Osteological Analysis

Mulgrave Place

Scarborough

North Yorkshire

Site Code: MP99
NGR: TA 04700 89715

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Summary

Osteological analysis of a single skeleton excavated in September 1999 by the Scarborough Archaeological and Historical Society was undertaken by York Osteoarchaeology Ltd on behalf of Palaeoecology Research Services Ltd in April 2004. The remains were excavated following their exposure through cliff erosion at Mulgrave Place, Scarborough, North Yorkshire (TA 04700 89715). It is probable that the skeleton had been interred In the northern part of the medieval cemetery associated with the chapel of St Mary Magdalene.

Osteological analysis revealed that the skeleton was a slight female, who was aged 46 years or older. She enjoyed good general health, with the exception of minor congenital anomalies. However, she suffered from four severe dental abscesses, which were active at death and may have been fatal.

Acknowledgements

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1.0 INTRODUCTION

In April 2004 York Osteoarchaeology Ltd was commissioned by Palaeoecology Research Services Ltd to carry out the osteological analysis of a complete skeleton excavated in September 1999 by the Scarborough Archaeological and Historical Society. The skeleton had been excavated following its exposure in a cliff face near Mulgrave Place, Scarborough, North Yorkshire (NGR TA 04700 89715).

The skeleton had been interred in an extended supine position, with the hands by the hips. It had been cut to the northwest by a footpath, which had caused the loss of the left shoulder (humerus, parts of the scapula and clavicle). The lower part of the skull was also missing. Three further fragments of human bone were recovered from the topsoil (Context 100). It is possible that skull bones had become displaced by root or rodent action.

1.1 AIMS AND OBJECTIVES

The aim of the skeletal analysis was to determine the age, sex and stature of the skeleton, as well as to record and diagnose any skeletal manifestations of disease and trauma.

1.2 METHODOLOGY

The skeleton and disarticulated remains were analysed in detail, assessing the preservation and completeness, as well as determining the age, sex and stature of the individual (Appendix 1). All pathological lesions were recorded and described.

2.0 OSTEOLOGICAL ANALYSIS

Osteological analysis is concerned with the determination of the identity of a skeleton, by estimating its age, sex and stature. Robusticity and non-metric traits can provide further information on the appearance and familial affinities of the individual studied. This information is essential in order to determine the prevalence of disease types and age-related changes. It is crucial for identifying gender dimorphism in occupation, lifestyle and diet, as well as the role of different age groups in society.

2.1 PRESERVATION

Skeletal preservation depends upon a number of factors, including the age and sex of the individual as well as the size, shape and robusticity of the bone. Burial environment, post-depositional disturbance and treatment following excavation can also have a considerable impact on bone condition. Preservation of human skeletal remains is assessed subjectively, depending upon the severity of bone surface erosion and post-mortem breaks, but disregarding completeness.

Preservation was assessed using a grading system of five categories: very poor, poor, moderate, good and excellent. Excellent preservation implied no bone surface erosion and very few or no breaks, whereas very poor preservation indicated complete or almost complete loss of the bone surface due to erosion and severe fragmentation.

The skeleton was in a good condition (Table 1). It had suffered from little superficial erosion, which was mostly noted on the sternum and has been attributed to root damage. Additionally, the skeleton had suffered from some bone loss in the spongy bones of the spine. The long bones were in excellent condition with the exception of few post-mortem breaks. The skull had been subject to moderate fragmentation, which was probably caused be the weight of the soil above it. Additionally, the loss of some cranial bones may be attributed to root damage or animal burrowing.

Table 1 Summary of osteological and palaeopathological results

Preservation	**Completeness**	**Age**	**Sex**	**Stature**	**Pathology**
Good	92%	46+	Female	148.4cm	Bone excavation, enthesopathies, manubrial-sternal fusion, slight spinal djd

The skeleton was almost complete: 92% of bone elements were represented (see Table 1). One of the cranial fragments recovered from the topsoil was found to match the skull of the full skeleton, implying that these bones had become displaced from the skeleton.

