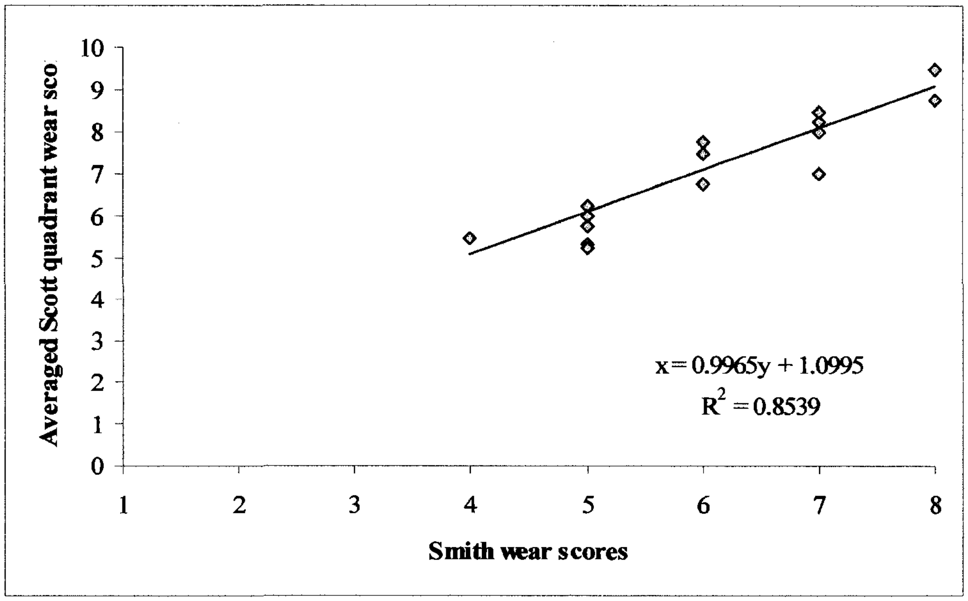


Testing the linear relationship between averaged Scott and Smith scores

M1s – Smith wear scores to averaged Scott quadrant wear scores

To create an equation for M1s, averaged Scott scores were placed on the *y*-axis and Smith scores on the *x*-axis. A regression line was then drawn through the points, resulting in the regression equation (slope) $\mathbf{y_{M1} = 0.9965 + 1.0995x}$. In order not to cause confusion with the equations for the previous transformation exercise, this equation can be rewritten as $\mathbf{x_{M1} = 0.9965 + 1.0995y}$. The mean difference between actual and transformed (or estimated) averaged Scott quadrant scores was 0.40. This difference was not significant at $\alpha = 0.05$, with a *p*-value of 0.9928. Therefore, it is possible to estimate averaged Scott scores using Smith scores and the regression equation $x_{M1} = 0.9965 + 1.0995y$.

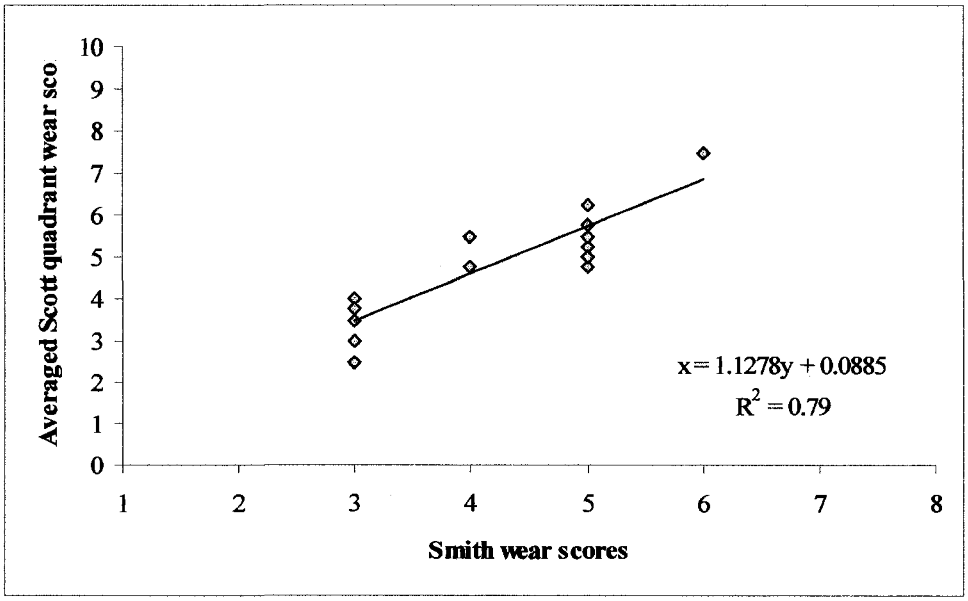
Figure 5.8 - Scatterplot illustrating the correlation between Smith M1 scores (*x*) and averaged Scott M1 quadrant wear scores (*y*). A regression line is drawn through the points and R^2 given. R^2 is an expression of the total variation of *y* explained by *x* on a scale of 0 to 1 (Madrigal, 1998).



M2s – Smith wear scores to averaged Scott quadrant wear scores

The equation for M2s was calculated as x_{M2} = **1.1278 + 0.0885*y***. The mean difference between observed and transformed averaged Scott quadrant scores was zero. The paired *t* test revealed that this difference was not significant at $\alpha = 0.05$, with a *p*-value of 0.9969. With a mean difference of zero between the two sets of scores and a high *p*-value, it can be said that the equation for M2s is able to estimate averaged Scott quadrant scores with relative accuracy for the Mendes sample.

