Osteological Analysis

Towton Hall & Towton Battlefield

Towton

North Yorkshire

Site Code: TOWMG03 & TOWARO03
NGR: SE 48444 3956 & SE 479 382

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Summary

York Osteoarchaeology Ltd was commissioned by the Towton Battlefield Society to carry out the osteological analysis of disarticulated and articulated human remains recovered from different phases of excavation at Towton, North Yorkshire (SE 48444 3956; SE 479 382).

Human remains were recovered from a previously inaccessible part of a mass grave at Towton Hall, which had been excavated in 1996. Parts of three individual skeletons were retrieved, as well as numerous disarticulated bones. It was possible to match some of the remains with skeletons excavated in 1996.

Two single graves were found in the vicinity of the mass grave. These were formally laid out in a Christian manner, unlike the individuals from the mass grave, who were interred in different orientations and positions. One of the skeletons, which had to remain *in situ*, was a middle aged man suffering from rickets. The other skeleton was a mature male, exhibiting evidence for joint degeneration, muscular trauma, a blade injury to the hand and a blunt force injury to the skull, which was probably fatal.

On the battlefield itself, a sample evaluation of a large pit revealed over three hundred human bone fragments. It is thought that the pit is a mass grave, which was cleared in 1483 following the orders of a grant by Richard III. The skeletons were re-interred in Saxton churchyard. The remaining bones were all small and may have been discarded or missed by the grave diggers. They represented individuals aged between fifteen to mature adulthood and included two cranial weapon injuries.

Where sex could be established, all individuals were male. Osteological and palaeopathological results largely corresponded with those established for the skeletons from the 1996 mass grave. Differences in physical expressions between individuals excavated at Towton Hall and the battlefield suggest that the two burial sites may represent different social groups of combatants.

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1.0 INTRODUCTION

In February 2004, York Osteoarchaeology Ltd was commissioned by the Towton Battlefield Society to carry out the analysis of human remains recovered during excavations carried out as part of the Towton Battlefield Archaeological Survey Project, Towton, North Yorkshire.

The skeletal remains discussed in this report were recovered during three different phases of excavation. The human remains recovered from all excavation phases of the Towton Battlefield Archaeological Survey Project listed in Table 1 were osteologically analysed and are discussed in this report collectively. The results were compared with those gained from the osteological analysis of 38 individuals excavated in 1996, from the north-eastern part of the mass grave.

Phase 1
A single grave was excavated during April 2002 (SE 9325 5425) at Towton Hall and contained the remains of a skeleton (100), which was partly located beneath the foundations of the hall (Table 1). The skeleton was analysed *in situ*. The individual was laid out in a formal position on its back, orientated east to west. The tip of a bodkin arrowhead was discovered in the thigh region of the individual.

Table 1 Summary of excavation areas and skeletal remains recovered

Skeleton No	**Area Code**	**Type**	**Excavation Date**	**Excavation Code**	**Position**	**Orientation**	**Artefacts**	**Intercutting Features**
100	TH03	single skeleton	April 2002	TOWFB02	supine extended	W-E	bodkin arrow	Towton Hall foundations
101	MG03	partial skeleton in mass grave	March 2003	TOWMG03	supine extended	E-W	-	legs cut by foundation trench; may be related to 'nest of skulls', found in 1996, or to unstratified pelvis (1004)
102/105	MG03	partial skeleton in mass grave	March 2003	TOWMG03	Prone	E-W	-	may be related to Towton 36 from 1996 grave, or unstratified arm, 1001, 1003, 1005
103	TH03	single skeleton	March 2003	TOWMG03	supine extended	W-E	-	individual skeleton
104	MG03	partial skeleton in mass grave	March 2003	TOWMG03	supine extended	E-W	-	may belong to Towton 37, from 1996
-	MG03	disarticulated	March 2003	TOWMG03	-	-	-	probably associated with 1996 and recently excavated skeletons
-	MG03	disarticulated	June 1996	TOWMG03	-	-	-	removed by builders
-	BF03	disarticulated	October 2003	TOWARO03	-	-	arrow heads	4m x 1m test pit

Phase 2

In March 2003, further skeletal remains were discovered at Towton Hall during a research excavation. This excavation targeted the south-eastern side of a known mass grave, which had been partially excavated when human remains had been discovered at Towton Hall during construction work in June 1996. Part of a mass grave was revealed, but the skeletons were reburied in a nearby churchyard without any scientific analysis (Fiorato *et al* 1997). The remainder of the grave was scientifically excavated in September 1996, with the exception of a small area in the south-eastern part of the grave, which was covered by a concrete slab. The slab was lifted during the 2003 excavation and two partial skeletons, as well as disarticulated human remains were revealed (see Table 1).

Additionally, a single grave was excavated immediately to the south of the mass grave, which contained a skeleton (103) that was partly cut by the corner of Towton Hall (see Table 1). The skeleton was interred in an extended supine position, with the head at the western end of the grave.

Phase 3

Following the discovery of additional human remains at Towton Hall, the Towton Battlefield was examined for evidence of battle casualties (SE 479 382). Geophysical survey revealed several archaeological features, one of which was evaluated in 2003 and found to be a grave (Table 1).

Additional Bone

Additional to the recently excavated bone assemblages, a single femoral bone fragment was included in this report. This bone had been removed from the Towton mass grave in June 1996, while builders excavated the first half of the mass grave.

For the purpose of this analysis, the mass grave excavated at Towton Hall in 1996 is called MG96, while the additional human remains recovered from the grave during the 2003 excavations are termed MG03. The two single graves discovered at Towton Hall have been given the code TH03 and the grave excavated on the battlefield is termed BF03. Skeleton and context numbers are used to identify different individuals or assemblages.

1.1 AIMS AND OBJECTIVES

The aim of the skeletal analysis was to determine the age, sex and stature of the skeletons, as well as to record and diagnose any skeletal manifestations of disease and trauma. Additionally, osteological analysis attempted to match any disarticulated skeletal elements with those from previously excavated skeletons in the Towton Hall mass grave.

1.2 METHODOLOGY

The skeletons and disarticulated remains were analysed in detail, assessing the preservation and completeness of each skeleton, as well as determining the age, sex and stature of the individuals (Appendix A). 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.

2.1.1 Skeletal Remains Excavated around Towton Hall

Two individual skeletons were excavated at Towton Hall (TH03). Skeleton 100 was assessed *in situ* and was not lifted, as the upper half of this skeleton was located under the foundations of the north-eastern part of the hall (see Table 1). Forty-five percent of the skeleton was exposed, consisting of the legs and pelvis (Table 2). The skeleton was in an excellent condition, exhibiting no surface erosion and no post-mortem breaks.

Table 2 Summary of osteological and palaeopathological results of individual skeletons

Area Code	Skeleton	Preservation	Completeness	Age	Sex	Stature	Pathology
TH03	100	excellent	45%	35+	male	159.0	enthesopathies, left tibial periostitis, coxa vara
TH03	103	good	65%	46+	male	179.0cm	Sharp force trauma to right hand, blunt force trauma to cranium, DJD in spine and hips, enthesopathies
MG03	101	good	10%	25-29	male?	-	none
MG03	102/105	good	10%	22=25	male	-	bone excavation
MG03	104	excellent	7%	17+	male?	-	none

The single grave of Skeleton 103 was discovered immediately to the south of the mass grave (MG03) and

northeast of Skeleton 100. This individual had been partially cut by the foundation trench for Towton Hall, causing the loss of the majority of the skull and prohibiting access to the shoulders, upper arms, most of the ribs and vertebrae. Thus only 65% of the skeleton was accessible for removal and analysis (see Table 2). Similar to the other skeletal remains excavated, the bones exhibited no surface erosion. Several post-mortem breaks were observed, probably as a result of construction work.

Skeleton 101 was excavated in the south-eastern part of the mass grave (MG03); it had been partially lifted in 1996 (MG96). This individual was 10% complete with the lower spine, left pelvis, left proximal femur, inferior part of the sternum and a number of rib fragments. The skeleton was in a good condition, exhibiting no surface erosion and only moderate post-mortem breaks (see Table 2).

Skeleton 102/105 comprised two separately recorded assemblages of bone found in MG03, which were found to correspond upon analysis. The right scapula, proximal femur, pelvis, first metacarpal and small fragments of the right humerus and ulna survived (10% complete). Similar to Skeleton 101, this skeleton exhibited no surface erosion, but had suffered from post-mortem breaks.

Skeleton 104 was also recovered from MG03 and comprised a left arm and hand (7% complete). It was in an excellent condition, with a few post-mortem breaks (see Table 2).

