Bioarchaeology of the Near East, 8:1–27 (2014)

Palaeopathology of human remains at ancient Mendes (Tell er-Rub'a), Egypt

Madeleine Mant
Department of Anthropology, University of Alberta,
13-15 Tory Building, Edmonton, AB, T6G 2H4 Canada
email: mantml@mcmaster.ca

Abstract: *This paper discusses selected pathological conditions from the skeletal remains of 41 adult individuals (13 males, six possible males, eight possible females, seven females, and seven unknown sex) from the Old Kingdom, First Intermediate, and Ptolemaic or Greco-Roman periods from ancient Mendes. Macroscopic analysis for pathological conditions revealed evidence of trauma, degenerative joint disease, pronounced muscle markings, cranial porosity, and a possible case of hyperostosis frontalis interna. These data provide a further source of information on the study of disease in ancient Egypt, particularly in the Nile Delta.*

Key words: palaeopathology; trauma; degenerative joint disease; Tell er-Rub'a

Introduction

Of the ancient town sites discovered in the Nile Delta, ancient Mendes (**Figure 1**) has proved to be one of the most expansive and best preserved. The site was occupied as early as the late fourth millennium BCE and served as a significant administrative and cult centre during the Old Kingdom (Brewer & Wenke 1992; Redford 1988). Mendes served as a provincial capital in northern Egypt and was a prominent trade centre, likely due to its position on one of the Nile's major branches (Brewer & Wenke 1992; Wenke 1991). It continued to be important until the Roman conquest of Egypt in 30 BCE, following which the community moved to the more southerly mound of Tell Timai (ancient Thmuis) (Redford 1988). This continuous occupation and consecutive record makes Mendes a key site for studying possible religious, political, and economic changes in the Nile Delta.

Primary settlement of Mendes occurred at the mound of Tell el-Rub'a (Hansen & Stieglitz 1980). Mudbrick walls partially surround the mound which comprises four basic parts: the Temple Precinct, including mudbrick temple foundations and the one surviving grand granite Naos (Bothmer 1988); the Northern Tip of the Kom, in which there is evidence of mudbrick buildings; Tell el 'Izam (also known as Kom el-Adhem), a cemetery mound that appears to have been a harbour facility previously;

Received 23 January 2013; accepted 20 July 2013; published online 2 August 2013 on www.anthropology.uw.edu.pl

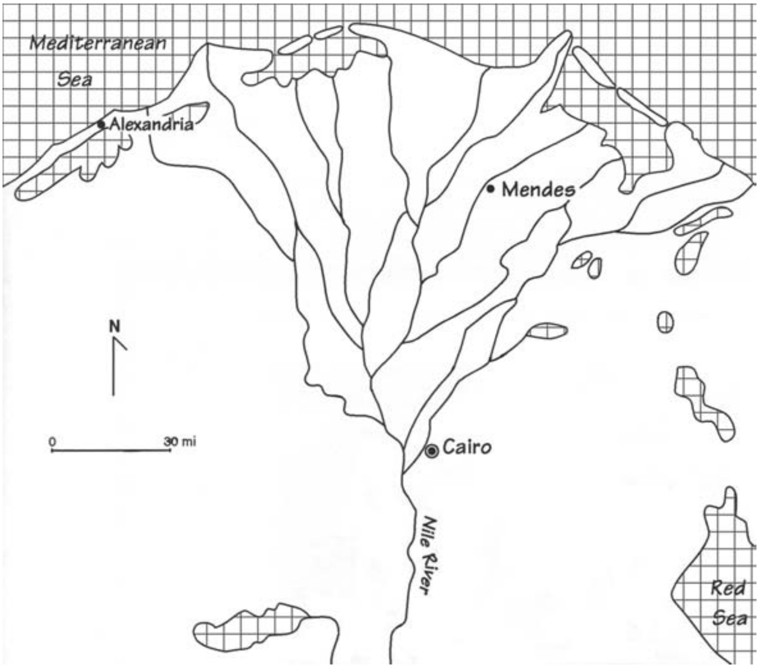

Figure 1. Map of the Egyptian Delta, showing the location of Mendes. Image courtesy Dr. Nancy Lovell.

and the Southern Mound, which consists of the remains of public buildings (Hansen & Stieglitz 1980; Lovell 1992).

Several seasons of excavation have occurred at Mendes, the earliest in 1947 under the supervision of Habachi who discovered some poorly preserved burials (Lovell 1992). Later work, between 1963 and 1980, was conducted by Bothmer (1988), Hansen (1967), and Wilson (1982). Hansen (1967), who excavated between 1965-67 and 1976-78 (with excavations at Kom el-Adhem in 1977 and 1978), notes that 31 burials had been discovered over three seasons of excavations, but these were almost impossible to date due to the lack of grave goods. The 1978 excavation season at Kom el-Adhem uncovered two burials with evidence of attempted mummification. Most bodies were found flexed into the fetal position with the head oriented north and the face to the east (Hansen 1967). Excavations by Canadian and American expeditions resumed in the 1990s in various areas of the site (Brewer & Wenke 1992; Lovell 1992; Redford 1988, 2004, 2009), though not all yielded burials.

Lovell's 1992 excavations at Kom el-Adhem identified 19 burials, 17 of which were excavated that year. These Late to Ptolemaic Period individuals displayed a range of pathological conditions including degenerative joint disease, healed fractures, ossification of ligamentous attachments, lesions possibly indicating childhood anemia, and dental pathology. Lang (2004) provides an overview of the 13 individuals from the Third Intermediate Period uncovered during the 1994 and 1995 field seasons at Mendes, focusing on pathological conditions in the teeth such as dental enamel defects. Lovell and Whyte (1999) analyzed temporal variation of enamel hypoplasia in the dentition of 72 individuals excavated from Mendes, 16 Old Kingdom individuals (OK), 17 First Intermediate Period individuals (FIP), and 39 individuals from the Ptolemaic Period (P). Their analysis suggested that the Old Kingdom was the period of highest nutritional stress and the authors note that famine and poverty are believed to have been widespread during the late Old Kingdom and early First Intermediate Period (Lovell & Whyte 1999). The possibility of famine or food shortage is supported by evidence of climactic changes and low Nile flooding during the late Old Kingdom and early First Intermediate periods (e.g., Hassan & Tassie 2006; Moeller 2005). Agricultural and commercial developments in Egypt by the Ptolemaic Period resulted in increased prosperity for the country as a whole, and the Delta region was less affected by political and economic strife than Upper Egypt (Bowman 1989; Ellis 1992; Grimal 1992; Watterson 1997).

Pathological lesions in the skeleton are a primary source of evidence to access information concerning the health and disease of past individuals. This paper presents the evidence of pathological conditions in a skeletal sample from the New York University Institute of Fine Arts excavations under the supervision of Donald Hansen. The sample is currently curated at the University of Alberta. An analysis of dental disease in the skeletal sample is forthcoming (Borstad & Lovell in press).

Materials and methods

Skeletal remains at Mendes represent individuals who lived at Mendes during three separate periods of occupation: the Old Kingdom (ca. 3000 to 2180 BCE), the First Intermediate Period (ca. 2180 to 2040 BCE), and the Ptolemaic or Greco-Roman Period (ca. 332 BCE to 395 CE). The skeletal sample under analysis was shipped to Dr. Nancy Lovell of the University of Alberta approximately 20 years after excavation. Lovell and Whyte (1999) note that the sample "did not stand up well to the rigors of excavation, curation, and transport" (p. 71). The sample consists of 41 adults and nine juveniles, with varying levels of completeness (**Table 1**). The minimum number of adult individuals for the sample is 41; however, the time periods are not equally represented, with a total of 21 Old Kingdom individuals (51%), 14 First Intermediate Period individuals (34%), five individuals from the Ptolemaic Period (12%), and one individual of unknown time period (2%).

The sex of the adults was ascertained using standard osteological methods based on the sexually dimorphic features of the pelvis and cranium (Bass 1995; Buikstra &

Ubelaker 1994; Ferembach et al. 1980; Phenice 1969; White & Folkens 2005), although some individuals were too fragmentary or incomplete to accurately determine sex. Individuals were categorized as male, possible male (male?), possible female (female?), female, and unknown. Sex was estimated for 34 of the 41 individuals (83%). Levels of completeness were determined in broad categories of complete (90-100% of the skeleton is present), partial (50-89%), and incomplete (<50%). Age of the adult individuals was assessed using multiple indicators, including the auricular surface (Lovejoy et al. 1985), the pubic symphysis (Brooks & Suchey 1990; Meindl et al. 1985), and the sternal rib ends (Işcan et al. 1984, 1985). Juvenile individuals were identified by their unfused or fusing epiphyses. Adult individuals (A, >18 years old), where possible, were divided into young adults (YA, 20-30 years), middle adults (MA,

Table 1. Catalogue of individuals from Mendes.