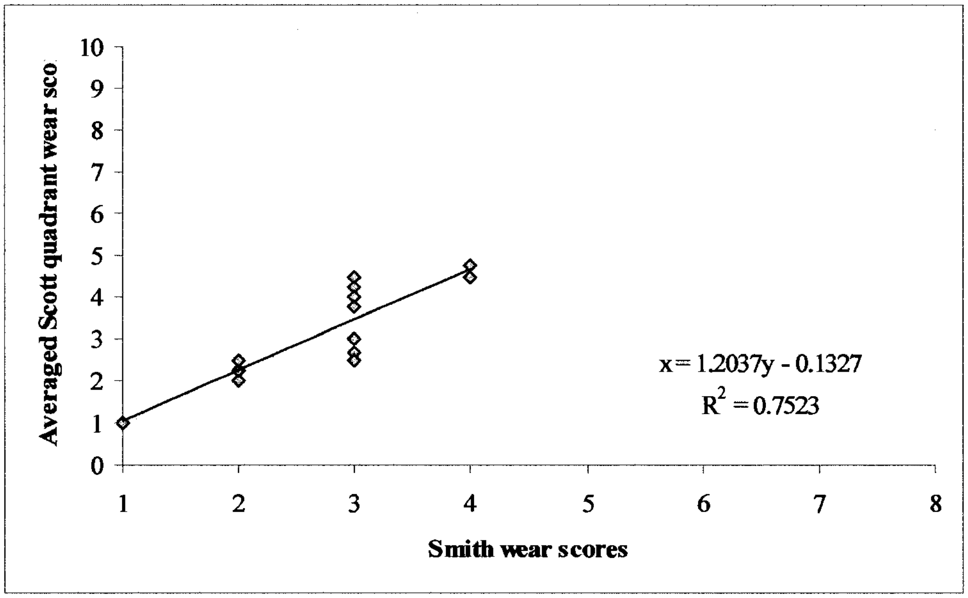
Figure 5.9 - Scatterplot illustrating the correlation between Smith M2 scores (*x*) and averaged Scott M2 quadrant wear scores (*y*). A regression line is drawn through the points and R^2 given. R^2 is an expression of the total variation of *y* explained by *x* on a scale of 0 to 1 (Madrigal, 1998).



M3s – Smith wear scores to averaged Scott quadrant wear scores

The final equation calculated in this regression exercise was that for transforming Smith scores for the third molars into estimated Scott quadrant wear scores. When inserting Smith scores into the equation, $\mathbf{x_{M3} = 1.2037 + 0.1327y}$, it was found that the mean difference between the actual and estimated averaged Scott scores was zero. This difference was not significant at the 0.05 level, with $p = 0.9901$. Again, the equation can be said to estimate averaged Scott quadrant wear scores using observed Smith scores from the Mendes sample reasonably effectively.

Figure 5.10 - Scatterplot illustrating the correlation between Smith M3 scores (*x*) and averaged Scott M3 quadrant wear scores (*y*). A regression line is drawn through the points and R^2 given. R^2 is an expression of the total variation of *y* explained by *x* on a scale of 0 to 1 (Madrigal, 1998).



Conclusion

It was shown in Chapter 4 that the revised Scott molar quadrant scoring method provides more information than the Smith method with respect to patterns of occlusal molar wear and wear directionality. This is because the Smith method provides a single overall wear score, whereas the Scott method scores wear by quadrants. With the revised Scott method, wear scores are kept separate (*i.e.*, not summed for a total score out of 40) so that they can be manipulated statistically, or summed and averaged for comparison with other scoring methods, such as was done in this study. Figures 5.1 and 5.2 provide an excellent example of why scoring by quadrants that are dependent on cusp location allows the researcher to visualize the type of occlusal wear, even when a photo is not present, by knowing the wear scores for each quadrant. If these quadrant scores were summed as suggested by Scott (1979), this information would be lost. For the purposes of this study, however, it was necessary to sum and average the Scott quadrant wear scores to facilitate comparison with Smith scores.

This study did not test whether these two methods can be equally reliable in the field and/or lab, However, it should be noted that, with the Scott method, molars would have to be oriented and cusps determined in order for the same quadrants to be scored consistently. This requires specific training or knowledge in dental analysis techniques and could add a considerable amount of time to the cataloguing and scoring of dental remains.

Estimating Smith scores in the Mendes sample through linear regression has shown that, for this sample, it is possible to rely on the actual averaged Scott quadrant wear score to approximate an estimated Smith score. The application of a regression equation derived from plotting averaged Scott quadrant scores against Smith scores can be also used to estimate average Scott scores in the Mendes sample. It is essential that a regression equation be derived for each molar tooth type as first, second, and third molars wear at different rates which relate mainly to their sequence of eruption.

One of the main goals of this study was to test whether regression equations could be used by anthropologists to compare observed wear on molars that have been scored according to Smith against those scored with the Scott method, and vice versa. This would facilitate comparisons between collections that have been scored using different methods. Nevertheless, it would be imprudent to apply these findings to other collections without first testing the equations on larger samples drawn from different populations. However, if a much larger sample of Smith and averaged Scott scores was available from a variety of ancient populations, different and more accurate equations may be generated. This would give a more accurate representation of overall wear among populations, which would in turn provide a more plausible and accurate regression equation, or a correction factor, that could be applied to any study sample.