2.2 MINIMUM NUMBER OF INDIVIDUALS

A count of the 'minimum number of individuals' (MNI) recovered from a cemetery is carried out as standard procedure in osteological reports on inhumations in order to establish how many individuals are represented by the articulated and disarticulated human bones (without taking the archaeologically defined graves into account). The MNI is calculated by counting all long bone ends, as well as other larger skeletal elements recovered. The largest number of these is then taken as the MNI. The MNI is likely to be lower than the actual number of skeletons which would have been interred on the site, but represents the minimum number of individuals which can be scientifically proven to be present.

Considering the fact that one of the three disarticulated skull fragments could be fitted with the cranium of the skeleton, and no skeletal elements were duplicated, the MNI was one.

2.3 ASSESSMENT OF AGE

Age was determined using standard ageing techniques, as specified in Scheuer and Black (2000a; 2000b) and Cox (2000). Age estimation relies on the presence of the pelvis and uses different stages of bone development and degeneration in order to calculate the age of an individual. Age is split into a number of categories, from foetus (up to 40 weeks in *utero*), neonate (around the time of birth), infant (newborn to one year), juvenile (1-12 years), adolescent (13-17 years), young adult (ya; 18-25 years), young middle adult (yma; 26-35 years), old middle adult (oma; 36 to 45 years, mature adult (ma; 46+) to adult (an individual whose age could not be determined more accurately as over the age of seventeen).

In this instance, the good preservation permitted analysis of several ageing criteria. The fact that the long bone ends were completely fused, including the late-fusing medial clavicle, suggested that this individual was at least 28 years old (Table 1). The cranial sutures were not completely closed, indicating that this individual was aged between twenty and 30 years. However, cranial sutures have been found to be a relatively inaccurate age

indicator and as a result, more emphasis was placed on the ageing criteria of the hip and ribs. Both of these age indicators suggested an age of 45 to 50 years. It was therefore determined that this individual was a mature adult, aged 46 years or older.

2.4 SEX DETERMINATION

Sex determination was carried out using standard osteological techniques, such as those described by Mays and Cox (2000). Assessment of sex in both males and females relies on the preservation of the skull and the pelvis and can only be carried out once sexual characteristics have developed, during late puberty and early adulthood.

On the basis of the cranial and pelvic characteristics, and measurements confirming the gracile nature of the bones, the skeleton was found to be female.

2.5 STATURE

Stature depends on two main factors, heredity and environment. However, stature can also fluctuate between chronological periods. Stature can only be established in skeletons if at least one complete and fully fused long bone is present. The bone is measured on an osteometric board, and stature is then calculated using a regression formula developed upon individuals of known stature.

It was possible to assess the stature using measurements of the femur and tibia. Together, these bones provide the most accurate stature assessment. The living height of this woman was 148.4cm, with an error margin of ±3.55cm. This is considerably lower than the mean female stature calculated for other medieval cemeteries (158.6cm) (Caffell 1997). However, this height still lies in the lower end of the medieval stature range for females (143.8cm to 171.4cm).

2.6 METRIC ANALYSIS

Craniometric measurements could not be taken on this skeleton because the skull was too fragmentary, so the general skull shape could not be established.

Leg measurements were obtained from the femora and tibiae and used to calculate robusticity indices. The *platymeria* index is a method of calculating the shape and robusticity of the femoral shaft. The femoral shafts were both *platymeric* (broad and flat). The *platycnemia* index (robusticity index) of the tibiae was calculated in order to establish the degree of tibial shaft flatness. The tibial shafts were *eurycnemic* (of average dimensions).

Measurements suggested that the skeleton was very petite.

2.7 NON-METRIC TRAITS

Non-metric traits are additional sutures, facets, bony processes, canals and foramina, which occur in a minority of skeletons and are believed to suggest hereditary affiliation between skeletons (Saunders 1989). The origins of non-metric traits have been extensively discussed in the osteological literature and it is now thought that

while most non-metric traits have genetic origins, some can be produced by factors such as mechanical stress (Kennedy 1989) or environment (Trinkhaus 1978).