Burial No.	Sex	Age	Completeness
		Old Kingdom	
4MB5	Female?	Adult	Incomplete
4MB7	Female?	Adult	Incomplete
4MB8	Female?	Adult	Incomplete
4MB11	Unknown	Adult	Incomplete
4MB12	Male?	Adult	Incomplete
4MB13	Male	Adult	Incomplete
4MB14	Male	Adult	Incomplete
4MB15	Female	Adult	Partial
4MB20	Unknown	Young Adult	Incomplete
4MB21	Unknown	Adult	Incomplete
5MB20	Unknown	Subadult	Incomplete
5MB21	Female	Adult	Incomplete
5MB25	Male	Adult	Incomplete
5MB26	Male	Middle Adult	Incomplete
5MB27	Male	Young Adult	Incomplete
5MB28	Female?	Adult	Incomplete
5MB29	Unknown	Subadult	Incomplete
5MB30	Unknown	Subadult	Incomplete
5MB31	Male	Middle Adult	Incomplete
5MB32	Unknown	Subadult	Incomplete
5MB38	Male?	Adult	Incomplete
5MB39	Male?	Adult	Incomplete
5MB41	Unknown	Subadult	Incomplete
5MB42	Male?	Adult	Incomplete
6MB1	Female?	Adult	Incomplete
6MB3	Female	Adult	Partial

Table 1. (continued)

Burial No.	Sex	Age	Completeness
		First Intermediate	
4MB1	Male	Adult	Partial
4MB2	Female?	Middle Adult	Incomplete
4MB4	Female?	Adult	Incomplete
4MB6	Unknown	Subadult	Incomplete
4MB19	Female	Adult	Incomplete
5MB1	Male	Middle Adult	Incomplete
5MB2	Male	Adult	Incomplete
5MB3	Male	Adult	Incomplete
5MB4	Unknown	Adult	Incomplete
5MB5	Unknown	Adult	Incomplete
5MB10	Unknown	Subadult	Partial
5MB12	Female	Adult	Incomplete
5MB13	Unknown	Adult	Incomplete
5MB14	Male?	Adult	Incomplete
5MB15	Unknown	Subadult	Incomplete
5MB16	Male?	Adult	Incomplete
5MB18	Male	Adult	Incomplete
		Ptolemaic	
5MB35	Female	Middle-Old Adult	Partial
5MB36	Male	Old Adult	Incomplete
5MB40	Female	Young Adult	Incomplete
6MB4	Male	Middle-Old Adult	Incomplete
6MB5	Female?	Adult	Incomplete
		Unknown	
6MB2	Unknown	Adult	Incomplete
No num.	Unknown	Subadult	Incomplete

31-40 years), and older adults (OA, >40 years) following the categories outlined by Lovell (1992) in the preliminary analysis of human remains from Mendes.

The sample is likely not representative demographically of contemporary sex or age ratios. Waldron (1994) outlines the extrinsic and intrinsic factors that serve to bias skeletal samples, noting that the proportion of individuals discovered and excavated generally differs greatly from the total number originally buried or preserved at a given site.

The adult remains were studied for evidence of degenerative joint disease (DJD), trauma, enthesophytes, cranial porosity, and other resorptive or proliferative anomalies. The juvenile remains were also examined for evidence of pathological conditions. The pathological lesions found in the adult remains were identified and described using accepted reference materials (e.g., Buikstra & Ubelaker 1994; Mann & Hunt 2005; Ortner 2003). Degenerative joint disease was diagnosed if an individual displayed both evidence of erosion and pitting on the joint surface and osteophytes, following the operational definition for osteoarthritis outlined by Waldron (2009). The remains were examined for evidence of healing and healed trauma based upon the descriptions provided by Galloway (1999) and Sauer (1998). Bones displaying possible enthesial changes were compared to skeletons in the University of Alberta skeletal teaching collection. *Cribra orbitalia* and porotic hyperostosis were noted as being present or absent in the adult remains. The remains were examined for macroscopic evidence of pathological lesions under bright light with the use of a 10× magnifying glass, supplemented by radiographs taken at the University of Alberta.

Results and discussion

Twenty-one of the 41 (51%) adult individuals exhibit pathological lesions. By time period, ten Old Kingdom individuals (48%), six First Intermediate Period individuals (43%), and five Ptolemaic individuals (100%) displayed pathological lesions. The general categories of pathological conditions, DJD, trauma, enthesial changes, cranial porosity, and other (non-categorized resorptive and/or proliferative anomalies) are summarized in **Figure 2** divided by time period. The juvenile remains were also examined, but no evidence of pathological conditions was found.

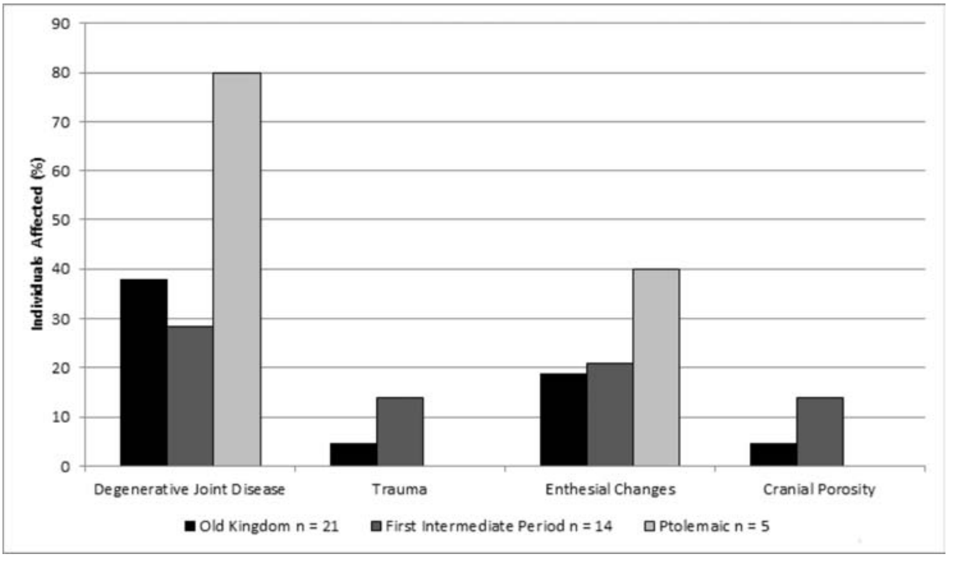

Figure 2. Percentage of individuals affected by pathological lesions at Mendes by time period.

Degenerative joint disease

The presence of DJD in the majority of the Mendes samples is represented by new bone formation at articular surface margins. DJD is discussed as the result of chronic stress on joints in the clinical (e.g., Goldring & Goldring 2007; Moskowitz et al. 2004; Radin et al. 1991) and bioarchaeological literature (e.g., Brown et al. 2008; Cope et al. 2005; Klaus et al. 2009; Lieverse et al. 2007). DJD is composed of three parts: breakdown of articular cartilage, formation of reactive bone in the subchondral compact bone and trabeculae, and new growth of cartilage and bone at the joint margins (Ortner 2003; Waldron 2009). DJD does not necessarily produce painful symptoms and it is therefore difficult to correlate bony changes with a patient's clinical experience (e.g., Bruyere et al. 2002; Watt 2000). The joints of the spine are commonly affected by DJD, particularly in the cervical and lumbar vertebrae (Prescher 1998) and some form of spinal degeneration occurs in nearly everyone over the age of 40 (Dieppe & Lim 1998). Indeed, Wood-Jones (1910:277) notes that nearly all adult ancient Nubian skeletons he analyzed displayed degenerative changes in the spine.

Sixteen individuals (six males, 1 male?, three females?, five females, and one unknown sex) displayed evidence indicative of degenerative joint changes (39% of total sample). By time period there were eight affected individuals from the Old Kingdom for an individual count prevalence of 38%, four from the First Intermediate Period (29%), and four from the Ptolemaic (80%). The most common locations were in the spine, but the hands, feet, knee, and shoulder joints were also affected. In addition, the left ulna of 4MB15 (OK, female, adult) has degenerative joint changes secondary to trauma. None of the affected individuals display eburnation, the pathognomonic feature of osteoarthritis (Waldron 2009). Arthritic changes of cartilage and other soft tissue are not evident. Due to the poor completeness of individuals in this skeletal sample, the underrepresentation of osteoarthritis in the Mendes sample is very likely.

Table 2. Element count prevalence of DJD in vertebral bodies by time period.