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CHAPTER 6 – CONCLUSION

The primary objective of this thesis was to create and test a revised method of scoring occlusal molar quadrant wear based on the method established by Scott (1979). The molar sample (n=96) was drawn from twenty adult individuals recovered from ancient Mendes, Lower Egypt, and dates to the Old Kingdom, First Intermediate/ Middle Kingdom, and Ptolemaic periods. The revised Scott quadrant scoring method for scoring occlusal molar wear presented in Chapter 4 provides more information regarding patterns of molar wear when compared to the original Scott method and the Smith method. This was achieved by consistently associating molar quadrants scored with evolutionary molar cusps. The original Scott method did not correlate each quadrant with a particular area on the occlusal surface of each molar; rather, quadrants were scored by visually dividing the surface into four areas of equal size and assigning a score between zero and 10. With the revised method, it was possible to see that patterns of molar wear in the Mendes sample followed the expected patterns of molar wear (Buikstra and Ubelaker, 1994; Miles, 1963): 1) heavier lingual wear for the maxillary molars and heavier buccal wear for the mandibular molars, and 2) a decrease in the degree of wear from the first to the third molars.

The secondary objective of this thesis was to develop regression formulae in order to transform wear scores obtained using the Smith (1984) method into averaged Scott scores—and vice versa—for each molar tooth type. The transformed scores were not significantly different from the original scores, demonstrating that it is possible to use regression equations to transform molars scored with one method (*e.g.*, the Smith method), with those scored with another method. This enables researchers to compare collections of molar teeth scored by either the Smith or Scott methods.

It was not possible to directly compare the Smith and revised Scott methods because they use different scales of measurement. The potential exists for the development of a correction factor or logarithm which would allow direct comparisons between scoring methods in order to determine whether significant differences exist between the two methods.

The relative severity of molar wear observed in the Mendes sample may be due to a number of factors which influence the rate and degree of tooth wear. These factors include using the teeth as tools (Borrman *et al.*, 1996; Merbs, 1983; Palichuk, 1994), the introduction of windborne particulate matter, likely desert sand, into food (Leek, 1966), the abrasive action of quartzite matter present in bread made from grains ground by grinding stones, and pathological conditions which may exacerbate attrition rates (Hillson, 1996; Pindborg, 1970). Also, malocclusion must remain a possible cause of abnormal patterns of wear, although it is not often cited as an important cause of tooth wear in the anthropological literature. Further research, a larger sample size, and the inclusion of wear scores for the anterior dentition are needed to make any possible connection between observed wear patterns in the Mendes sample and malocluded dentition.

In order to test the viability of the revised Scott method, a future study is recommended using a larger study sample drawn from disparate populations. A larger sample would also be beneficial in testing the validity of the regression equations proposed in this thesis, possibly resulting in different and more accurate equations that could then be applied across populations.

Another avenue of future research using the Mendes sample would be to compare wear patterns across time periods to see if any differences in wear severity existed. By scoring the anterior dentition and incorporating these scores into the molar sample, a larger sample size could be created and a more complete picture of overall tooth wear across time periods obtained. Should any differences be found, it may be valuable to explore changes in diet from the Old Kingdom to the Ptolemaic period.

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SITE NAME/NUMBER	MENDES	**OBSERVER**	Natalie Shykoluk
BURIAL/SKELETON NUMBER	4MB1	**DATE**	04-May-06
AGE	19-45	**PRESENT LOCATION OF COLLECTION**	University of Alberta
SEX	M		

First Intermediate Period/Middle Kingdom					**Scott (modified)**		**Scott Average**	**Smith**
	Tooth		**Presence**	**Eruption**	**Cusp**	**Wear**	**Wear**	**Wear**
Maxillary Right	1	M^3	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		
	2	M^2	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		
	3	M^1	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		
Maxillary Left	14	M^1	5A	1	1	9	9.50	8
					2	9		
					3	10		
					4	10		
	15	M^2	5A	1	1	8	6.50	6
					2	6		
					3	5		
					4	7		
	16	M^3	5A	1	1	4	3.00	3
					2	3		
					3	2		
					4	3		

First Intermediate Period/Middle Kingdom					Scott (modified)		Scott Average	Smith
	Tooth		Presence	Eruption	Cusp	Wear	Wear	Wear
Mandibular Left	17	M_3	1A	1	1	5	4.50	3
					2	3		
					3	5		
					4	5		
	18	M_2	1A	1	1	7	6.25	5
					2	7		
					3	6		
					4	5		
	19	M_1	1A	1	1	9	8.25	7
					2	9		
					3	7		
					4	8		
Mandibular Right	30	M_1	1A	1	1	9	7.75	6
					2	8		
					3	7		
					4	7		
	31	M_2	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		
	32	M_3	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		

SITE NAME/NUMBER	MENDES	**OBSERVER**	Natalie Shykoluk
BURIAL/SKELETON NUMBER	4MB2	**DATE**	08-May-06
AGE	MA	**PRESENT LOCATION OF COLLECTION**	University of Alberta
SEX	F		