A total of 140 disarticulated human remains were recovered from the 2003 excavation of MG03, including both complete bones and bone fragments (Table 3; Table 1, Appendix A). Almost half of these (46.5%) were small fragments and therefore unidentifiable. Additionally, a substantial number of rib fragments (11%), foot phalanges (7%) and pelvis fragments (6%) were found.

An attempt was made to match the disarticulated bones with those from individual skeletons (TH03), as well as to those skeletons from MG96. It was possible to determine that Skeleton 101 matched with an unstratified pelvis from context 1004 (see Table 1). It is also probable that Skeleton 102/105 is related to disarticulated bones from context 1001, 1002 and 1003. Additionally, the skeleton may be related to Towton 36 from MG96. Skeleton 104 may also relate to an incomplete skeleton (Towton 37) from MG96.

Table 3 Summary of disarticulated bones

Bone Element	**Bone from Towton Hall (MG03)**		**Bone from Towton Battlefield Test Pit (BF03)**	
	No	**%**	**No**	**%**
Cranium	7	5	38	9.5
Teeth	0	0	22	5.5
Clavicle	0	0	1	0.1
Scapula	0	0	3	1
Humerus	0	0	0	0
Radius	1	0.5	1	0.1

Ulna	2	1.5	2	0.5
Carpal	1	0.5	22	5.5
Metacarpal	0	0	16	4
Hand Phalanx	2	1.5	33	8
Sternum	0	0	1	0.1
Ribs	15	11	60	15
Vertebrae	7	5	24	6
Sacrum	2	1.5	2	0.5
Pelvis	9	6	7	2
Femur	0	0	0	0
Patella	0	0	4	1
Tibia	7	0	1	0.1
Fibula	4	3	0	0
Tarsal	3	2	31	8
Metatarsal	5	4	31	8
Foot Phalanx	10	7	39	10
Undetermined	65	46.5	59	15
Total	140	100	397	100

An unstratified single femoral bone fragment removed from the Towton mass grave in 1996 (MG96), while builders excavated the first half of the mass grave, was also incorporated in the analysis (not included in the bone count in Table 3). The proximal third of this left femur was in excellent condition.

Similar to the skeletons from the MG96, many of the bones from the skeletal remains excavated in 2003 around Towton Hall exhibited small post-mortem indentations. These marks were caused by compression of small pebbles and gravel into the bone matrix.

2.1.2 Skeletal Remains Recovered from the Battlefield

Prior to the excavation of a test pit in the centre of the Towton battlefield (BF03), human remains were found on the plough soil surface. These included two teeth, an ulna and a clavicle shaft fragment as well as one unidentifiable bone fragment (not included in the bone count in Table 3). The presence of the remains on the soil surface meant that they were subject to weathering and plough damage. As a result, their preservation was moderate to poor.

The excavation of the test trench at BF03 produced 397 complete bones and bone fragments (Table 3; Table 2,

Appendix A). The majority of the skeletal remains were disarticulated, although a small number remained articulated and were recorded as such (Plate 1). Fifteen percent of the bones were unidentifiable, while a further 15% was made up of rib fragments. Additionally, foot phalanges (10%), skull fragments (9.5%), hand phalanges (8%), tarsals (8%) and metatarsals (8%) were well-represented. Even tiny bones were frequently observed; these included the carpals of the wrist and sesamoid bones, which are normally less than 10mm in size. Unusually, bones which tend to be most common in other cemetery excavations, such as the large joints or robust parts of the skeleton were absent (Willey *et al* 1997; Waldron 1987).

Plate 1 BF03, articulated left foot from SF32

The bones from BF03 were by and large well-preserved, with little surface erosion. However, a number of old post-mortem breaks and cuts were observed. Discolouration of fracture lines and cut marks were probably caused by sharp instruments on the bone in antiquity. These breaks were unlike recent post-mortem breaks, with a discoloured surface, and were also different from peri-mortem injuries (occurring 'at death'), which are characterised by a different bone response when the bone is still a living matrix.

The lack of larger bones in this assemblage, together with the occurrence of old post-mortem breaks and cut marks supports the theory that this feature had been a mass grave, which was cleared some years after the Battle of Towton in 1461 (Tim Sutherland *pers. comm.*). Richard III dictated a grant in 1483, 23 years after the battle took place. The grant ordered that the dead still remaining on the battlefield in 1483 should be removed and receive Christian burial in Saxton churchyard. It is likely that the grave had been cleared with sharp tools, such as spades, producing cut marks on the still green bone. Three feet, one hand and one lower arm were the only articulated bones. This suggests that the bones were not completely skeletonised when the bodies were removed, but had remained articulated due to partial muscle, cartilage and fatty tissue survival. The remaining bones were perhaps not considered large enough to warrant their removal to another grave site, or were missed entirely.

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 that can be scientifically proven to be present.

The MNI for the skeletons from the two single burials (Skeleton 100 and Skeleton 103; TH03) was two individuals, the same as the archaeologically represented number of individuals.

The loose and articulated bones from the MG03 were counted together. The MNI for the bones recovered from the 2003 mass grave excavation was two, based on the bone count. Distal ulnae and sacra were the most

frequently represented bones.

A full count of every single bone and bone fragment was carried out from BF03. There were no major joints; the largest number of other bones represented was nine left fourth metatarsals. This suggested an MNI of nine individuals. It is probable that a much larger number of individuals were interred in this feature. However, only full excavation of the site would provide an MNI to accurately reflect the number of individuals interred.

2.3 ASSESSMENT OF AGE

Age was determined using standard ageing techniques, as specified in Scheuer and Black (2000a; 2000b) and Cox (2000a). 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; 36-45 years, mature adult (ma; 46+) to adult (an individual whose age could not be determined more accurately as over the age of seventeen). The poor representation of those skeletal elements required for age assessment meant that it was only possible to determine age in a small number of remains.

It was not possible to lift and clean any of the bones of Skeleton 100 (TH03) and age estimation therefore remained vague. According to the pubic symphysis, this individual was over 35 years of age, suggesting that this was an old middle or mature adult (see Table 2).

Age estimation of Skeleton 101 (MG03) was based solely on the auricular surface, which suggested that this individual was a young middle adult, probably aged between 25 and 29 years. Skeletal fusion together with ageing criteria of the hip suggested that Skeleton 102/105 (MG03) was a young adult, aged between 22 and 25 years. None of the common ageing characteristics were preserved in Skeleton 104 (MG03). As a result, age assessment relied on long bone fusion, which suggested an age of at least seventeen years. Few ageing criteria survived in the disarticulated bone assemblages. Age could only be assessed in one case from MG03 (Context unstratified) using the pubic symphysis, which suggested that it belonged to a young adult.

Based on the hip joints and on sternal rib end ossification, Skeleton 103 (TH03) was a mature adult, who was probably older than 50 years.

It was possible to determine age in four bone fragments from the BF03, including one young to young middle adult, whose age assessment was based on dental wear (SF 14). The tooth development of a third molar (SF 36) suggested that this belonged to a fifteen to sixteen year old adolescent, the youngest individual so far identified from all excavations at Towton. Additionally, age could be estimated in an old middle adult, based on the pubic symphysis (SF 42) and a young adult, based on dental wear (SF 46).

The wide age distribution demonstrates that individuals of all ages participated in the Battle of Towton. The results from the recent excavations were very similar to those from the 1996 excavation: the youngest individual being between fifteen and sixteen years, while the oldest individual was aged over 46 years (Boylston *et al* 2000, 51), with a mean of 30 years.

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.

Based on cranial and pelvic characteristics, and measurements confirming the robust nature of the bones, all individual skeletons (Skeletons 100, 101, 102/105 and 103) were male. However, while Skeleton 103 was clearly male, with very strongly developed bones, Skeletons 101 and 102/105 also exhibited some female skeletal characteristics. Skeleton 101 had an unusually wide sciatic notch (hip angle) for a male, although the acetabulum (hip joint) was male in appearance and measurements of the femoral head suggested that this was a male. Interestingly, male skeleton 102/105 was male in appearance, but exhibited a slight preauricular sulcus (groove at the hip joint), which is usually seen in women and has been associated with childbirth. However, recent studies have found that childbirth is not the only cause for such marks, and in fact, they are more closely related to biomechanics, and in particular, pelvic flexibility (Cox 2000b).

It was only possible to estimate sex in one of the disarticulated skeletal elements. This was a pubic symphysis (hip bone) from the MG03 (SF 36), which had male characteristics.

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.