Period	**Cervical**			**Thoracic**			**Lumbar**		
	n	**N**	**%**	**n**	**N**	**%**	**n**	**N**	**%**
Old Kingdom	9	36	25	6	30	20	3	12	25
First Intermediate	1	6	17	0	3	0	7	7	100
Ptolemaic	12	29	41	1	32	3	8	17	47
Total	22	71	31	7	65	11	18	36	50

Evidence of DJD in the spine was found primarily on the vertebral bodies. The Mendes sample has a total of 71 cervical vertebral bodies, 65 thoracic vertebral bodies, 36 lumbar vertebral bodies, and nine sacra. Evidence of DJD was found in 22 cervical bodies (31%), seven thoracic bodies (11%), 18 lumbar bodies (50%), and two sacra (22%). Though these results are based upon a small sample, they echo previous findings. For example, Hussien et al. (2009) and Sarry El-Din (2002), studying Egyptians from Greco-Roman Bahriyah Oasis and Old Kingdom Giza respectively, discovered that most degenerative changes were found in the lumbar vertebrae, followed by the cervical vertebrae, with the least in the thoracic vertebrae. When broken down by time period, the samples generally follow this pattern (**Table 2**); however, in the Old Kingdom sample the lumbar and cervical vertebral bodies were equally affected. **Figure 3a** shows a cervical vertebral body with severe erosion and porous alteration. **Figure 3b** shows the fourth lumbar vertebra of male individual 6MB4 (P, middle-old adult), exhibiting a large osteophyte.

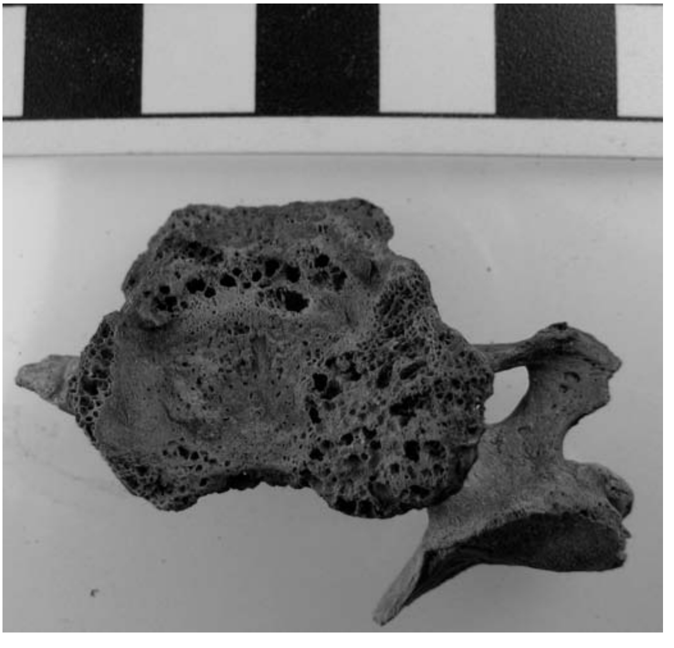

Figure 3a. Degenerative joint disease, cervical vertebra. Ptolemaic male, old adult (5MB36).

Many of the bony changes to the vertebral bodies and sacra can be attributed to a condition referred to as spinal osteophytosis, which is characterized by osteophytes forming horizontally from the vertebral body (Rogers & Waldron 1995). The endplates of the affected vertebrae often appeared pitted and porous. Further, five individuals (12%) have Schmorl's nodes, a condition caused by intervertebral disc material rupturing through the endplate into the cancellous bone of the vertebral body, leaving behind rounded defects (Ortner 2003). Although spinal osteophytosis and Schmorl's nodes are often found together, there is no evidence to suggest that they share a causative factor (Rogers & Waldron 1995). Other locations of degener-

Figure 3b. Degenerative joint disease, lumbar vertebra. Ptolemaic male, middle-old adult (6MB4).

ative joint changes in the spine include the superior articular and transverse processes of the fifth lumbar vertebra of 5MB36 (P, male, old adult) and the superior articular processes of one lumbar vertebral neural arch in 5MB26 (OK, male, middle adult). The atlantoaxial joint was affected by DJD in four individuals (10%), evidenced by osteophytes on the facet for the dens on the atlas of 5MB35 (P, female, middle-old adult), the odontoid process of the axis of 5MB31 (OK, male, middle adult), and both in 4MB15 (OK, female, adult) and 6MB4 (P, male, middle-old adult).

The affected hand bones display marginal osteophytes on the distal interphalangeal joints. 4MB12 (OK, male?, adult), has a raised, proliferative area of bone on the distal articular surface of one proximal pedal phalanx. Unfortunately, this individual was incomplete and only six pedal phalanges are present, severely limiting further analysis. Three female individuals (5MB21 (OK, adult), 5MB35 (P, middle-old adult), and 5MB40 (P, young adult)) each have one intermediate and one distal pedal phalanx fused together. The fusion did not appear to be in response to past trauma. 5MB36 (P, male, old adult) had one proximal and one intermediate hand phalanx fused together at an angle (**Figure 4**), suggesting that this individual would have lost all mobility in that particular interphalangeal joint. Further, individuals 5MB35 and 5MB36 were placed in the older adult range, suggesting that their phalangeal fusion could be age related. One proximal pedal phalanx in 6MB5 (P, female?, adult) has a bony growth measuring 5.0mm in length extending inferiorly off the distal articular surface.

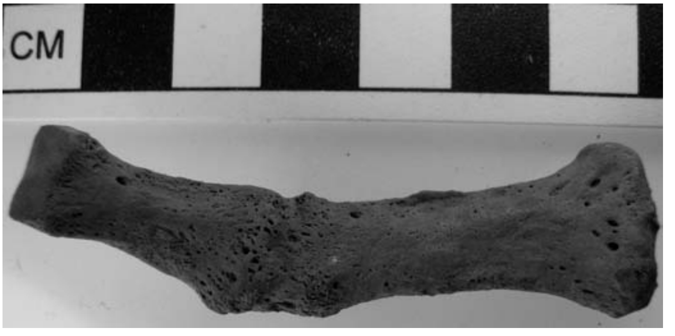

Figure 4. Fused proximal and intermediate hand phalanx. Ptolemaic male, old adult (5MB36).

Two individuals from Mendes, 4MB14 (OK, male, adult) and 5MB35 (P, female, middle-old adult) exhibit periarticular resorptive lesions, consistent with rheumatoid arthritis, a form of erosive arthropathy. This variety of systemic joint disease results in severe inflammation and erosion to joints and the entheses surrounding joints (Ortner 2003; Rogers & Waldron 1995). Women are more likely than men to have rheumatoid arthritis (Alamanos & Drosos 2005) and it is more common in older rather than younger adults (Kvien 2004). The pathogenesis of the condition is still unknown, although an environmental stimulus may activate a genetic predisposition for the specific, erosive autoimmune response (Ortner 2003). 4MB14 had severe and jagged erosive changes to the proximal end of one proximal hand phalanx. 5MB35 displayed lesions affecting two metatarsophalangeal joints, leaving the bases of two proximal pedal phalanges severely altered (**Figure 5**). 5MB35 also displayed evidence of DJD, with erosion to joint surfaces, and osteophytes present on the sternum, cervical vertebrae and lumbar vertebrae. Rothschild et al. (1990) note that the most severe lesions tend to occur at metatarsophalangeal, metacarpophalangeal, and proximal interphalangeal joints. The lytic, erosive lesions are consistent with those reported by Kilgore (1989), who describes a case of possible rheumatoid arthritis from Sudanese Nubia, stating that there is increasing evidence suggesting that rheumatoid arthritis is of greater antiquity than previously thought (though this conclusion has been critiqued by Rothschild et al. 1999). The possible presence of rheumatoid arthritis is only a tentative suggestion; overall poor preservation hampers the possibility of examining these individuals for symmetrical joint involvement. Rothschild and Woods (1991) note that trabecular loss under arthritic erosions will contribute to their poor preservation in postmortem contexts.

Figure 5. Erosive lesions, proximal pedal phalanges. Ptolemaic female, middle-old adult (5MB35).

Trauma

Studying fracture patterns in ancient groups may provide information concerning interpersonal relations and individuals' interactions with their environments. For example, Buzon and Richman (2007) studied fracture patterns in individuals from an Egyptian colonial cemetery in Nubia dating from the Middle Kingdom (2050-1650 BCE) and New Kingdom (1550-1050 BCE) periods and posited that the decrease in traumatic injuries (compared with Judd's (2004) analysis of Middle Kingdom burials from Kerma) was related to changes in Egyptian administrative policies. Erfan et al. (2009) discovered a high prevalence of cranial trauma in Ptolemaic or Greco-Roman individuals from the Bahriyah Oasis and suggested the trauma may be related to social and political disruption in Egyptians under oppressive Roman administration. Individuals of both sex (as well as subadults) from the Amarna South Tombs cemetery have exhibited healed and healing trauma (Rose & Dabbs 2012), suggesting that the risk of trauma was present for all individuals regardless of sex and age.