First Intermediate Period/Middle Kingdom					**Scott (modified)**		**Scott Average**	**Smith**
	Tooth		**Presence**	**Eruption**	**Cusp**	**Wear**	**Wear**	**Wear**
Maxillary Right	1	M^3	5A	1	1	4	3.50	3
					2	3		
					3	3		
					4	4		
	2	M^2	5A	1	1	6	5.25	5
					2	4		
					3	5		
					4	6		
	3	M^1	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		
Maxillary Left	14	M^1	5A	1	1	8	8.25	7
					2	8		
					3	8		
					4	9		
	15	M^2	5A	1	1	5	4.75	4
					2	4		
					3	4		
					4	6		
	16	M^3	5A	1	1	2	2.50	2
					2	2		
					3	3		
					4	3		

First Intermediate Period/Middle Kingdom					Scott (modified)		Scott Average	Smith
	Tooth		Presence	Eruption	Cusp	Wear	Wear	Wear
Mandibular Left	17	M_3	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		
	18	M_2	1A	1	1	6	5.50	4
					2	6		
					3	5		
					4	5		
	19	M_1	1A	1	1	8	7.50	6
					2	8		
					3	7		
					4	7		
Mandibular Right	30	M_1	5A	1	1	8	6.00	5
					2	6		
					3	5		
					4	5		
	31	M_2	5A	1	1	5	4.75	4
					2	6		
					3	4		
					4	4		
	32	M_3	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		

SITE NAME/NUMBER	MENDES	**OBSERVER**	Natalie Shykoluk
BURIAL/SKELETON NUMBER	4MB5	**DATE**	16-May-06
AGE	MA	**PRESENT LOCATION OF COLLECTION**	University of Alberta
SEX	F		

First Intermediate Period/Middle Kingdom					**Scott (modified)**		**Scott Average**	**Smith**
	Tooth		**Presence**	**Eruption**	**Cusp**	**Wear**	**Wear**	**Wear**
Maxillary Right	1	M^3	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		
	2	M^2	5A	1	1	5	5.25	5
					2	4		
					3	6		
					4	6		
	3	M^1	5A	1	1	5	6.50	5
					2	6		
					3	7		
					4	8		
Maxillary Left	14	M^1	5A	1	1	5	5.00	6
					2	5		
					3	0		
					4	0		
	15	M^2	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		
	16	M^3	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		

First Intermediate Period/Middle Kingdom					Scott (modified)		Scott Average	Smith
	Tooth		Presence	Eruption	Cusp	Wear	Wear	Wear
Mandibular Left	17	M_3	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		
	18	M_2	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		
	19	M_1	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		
Mandibular Right	30	M_1	/		1	0	/	/
					2	0		
					3	0		
					4	0		
	31	M_2			1	0		
					2	0		
					3	0		
					4	0		
	32	M_3			1	0		
					2	0		
					3	0		
					4	0		

SITE NAME/NUMBER	MENDES	**OBSERVER**	Natalie Shykoluk
BURIAL/SKELETON NUMBER	4MB7	**DATE**	16-May-06
AGE	19-45	**PRESENT LOCATION OF COLLECTION**	University of Alberta
SEX	F		

Old Kingdom					**Scott (modified)**		**Scott Average**	**Smith**
	Tooth		**Presence**	**Eruption**	**Cusp**	**Wear**	**Wear**	**Wear**
Maxillary Right	1	M^3	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		
	2	M^2	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		
	3	M^1	5A	1	1	5	5.00	/
					2	4		
					3	6		
					4	0		
Maxillary Left	14	M^1	5A	1	1	5	4.50	/
					2	4		
					3	0		
					4	0		
	15	M^2	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		
	16	M^3	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		

Old Kingdom					Scott (modified)		Scott Average	Smith
	Tooth		Presence	Eruption	Cusp	Wear	Wear	Wear
Mandibular Left	17	M_3	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		
	18	M_2	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		
	19	M_1	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		
Mandibular Right	30	M_1	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		
	31	M_2	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		
	32	M_3	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		

SITE NAME/NUMBER	MENDES	**OBSERVER**	Natalie Shykoluk
BURIAL/SKELETON NUMBER	4MB8	**DATE**	16-May-06
AGE	19-45	**PRESENT LOCATION OF COLLECTION**	University of Alberta
SEX	F		

	Old Kingdom				**Scott (modified)**		**Scott Average**	**Smith**
	Tooth		**Presence**	**Eruption**	**Cusp**	**Wear**	**Wear**	**Wear**
Maxillary Right	1	M^3	5A	1	1	1	1.00	1
					2	1		
					3	1		
					4	1		
	2	M^2	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		
	3	M^1	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		
Maxillary Left	14	M^1	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		
	15	M^2	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		
	16	M^3	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		

Old Kingdom						Scott (modified)		Scott Average	Smith
	Tooth		Presence	Eruption		Cusp	Wear	Wear	Wear
Mandibular Left	17	M_3	/	/		1	0	/	/
						2	0		
						3	0		
						4	0		
	18	M_2	5A	1		1	6	5.00	5
						2	6		
						3	4		
						4	4		
	19	M_1	/	/		1	0	/	/
						2	0		
						3	0		
						4	0		
Mandibular Right	30	M_1	/	/		1	0	/	/
						2	0		
						3	0		
						4	0		
	31	M_2	/	/		1	0	/	/
						2	0		
						3	0		
						4	0		
	32	M_3	/	/		1	0	/	/
						2	0		
						3	0		
						4	0		