A total of thirty cranial and thirty post-cranial (bones of the body and limbs) non-metric traits were selected from the osteological literature (Buikstra and Ubelaker 1994, Finnegan 1978, Berry and Berry 1967) and recorded. Six traits were observed in this skeleton. These included a *parietal foramen* and an *accessory supraorbital foramen*, which are additional small holes in the cranium that may be related to blood vessels, as well as *bridging of the supraorbital notch* (a small indentation above the eye orbit). Cranial traits are more likely to be genetic in origin than those noted on the remaining part of the skeleton, which can often be affected by mechanical stress. These included *third trochanters* (bone protrusions at the upper parts of the femoral shaft), which have been attributed to mechanical stress, in particular to the main bottom muscle, *gluteus maximus* and may therefore be activity-related. Further evidence for mechanical strain was observed in the form of a *peroneal tubercle* (a bony process at calcaneus, or heel bone). An additional trait was noted at the distal end of the tibiae (ankle). Marked depressions at this point are termed *lateral tibial squatting facets*, and are thought to be caused through habitual squatting.

2.8 CONCLUSION

Osteological analysis of the skeleton established that this individual was a mature adult female, who was relatively slight in appearance and comparatively short for medieval women. It is possible that she carried out a habitual activity, which involved squatting.

3.0 PATHOLOGICAL ANALYSIS

Pathological conditions can manifest themselves on the skeleton during life, especially when these are chronic conditions or the result of trauma to the bone. The bone elements to which muscles attach can also provide information on muscle trauma and excessive use of muscles.

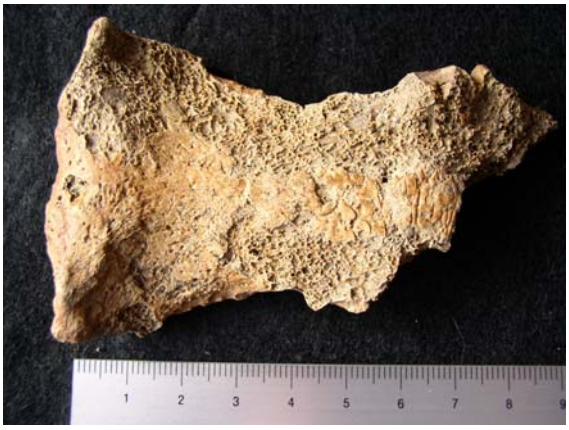

Plate 1 Fused manubrium and sternum

Heredity and environment can predispose an individual to congenital anomalies. Congenital malformations are commonly observed in archaeological populations. Individual anomalies, however, tend to occur in one, rather than in a number of skeletons (Turkel 1989), and can vary in prevalence between populations. Most congenital conditions observed in skeletons are simple anomalies, which do not affect the person exhibiting the defect. One of these was noted in the sternum of this woman (Plate 1), and was characterised by fusion of the sternum and manubrium (breast bones). Fusion of the manubrium and sternum occurs in those cases, where the fibrous lamina fails to develop at the joint (Barnes 1994, 211). This congenital anomaly is not uncommon, and has been found in up to 10% of some populations, although its prevalence is population-specific (*ibid*). Fusion of the two bones can cause some

limitations to optimum respiration and can lead to greater susceptibility in contracting pneumonia, although no evidence for any lung infections could be observed.

Occasionally, it is possible to infer trauma to the soft tissue on the bones, in the form of ligamentous or muscular trauma. This is expressed through the formation of bony processes (enthesopathies) at the site of ligament attachments. Additionally, it is possible to observe cortical defects at the site of muscle insertions, which are the result of constant micro-trauma and are usually activity-related (Hawkey and Merbs 1995, 334).