In this instance, it was only possible to estimate the stature of the two individually interred skeletons (TH03). Their stature differed considerably: Skeleton 100 was 159cm (5ft 2.5in) tall (±2.99cm), while Skeleton 103 was 179cm (5ft 10.5in) tall (±3.27cm). The stature of both men fitted within the range previously established for the individuals recovered from MG96, whose stature ranged from 158.5cm to 183.5cm, with a mean of 171.6cm (Boylston *et al* 2000, 54). This was slightly taller than the mean stature (170.5cm) calculated for a number of medieval cemeteries by Caffell (1997).

Upper limb bones do not provide very accurate measurements for stature compared with lower limb bones. Measurement of a complete disarticulated ulna from BF03, suggested that this individual was 162.9cm (5ft 3.5in) tall (±4.32).

2.6 METRIC ANALYSIS

Craniometric measurements could not be taken, because the skulls had either not survived or were extremely fragmented. As a result, general skull shapes could not be established.

Leg measurements were obtained from the femora and tibiae of Skeletons 100 and 103 (TH03), and these were 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 *platymeric* (broad and flat) in both individuals. The *platycnemia* index (robusticity index) of the tibiae was calculated in order to establish the degree of tibial shaft flatness. The tibial shafts of Skeleton 100 and 103 were *eurycnemic* (of average dimensions).

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 non-metric traits were selected from the osteological literature (Buikstra and Ubelaker 1994, Finnegan 1978, Berry and Berry 1967) and recorded for each skeleton. The disarticulated bones were also scanned for non-metric traits.

No bones that tend to exhibit the traits were represented in Skeleton 104.

Only six different traits were observed in the skeletal assemblages recovered from around Towton Hall, which was probably the result of poor representation of many of the bones, particularly the skull. Skeletons 100, 103 (TH03) and 101 (MG03) were found to have *exostoses in trochanteric fossa* (bone projections at the femoral neck), suggesting that this may have been a population-specific trait. However, this trait is often associated with mechanical stress on the *obturator externus* muscle, which laterally rotates the thigh and may therefore by activity-related (Stone and Stone 1990, 159).

Hypotrochanteric fossae (depressions at the upper parts of the femoral shaft) were observed in Skeleton 101 (MG03) and 103 (TH03). This trait has also been attributed to mechanical stress, in particular to the main bottom muscle, *gluteus maximus* and may therefore be activity-related. Further evidence for strain to this muscle may have been observed in the form of a third trochanter (a bony process at the same location), which was noted in the Skeletons 101, 102/105 (MG03) and 103 (TH03).

Poirier's facets (bulging of the femoral joint surface) were noted in Skeleton 103 (TH03), as well as additional articular facets (joint surface) on the talus and calcaneus (ankle bones). A less common trait was a double anterior condylar canal at the base of the skull (additional hole for blood vessel), also present in Skeleton 103.

The skeletal assemblage from the (BF03) did not exhibit any non-metric traits.

2.8 CONCLUSION

Osteological analysis of the skeletal remains from Towton established that the assemblages from the battlefield and Towton Hall represented men of all ages. The men were of varying heights and build and exhibited evidence for mechanical stress in the form of bone projections or strongly developed muscle attachments at the thigh bone.

3.0 PATHOLOGICAL ANALYSIS

Pathological conditions can manifest themselves on the skeleton during life, especially when the condition is chronic 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.

3.1 CONGENITAL ANOMALIES

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 an unstratified sacrum from MG03. This was characterised by incomplete fusion of the first sacral vertebra to the second sacral vertebra. This anomaly is termed 'lumbarization', because the sacral vertebra has some characteristics of the fifth lumbar vertebra. This defect would have had little effect on the individual.

A similar defect was observed in a skeleton from MG96 (Towton 30), whose 5th lumbar vertebra resembled the first sacral vertebra, a condition termed 'sacralisation' (Coughlan and Holst 2000, 61-62).

3.2 INFECTION

Evidence for infection was observed in Skeleton 100 and Skeleton 103 (TH03). The infection was characterised by superficial inflammatory lesions on the medial surfaces of the tibiae in both individuals, and on the fibulae (lower legs) of Skeleton 103. Tibiae are the most likely bones to show evidence for inflammation. The type of skeletal lesion (lamellar bone) on Skeleton 100's shin bones suggested that the inflammation was receding. The lesions on the legs of Skeleton 103, on the other hand, were less regular and included lamellar bone, as well as very irregular new bone formation, which was most severe on the right fibula (Plate 2). The nature of the lesions suggested that the infection had been more virulent in this individual, but had also receded prior to this person's death.

Plate 2 Skeleton 103, inflammation on right fibula – note the irregular bone surface appearance

Inflammatory lesions on human bones can be indicative of infectious diseases, such as leprosy and syphilis, and of non-specific localised infection, such as varicose veins, leg ulcers or trauma to the shins. However, the lesions only form in the bone if the inflammation is chronic and long-standing (Roberts and Manchester 1995, 125). Evidence for infection was common before the introduction of antibiotics and is therefore frequently observed in populations derived from archaeological contexts. The prevalence rate of non-specific infection on the tibiae was low in the individuals from MG96 (Coughlan and Holst 2000, 64), with 5.9% of left tibiae and 8% of right tibiae affected. It is probable that cases of infection would have been noted in the test pit on the battlefield if any tibiae had been present.

3.3 METABOLIC CONDITIONS

Skeleton 100 from TH03 probably suffered from rickets. The femora bowed both laterally and anteriorly, while the tibiae bowed most severely at the lower part of the shafts. It was not possible to assess bowing of the fibulae, which remained *in situ*. The relatively short stature of this individual supports the diagnosis. Additionally, the individual showed slight shortening of the femoral necks, with a decreased angle between the femoral shaft and neck, which may be the result of softening of the bones (M. Lewis *pers. comm.*).

Rickets is caused by prolonged vitamin D deficiency during childhood, and is characterised by bowing of the weight-bearing bones. The majority of vitamin D is obtained directly from ultraviolet light. As a result, rickets was little known before the demographic shift into cities during the post-medieval period (Aufderheide and Rodríguez-Martín 1998, 305).

Rickets tends to occur most commonly during rapid growth spurts between the ages of six months and four years, and in puberty, particularly prevalent in winter (Ortner and Putschar 1985, 274; Stuart-Macadam 1989, 202). Although most archaeological cases of rickets date to the industrial period, a number of earlier examples, including prehistoric cases, have been noted (Aufderheide and Rodríguez-Martín 1998, 309).

Although rickets was not prevalent in the medieval period, there are some contemporary examples from the region: at Fishergate House in York, 2.5% of individuals displayed skeletal manifestations indicative of rickets (Holst, forthcoming). At Wharram Percy (North Yorkshire) eight juveniles from the site were found to have rickets (Ortner and Mays 1989), none of which showed evidence for healing. It is possible that those individuals with rickets had been sickly children who were kept indoors, contributing to the development of the condition.

3.4 DEGENERATIVE JOINT DISEASE

The term joint disease encompasses a large number of conditions with different causes, which all affect the articular joints of the skeleton. Factors influencing joint disease include physical activity, occupation, workload and advancing age, which manifest as degenerative joint disease and osteoarthritis. Alternatively, joint changes may have inflammatory causes in the *spondyloarthropathies*, such as sceptic or rheumatoid arthritis. Different joint diseases affect the articular joints in a different way, and it is the type of lesion, together with the distribution of skeletal manifestations, which determines the diagnosis.

The most common type of joint disease observed in the skeletons was degenerative joint disease (DJD). DJD is characterised by both bone formation (osteophytes) and bone resorption (porosity) at and around the articular surfaces of the joints, which can cause great discomfort and disability (Rogers 2001).

Skeleton 101 from TH03 suffered from slight porosity on the body of the twelfth thoracic vertebra (Table 4). Similarly, Skeleton 103 from TH03 suffered from mild porosity and osteophyte formation on the vertebral bodies of the first to fifth lumbar vertebra and the first sacral vertebra.

The intervertebral discs are the ‘shock absorbers’ of the spine, but these can degenerate as a result of gradual desiccation, which then causes transmission of the stress from the vertebral discs to the articular facets and

ligaments (Hirsh 1983, 123). Spinal osteophytes (outgrowths of bone) form in response to the constant stress that is placed on the spine as a result of human posture (Roberts and Manchester 1995, 106) to compensate. Increasing stress or activity can therefore lead to increased size and prevalence of osteophytes (*ibid*).