SITE NAME/NUMBER	MENDES	**OBSERVER**	Natalie Shykoluk
BURIAL/SKELETON NUMBER	4MB11	**DATE**	18-May-06
AGE	19-45	**PRESENT LOCATION OF COLLECTION**	University of Alberta
SEX	M		

Old Kingdom					**Scott (modified)**		**Scott Average**	**Smith**
	Tooth		**Presence**	**Eruption**	**Cusp**	**Wear**	**Wear**	**Wear**
Maxillary Right	1	M^3	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		
	2	M^2	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		
	3	M^1	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		
Maxillary Left	14	M^1	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		
	15	M^2	5A	1	1	3	3.00	3
					2	3		
					3	3		
					4	3		
	16	M^3	5A	1	1	1	2.25	3
					2	2		
					3	3		
					4	3		

Old Kingdom					Scott (modified)		Scott Average	Smith
	Tooth		Presence	Eruption	Cusp	Wear	Wear	Wear
Mandibular Left	17	M_3	5A	1	1	3	2.50	3
					2	3		
					3	2		
					4	2		
	18	M_2	5A	1	1	4	3.00	3
					2	3		
					3	3		
					4	2		
	19	M_1	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		
Mandibular Right	30	M_1	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		
	31	M_2	5A	1	1	3	2.50	3
					2	3		
					3	2		
					4	2		
	32	M_3	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		

SITE NAME/NUMBER	MENDES	**OBSERVER**	Natalie Shykoluk
BURIAL/SKELETON NUMBER	5MB1	**DATE**	18-May-06
AGE	A (~30)	**PRESENT LOCATION OF COLLECTION**	University of Alberta
SEX	M		

First Intermediate Period/Middle Kingdom					**Scott (modified)**		**Scott Average**	**Smith**
	Tooth		**Presence**	**Eruption**	**Cusp**	**Wear**	**Wear**	**Wear**
Maxillary Right	1	M^3	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		
	2	M^2	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		
	3	M^1	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		
Maxillary Left	14	M^1	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		
	15	M^2	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		
	16	M^3	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		

First Intermediate Period/Middle Kingdom					Scott (modified)		Scott Average	Smith
	Tooth		Presence	Eruption	Cusp	Wear	Wear	Wear
Mandibular Left	17	M_3	5A	1	1	7	6.00	5
					2	6		
					3	5		
					4	6		
	18	M_2	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		
	19	M_1	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		
Mandibular Right	30	M_1	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		
	31	M_2	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		
	32	M_3	5A	1	1	0	2.67	3
					2	3		
					3	2		
					4	3		

SITE NAME/NUMBER	MENDES	**OBSERVER**	Natalie Shykoluk
BURIAL/SKELETON NUMBER	5MB3	**DATE**	18-May-06
AGE	19-45	**PRESENT LOCATION OF COLLECTION**	University of Alberta
SEX	M		

First Intermediate Period/Middle Kingdom					**Scott (modified)**		**Scott Average**	**Smith**
	Tooth		**Presence**	**Eruption**	**Cusp**	**Wear**	**Wear**	**Wear**
Maxillary Right	1	M^3	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		
	2	M^2	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		
	3	M^1	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		
Maxillary Left	14	M^1	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		
	15	M^2	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		
	16	M^3	5A	1	1	3	3.75	3
					2	4		
					3	4		
					4	4		

First Intermediate Period/Middle Kingdom					Scott (modified)		Scott Average	Smith
	Tooth		Presence	Eruption	Cusp	Wear	Wear	Wear
Mandibular Left	17	M_3	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		
	18	M_2	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		
	19	M_1	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		
Mandibular Right	30	M_1	5A	1	1	9	7.00	7
					2	9		
					3	4		
					4	6		
	31	M_2	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		
	32	M_3	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		

SITE NAME/NUMBER	MENDES	**OBSERVER**	Natalie Shykoluk
BURIAL/SKELETON NUMBER	5MB12	**DATE**	29-May-06
AGE	28-54 (MA)	**PRESENT LOCATION OF COLLECTION**	University of Alberta
SEX	F		

First Intermediate Period/Middle Kingdom					**Scott (modified)**		**Scott Average**	**Smith**
	Tooth		**Presence**	**Eruption**	**Cusp**	**Wear**	**Wear**	**Wear**
Maxillary Right	1	M^3	5A	1	1	4	4.00	3
					2	4		
					3	4		
					4	0		
	2	M^2	5A	1	1	6	7.25	5
					2	5		
					3	9		
					4	9		
	3	M^1	5A	1	1	10	9.25	7
					2	9		
					3	9		
					4	9		
Maxillary Left	14	M^1	5A	1	1	10	10.00	8
					2	10		
					3	10		
					4	10		
	15	M^2	5A	1	1	6	7.25	6
					2	6		
					3	8		
					4	9		
	16	M^3	5A	1	1	6	4.25	3
					2	4		
					3	4		
					4	3		