Muscle trauma in the form of cortical bone excavations was observed in both clavicles. This was mild in the left clavicle, but severe in the right bone, with a 13.3mm by 6.9mm bone excavation, which was up to 4mm deep (Plate 2). The size of this bone excavation was unusual, especially when compared with the otherwise gracile nature of this skeleton. It is probable that this individual carried out a habitual activity, which caused continual micro-trauma at the attachment sites of the costoclavicular ligament. The lesion was much more severe in the right collar bone, and measurements suggesting that the right upper limb was more strongly developed implied that this woman was right-handed.

Plate 2 Bone excavation in right clavicle

This skeleton showed evidence for muscular strain to *gluteus maximus*, the main muscle of the bottom (discussed above). This muscle extends and laterally rotates the hip joint and extends the trunk. Repetitive strain injuries to *gluteus maximus* are commonly observed in most archaeological populations. Further evidence for trauma to the leg muscles could be observed at the insertions of the *tibial collateral* ligament on the left tibia. Additionally, large bilateral *enthesopathies* were noted on both calcanei, at the attachment site of *flexor accessories*. It is possible that habitual squatting, as indicated by squatting facets on the tibiae, also caused strain to muscles of the ankle, therefore producing the muscle trauma on the heel bone.

Joint disease is commonly observed in populations of all periods, especially in those where older individuals are well-represented. Degenerative joint disease (DJD) is caused by a variety of factors, including increasing age, mechanical factors, hereditary predisposition and endocrine stress. Different factors can affect different joints; Jurmain (1980, 1991) observed that DJD in the elbow and knee was more likely to be caused by functional stress, whereas the hip and shoulder were more likely to degenerate as a result of increasing age. DJD is expressed as bony protrusions around the joint margins (osteophytes), or through pitting of the joint surface.

Mild DJD in the form of moderate osteophyte formation was observed at the tubercles of the four left and three right ribs. Ribs connect with the tubercles to the thoracic (central) vertebrae. It is not uncommon to observe DJD at the rib tubercles, especially in more mature individuals, such as this woman. Further mild DJD was noted in the vertebral bodies of two thoracic vertebrae. These changes are also common in elderly people and are exacerbated by the pressure exerted on the spine through bipedalism. It is likely that these degenerative changes were therefore age- rather than activity-related.

The skeletal evidence suggests that this individual enjoyed general good health, with no evidence for commonly observed conditions such as infection, sinusitis, iron deficiency, fractures or weapon trauma. However, physical work took its toll on the skeleton in the form of micro-trauma at some muscle attachments. The advancing age of this woman had let to the onset of joint deterioration, which remained relatively inconsequential.

4.0 DENTAL HEALTH

Analysis of the teeth from archaeological populations provides vital clues about health, diet and oral hygiene, as well as information about environmental and congenital conditions. Only parts of the left upper and lower jaw survived. In total, sixteen teeth were recovered with the skeleton. One of the teeth was broken post-mortem, leaving only the base of the root in the tooth socket. Additionally, the left upper first molar had been lost ante-mortem and the jaw bone had grown over the tooth socket, filling it entirely.

A moderate degree of periodontitis was observed in the upper and lower jaws of this woman. The jaw bone had receded, exposing the roots of the surviving teeth to the formation of dental plaque concretions (calculus). Calculus is commonly observed in archaeological populations whose dental care was not as rigorous as it is in Britain today. Calculus mineralises and forms concretions on the tooth crowns, along the line of the gums. The calculus formation would have irritated the gums and further aggravated the periodontal disease.

Dental wear tends to be more common and severe in archaeological populations than in modern societies, being caused by a much coarser diet based on contemporary corn grinding techniques. Severity of the dental wear was assessed using a chart developed by Smith (1984). Each tooth was scored using a grading system ranging from 1 (no wear) to 8 (severe attrition of the whole tooth crown). Dental wear was moderate throughout the jaw, ranging from grade 2 to 4 in severity.

The dental anterior wear was accompanied by a tooth infraction (chipping) on the first right maxillary incisor on the front of the chewing surface of the tooth. It is possible, that this individual carried out a task which involved the use of the front teeth as tools.