Table 4 Summary of joint disease

Area Code	Skeleton/Finds Number	Bone	Expression
MG03	101	12th thoracic vertebra	mild porosity
MG03	103	3 hand phalanges	mild osteophytes
MG03	103	Both first metatarsals	moderate osteophytes
MG03	103	1st to fifth lumbar vertebra, first sacral vertebra	mild porosity, osteophytes
BF03	23	First thoracic vertebra	mild porosity, osteophytes
BF03	32	1st proximal foot phalanx	mild osteophytes
BF03	44	Left rib tubercle	moderate osteophytes
BF03	70	lower thoracic vertebra , inferior body	large osteophyte
BF03	Lower bones	Central cervical vertebra	large porosity and osteophytes
BF03	Unstrat	Distal hand phalanx	large osteophyte

Skeleton 103 (TH03) also suffered from mild osteophyte formation around the joint margins of three hand phalanges (finger bones) and around the margins of the first metatarsals (big toes) (see Table 3). Asymmetrical, or severe DJD is often the result of functional stress, with lesions on the joint surface in the form of porosity. Age-related DJD on the other hand, is more likely to be symmetrical, with osteophyte formation at the joint margins. Considering the older age of this individual and the symmetry of the lesions, it is probable that advancing age was a major factor in the condition.

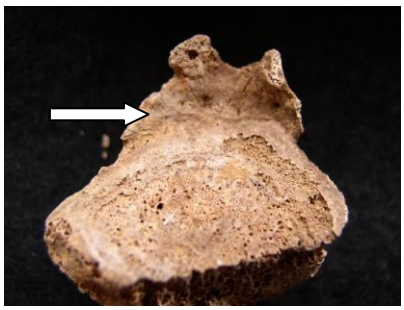

Plate 3 Thoracic vertebra from BF03 with large osteophyte (arrow)

Evidence for DJD was also observed in the disarticulated remains from BF03 (Table 4). Six bones showed evidence for DJD, the majority of which was mild, with slight marginal osteophyte formation. However, a particularly large osteophyte observed on a lower thoracic vertebra (SF 70) was indicative of severe DJD (Plate 3). In none of the joints was the disease so severe to be classed as osteoarthritis.

The widespread evidence for DJD in the skeletons from the recent excavations was not unexpected, considering that 50% of the individuals recovered from MG96 showed signs of degenerative changes (Coughlan and Holst 2000, 66). Similar to the recently excavated skeletal remains, the majority of lesions were found in the spines (80%). The fact that DJD had not increased with advancing age in the assemblage suggested that the condition was due to functional stress, rather than age.

A different condition which affects the spine are Schmorl's nodes. Schmorl's nodes are indentations in the upper and lower surfaces of the vertebral bodies, most commonly in the lower thoracic vertebrae (Hilton *et al* 1976). Schmorl's nodes can result from damage to the intervertebral discs, which then impinge onto the vertebral body surface (Rogers 2001), and may cause necrosis (death) of the surrounding tissue. Rupture of the

discs only occurs if sufficient axial compressive forces are causing pressure on the central part of the discs. Physical stress on the spine from continual heavy loading, such as frequent lifting or carrying of heavy loads can cause disc rupture.

Schmorl's nodes were observed in the twelfth thoracic vertebra of Skeleton 101 from MG03 (Plate 4) and in a lumbar vertebra from the MG03 (Context 1001). No Schmorl's nodes were observed in any of the eight thoracic or three lumbar vertebral bodies recovered from BF03. The lack of Schmorl's nodes in this assemblage was unexpected considering that 80% of individuals with spines (40% of vertebrae) from MG96 exhibited the lesions (Coughlan and Holst 2000, 68).

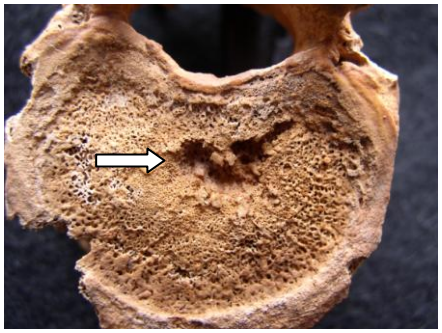

Plate 4 Schmorl's node on lumbar vertebra of Skeleton 101, MG03

The prevalence of Schmorl's nodes in the skeletons from MG96 was higher than that observed in most other medieval cemeteries. The high prevalence of Schmorl's nodes in the Towton soldiers was attributed to the physical stresses the soldiers must have been exposed to, either through carrying weights on their marches, or during civilian life, in their daily activities.

3.5 TRAUMA

3.5.1 Activity-Related Trauma

Bone is a dynamic material which can change its morphology, size and robustness in response to prolonged activity (Knüsel 2000, 383). As a result, greater activity and mechanical stress causes the bone to become shapelier, with ridges and depressions caused by muscle action. Constant stress can cause *enthesopathies* (bony processes) or cortical bone defects at the site of muscle or ligament attachments when they lose the capacity to properly absorb the stress imposed (Hawkey and Merbs 1995, 329). *Enthesopathies* are frequently caused by constant microtrauma, but may also be the result of inflammatory disease, endocrine or degenerative diseases as well as severe sudden trauma (Resnick and Niwayama 1983).

Plate 5 Left femur of Skeleton 103, TH03, *enthesopathies* for *gluteus maximus*

Considerable muscle trauma was observed in Skeleton 103 (TH03), which may have caused discomfort. The *enthesopathies* observed in Skeleton 103 affected muscles aiding flexion and extension of the forearm, plantar flexion of the foot, extension and flexion of the leg at the knee joint and particularly all movements of the hip (Pate 5). All of the lower limb *enthesopathies* affected those muscles which are responsible for movements required for walking and it is possible that long distance marching may have caused the necessary stress to produce muscular trauma.

Table 5 Summary of muscular trauma of individual skeletons based on Stone and Stone 1990, 102

Skeleton No	**Expression**	**Site**	**Muscle**	**Action**
103	*enthesopathy*	pelvis	external oblique	adduct thigh at hip joint, aids in lateral rotation and extension
103	*enthesopathy*	pelvis	*interosseous sacro-iliac ligament*	adduct thigh at hip joint, aids in lateral rotation and extension
103	*enthesopathy*	pelvis	*adductor magnus*	adduct thigh at hip joint, aids in lateral rotation and extension
103	*enthesopathy*	pelvis	*semitendinosus*	flexes and medially rotates knee, extends thigh at hip joint
103	*enthesopathy*	pelvis	long head of *biceps*	flexes leg at knee, extends thigh at hip joint
103	bone defect & *enthesopathies*	femora	*gluteus maximus* (Plate 5)	extends, laterally rotates hip joint and extends trunk
103	*enthesopathy*	femora	*obturator externus*	laterally rotates the thigh
100, 103	*enthesopathy*		*gluteus minimus*	adducts the femur at the hip joint and rotates the thigh medially
103	*enthesopathy*	femora	*psoas major* and *iliacus*	both muscles flex the thigh at the hip *enthesopathy* joint
103	*enthesopathy*	femora	*adductor longus*	adducts thigh at the hip joint and aids lateral rotation
103	*enthesopathy*	left tibia	*vastus medials*	extends the leg at the knee
103	*enthesopathy*	tibiae	*soleus*	cause the tip of the foot to move downwards
100, 103	*enthesopathy*	calcanei	*Achilles tendon*	cause the tip of the foot to move downwards
103	*enthesopathy*	radii	*biceps brachii*	supinates the hand, flexes the forearm and flexes the arm at the shoulder
103	*enthesopathy*	ulane	*brachialis*	flexes the forearm
103	*enthesopathy*	left ulna	*triceps*	aids in adduction
100	*enthesopathy*	patellae	*rectus femoris*	aids in extending the leg at the knee joint and flexing the thigh at the hip

Muscular trauma was also observed in the disarticulated remains from BF03. This included slight *enthesopathies* on a right patella (SF 27) and a left patella (SF 67) at the insertion of *rectus femoris*. It is possible that both patellae belonged to the same individual, as they were equally large and had corresponding muscular trauma.

The remaining *enthesopathies* noted in the disarticulated remains from BF03 corresponded to those described above for Skeleton 103. A left ulna (SF 45) had a moderate bone defect, the attachment site for *brachialis*. As discussed above, this muscle is responsible for flexion of the forearm. The same ulna also showed evidence for an *enthesopathy* at the *triceps* attachment. A right calcaneus from (SF 28) was found to have an *enthesopathy* at the Achilles tendon attachment.

The muscular trauma observed in this population suggests that individuals from this group led a physically active life, involving walking, climbing and activities placing strain on the forearms.