First Intermediate Period/Middle Kingdom					Scott (modified)		Scott Average	Smith
	Tooth		Presence	Eruption	Cusp	Wear	Wear	Wear
Mandibular Left	17	M_3	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		
	18	M_2	5A	1	1	8	8.00	7
					2	0		
					3	8		
					4	8		
	19	M_1	5A	1	1	10	9.25	8
					2	9		
					3	9		
					4	9		
Mandibular Right	30	M_1	1A	1	1	10	9.50	8
					2	10		
					3	9		
					4	9		
	31	M_2	5A	1	1	8	7.00	6
					2	8		
					3	5		
					4	7		
	32	M_3	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		

SITE NAME/NUMBER	MENDES	**OBSERVER**	Natalie Shykoluk
BURIAL/SKELETON NUMBER	5MB14	**DATE**	29-May-06
AGE	19-45	**PRESENT LOCATION OF COLLECTION**	University of Alberta
SEX	M		

First Intermediate Period/Middle Kingdom					**Scott (modified)**		**Scott Average**	**Smith**
	Tooth		**Presence**	**Eruption**	**Cusp**	**Wear**	**Wear**	**Wear**
Maxillary Right	1	M^3	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		
	2	M^2	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		
	3	M^1	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		
Maxillary Left	14	M^1	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		
	15	M^2	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		
	16	M^3	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		

First Intermediate Period/Middle Kingdom					Scott (modified)		Scott Average	Smith
	Tooth		Presence	Eruption	Cusp	Wear	Wear	Wear
Mandibular Left	17	M_3	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		
	18	M_2	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		
	19	M_1	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		
Mandibular Right	30	M_1	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		
	31	M_2	5A	1	1	5	5.50	4
					2	6		
					3	6		
					4	5		
	32	M_3	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		

SITE NAME/NUMBER	MENDES	**OBSERVER**	Natalie Shykoluk
BURIAL/SKELETON NUMBER	5MB16	**DATE**	09-Jun-06
AGE	A	**PRESENT LOCATION OF COLLECTION**	University of Alberta
SEX	M		

First Intermediate Period/Middle Kingdom					**Scott (modified)**		**Scott Average**	**Smith**
	Tooth		**Presence**	**Eruption**	**Cusp**	**Wear**	**Wear**	**Wear**
Maxillary Right	1	M^3	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		
	2	M^2	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		
	3	M^1	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		
Maxillary Left	14	M^1	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		
	15	M^2	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		
	16	M^3	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		

First Intermediate Period/Middle Kingdom					Scott (modified)		Scott Average	Smith
	Tooth		Presence	Eruption	Cusp	Wear	Wear	Wear
Mandibular Left	17	M_3	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		
	18	M_2	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		
	19	M_1	5A	1	1	6	5.33	5
					2	0		
					3	5		
					4	5		
Mandibular Right	30	M_1	5A	1	1	6	5.75	5
					2	6		
					3	5		
					4	6		
	31	M_2	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		
	32	M_3	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		

SITE NAME/NUMBER	MENDES	**OBSERVER**	Natalie Shykoluk
BURIAL/SKELETON NUMBER	5MB18	**DATE**	09-Jun-06
AGE	19-45	**PRESENT LOCATION OF COLLECTION**	University of Alberta
SEX	M		

First Intermediate Period/Middle Kingdom					**Scott (modified)**		**Scott Average**	**Smith**
	Tooth		**Presence**	**Eruption**	**Cusp**	**Wear**	**Wear**	**Wear**
Maxillary Right	1	M^3	5A	1	1	2	2.00	2
					2	2		
					3	2		
					4	2		
	2	M^2	5A	1	1	5	4.75	4
					2	4		
					3	5		
					4	5		
	3	M^1	5A	1	1	6	7.50	6
					2	6		
					3	9		
					4	9		
Maxillary Left	14	M^1	5A	1	1	0	8.00	7
					2	0		
					3	8		
					4	8		
	15	M^2	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		
	16	M^3	5A	1	1	2	2.50	3
					2	2		
					3	3		
					4	3		

First Intermediate Period/Middle Kingdom					Scott (modified)		Scott Average	Smith
	Tooth		Presence	Eruption	Cusp	Wear	Wear	Wear
Mandibular Left	17	M_3	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		
	18	M_2	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		
	19	M_1	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		
Mandibular Right	30	M_1	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		
	31	M_2	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		
	32	M_3	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		

SITE NAME/NUMBER	MENDES	**OBSERVER**	Natalie Shykoluk
BURIAL/SKELETON NUMBER	5MB21	**DATE**	14-Jun-06
AGE	19-45	**PRESENT LOCATION OF COLLECTION**	University of Alberta
SEX	F		

Old Kingdom					**Scott (modified)**		**Scott Average**	**Smith**
	Tooth		**Presence**	**Eruption**	**Cusp**	**Wear**	**Wear**	**Wear**
Maxillary Right	1	M^3	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		
	2	M^2	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		
	3	M^1	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		
Maxillary Left	14	M^1	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		
	15	M^2	5A	1	1	5	5.75	5
					2	4		
					3	6		
					4	8		
	16	M^3	5A	1	1	4	4.00	3
					2	4		
					3	3		
					4	5		

Old Kingdom					Scott (modified)		Scott Average	Smith
	Tooth		Presence	Eruption	Cusp	Wear	Wear	Wear
Mandibular Left	17	M_3	5A	1	1	4	3.75	3
					2	4		
					3	4		
					4	3		
	18	M_2	1A	1	1	6	5.50	5
					2	5		
					3	7		
					4	4		
	19	M_1	1A	1	1	8	7.50	6
					2	8		
					3	7		
					4	7		
Mandibular Right	30	M_1	5A	1	1	8	7.50	6
					2	8		
					3	7		
					4	7		
	31	M_2	5A	1	1	6	6.25	5
					2	7		
					3	7		
					4	5		
	32	M_3	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		