Plate 3 Mandibular abscesses showing additional new bone formation around the bone cavity

Dental abscesses, also termed 'periapical inflammations', are recognised in skeletons when a sinus (fistula, or opening) develops in the bone to release pus from the site of infection at the tooth root through the bone. Dental abscesses develop when the tooth pulp is exposed to bacteria, or allowed to enter the root cavity through cavities (caries) or severe wear or trauma (Dias and Tayles 1997, 548). Occasionally, new bone formation can be observed around the pus-releasing sinus, which is indicative of active infection (Plate 3).

This individual had suffered from four dental abscesses, which were located at the first and second left mandibular molars and at the first and second left maxillary premolars. The infection was localised, causing

sinus formation on the cheek sides of the jaws (Plate 4), which had released the pus from the bone into the mouth. New 'woven' bone formation was observed around the sites of the infection, suggesting that the infection had been active at the time of death.

Plate 4 Maxillary abscesses showing exposure of root of the premolar

It is probable that the infections were extremely painful. Even today, with the availability of antibiotics, dental abscesses can be extremely persistent. In the past, however, they must have played a more significant role, debilitating and causing extreme pain, weakening of the immune system and, if the infection entered the bloodstream, fatal septicaemia

It is probable that the infection had developed as a result of large caries (cavities) at the left maxillary first and second premolars and first and second mandibular molars, which had been so severe that they had caused the complete destruction of the tooth crowns.

Cavities are multifactoral in origin, but develop as a result of aggressive bacterial attack in the presence of sucrose (Hillson 1996, 282) and fermentable carbohydrates (Roberts and Manchester 1995, 47). Cavities become more prevalent once cane sugar was available to the greater majority of people from the seventeenth century onwards (Moore and Corbett 1975).

Dental enamel hypoplasia (DEH) is the manifestation of lines, grooves or pits on the crown surface of the teeth which represent cessation of crown formation. The defects represent periods of severe stress during childhood, including malnutrition or disease, when the body concentrates on survival rather than growth. DEH lesions produce a permanent record of episodes of pathological and nutritional disturbance before the age of seven, as the permanent tooth crowns (except for those of the wisdom teeth) are fully formed by that age. DEH was observed in seven tooth crowns and in many cases several lines could be observed. This suggests that this woman experienced several episodes of physical stress during childhood, which were caused by disease or malnutrition.

Dental analysis showed that this woman suffered from poor dental health, which was probably caused by inadequate oral hygiene, or a sucrose-rich or carbohydrate-rich diet. This had led to the formation of dental plaque concretions on the teeth, periodontal disease, large cavities and severe abscesses, which may have been fatal. Additionally, chipping of one of the upper incisors may have been caused by a habitual activity. Lines on many of the teeth provide evidence for a childhood characterised by periods of suffering from malnutrition or disease.

5.0 MORTUARY PRACTICE

The single female skeleton had been interred in a typical Christian manner, in a supine and extended position, with the head at the western end of the grave. The grave was located in the vicinity of the chapel of St Mary

Magdalene and its associated cemetery, known to have contained charnel (loose bone) as well as single burials (Pearson and Jowett 1999). The chapel was converted into a school in the middle of the sixteenth century and it is probable that the cemetery was abandoned at this point.

It has alternatively been suggested that this woman had been interred in the cemetery in 1645 or 1648, during sieges of Scarborough Castle. However, the lack of evidence for musket injuries together with the Christian manner of the burial suggests that it is more likely to date to the medieval period.

6.0 DISCUSSION AND SUMMARY

A single skeleton was excavated following its exposure as a result of cliff erosion near Mulgrave Place, Scarborough. The skeleton had received a Christian burial and it is presumed that the individual had been interred in the cemetery of the chapel of St Mary Magdalene, which was de-consecrated in the mid sixteenth century.

Osteological analysis found that the skeleton was that of a mature adult female, aged over than 46 years. It is probable that advancing age had contributed to mild joint deterioration in the spine and ribs.