3.5.2 Circulatory Disorders

The left head of the disarticulated femur MG96 displayed some shortening of the femoral neck, also termed *coxa vara* (Plate 6). This condition can have a number of different causes, including Perthes' disease (inflammation of the hip joint, probably due to interference of blood supply), slipped femoral epiphysis (hip joint) or *avascular necrosis* (death of bone due to limited blood supply). Notably, shortened femoral necks were also observed in Skeleton 100 and in one of the skeletons from MG96 (Towton 47) (Coughlan and Holst 2000, 74).

Plate 6 Femur from MG96, showing *coxa vara* and gravel damage

Towton 47 suffered from *avascular necrosis*, with shortening of the femoral necks, flattening of the femoral heads (hip joints) and large necrotic lesions on the femoral heads. The presence of a very small similar lesion on the femur from MG96 may suggest a similar cause. However, the lack of evidence for joint disease and other skeletal manifestations helpful for a diagnosis means that this individual suffered from shortening of the femoral neck with an undiagnosed cause.

The bilateral *coxa vara* observed in the femora of Skeleton 100 was probably due to rickets, discussed above.

3.5.3 Fractures

The type and distribution of broken bones sustained depends on the environment the population lived in and is therefore often population-specific. Factors influencing fracture frequency include rough terrain, hard physical labour or dangerous work and interpersonal violence, which is well-illustrated by the high incidence of fractures in modern boxers (Hershkovitz *et* al 1996).

Plate 7 Left ulna from BF03 fracture

A complete ulna from BF03 (SF 45) showed slight antero-lateral angulation of the lower eighth of the bone (Plate 7). The associated radius was normal in appearance. It is probable that the ulna had been fractured, but was well-healed, indicated by lack of thickening. The lack of clear evidence on the bone surface for a fracture line suggests that the bone may have been broken during childhood, producing a so-called 'greenstick' fracture (this means that the bone is not broken into separate parts, similar to when a green stick is snapped). The bone does not spring back into its original position, but often heals with a slight kink (Dandy and Edwards 1995, 95; 212). In children, these types of fractures can be caused through falls on an outstretched arm. Alternatively, the fracture may have occurred as a result of a direct blow, and could therefore be an adult parry (defence) injury (*ibid*, 204).

There is little evidence for treatment of fractures, probably because most splints and other types of support would have been made from biodegradable materials. However, a splint from the Gilbertine Priory of St Andrew's, Fishergate has been found (Stroud 1993). Considering the presence of angulation of the bone at the ulna fracture site, it is probable that this break was not treated using a splint.

Twelve of the 37 individuals from MG96 had suffered from a total of fourteen fractures (Coughlan and Holst 2000, 71). They included three greenstick fractures, all of which affected the lower limb and were well-healed. Ulna fractures tend to occur relatively rarely in medieval skeletons. A comparative study of eight medieval populations from very different backgrounds suggested an incidence of between none to 8.2% of ulnae fractured, with a mean of 1.8% (Holst forthcoming).

3.5.4 Weapon-Related Trauma

Skeletal injuries present clear documentation of conflicts in the past and are thus the only direct evidence for violent interaction. This is important, because historical accounts of conflicts can be used as propaganda by the victor, frequently omitting the extent of cruelty and violence in official documents.

Evidence for weapon-related trauma was observed in Skeleton 103 from TH03, as well as two disarticulated bone fragments from BF03. Evidence for cranial injuries was the most commonly observed weapon-related trauma in the individuals from MG96. Correspondingly, the only evidence for weapon injuries in bones from BF03 was noted in two skull fragments.

A left zygomatic process (a bridge of bone above the ear) from the battlefield test pit was found to show an unhealed peri-mortem (at death) cut or fracture on its posterior part. The site of injury was smooth and oblique, running from a supero-posterior angle inferiorly and anteriorly. The injury severed the zygomatic process and it is possible that the weapon would have penetrated further into the left temporal. However, without the remainder of the left side of this skull, it is impossible to determine any further damage from this blow.

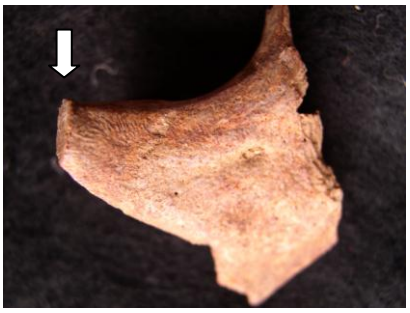

Plate 8 Right zygomatic with weapon injury

A further unhealed injury was observed on the frontal process of the right zygomatic (right eye) from an unstratified assemblage from BF03. This injury was smooth, transverse and severed the zygomatic completely (Plate 8). The weapon entered the right eye and probably came from the right or left side of the victim. The perpetrator may have been tall, or the victim short, considering the blow was at eye height and was horizontal. Alternatively, the attacker may have been raised, such as on a horse or higher ground, or the victim may have been kneeling or lying down. The force of the blow caused shearing of the posterior and inferior parts of the zygomatic. Furthermore, a small, 3mm long nick was observed in the inferior part of the orbit on the same zygomatic. This injury was probably caused by a bladed weapon and may represent a further injury, or may be related to the blow described above. The lack of further associated bones or bone fragments means that it is difficult to form an interpretation on the type of weapon used, but it may have been a morning star.

Little survives of the skull of Skeleton 103 from TH03, as this had been cut by the foundations of Towton Hall. However, parts of the occipital and temporal bones (parts of the skull) were retrieved. The body of the occipital (back of the skull) showed considerable evidence for peri-mortem fracture lines and for so-called ‘twig peel’, which is characterised by separation of the inner or outer skull table from the spongy bone in between. This occurs when high velocity or strong force objects hit the skull table, producing the ‘twig peel’ effect on the opposing surface of the skull.

Plate 9 Inner view of occipital of Skeleton 103, with skull fragments, which had shattered off following blunt force injury

Plate 10 Right third metacarpal of Skeleton 103 with blade injury

The actual size of the fragment had been determined by a blunt force injury, which caused the occipital to fracture off from the remainder of the skull. The blow struck the right superior part of the occipital, suggested by the presence of three bone fragments, which were shattered off from the inner skull table, causing the internal 'twig peel' effect (Plate 9).

The attacker probably struck his victim with a blunt weapon from behind, almost certainly causing instant death through the velocity of the force, and causing the skull to shatter.

The same individual also suffered from a blade injury to the right hand, affecting the third and fourth metacarpal (palm bone). The bladed weapon had penetrated the bone in the centre of both metacarpals on the back of the palm, and had moved towards the wrist, therefore penetrating the bone to a depth of 1mm and a length of 4mm. On the third metacarpal, the blade caused a little nick and then continued on the same plain for 16mm without penetrating the cortex of the bone (Plate 10), but this was penetrated in the fourth metacarpal. The withdrawal of the blade then caused fracturing of the joint. It is probable that the back of the hand was caught by a blow with a knife or sword, probably while the hand was clenched.

The presence of these tiny bone fragments *in situ* means that the skeleton must have been interred prior to soft tissue deterioration.

Evidence for trauma in this single skeleton, which was similar to that observed in the victims of the Battle of Towton from MG96, offers support to the theory that this individual had also been a victim of the battle. In 'normal' medieval cemeteries, occasional victims of trauma can be found, but not in the quantity observed at Towton. Weapon-related trauma victims from other medieval cemeteries include four individuals (1.6% of the population) from Hull Magistrate's Court (Holst *et al*, forthcoming) and 29 individuals (7.2%) from St Andrew's Phase 6 in York (Stroud 1993). Injuries caused by weapons were also found in nine individuals (3.7%) from Fishergate House in York (Holst, forthcoming).

The high prevalence of skull injuries in the comparatively small cranial assemblage from both the recent Towton Hall and battlefield excavations is similar to weapon trauma evidence from MG96, where a total of 27 of 28 crania exhibited at least one injury, with a total of 113 cranial injuries identified. In comparison, only 43 injuries were noted on the bones of the body and limbs (Novak 2000).

The presence of weapon trauma in Skeleton 103 and a bodkin arrowhead in the grave of Skeleton 100 suggests that they were both associated with the Battle of Towton.

3.6 CONCLUSION

The skeletal evidence suggests that pathological manifestations of disease and trauma observed in the recently recorded skeletal remains resembled those observed in MG96. The individuals were healthy; however, hard physical work took its toll on the skeletons in the form of micro-trauma at muscle attachments and joint degeneration. The presence of weapon trauma in disarticulated bones from the battlefield, as well as one of the single burials implies that these individuals also died at the Battle of Towton.

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. A total of 22 teeth were recovered from the BF03, six of which were still retained in a right maxilla (Table 5). Additionally, two teeth were recovered from the plough soil on the battlefield prior to the excavation BF03, which were included in Table 5. No teeth were recovered from TH03 or MG03.