The overall frequency of fracture in the Mendes sample is low and was likely caused by isolated incidents. There were five examples of trauma—healed fractures of two ribs, one humerus, one ulna, and one proximal hand phalanx—in three of the 22 individuals, one individual from the Old Kingdom and two from the First Intermediate Period for an individual count prevalence of 4.8% and 14% respectively. The two rib fractures (4MB1 and 4MB15) appear to be simple, transverse fractures, both of which were likely caused by trauma to the chest, resulting from a blow or a fall (Kara et al. 2003). The rib fractures present in the Mendes skeletal sample are both found on rib fragments resulting from postmortem damage; it is not possible to assign the fractures a rib number or side. Both fractures display significant remodeling, the bony callus having been almost totally obliterated in both cases. Slight compensatory remodeling is present in both, since neither fracture shows perfect alignment between the fractured ends. Rib fractures are the most commonly recorded type of fracture in archaeological human remains, and have the potential to yield important sociocultural information (Brickley 2006). Clinically, despite the fact that rib fractures often go unreported, they are the most commonly reported chest injury in modern groups (Kramaker & Anthony 2003) and are the most frequently fractured bones in the thorax (Tekinbas et al. 2003).

Burial 4MB1 (FIP, male, adult) exhibits a healed transverse rib fracture and a healed midshaft fracture of the left ulna. It is possible the two fractures occurred due to the same incident since both show considerable remodeling of the bony callus. Judd (2002), however, notes that multiple fractures sustained by ancient people may suggest injury recidivism. The single ulnar fracture in 4MB1 displays slight angulation with compensatory remodeling, indicating that the fracture was not properly set. Clinical cases involving an isolated ulnar fracture are generally associated with fending off a blow (e.g., DuToit & Gräbe 1979; Heppenstall 1980; Rogers 2001); however, ulnar shaft fractures can alternatively result from a fall (Judd 2006, 2008; Jurmain 1999; Lovell 1997; Ortner 2003; Walker 2001).

The female individual 4MB15 (OK, adult) has healed fractures of a rib and the left distal humerus. The distal humeral fracture in 4MB15 (**Figure 6**) displays significant remodeling in response to what appears to have been trauma in the area above the olecranon fossa. A radiograph of the fracture reveals the fracture was likely supracondylar, as described by Glencross and Stuart-Macadam (2001). The associated left ulna displays lipping around the olecranon process, which is likely an osteoarthritic response to the humeral trauma (Roberts & Manchester 2005; Rogers 2000). Clinical studies indicate that the limb fractures appearing in the Mendes sample are relatively rare in modern groups, a finding also discussed by Judd (2004) in an examination of ancient Nubian individuals. Fractures of the forearm comprise only 1.2% of orthopedic surgeons' cases and are more common in men while fractures of the distal humerus comprise only 0.5% of cases and are over two times more common in female patients (Court-Brown & Caesar 2006). When elbow fractures do occur, approximately 33% involve the distal humerus (Mehne & Jupiter 1992). Distal humeral fractures are rare in contemporary adults; they are more commonly found in children involved in traffic accidents (Lekšan et al. 2007) or falling onto outstretched arms (Green 1994).

Figure 6. Healed fracture of distal left humerus. Old Kingdom female, adult (4MB15).

4MB19 (FIP, female, adult) displays a healed fracture of a proximal phalanx of the hand. Fractures of metacarpals or phalanges are clinically the most common fractures in the upper limbs (Stern 1999) and the proximal hand phalanx is more commonly fractured than the intermediate or distal phalanges (Singh et al. 2011). Judd (2002) cautions that the ambiguous etiology of trauma to the extremities limits the use of these bones in interpretations of interpersonal violence or accidents among ancient people. Fractures of finger phalanges are more common than those of the forearm or humerus at 9.6% of surgical orthopedic cases (Court-Brown & Caesar 2006). Clinical research has suggested that many fracture types (e.g., distal radius) are generally more common in young men and older women (e.g., Buhr & Cooke 1959; Donaldson et al. 1990; Singer et al. 1998). This does not, however, apply to every type of fracture and risk factors change throughout life (Court-Brown & Caesar 2006; Court-Brown & Clement 2009; Sahlin 1990; van Staa et al. 2001).

Enthesial changes

Nine individuals showed bony changes that may be classified as enthesial changes (after Jurmain & Villotte 2010) such as: enthesophytes (acromial ends of clavicles, supinator crest of ulna, radial tuberosities), exostoses (heads of metatarsals), active bone resorption (femoral heads around fovea capitis, above the capitulum of the humerus), and a possible accessory facet (talar head). By temporal period there were four affected individuals from the Old Kingdom for an individual count prevalence of 19%, three from the First Intermediate Period (21%), and two from the Ptolemaic Period (40%). There is value in noting patterns of bony changes in the skeleton; however, caution must be used. Enthesophytes and other lesions have commonly been interpreted in the bioarchaeological literature as markers of occupational or activity-related stress and used to reconstruct activity patterns (e.g., Hawkey & Merbs 1995; Kelley & Angel 1987; Kennedy 1989), some focusing on ancient Egyptian and Nubian sites (e.g., Bellandi et al. 2013; Judd 2010; Schrader 2012). Further research has revealed the potential multifactorial origin of these changes; they may also represent the effects of age, hormonal or genetic factors, diet, and disease (Jurmain 1999; Jurmain et al. 2012; Roberts & Manchester 2005; Weiss 2003). Due to the preservation problems that limit the analysis of patterns of enthesial changes throughout the skeleton and the general age assessments available, it would be unwise to attempt to assign particular activities or occupations to the individuals from Mendes. Descriptions are reported here to provide a source of data for future inter-population studies of enthesial changes (e.g., Villotte et al. 2010a).

Two individuals had clavicles whose acromial ends appeared expanded, porous, and flattened. 4MB19 (FIP, female, adult) displayed a particularly well-developed supinator crest, which may be caused by excessive supination and hypertension of the arm (Villotte et al. 2010b). Unfortunately the other arm was poorly preserved, thus a study of limb symmetry was not possible. This individual also displayed osteophytic spicules on the superior surface of the left patella. Both radial tuberosities of 5MB36 (P, male, old adult) display resorptive lesions and inferior osteophytes, which may also be age-related. In addition, the left humerus of this individual has an unusual concave resorbed area above the capitulum, accompanied by a small, raised ridge of bone above the boundary between the capitulum and trochlea. Two individuals, 4MB1 (FIP, male, adult) and 4MB2 (FIP, female?, middle adult) display active resorption on the femoral heads around the fovea capitis. It is possible that strain on the ligamentum teres caused a bony reaction; however, none of the corresponding acetabula were preserved, which prevents further analysis. 5MB26 (OK, male, middle adult) displays protruding exostoses on the first metatarsal heads and accompanying body build-up on the first proximal pedal phalanges. Similar findings have been described in the bioarchaeological literature (e.g., Lai & Lovell 1992; Lovell & Lai 1994; Ubelaker 1979). Finally, 6MB3 (OK, female, adult) exhibits a possible accessory facet on the talar head (**Figure** 7).

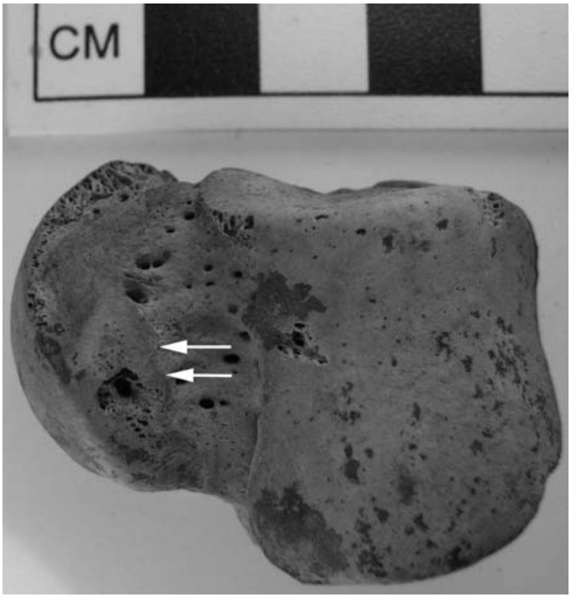

Figure 7. Possible accessory facet, talus. Old Kingdom female, adult (6MB3).