The woman was short in stature and petite. Measurements, together with muscular trauma suggested that she was right-handed. There was little evidence of strong muscle build on the upper arms, which is frequently observed in medieval skeletons. However, the woman suffered from severe muscle trauma to on of the right shoulder ligaments, as well as less severe muscle strain to the bottom muscle and the muscles of the ankles. It is possible that she carried out tasks, which involved habitual squatting.

The presence of four large cavities suggests that she either enjoyed access to sugar or to a carbohydrate-rich diet, or that her oral hygiene was poor, though the limited presence of plaque concretions on the teeth suggests that her diet, rather than poor oral hygiene caused cavity formation.

Her teeth showed evidence for childhood deprivation between the ages of one and seven. She experienced several episodes of malnutrition or disease, which led to the formation of lines of arrested growth in the dental enamel. The lines form, when the body concentrates all its strength on survival, rather than on growth.

A minor congenital defect was observed in the fusion of the breast bones. This could have caused some limitations to optimum breathing and could have led to greater susceptibility in contracting pneumonia, although no evidence for lung infection could be observed. The woman suffered from four dental abscesses, all of which were active at the time of death. The presence of such infectious foci would have caused weakening of the immune system. Although the abscesses had drained pus into her mouth, it is possible that they caused septicaemia and proved to be fatal.

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APPENDIX A: OSTEOLOGICAL AND PALAEOPATHOLOGICAL CATALOGUE

Skeleton Number	**1999.1526**
Preservation	Good
Completeness	92%, complete, with the exception of the left humerus, left scapula, distal left clavicle, , second to fifth cervical vertebrae, base of skull, right mandible and maxilla, a small number of carpals
Age	46+, mature adult
Sex	female
Stature	148.4 ±3.55cm
Non-Metric Traits	Parietal foramen (right), bridging of supraorbital notch (left), \accessory surpraorbital foramen (left), third trochanter (bilateral), lateral tibial squatting facets (bilateral), peroneal tubercle (bilateral)
Pathology	Mild spinal djd (T4, T5) and ribs (right 4th, 5th, 6th, 10th rib; left 4th, 6th, 9th rib), bone excavations for costoclavicular ligament, enthesopathies for flexor accessories and tibial collateral ligament, congenital fusion of manubrium and sternum,
Dental Health	Left mandible and maxilla present; moderate periodontitis; calculus on 317/15 teeth; moderate wear; infraction on the right maxillary first incisors, caries on the left maxillary premolars and left mandibular first and second molar, abscesses at the same sites, DEH on 7/15 teeth

	Right Dentition								Left Dentition							
Present	-	-	-	-	-	P	-	P	P	P	P	P	P	AM	-	-
Calculus	-	-	-	-	-	-	-	Mm	Sm	-	-	-	-	-	-	-
DEH	-	-	-	-	-	L	-	L	L	-	-	-	-	-	-	-
Caries	-	-	-	-	-	-	-	-	-	-	-	L	L	-	-	-
Wear	-	-	-	-	-	2	-	3	4	2	3	-	-	-	-	-
Maxilla	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Mandible	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Present	-	-	-	-	-	-	P	P	P	P	P	P	B	P	P	-
Calculus	-	-	-	-	-	-	Ma	Ma	Mm	Sd	-	Sd	-	-	-	-
DEH	-	-	-	-	-	-	L	-	-	-	L	L	-	-	-	-
Caries	-	-	-	-	-	-	-	-	-	-	-	-	-	L	L	-
Wear	-	-	-	-	-	-	3	3	4	4	3	2	3	-	-	-

KEY:
Present - Tooth presence; am - ante-mortem tooth loss; pm - post-mortem tooth loss; p - tooth present; - - jaw not present
Caries - Calculus; F - flecks of calculus; S - slight calculus; M - moderate calculus; H - heavy calculus; a - all surfaces; b - buccal surface; d - distal surface; m - mesial surface; l - lingual surface; o - occlusal surface
DEH - dental enamel hypoplasia; l - lines; g - grooves; p - pits
Caries - caries; s - small lesions; m - moderate lesions; l - large lesions
Wear - dental wear; numbers from 1-8 - slight to severe wear