The lack of skulls meant that none of the individual skeletons had surviving dentitions. Similarly, no loose teeth were recovered from the recently excavated part of the mass grave.

Table 6 Summary of teeth from BF03

Context	**Tooth**	**Pathology**
3	right second mandibular incisor	moderate wear, slight calculus
4	right maxillary first incisor	considerable wear
6	right first maxillary incisor	moderate wear, slight calculus
6	canine? root	none
14	right third molar	slight wear
36	left first maxillary incisor	moderate wear, slight calculus, DEH, very short root
36	left third molar	no wear, root only 75% formed
41	left maxillary canine	moderate wear, calculus flecks, DEH
46	right maxilla, including first to third molars, first and second premolars, canine	slight wear, slight calculus, DEH on canine and premolars, ante-mortem fracture of first molar, the third molar is unusually small
48	mandibular premolar, partial crown	none
62	left mandibular canine	slight wear, DEH
67	right second maxillary premolar	slight wear, slight calculus
Lower Bones	right canine	considerable wear, slight calculus, large cavity
Unstrat	right first maxillary incisor	moderate wear, slight calculus, root fractured peri-mortem?
Unstrat	crown fragment	fractured peri-mortem?

Dental wear tends to be more common and severe in archaeological populations than in modern societies, and is caused by a much coarser diet. The severity of the anterior wear on the teeth recovered was greater compared with that in the posterior teeth. This may be because the majority of posterior teeth found were third molars

(wisdom teeth), which are subject to less use.

Calculus (dental plaque) is commonly observed in archaeological populations whose dental hygiene was not as rigorous as it is today. Calculus mineralises and forms concretions on the tooth crowns, along the line of the gums. Calculus was observed in the majority of teeth (70%), and was slight throughout. The prevalence of calculus was similar to that observed in the skeletons from MG96, which affected 78.6% of teeth (Holst and Coughlan 2000, 81) and which is normal for medieval cemeteries.

Caries lesions (cavities) were not very common before an increase in the availability of sugar in the 17th century (Roberts and Manchester 1995, 49). Diet in medieval England was largely sucrose-free for the majority of the populace. Only one cavity was observed in a right canine from BF03 (see Table 5; Plate 11), which was large and had destroyed most of the tooth crown. A total of 85.7% of individuals from MG96 suffered from caries, although only 8.9% of teeth were affected (Holst and Coughlan 2000, 80).

Plate 11 Right canine from BF03 with cavity

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. DEH lesions produce a permanent record of episodes of pathological and nutritional disturbance before the age of seven, while the permanent tooth crowns (except for those of the wisdom teeth) are forming. DEH was observed in six teeth (28.6%), all of which were anterior teeth, with the exception of two premolars. In comparison, nine individuals (32.1%) from MG96 suffered from DEH, which affected 5.1% of the teeth. This prevalence corresponds with that observed at many medieval cemeteries. However, the prevalence of DEH in the teeth from BF03 was considerably higher. This could suggest that the individuals who were buried on the battlefield were of lower socio-demographic status, enduring a more stressful childhood than those individuals buried at Towton Hall, or that the teeth recovered were coincidentally high in DEH.

Plate 12 Right maxilla with fractured first molar

Manifestations of dental injuries are commonly observed in skeletons from archaeological excavations. These can be the result of bumps and falls during childhood (the cause of most dental injuries today) (Andreasen 1981, 24), or alternatively, might be related to interpersonal violence or combat. A further explanation might be the usage of teeth in occupational tasks, such as hide preparation or mending of fishing nets. Three ante- /peri-mortem fractures were observed in the teeth recovered from BF03. These affected a first molar, a maxillary incisor and a further unidentifiable tooth. Infractions (chipping) of the anterior teeth are commonly observed, while molar infractions tend to be much less common, although ten of these were observed in soldiers from the MG96. The dental injuries were related either to head trauma or to clenching of the teeth in stressful battle situations (Hicks, *pers. comm.*).

5.0 MORTUARY PRACTICE

The burials excavated were distinct in their character of interment. Skeletons recovered from MG96 and MG03 were found in numerous positions and orientations. Upon excavation, it was observed that the skeletons had been placed in an organised, tightly packed way, which meant that a larger number of individuals could be buried in the pit.

Notably, the individuals in the two single graves (TH03) adjacent to the mass grave had been buried in a formal Christian manner, on their backs in extended positions and with their heads to the west. Whether the manner of burial was related to the status of the men, or to the time of burial, could not be established.

The bones recovered from BF03 were generally found in no particular order, widely distributed throughout the fill of the feature, although few skeletal elements were still articulated. The burial was almost certainly cleared in 1483 following Richard III's grant, and it was therefore not possible to determine whether the skeletons had initially been buried in a Christian manner, or crammed in, as observed at Towton Hall. The presence of articulated bone elements in the grave suggests that soft tissues survived to a degree, and meant that the clearing of the graves must have been an unpleasant task. This may explain why so many small bones and bone fragments remained in the pit.

6.0 DISCUSSION AND SUMMARY

The osteological analysis of skeletons from the recent excavations (MG03, TH03) at Towton Hall and on the battlefield (BF03) supports conclusions made following the analysis of 38 skeletons from the battle recovered from a mass grave in 1996 (MG96). The recent excavations recovered further skeletal remains from a previously unexcavated part of MG96, as well an immediately adjacent single grave and a similar single grave to the south of the mass grave. All of these burials were located within the vicinity of Towton Hall, and, in the case of the single burials, the hall was built on top of the graves. Additionally, an assemblage of over 300 human bones was excavated during the evaluation of a pit on the Towton battlefield (BF03), thought to represent a previously disturbed mass grave. The bone from this feature is under threat of deterioration as a result of ploughing. Bones brought up by the plough to the soil surface were in much poorer condition than those in the pit below.

Analysis found that in those cases where sex could be assessed, the individuals were exclusively male. The youngest individual was a fifteen to sixteen years old adolescent, who had been interred on the battlefield. Previously, the youngest person recovered from the mass grave at Towton Hall was 17 years old (Boylston *et al* 2000). The individuals represented all ages, including two individuals who were aged over 46 years. It was not possible to determine age more accurately in these cases, as age becomes increasingly difficult to assess osteologically over the age of 45. Stature could be assessed in three cases, all of whom fitted into the previously established stature range for the mass grave, which was slightly taller than the average height of medieval men.

As established in MG96, the men were generally strongly built, with well-developed muscles and often exhibiting muscular trauma representing a hard physical lifestyle. This was supported by evidence for spinal disc rupture in a number of individuals due to carrying of heavy loads. These lesions were unusually prevalent

in skeletons from MG96, suggesting that the soldiers had to do much lifting and carrying. Notably, neither the individual in the single grave whose vertebrae were accessible (Skeleton 103), nor any of the disarticulated vertebrae from BF03 exhibited evidence for these lesions. This suggests that the Towton Hall mass grave may represent a particular group of soldiers, who had to carry out particularly physically strenuous tasks, or it may be a coincidence that the few surviving vertebrae of Skeleton 103 and from the battlefield did not show the lesions.

The individuals recovered from the recent excavations enjoyed general good health. However, some pathological conditions were noted: one individual (Skeleton 100; TH03) suffered from rickets. A large number of skeletal remains exhibited mild evidence for joint degeneration, attributable to functional stress, although it was probably age-related in a mature man buried in a single grave near Towton Hall (Skeleton 103; TH03). Joint degeneration was also frequently observed in the individuals from MG96 and it is probable that the soldiers' lifestyle contributed to the development of the condition.

Further evidence for disease was noted in the form of inflammation of the shins of the two individually interred skeletons (Skeletons 100 and 103; TH03). In both cases, the inflammation had receded prior to death, although it must have been quite severe in the mature man (Skeleton 103). Similar cases of leg inflammation were also observed in a small number of shins from MG96. It is possible that the soldiers' physically active life contributed to the inflammation, which may have resulted from bumps of the shins, ulcers or varicose veins.

A single fracture was noted in a lower arm bone from the battlefield; these are rare in skeletons from archaeological contexts. The well-healed state of the ulna fracture suggests that it had occurred some time before death. It may have been a greenstick fracture, and the result of a fall on the arm, or may have been a defence injury.

One third of the fourteen fractures from skeletons recovered from MG96 affected the lower limbs, particularly on the tibiae (Coughlan and Holst 2000, 71). Three of these were greenstick fractures, all of which were well-healed.

It was possible to identify two cases of weapon trauma in the assemblage from BF03. Both of these affected the skulls, similar to the injuries noted previously in MG96. Both injuries had probably been inflicted using sharp force weapons. The injuries support the theory that the individuals interred on the battlefield were casualties from the Battle of Towton.