SITE NAME/NUMBER	MENDES	**OBSERVER**	Natalie Shykoluk
BURIAL/SKELETON NUMBER	5MB26	**DATE**	14-Jun-06
AGE	MA	**PRESENT LOCATION OF COLLECTION**	University of Alberta
SEX	M		

Old Kingdom					**Scott (modified)**		**Scott Average**	**Smith**
	Tooth		**Presence**	**Eruption**	**Cusp**	**Wear**	**Wear**	**Wear**
Maxillary Right	1	M^3	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		
	2	M^2	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		
	3	M^1	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		
Maxillary Left	14	M^1	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		
	15	M^2	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		
	16	M^3	5A	1	1	3	3.75	3
					2	3		
					3	4		
					4	5		

Old Kingdom					Scott (modified)		Scott Average	Smith
	Tooth		Presence	Eruption	Cusp	Wear	Wear	Wear
Mandibular Left	17	M_3	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		
	18	M_2	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		
	19	M_1	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		
Mandibular Right	30	M_1	5A	1	1	7	6.25	5
					2	7		
					3	6		
					4	5		
	31	M_2	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		
	32	M_3	5A	1	1	3	3.75	3
					2	3		
					3	4		
					4	5		

SITE NAME/NUMBER	MENDES	**OBSERVER**	Natalie Shykoluk
BURIAL/SKELETON NUMBER	5MB35	**DATE**	23-Jun-06
AGE	MA-OA	**PRESENT LOCATION OF COLLECTION**	University of Alberta
SEX	F		

Ptolemaic					**Scott (modified)**		**Scott Average**	**Smith**
	Tooth		**Presence**	**Eruption**	**Cusp**	**Wear**	**Wear**	**Wear**
Maxillary Right	1	M^3	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		
	2	M^2	5A	1	1	4	3.75	3
					2	4		
					3	3		
					4	4		
	3	M^1	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		
Maxillary Left	14	M^1	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		
	15	M^2	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		
	16	M^3	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		

Ptolemaic					Scott (modified)		Scott Average	Smith
	Tooth		Presence	Eruption	Cusp	Wear	Wear	Wear
Mandibular Left	17	M_3	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		
	18	M_2	5A	1	1	4	3.25	3
					2	3		
					3	3		
					4	3		
	19	M_1	5A	1	1	6	5.50	4
					2	6		
					3	5		
					4	5		
Mandibular Right	30	M_1	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		
	31	M_2	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		
	32	M_3	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		

SITE NAME/NUMBER	MENDES	**OBSERVER**	Natalie Shykoluk
BURIAL/SKELETON NUMBER	5MB38	**DATE**	23-Jun-06
AGE	A	**PRESENT LOCATION OF COLLECTION**	University of Alberta
SEX	M		

Old Kingdom					**Scott (modified)**		**Scott Average**	**Smith**
	Tooth		**Presence**	**Eruption**	**Cusp**	**Wear**	**Wear**	**Wear**
Maxillary Right	1	M^3	/	/	1	0	/	
					2	0		
					3	0		
					4	0		
	2	M^2	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		
	3	M^1	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		
Maxillary Left	14	M^1	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		
	15	M^2	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		
	16	M^3	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		

Old Kingdom					Scott (modified)		Scott Average	Smith
	Tooth		Presence	Eruption	Cusp	Wear	Wear	Wear
Mandibular Left	17	M_3	5A	1	1	3	2.50	2
					2	3		
					3	2		
					4	2		
	18	M_2	5A	1	1	4	3.50	3
					2	4		
					3	3		
					4	3		
	19	M_1	5A	1	1	6	5.50	4
					2	6		
					3	5		
					4	5		
Mandibular Right	30	M_1	5A	1	1	6	5.50	4
					2	6		
					3	5		
					4	5		
	31	M_2	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		
	32	M_3	5A	1	1	2	2.25	2
					2	3		
					3	2		
					4	2		

SITE NAME/NUMBER	MENDES	**OBSERVER**	Natalie Shykoluk
BURIAL/SKELETON NUMBER	5MB39	**DATE**	23-Jun-06
AGE	A	**PRESENT LOCATION OF COLLECTION**	University of Alberta
SEX	M		

Old Kingdom					**Scott (modified)**		**Scott Average**	**Smith**
	Tooth		**Presence**	**Eruption**	**Cusp**	**Wear**	**Wear**	**Wear**
Maxillary Right	1	M^3	5A	1	1	5	4.75	4
					2	4		
					3	4		
					4	6		
	2	M^2	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		
	3	M^1	5A	1	1	5	6.25	5
					2	6		
					3	7		
					4	7		
Maxillary Left	14	M^1	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		
	15	M^2	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		
	16	M^3	5A	1	1	4	4.50	4
					2	4		
					3	4		
					4	6		