Cranial porosity

Three individuals in the Mendes sample showed evidence of two conditions—*cribra orbitalia* and porotic hyperostosis. There was one affected individual from the Old Kingdom for an individual count prevalence of 4.8% and two from the First Intermediate Period (14%). These conditions have been studied in Egyptian and Sudanese contexts before, yielding variable levels prevalence rates in samples drawn from ancient to medieval contexts (e.g., Batrawi 1935; Carlson et al. 1974; Fairgrieve & Molto 2000; Hummert & van Gerven 1983; Mittler & van Gerven 1994; Rose 2006; Rose & Dabbs 2012; Satinoff 1972a,b; Strouhal & Jungwirth 1980; Zink et al. 2000). An orbital fragment from 4MB1 (FIP, male, adult) exhibits remodeled lesions of *cribra orbitalia* (**Figure 8**), suggesting the individual suffered from the condition during childhood. An unsided parietal fragment of individual 5MB14 (FIP, male?, adult) has a pattern of porosity suggesting parietal hyperostosis, with holes ranging in size from 0.5mm to 1.0mm in diameter. The endocranial surface also displays porosity, particularly along grooves for the meningeal vessels. The etiology of these two conditions and the relationship between them is unclear; however, iron deficiency and nutrient loss through diarrhea have been suggested as possible causes (Mann & Hunt 2005; Roberts & Manchester 2005; Stuart-Macadam 1987, 1989, 1992). The iron deficiency hypothesis suggests that in response to subnormal levels of hemoglobin or red blood cells, the production of red blood cells increases, causing the hypertrophy of red bone marrow and an expansion of cancellous bone. This expansion, coupled with the resulting thinning of the outer table of compact cranial bone, leads to pitting and porosity that may be observed macroscopically in dry bone. Walker et al. (2009) have argued against the iron deficiency hypothesis (though this work was subsequently criticized by Oxenham and Cavill 2010), stating that the porotic bony changes may be due to hemolytic anemias (such as thalassemia) and megaloblastic anemias, which are mainly caused by Vitamin B_{12} and Vitamin B_9 shortages.

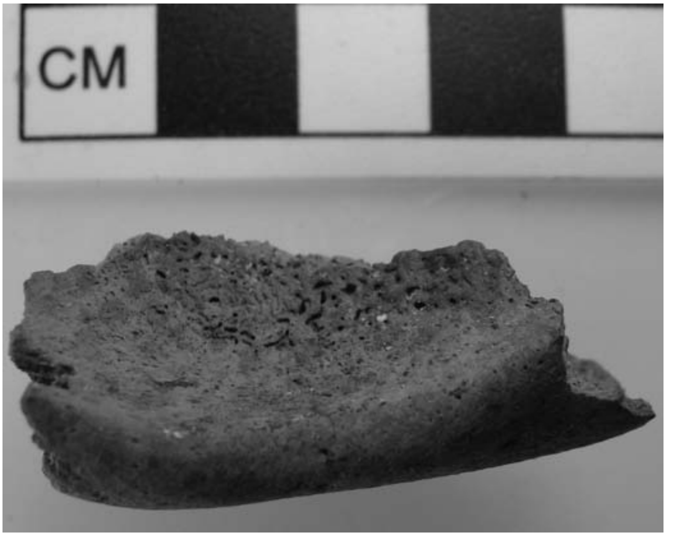

Figure 8. Remodeled *cribra orbitalia* lesions, orbital fragment, First Intermediate male, adult (4MB1).

In a previous study of human remains from Mendes, two individuals (of the 13 excavated during the 1994 and 1995 field seasons) from the Third Intermediate Period (ca. 1070 to 600 BCE) displayed evidence of porotic hyperostosis. Both individuals, an adult aged at over 45 years and a subadult aged at less than 13 years, had expanded diploë, 9.96mm and 10.01mm respectively, leading the author to comment that this likely indicated an iron deficient diet (Lang 2004). One individual in this sample 5MB27 (OK, male, young adult) exhibits porotic hyperostosis on the ectocranial surface of unsided parietal fragments and has diploë comparatively expanded to 11.00mm.

Other findings

Eleven individuals display pathological conditions that do not clearly fall under the general categories described above. 5MB35 (P, female, middle-old adult) has an unusual spicular growth extending down from the left palate surface. One individual, 4MB11 (OK, unknown sex, adult) exhibits reactive bone inside the scaphoid's articular surface for the capitate. The reactive bone inside the scaphoid may have formed in response to trauma; this diagnosis is tentative, however, because the capitate was not recovered.

Eight individuals displayed conditions involving resorptive lesions that may be traumatic, infectious, or taphonomic in origin. 4MB1 (FIP, male, adult) has a smooth, circular resorptive lesion 4.0mm in diameter on the right occipital condyle, suggesting that the atlanto-occipital joint may have been affected; unfortunately the individual's atlas was not recovered. The right trapezoid of 4MB2 (FIP, female?, middle adult) displays a small circular resorption of unknown cause. Four individuals, 4MB15 (OK, female, adult), 5MB5 (FIP, unknown sex, adult), 5MB26 (OK, male, middle adult), and 5MB35 (P, female, middle-old adult) exhibit what appear to be isolated irregularly resorptive lesions on the inner table of the cranium (**Figure 9**), though it has been suggested that such lesions may be a pseudopathology caused by insect activity (Pittoni 2009). Two individuals, 5MB36 (P, male, old adult) and 5MB40 (P, female, young adult), display resorption on the sternal end of their left clavicles, although the lesions differ dramatically; 5MB40 has a well-defined, remodeled lesion, while 5MB36 shows ragged resorption that indicates an active condition. The manubrium, unfortunately, is absent in 5MB40 and only partially preserved in 5MB36, making diagnosis difficult. Periostitis was not observed in any of the individuals from Mendes, perhaps due to the poor level of preservation of the sample.

One female individual 4MB15 (OK, adult) displays possible signs of developing *hyperostosis frontalis interna* (HFI), shown in **Figure 10**. This individual has thin sheets of appositional bone on the endocranial surface of the frontal vault, consistent with an early form of HFI. This benign disorder causes irregular endocranial bony buildup. It is more commonly found in women, particularly postmenopausal women, and its etiology may be linked to levels of female hormones (Mann & Hunt 2005). The bony accretions on the frontal bone of individual 4MB15 are closest to Hershkovitz et al.'s (1999) Type A description of the macroscopic morphology of HFI. Individual 4MB15 was aged broadly as a female adult in the age range of 19-45. Other researchers have identified this condition in Meroitic Nubia (Armelagos & Chrisman 1988) and ancient Egypt (Baker 2013; Watrous et al. 1993), though the

Figure 9. Lesion, endocranial surface. Old Kingdom female, adult (4MB15).

cases these authors describe are significantly more dramatic. The thickening of the frontal bone may also be found in acromegaly, though there was no evidence of other skeletal lesions suggestive of acromegaly such as widened ribs, thickened hand bones, or mandibular prognathism (Aufderheide & Rodriguez-Martin 1998). Fibrous dysplasia is another possibility; Ortner and Putschar (1985) describe a female individual from twelfth dynasty Lisht, Egypt with thickening of the frontal bone. Paget's disease also involves the thickening of the frontal bone though the lytic effects of Paget's disease outlined by Jaffe (1972) and Ortner (2003) are not present.