Initially, it was not certain, whether the skeletons of the individually buried men at Towton Hall (TH03) were associated with the Battle of Towton. However, the presence of a blunt force injury to the back of the skull of Skeleton 103, causing the back of the cranium to break off, provided sufficient evidence to suggest that he was also a battle victim. Additionally, this individual suffered from a possible defence injury to the back of the right palm, which was inflicted with a knife or sword. Similarly, the presence of the tip of a bodkin arrow head in the second individual grave (Skeleton 100; TH03) suggests that this burial also dates to the time of the battle. It has not been possible to determine why these two individuals were buried separately; perhaps they were of higher social standing, or buried prior to or after the mass grave had been dug.

Evidence for dental disease from the recent excavations was similar to that observed in the skeletons from

MG96, despite the fact that all the teeth recently recovered derived from the battlefield (BF03). The amount of dental wear, concretions of dental plaque and caries were all normal for the medieval period and similar to the skeletons from MG96.

Notably, the prevalence of early childhood dental defects was greater in the assemblage from BF03 than MG96. The defects occur as a result of malnutrition or episodes of disease and result in lines of arrested growth in the teeth. Notably, almost 30% of teeth from BF03 exhibited such defects, whereas only 5% of teeth from MG96 were found to have these lines. This may infer that individuals buried on the battlefield may have been of lower socio-economic status than those interred at Towton Hall. Coupled with the lack of evidence for back strain from heavy lifting suggests that the skeletons interred at Towton Hall represent a different group of combatants than those interred on the battlefield.

There are numerous post-mortem cut marks and breaks preserved on the battlefield bones. This could be evidence of exhumation in 1483, following Richard III grant to remove skeletons from the battlefield for Christian re-interment (Sutherland *pers. comm.*.). The remaining bones were perhaps not considered large enough to warrant their removal to another grave site, or were missed entirely.

The analysis of the assemblages so far has given an insight into the demography, health, diet and physical appearance of the combatants. Further excavation of the battlefield graves, allowing additional skeletal analysis would help to ascertain the nature, size and quantity of burials on the battlefield, as well as to determine any socio-economic distinction between battle victims buried at Towton Hall and on the battlefield.

References

Andreasen, J.O. 1981. *Traumatic Injuries of Teeth* (Copenhagen)

Aufderheide, A.C. and Rodríguez-Martín, C. 1998. *The Cambridge Encyclopedia of Human Paleopathology* (Cambridge)

Berry, A.C. and Berry, R.J. 1967. 'Epigenetic variation in the human cranium', *Journal of Anatomy* 101 (2): 361-379

Boylston, A., Holst, M. And Coughlan, J. 2000. 'The human remains', in V. Fiorato, A. Boylston and C. Knüsel, *Blood Red Roses: The Archaeology of a Mass Grave from the Battle of Towton AD 1461* (Oxford): 60-76

Buikstra, J.E. and Ubelaker D.H. (eds) 1994. *Standards for Data Collection from Human Skeletal Remains* (Fayetteville)

Caffell, A. 1997. *A Comparison of Stature between British Skeletal Populations*, Bradford University, Unpublished Undergraduate Dissertation

Coughlan, J. And Holst, M. 2000. 'Health status', in V. Fiorato, A. Boylston and C. Knüsel, *Blood Red Roses: The Archaeology of a Mass Grave from the Battle of Towton AD 1461* (Oxford): 60-76

Cox, M. 2000a. 'Ageing adults from the skeleton', in M. Cox and S. Mays (eds), *Human Osteology in Archaeology and Forensic Science* (London): 61-82

Cox, M. 2000b. 'Assessment of parturition', in M. Cox and S. Mays (eds), *Human Osteology in Archaeology and Forensic Science* (London): 131-142

Dandy, D.J. and Edwards, D.J. 1998. *Essential Orthopaedics and Trauma*, 3rd Edition (London)

Finnegan, M. 1978. 'Non-metric variation of the infracranial skeleton', *Journal of Anatomy* 125: 23-37

Fiorato, V., Boylston, A. And Knüsel, C. *Blood Red Roses: The Archaeology of a Mass Grave from the Battle of Towton AD 1461* (Oxford)Hawkey, D.E. and 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

Hawkey, D.E. and 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

Hershkovitz, I., Bedford, L., Jellema, L.M. and Latimer, B. 1996. 'Injuries to the skeleton due to prolonged activity in hand-to-hand combat', *International Journal of Osteoarchaeology* 6: 167-178

Hilton, R.C., Ball, J. and Benn R.T. 1976. 'Vertebral end-plate lesions (Schmorl's nodes) in the dorsolumbar spine', *Ann Rheum. Dis.* 35: 127-132

Hirsh, L. 1983. 'Cervical degenerative arthritis - possible cause of neck and arm pain', *Postgraduate Medicine* 74 (1): 123-130

Holst, M. Forthcoming. *Osteological Analysis of the Skeletons from Fishergate House, York*

Holst, M. and Coughlan, J. 2000 'Dental Health and Disease', in V. Fiorato, A. Boylston and C. Knüsel (eds), *Blood Red Roses: The Archaeology of a Mass Grave* (Oxford): 77-89

Holst, M., Isaac, L. Boylston, A. and Roberts, C.A. Forthcoming. *Hull Magistrate's Court: Osteological Analysis* Unpublished Osteological Report, University of Bradford

Kennedy, K.A.R. 1989. 'Skeletal markers of occupational stress', in M.Y. Işcan. and K.A.R. Kennedy (eds), *Reconstruction of Life from the Skeleton* (New York):129-160

Knüsel, C. 2000. 'Bone adaptation and its relationship to physical activity in the past', in M. Cox and S. Mays (eds), *Human Osteology in Archaeology and Forensic Science* (London): 381-402

Mays, S. and Cox, M. 2000. 'Sex determination in skeletal remains', in M. Cox and S. Mays (eds), *Human Osteology in Archaeology and Forensic Science* (London): 117-130

Novak, S. 2000. 'Battle-related trauma', in V. Fiorato, A. Boylston and C. Knüsel (eds), *Blood Red Roses: The Archaeology of a Mass Grave* (Oxford):90-102

Ortner, D.J. and Mays, S. 1989. 'Dry-bone manifestations of rickets in infancy and early childhood', *International Journal of Osteoarchaeology* 8: 45-55

Ortner, D.J. and Putschar, W.G.J. 1985. *Identification of Pathological Conditions in Human Skeletal Remains* (Washington)

Resnick, D. and Niwayama, G. 1983 'Entheses and enthesopathies', *Radiology* 146: 1-9

Roberts, C.A. and Manchester, K. 1995. *The Archaeology of Disease* (Stroud)

Rogers, J. 2001. 'The palaeopathology of joint disease', in M. Cox and S. Mays (eds), *Human Osteology in Archaeology and Forensic Science* (London): 163-182

Saunders, S.R. 1989. 'Non-metric variation', in M.Y. Işcan and K.A.R. Kennedy (eds) *Reconstruction of Life from the Skeleton* (New York): 95-108

Scheuer, L. and Black, S. 2000a. 'Development and ageing of the juvenile skeleton', in M. Cox and S. Mays (eds), *Human Osteology in Archaeology and Forensic Science* (London): 9-22

Scheuer, L. and Black, S. 2000b. *Developmental Juvenile Osteology* (San Diego)

Stone, R.J. and Stone, J.A. 1990. *Atlas of the Skeletal Muscles* (Iowa)

Stroud, G. 1993. 'The human bones', in G. Stroud and R.L. Kemp, *Cemeteries of St Andrew, Fishergate* (York):160-241

Stuart-Macadam, P. 1989. 'Nutritional deficiency diseases: a survey of scurvy, rickets and iron-deficiency anemia', in M.Y. Işcan and K.A.R. Kennedy (eds) *Reconstruction of Life from the Skeleton* (New York): 201-222

Trinkhaus, E. 1978. 'Bilateral asymmetry of human skeletal non-metric traits', *American Journal of Physical Anthropology* 49: 315-318

Turkel, S.J. 1989. 'Congenital abnormalities in archaeological populations', in M.Y. Işcan and K.A.R. Kennedy (eds) *Reconstruction of Life from the Skeleton* (New York): 109-127

Waldron, T. 1987. 'The relative survival of the human skeleton: implications for palaeopathology', in W. D. Haglund and M.H. Sorg (eds) *Advances in Forensic Taphonomy: Method, Theory and Archaeological Perspectives* (London): 55-64