Old Kingdom					Scott (modified)		Scott Average	Smith
	Tooth		Presence	Eruption	Cusp	Wear	Wear	Wear
Mandibular Left	17	M_3	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		
	18	M_2	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		
	19	M_1	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		
Mandibular Right	30	M_1	1A	1	1	8	6.75	6
					2	7		
					3	6		
					4	6		
	31	M_2	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		
	32	M_3	5A	(Fragments)	1	0	/	/
					2	0		
					3	0		
					4	0		

SITE NAME/NUMBER	MENDES	**OBSERVER**	Natalie Shykoluk
BURIAL/SKELETON NUMBER	5MB42	**DATE**	23-Jun-06
AGE	A	**PRESENT LOCATION OF COLLECTION**	University of Alberta
SEX	M		

	Old Kingdom				**Scott (modified)**		**Scott Average**	**Smith**
	Tooth		**Presence**	**Eruption**	**Cusp**	**Wear**	**Wear**	**Wear**
Maxillary Right	1	M^3	5A	1	1	2	2.00	2
					2	1		
					3	2		
					4	3		
	2	M^2	5A	1	1	5	4.75	4
					2	4		
					3	4		
					4	6		
	3	M^1	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		
Maxillary Left	14	M^1	5A	1	1	9	8.75	8
					2	9		
					3	8		
					4	9		
	15	M^2	5A	1	1	5	4.75	5
					2	4		
					3	4		
					4	6		
	16	M^3	5A	1	1	3	2.00	2
					2	1		
					3	1		
					4	3		

Old Kingdom					Scott (modified)		Scott Average	Smith
	Tooth		Presence	Eruption	Cusp	Wear	Wear	Wear
Mandibular Left	17	M_3	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		
	18	M_2	5A	1	1	6	5.25	5
					2	6		
					3	5		
					4	4		
	19	M_1	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		
Mandibular Right	30	M_1	5A	1	1	9	8.50	7
					2	8		
					3	8		
					4	9		
	31	M_2	5A	1	1	6	5.50	5
					2	6		
					3	5		
					4	5		
	32	M_3	5A	1	1	2	2.25	2
					2	3		
					3	2		
					4	2		

SITE NAME/NUMBER	MENDES	**OBSERVER**	Natalie Shykoluk
BURIAL/SKELETON NUMBER	6MB3	**DATE**	30-Jun-06
AGE	19-45	**PRESENT LOCATION OF COLLECTION**	University of Alberta
SEX	F		

	Old Kingdom				**Scott (modified)**		**Scott Average**	**Smith**
	Tooth		**Presence**	**Eruption**	**Cusp**	**Wear**	**Wear**	**Wear**
Maxillary Right	1	M^3	5A	1	1	4	3.75	3
					2	4		
					3	3		
					4	4		
	2	M^2	5A	1 (broken)	1	5	/	/
					2	4		
					3	0		
					4	0		
	3	M^1	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		
Maxillary Left	14	M^1	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		
	15	M^2	5A	1	1	4	4.75	4
					2	4		
					3	5		
					4	6		
	16	M^3	5A	1	1	4	3.75	3
					2	4		
					3	3		
					4	4		

Old Kingdom					Scott (modified)		Scott Average	Smith
	Tooth		Presence	Eruption	Cusp	Wear	Wear	Wear
Mandibular Left	17	M_3	5A	1	1	5	4.25	3
					2	4		
					3	3		
					4	5		
	18	M_2	5A	1	1	6	5.50	4
					2	6		
					3	5		
					4	5		
	19	M_1	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		
Mandibular Right	30	M_1	5A	1	1	6	6.00	5
					2	7		
					3	6		
					4	5		
	31	M_2	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		
	32	M_3	5A	1 (broken)	1	0	/	/
					2	0		
					3	0		
					4	0		

SITE NAME/NUMBER	MENDES	**OBSERVER**	Natalie Shykoluk
BURIAL/SKELETON NUMBER	6MB5	**DATE**	07-Jul-06
AGE	A (~30)	**PRESENT LOCATION OF COLLECTION**	University of Alberta
SEX	F		

	Ptolemaic				**Scott (modified)**		**Scott Average**	**Smith**
	Tooth		**Presence**	**Eruption**	**Cusp**	**Wear**	**Wear**	**Wear**
Maxillary Right	1	M^3	1A	1	1	3	2.50	2
					2	3		
					3	2		
					4	2		
	2	M^2	1A	1	1	4	3.75	3
					2	3		
					3	4		
					4	4		
	3	M^1	1A	1 (broken)	1	0	/	/
					2	0		
					3	5		
					4	7		
Maxillary Left	14	M^1	1A	1	1	5	5.25	5
					2	5		
					3	5		
					4	6		
	15	M^2	1A	1	1	4	4.00	3
					2	4		
					3	4		
					4	4		
	16	M^3	1A	1	1	3	2.50	2
					2	3		
					3	2		
					4	2		

Ptolemaic					Scott (modified)		Scott Average	Smith
	Tooth		Presence	Eruption	Cusp	Wear	Wear	Wear
Mandibular Left	17	M_3	4A	3	1	0	/	/
					2	0		
					3	0		
					4	0		
	18	M_2	1A	1	1	4	3.75	3
					2	4		
					3	3		
					4	4		
	19	M_1	1A	1	1	7	6.00	5
					2	6		
					3	5		
					4	6		
Mandibular Right	30	M_1	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		
	31	M_2	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		
	32	M_3	/	/	1	0	/	/
					2	0		
					3	0		
					4	0		