Conclusions

This skeletal sample represents adult individuals from the Old Kingdom to the Ptolemaic Period. Despite the fragmentary nature of the skeletal sample under analysis, evidence of DJD, trauma, enthesial changes, cranial porosity, and other pathological lesions were observed. Palaeopathological analysis also revealed possible findings of rheumatoid arthritis and *hyperostosis frontalis interna*. DJD was observed primarily in the spine, but also found at hand, foot, knee, and shoulder joints. The overall pattern of DJD in the Mendes sample was found to be similar to previous studies of Egyptian material (e.g., Hussien et al. 2009; Sarry El-Din 2002). Traumatic injury was represented by five healed fractures. These fractures likely resulted from individual incidents rather than from the cultural patterned violence described in other bioarchaeological studies of ancient Egyptian and Nubian skeletal samples (e.g., Buzon & Richman 2007; Erfan et al. 2009; Judd 2004); however, it is hoped that further studies at Mendes with greater sample sizes will provide a clearer picture. Enthesial changes have been described to provide data for future inter-population studies as the

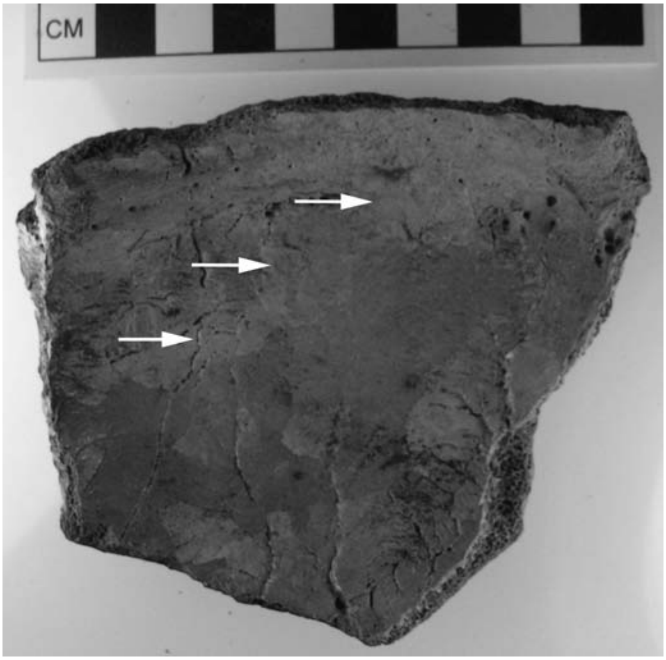

Figure 10. Possible *hyperostosis frontalis interna*, endocranial surface of frontal bone. Old Kingdom female, adult (4MB15).

significance and multifactorial origin of enthesophytes is studied and debated. *Cribra orbitalia* and porotic hyperostosis were discovered in the Mendes sample. These conditions have been studied in Egyptian contexts before (e.g., Rose & Dabbs 2012; Zink et al. 2000) though the overall low levels of cranial completeness in this sample limit possible comparisons.

It would be beneficial to undertake further studies of skeletal samples from Mendes to create a more comprehensive picture of health and disease in the city; investigating correlations between health and sex, as well as extending the range of ages represented will be advantageous. The data discussed here provide another source of information on life in ancient Egypt; it is anticipated that further research will be completed in Mendes and its surrounding area to improve and deepen understanding and appreciation of the region.

Acknowledgements

Many thanks are owed to Dr. Nancy Lovell, who granted access to the Mendes skeletal samples, provided the map of the Egyptian Delta, and encouraged the creation of this paper with constructive criticism and guidance. Special thanks are due to Dr. Mindy Pitre, who graciously shared lab space and resources during the data collection phase of this research. Thank you to the two anonymous reviewers and to Scott Haddow whose insightful comments improved this manuscript.

References

Alamanos Y., Drosos A.A. (2005), *Epidemiology of adult rheumatoid arthritis*, Autoimmunity Reviews 4:130-136.

Armelagos G.J., Chrisman O.D. (1988), *Hyperostosis frontalis interna: A Nubian case*, American Journal of Physical Anthropology 76:25-28.

Aufderheide A.C., Rodriguez-Martin C. (1998), *The Cambridge encyclopedia of human paleopathology*, Cambridge: Cambridge University Press.

Baker B.J. (2013), *Sacrifices for the state? The subsidiary burials from Aha's funerary enclosures at Abydos*, PalArch's Journal of Archaeology of Egypt/Egyptology 10:11-12.

Bass W.M. (1995), *Human osteology: A laboratory and field manual*, 4th ed., Columbia: Missouri Archaeological Society.

Batrawi A.M. (1935), *Report on the human remains, mission archéologie de Nubie 1929-1934*, Cairo: Service des Antiquités du l'Egypte, Government Press.

Bellandi G., De Marzo R., Benazzi S., Sesana A. (2013), *Burial under the Temple of Millions of Years of Amenhotep II in Luxor, West Thebes, Italian Archaeological Project*, PalArch's Journal of Archaeology of Egypt/Egyptology 10:12-13.

Borstad C.M., Lovell N.C. (in press), *Dental disease at ancient Mendes (Tell er-Rubca), Egypt*, Journal of the Society for the Study of Egyptian Antiquities.

Bothmer B.V. (1988), *The great naos at Mendes and its sculpture* [in:] "The archaeology of the Nile Delta: Problems and priorities", E.C.M. van den Brink (ed.), Amsterdam: Netherlands Foundation for Archaeological Research in Egypt, pp. 205-220.

Bowman A.K. (1989), *Egypt after the pharaohs*, Berkeley: University of California Press.

Brewer D.J., Wenke R.J. (1992), *Transitional Late Predynastic-Early Dynastic occupations at Mendes: A preliminary report* [in:] "The Nile Delta in transition", E.C.M. van den Brink (ed.), Jerusalem: R. Pinkhas, pp. 191-197.

Brickley M. (2006), *Rib fractures in the archaeological record: A useful source of sociocultural information?*, International Journal of Osteoarchaeology 16:61-75.

Brooks S.T., Suchey J.M. (1990), *Skeletal age determination based on the os pubis: A comparison of the Ascadi-Nemeskeri and Suchey-Brooks methods*, Journal of Human Evolution 5:227-238.

Brown K.R., Pollintine P., Adams M.M. (2008), *Biomechanical implications of degenerative joint disease in the apophyseal joints of human thoracic and lumbar vertebrae*, American Journal of Physical Anthropology 136:318-326.

Bruyere O., Honore A., Rovati L.C., Giacovelli G., Henrotin Y.E., Seidel L., Reginster J.-Y.L. (2002), *Radiological features poorly predict clinical outcomes in knee osteoarthritis*, Scandinavian Journal of Rheumatology 31:13-16.

Buhr A.J., Cooke A.M. (1959), *Fracture patterns*, The Lancet 1:531-536.

Buikstra J.E., Ubelaker D., ed. (1994), *Standards for data collection from human skeletal remains*, "Arkansas Archaeological Survey Research Series" 44, Fayetteville.

Buzon M.R., Richman R. (2007), *Traumatic injuries and imperialism: The effects of Egyptian colonial strategies at Tombos in Upper Nubia*, American Journal of Physical Anthropology 133:783-791.

Carlson D.S., Armelagos G.J., van Gerven D.P. (1974), *Factors influencing the etiology of cribra orbitalia in prehistoric Nubia*, Journal of Human Evolution 3:405-410.

Cope J.M., Berryman A.C., Martin D.L., Potts D.D. (2005), *Robusticity and osteoarthritis at the trapeziometacarpal joint in a Bronze Age population from Tell Abraq, United Arab Emirates*, American Journal of Physical Anthropology 126:391-400.

Court-Brown C.M., Caesar B. (2006), *Epidemiology of adult fractures: A review*, Injury 37:691-697.

Court-Brown C.M., Clement N. (2009), *Four score years and ten: An analysis of the epidemiology of fractures in the very elderly*, Injury 40:1111-1114.

Dieppe P., Lim K. (1998), *Osteoarthritis and related disorders: Clinical features and diagnostic problems* [in:] "Rheumatology", 2nd ed., J.H. Klippel, P. Dieppe (eds.), London: Mosby, pp. 1-16.

Donaldson L.J., Cook A., Thomson R.G. (1990), *Incidence of fractures in a geographically defined population*, Journal of Epidemiology and Community Health 44:241-245.

DuToit F.P., Gräbe R.P. (1979), *Isolated fractures of the shaft of the ulna*, South African Medical Journal 56:21-25.

Ellis S.P. (1992), *Graeco-Roman Egypt*, Aylesbury: Shire Egyptology.

Erfan M., El-Sawaf A., Al-Tohamy Soliman M., Sarry El-Din A., Kandeel W.A., Abd El-Shafy El-Banna R., Azab A. (2009), *Cranial trauma in ancient Egyptians from the Bahriyah Oasis, Greco-Roman period*, Research Journal of Medicine and Medical Sciences 4:78-84.

Fairgrieve S.I., Molto J.E. (2000), *Cribra orbitalia in two temporally disjunct population samples from the Dakhleh Oasis, Egypt*, American Journal of Physical Anthropology 111:319-331.

Ferembach D., Schwidetzky I., Stoukal M. (1980), *Recommendations for age and sex diagnoses of skeletons*, Journal of Human Evolution 9:517-549.

Galloway A. (1999), *Broken bones: Anthropological analysis of blunt force trauma*, Springfield: Charles C. Thomas.

Glencross B., Stuart-Macadam P. (2001), *Radiographic clues to fractures of distal humerus in archaeological remains*, International Journal of Osteoarchaeology 11:298-310.

Goldring M.B., Goldring S.R. (2007), *Osteoarthritis*, Journal of Cellular Physiology 213:626-634.

Green N.E. (1994), *Fractures and dislocations about the elbow* [in:] "Skeletal trauma in children", N.E. Green, M.F. Swiontkowski (eds.), Philadelphia: W.B. Saunders Company, pp. 213-256.

Grimal N. (1992), *A history of ancient Egypt*, Oxford: Blackwell.

Hansen D.P. (1967), *The excavations at Tell el-Rubca*, Journal of the American Research Center in Egypt 6:5-16.

Hansen D.P., Stieglitz D. (1980), *Mendes today: Tell el Rub'a* [in:] "Mendes I", R.K. Holz, D. Stieglitz, D.P. Hansen, E. Ochsenschlager (eds.), Cairo: American Research Center in Egypt, pp. 23-24.

Hassan F., Tassie G. (2006), *Modelling environmental and settlement change in the Fayum*, Egyptian Archaeology 29:37-40.

Hawkey D.E., Merbs, C.F. (1995), *Activity-induced musculoskeletal stress markers (MSM) and subsistence strategy changes among ancient Hudson Bay Eskimos*, International Journal of Osteoarchaeology 5:324-338.

Heppenstall R.B. (1980), *Fractures of the forearm* [in:] "Fracture treatment and healing", R.B. Heppenstall (ed.), Philadelphia: W.B. Saunders, pp. 481-503.

Hershkovitz I., Greenwald C., Rothschild B.M., Latimer B., Dutour O., Jellema L.M., Wish-Baratz S. (1999), *Hyperostosis frontalis interna: An anthropological perspective*, American Journal of Physical Anthropology 109:303-325.

Hummert J.R., van Gerven D.P. (1983), *Skeletal growth in a medieval population from Sudanese Nubia*, American Journal of Physical Anthropology 60:471-478.

Hussien F.H., Sarry El-Din A.M., El Samie Kandeel W.A., El Banna R.A. E-S. (2009), *Spinal pathological findings in ancient Egyptians of the Greco-Roman period living in Bahriyah Oasis*, International Journal of Osteoarchaeology 19:613-627.

Işcan M.Y., Loth S.R., Wright R.K. (1984), *Age estimation from the rib by phase analysis: white males*, Journal of Forensic Science 29:1094-1104.

Işcan M.Y., Loth S.R., Wright R.K. (1985), *Age estimation from the rib by phase analysis: white females*, Journal of Forensic Science 30:853-863.

Jaffe H.L. (1972), *Metabolic, degenerative and inflammatory disease of bones and joints*, Philadelphia: Lea and Febiger.

Judd M.A. (2002), *Ancient injury recidivism: An example from the Kerma period of Ancient Nubia*, International Journal of Osteoarchaeology 12:89-106.

Judd M.A. (2004), *Trauma in the city of Kerma: Ancient versus modern injury patterns*, International Journal of Osteoarcheology 14:34-51.

Judd M.A. (2006), *Continuity of interpersonal violence between Nubian communities*, American Journal of Physical Anthropology 131:324-333.

Judd M.A. (2008), *The parry problem*, Journal of Archaeological Science 35:1658-1666.

Judd M.A. (2010), *Pubic symphyseal face eburnation: An Egyptian sport story?*, International Journal of Osteoarchaeology 20:280-290.

Jurmain R. (1999), *Stories from the skeleton: Behavioral reconstruction in human osteology*, Amsterdam: Gordon and Breach Publishers.

Jurmain R., Villotte S. (2010), *Terminology: Entheses in medical literature: A brief review* [in:] "Workshop in musculoskeletal stress markers (MSM): Limitations and achievements in the reconstruction of past activity patterns", http://www.uc.pt/en/cia/msm/msm_after. Accessed 15 May 2013.

Jurmain R., Cardoso F.A., Henderson C., Villotte S. (2012), *Bioarchaeology's Holy Grail: The reconstruction of activity* [in:] "A companion to paleopathology", A.L. Grauer (ed.), Chichester: Wiley-Blackwell, pp. 531-552.

Kara M., Dikmen E., Erdal H.H., Simsir I., Kara S.A. (2003), *Disclosure of unnoticed rib fractures with use of ultrasonography in minor blunt chest trauma*, European Journal of Cardiothoracic Surgery 24:608-613.

Kelley J.O., Angel J.L. (1987), *Morphological variations in ulnar supinator crests and fossae as identifying markers of occupational stress*, Journal of Forensic Sciences 28:871-876.

Kennedy K.A.R. (1989), *Skeletal markers of occupational stress* [in:] "Reconstruction of life from the skeleton", M. Yasar Işcan, K.A.R. Kennedy (eds.), New York: Alan R. Liss, pp. 129-160.

Kilgore L. (1989), *Possible case of rheumatoid arthritis from Sudanese Nubia*, American Journal of Physical Anthropology 79:177-183.

Klaus H.D., Larsen C.S., Tam M.E. (2009), *Economic intensification and degenerative joint disease: Life and labor on the postcontact North Coast of Peru*, American Journal of Physical Anthropology 139:204-221.

Kramaker M.K., Anthony M. (2003), *Acute pain management of patients with multiple fractured ribs*, Journal of Trauma: Injury, Infection and Critical Care 53:615-625.

Kvien T.K. (2004), *Epidemiology and burden of illness of rheumatoid arthritis*, Pharmacoeconomics 22(suppl. 2):1-12.

Lai P., Lovell N. (1992), *Skeletal markers of occupational stress in the fur trade: A case study from a Hudson's Bay Company fur trade post*, International Journal of Osteoarchaeology 2:221-234.

Lang C. (2004), *The human remains (Third Intermediate Period)* [in:] "Excavations at Mendes: Volume 1. The Royal Necropolis", D.B. Redford (ed.), Boston: Brill, pp. 185-196.

Lekšan I., Nikolić V., Mrcela T., Lovrić I., Kristek J., Selthofer R. (2007), *Supracondylar fractures of the humerus in children caused by traffic*, Collegium Antropologicum 31:1009-1013.

Lieverse A.R., Weber A.W., Bazaliiskiy V.I., Goriunova O.I., Savel'ev N.A. (2007), *Osteoarthritis in Siberia's Cis-Baikal: Skeletal indicators of hunter-gatherer adaptation and cultural change*, American Journal of Physical Anthropology 132:1-16.

Lovejoy C.O., Meindl R.S., Pryzbeck T.R., Mensforth R.P. (1985), *Chronological metamorphosis of the auricular surface of the ilium: A new method for the determination of adult skeletal age at death*, American Journal of Physical Anthropology 68:15-28.

Lovell N. (1992), *The 1992 excavations at Kom El-Adhem, Mendes*, The Journal of the Society for the Study of Egyptian Antiquities 21:20-36.

Lovell N.C. (1997), *Trauma analysis in palaeopathology*, Yearbook of Physical Anthropology 40:139-170.

Lovell N.C., Lai P. (1994), *Lifestyle and health of voyageurs in the Canadian fur trade* [in:] "Strength and diversity: A reader in physical anthropology", A. Herring, L. Chan (eds.), Toronto: Canadian Scholars' Press, pp. 327-343.

Lovell N.C., Whyte I. (1999), *Patterns of dental enamel defects at Ancient Mendes, Egypt*, American Journal of Physical Anthropology 110:69-80.

Mann R., Hunt D.R. (2005), *Photographic regional atlas of bone disease: A guide to pathologic and normal variation in the human skeleton*, Springfield: Charles C. Thomas.

Mehne D.K., Jupiter J.B. (1992), *Part II—Fractures of the distal humerus* [in:] "Skeletal trauma: Fractures, dislocations, ligamentous injuries", B.D. Browner, J.B. Jupiter, A.M. Levine, P.G. Trafton (eds.), Philadelphia: W.B. Saunders Company, pp. 1146-1176.

Meindl R.S., Lovejoy C.O., Mensforth R.P., Walker R.A. (1985), *A revised method of age determination using the os pubis, with a review and tests of accuracy of other current methods of pubic symphyseal aging*, American Journal of Physical Anthropology 68:29-45.

Mittler D.M., van Gerven D.P. (1994), *Developmental, diachronic, and demographic analysis of cribra orbitalia in the Medieval Christian population of Kulubnarti*, American Journal of Physical Anthropology 93:287-297.

Moeller N. (2005), *The First Intermediate Period: A time of famine and climate change?* [in:] "Ägypten und Levant/Egypt and the Levant XV", M. Bietak (ed.), Austrian

Academy of Sciences Press, pp. 153-167.

Moskowitz R.W., Kelly M.A., Lewallen D.G. (2004), *Understanding osteoarthritis of the knee: causes and effects*, American Journal of Orthopedics 33(suppl. 2):5-9.

Ortner D.J. (2003), *Identification of pathological conditions in human skeletal remains*, 2nd ed., San Diego: Academic Press.

Ortner D.J., Putschar W. (1985), *Identification of paleopathological conditions in human skeletal remains*, Washington: Smithsonian Institution Press.

Oxenham M.F., Cavill I. (2010), *Porotic hyperostosis and cribra orbitalia: The erythropoietic response to iron-deficiency anaemia*, Anthropological Science 118:199-200.

Phenice T.W. (1969), *A newly developed visual method of sexing the os pubis*, American Journal of Physical Anthropology 30:297-302.

Pittoni E. (2009), *Necropoli of Pill'e Matta Quartucciu (Cagliari, Sardinia): Wild bee and solitary wasp activity and bone diagenetic factors*, International Journal of Osteoarchaeology 19:386-396.

Prescher A. (1998), *Anatomy and pathology of the aging spine*, European Journal of Radiology 27:181-195.

Radin E.L., Burr D.B., Caterson B., Fyhrie D., Brown T.D., Boyd R.D. (1991), *Mechanical determinants of osteoarthritis*, Seminars in Arthritis and Rheumatism 21(3, suppl. 2):12-21.

Redford D.B. (1988), *The first season of excavations at Mendes (1991)*, The Journal of the Society for the Study of Egyptian Antiquities 18:49-79.

Redford D.B. (2004), *Excavations at Mendes: Volume 1. The Royal Necropolis*, Boston: Brill.

Redford D.B., ed. (2009), *Delta reports (Research in Lower Egypt)*, vol. I, Oxford: Oxbow Books.

Roberts C., Manchester K. (2005), *The archaeology of disease*, 3rd ed., Ithaca: Cornell University Press.

Rogers J. (2000), *The palaeopathology of joint disease* [in:] "Human osteology in archaeology and forensic science", M. Cox, S. Mays (eds.), Cambridge: Cambridge University Press, pp. 163-182.

Rogers L. (2001), *Radiology of skeletal trauma*, 3rd ed., Philadelphia: Churchill Livingstone.

Rogers J., Waldron T. (1995), *A field guide to joint disease in archaeology*, Chichester: John Wiley & Sons.

Rose J.C. (2006), *Paleopathology of the commoners at Tell Amarna, Egypt, Akhenaten's capital city*, Memórias do Instituto Oswaldo Cruz 101(supplement 2):73-76.

Rose J.C., Dabbs G.R. (2012), *Report on the 2012 skeletal analysis of the South Tombs Cemetery Project*, http://amarnaproject.com/documents/pdf/STC-2012- bioarchaeology.pdf. Accessed 16 May 2013.

Rothschild B.M., Woods R.J., Ortel W. (1990), *Rheumatoid arthritis "in the buff": Erosive arthritis in defleshed bones*, American Journal of Physical Anthropology 82:441-449.

Rothschild B.M., Woods R.J. (1991), *Spondyloarthropathy: Erosive arthritis in representative defleshed bones*, American Journal of Physical Anthropology 85:125-134.

Rothschild B.M., Arriaza B., Woods R.J., Dutour, O. (1999), *Spondyloarthropathy identified as the etiology of Nubian erosive arthritis*, American Journal of Physical Anthropology 109:259-267.

Sahlin Y. (1990), *Occurrence of fractures in a defined population: a 1-year study*, Injury 21:158-160.

Sarry El-Din M.A. (2002), *Degenerative spinal arthritis in ancient Egyptians from the Old Kingdom*, Egyptian Journal of Anatomy 25:179-193.

Satinoff M.I. (1972a), *The origins and geographical spread of the thalassemias and abnormal haemoglobins*, Journal of Human Evolution 1:79-82.

Satinoff M.I. (1972b), *The medical biology of the early Egyptian populations from Aswan, Assyut, and Gebelen*, Journal of Human Evolution 1:247-257.

Sauer N.J. (1998), *The timing of injuries and manner of death: Distinguishing among antemortem, perimortem, and postmortem trauma* [in:] "Forensic osteology: Advances in the identification of human remains", 2nd ed., K.J. Reichs (ed.), Springfield: Charles C. Thomas, pp. 321-332.

Schrader S.A. (2012), *Activity patterns in New Kingdom Nubia: An examination of entheseal remodeling and osteoarthritis at Tombos*, American Journal of Physical Anthropology 149:60-70.

Singer B.R., McLauchlan G.J., Robinson C.M., Christie J. (1998), *Epidemiology of fractures in 15 000 adults: The influence of age and gender*, The Journal of Bone and Joint Surgery (Br) 80/B:243-248.

Singh J., Jain K., Mruthyunjaya, Ravishankar R. (2011), *Outcome of closed proximal phalangeal fractures of the hand*, Indian Journal of Orthopaedics 45:432-438.

Stern P.J. (1999), *Fractures of metacarpals and phalanges* [in:] "Green's operative hand surgery", vol. 1, 4th ed., D.P. Green, R.N. Hotchkiss, W.C. Pederson (eds.), Philadelphia: Churchill Livingstone, pp. 711-757.

Strouhal E., Jungwirth J. (1980), *Paleopathology of the Late Roman-Early Byzantine cemeteries at Sayala, Egyptian Nubia*, Journal of Human Evolution 9:61-70.

Stuart-Macadam P. (1987), *Porotic hyperostosis: new evidence to support the anemia theory*, American Journal of Physical Anthropology 74:521-526.

Stuart-Macadam P. (1989), *Porotic hyperostosis: relationship between orbital and vault lesions*, American Journal of Physical Anthropology 80:187-193.

Stuart-Macadam P. (1992), *Anemia in past human populations* [in:] "Diet, demography, and disease: Changing perspectives on anemia", P. Stuart-Macadam, S.K.

Kent (eds.), New York: Aldine De Gruyter, pp. 151-170.

Tekinbas C., Eroglu A., Kurkcuoglu I.C., Turkyilmaz A., Yekeler E., Yavuz C. (2003), *Chest trauma analysis of 529 cases*, Ulus Travma Derg 9:275-280.

Ubelaker D.H. (1979), *Skeletal evidence for kneeling in prehistoric Ecuador*, American Journal of Physical Anthropology 51:679-685.

van Staa T.P., Dennison E.M., Leufkens H.G.M., Cooper C. (2001), *Epidemiology of fractures in England and Wales*, Bone 29:517-522.

Villotte S., Churchill S.E., Dutour O., Henry-Gambier D. (2010a), *Subsistence activities and the sexual division of labor in the European Upper Paleolithic and Mesolithic: Evidence from upper limb enthesopathies*, Journal of Human Evolution 59:35-43.

Villotte S., Castex D., Couallier V., Dutour O., Knüsel C.J., Henry-Gambier D. (2010b), *Enthesopathies as occupational stress markers: Evidence from the upper limb*, American Journal of Physical Anthropology 142:224-234.

Waldron T. (2009), *Palaeopathology*, Cambridge: Cambridge University Press.

Walker P.L. (2001), *A bioarchaeological perspective on the history of violence*, Annual Review of Anthropology 30:573-596.

Walker P.L., Bathurst R.R., Richman R., Gjerdrum T., Andrushko V.A. (2009), *The causes of porotic hyperostosis and cribra orbitalia: A reappraisal of the iron-deficiency-anemia hypothesis*, American Journal of Physical Anthropology 139:109-125.

Watrous A.C., Anton, S.C., Plourde, A.M. (1993), *Hyperostosis frontalis interna in ancient Egyptians*, American Journal of Physical Anthropology 16 (suppl.):205.

Watt I. (2000), *Bone disorders: A radiological approach*, Balliere's Clinical Rheumatology 14:173-199.

Watterson B. (1997), *The Egyptians*, Cambridge: Blackwell.

Weiss E. (2003), *Understanding muscle markers: Aggregation and construct validity*, American Journal of Physical Anthropology 121:230-240.

Wenke R.J. (1991), *The evolution of early Egyptian civilization: Issues and evidence*, Journal of World Prehistory 5:279-329.

White T.D., Folkens P.A. (2005), *The human bone manual*, Burlington: Elsevier Academic Press.

Wilson K.L. (1982), *Cities of the Delta, Part II: Mendes, preliminary report on the 1979 and 1980 seasons*, Malibu: Undena Publications.

Wood-Jones F. (1910), *General pathology including diseases of the teeth* [in:] "The archaeological survey of Nubia report for 1907-1908, vol II: Report on the human remains", G. Elliot-Smith, F. Wood-Jones (eds.), Cairo: National Printing Department, pp. 263-292.

Zink N.A., Hagedorn H.G., Szeimies U., Weyss C. (2000), *Anthropological and palaeopathological analysis of the human remains from three "Tombs of the Nobles" of the Necropolis of Thebes-west, Upper Egypt*, Anthropologischer Anzeiger 58:321-343.