Willey, P., Galloway, A. and Snyder, L. 1997. 'Bone mineral density and survival of elements and element portions in the bones of the Crow Creek Massacre', *American Journal of physical Anthropology* 104: 513-528

APPENDIX A: OSTEOLOGICAL AND PALAEOPATHOLOGICAL CATALOGUE

Skeleton Number	**100**
Preservation	Excellent
Completeness	45%, legs, feet, hands and parts of the pelvis were analysed
Age	35+ Old middle adult
Sex	Male
Stature	159.0 ± 2.99cm
Non-Metric Traits	Exostosis in trochlea fossa (left)
Pathology	Bilateral femoral coxa vara, bowing of femora and tibia, rickets?, enthesopathies, diffuse lamellar bone on both tibiae (periosteal inflammatory lesions)
Dental Health	No dentition

Skeleton Number	**101**
Preservation	Good
Completeness	10%, lumbar vertebrae, 12th thoracic vertebra, parts of sternum, left hip, left proximal femur
Age	25-29, young middle adult
Sex	Male
Stature	-
Non-Metric Traits	Hypotrochanteric fossa (left), exostosis in trochlea fossa (left), third trochanter (left)
Pathology	-
Dental Health	-

Skeleton Number	**102/105**
Preservation	Good
Completeness	10%, right scapula, right proximal femur, right hip, right first metacarpal
Age	22-25, young adult
Sex	Male
Stature	-
Non-Metric Traits	Third trochanter (right)
Pathology	-
Dental Health	-

Skeleton Number	**104**
Preservation	Excellent
Completeness	7%, left distal humerus, left radius and ulna, all left carpals and metacarpals, 1 proximal and two distal hand phalanges
Age	17+, adult
Sex	Male?
Stature	-
Non-Metric Traits	none
Pathology	none
Dental Health	None

Skeleton Number	**103**
Preservation	Good
Completeness	65%, legs, feet, hands, pelvis, sacrum, lumbar vertebrae, left radius and ulna, left distal humerus
Age	46+, mature adult
Sex	Male
Stature	179.0 ±3.27cm
Non-Metric Traits	Double anterior condylar canal (left), Poirier's facet (left), hypotrochanteric fossa (bilateral), exostosis in trochlea fossa (bilateral), third trochanter (bilateral), double anterior calcaneal facets (bilateral), double inferior talar extension (bilateral)
Pathology	DJD in spine, DJD in hips, 1st foot and first hand digit, enthesopathies, periosteal inflammatory lesions on tibiae and fibulae, sharp force weapon trauma on right 3rd and 4th metacarpal, blunt force trauma at occipital
Dental Health	-

Table 1 Disarticulated bone from Excavations at Towton Hall

Site Code	Context/Find No	Element	Bone	Part	Side	% Present	Age	Sex	Comments
TOWMG03	(02)	undetermined	undetermined	13 fragments	-	-	-	-	
TOWMG03	(02)	pelvis	ilium	7 small fragments	u	1	a	u	
TOWMG03	(02)	hand	phalanx distal	all	u	100	a	u	
TOWMG03	(02)	ribs	shaft	2 fragments	u	5	a	u	
TOWMG03	(02)	leg	tibia	4 shaft fragments	u	30	a	u	
TOWMG03	(07)	foot	talus	all	l	100	a	u	spare talus, was originally in concrete with SK103
TOWMG03	1001	spine	lumbar vertebra	body	-	60	a	u	slight Schmorl's node at superior surface
TOWMG03	1001	arm	ulna	styloid	r	1	a	u	
TOWMG03	1001	arm	ulna	distal 1/3	r	30	a	u	
TOWMG03	1001	ribs	shaft	2 fragments	u	20	a	u	
TOWMG03	1001	spine	coccyx	all	-	1	a	u	
TOWMG03	1001	spine	thoracic vertebra	spinous process	-	1	a	u	
TOWMG03	1001	undetermined	undetermined	4 fragments	-	-	-	-	
TOWMG03	1003	leg	fibula	proximal shaft fragment	u	0.5	a	u	
TOWMG03	1003	leg	fibula	proximal epiphysis	l	1	a	u	
TOWMG03	1003	leg	tibia	shaft fragments	u	1	a	u	
TOWMG03	1004	undetermined	undetermined	1 fragment	-	-	-	-	
TOWMG03	1004	foot	phalanx distal	all	u	100	a	u	
TOWMG03	1004	foot	phalanx intermediate	all	u	100	a	u	
TOWMG03	1004	foot	phalanx intermediate	all	u	100	a	u	
TOWMG03	1004	foot	phalanx proximal	all	u	100	a	u	
TOWMG03	1004	foot	phalanx proximal	all	u	100	a	u	
TOWMG03	1005	hand	phalanx	all	u	100	a	u	

			intermediate						
TOWMG03	1005	undetermined	undetermined	4 fragments	-	-	-	-	
TOWMG03	1005	hand	phalanx distal	all	u	100	a	u	
TOWMG03	1005	hand	metacarpal	3 shaft fragments	u	1	a	u	
TOWMG03	1005	hand	metacarpal	2 distal fragments	u	25	a	u	
TOWMG03	1005	spine	coccyx	all	-	100	a	u	
TOWMG03	1005	hand	phalanx distal	all	u	100	a	u	
TOWMG03	1005	hand	phalanx proximal	all	u	100	a	u	
TOWMG03	1005	hand	phalanx intermediate	all	u	100	a	u	
TOWMG03	1005	hand	metacarpal	3rd	r	100	a	u	
TOWMG03	1005	hand	phalanx proximal	all	u	100	a	u	
TOWMG03	1005	arm	radius	head fragment	u	5	a	u	
TOWMG03	1005	hand	phalanx proximal	all	u	100	a	u	
TOWMG03	1005	hand	phalanx distal	all	u	100	a	u	
TOWMG03	SK 10 6	hand	phalanx intermediate	all	u	100	a	u	
TOWMG03	SK 106	hand	phalanx intermediate	all	u	100	a	u	
TOWMG03	SK 10 6	hand	phalanx proximal	all	u	100	a	u	
TOWMG03	SK 10 6	hand	phalanx proximal	all	u	100	a	u	
TOWMG03	SK 106	hand	phalanx intermediate	all	u	100	a	u	
TOWMG03	SK 106	foot	phalanx distal	all	u	100	a	u	
TOWMG03	unstrat	foot	medial cuneiform	all	r	100	a	u	
TOWMG03	unstrat	leg	fibula	shaft	u	1	a	u	
TOWMG03	unstrat	leg	fibula	distal epiphysis	l	1	a	u	
TOWMG03	unstrat	foot	phalanx proximal	distal 1/2	u	50	a	u	
TOWMG03	unstrat	foot	phalanx intermediate	2nd	u	100	a	u	
TOWMG03	unstrat	foot	phalanx proximal	1st	u	100	a	u	
TOWMG03	unstrat	ribs	shaft	11 fragments	u	3	a	u	
TOWMG03	unstrat	foot	metatarsal	5th	r	90	a	u	all but proximal epiphysis
TOWMG03	unstrat	foot	metatarsal	4th	r	90	a	u	head partial
TOWMG03	unstrat	foot	metatarsal	3rd	r	70	a	u	all but head
TOWMG03	unstrat	foot	metatarsal	2nd	r	100	a	u	2 fragments
TOWMG03	unstrat	foot	phalanx proximal	2nd	u	100	a	u	
TOWMG03	unstrat	hand	hamate	all	r	100	a	u	
TOWMG03	unstrat	pelvis	pubic symphysis	all	l	15	ya	m	may be related to skeleton 102
TOWMG03	unstrat	spine	sacral vertebra	S1-5	u	95	a	u	lumbarization of S1, partial fusion of s1-s2 and inferior articular facets
TOWMG03	unstrat	skull	petrous temporal	all	r	1	a	u	
TOWMG03	unstrat	skull	temporal	6 fragments	u	0.5	a	u	
TOWMG03	unstrat	spine	thoracic vertebra	2 spinous processes	u	5	a	u	
TOWMG03	unstrat	spine	thoracic vertebra	3 articular facets	u	5	a	u	

TOWMG03	unstrat	undetermined	undetermined	43 fragments	u	-	-	-	
TOWMG03	unstrat	pelvis	ilium	small fragment	u	1	a	u	
TOWMG03	unstrat	leg	tibia	2 epiphysis fragments	u	0.5	a	u	
TOWMG03	unstrat	foot	metatarsal	1st	r	100	a	u	2 fragments
TOWMG03	unstrat	foot	lateral cuneiform	all	l	100	a	u	

Table 2 Disarticulated bone from test pit on battlefield

Site Code	Finds No	Element	Bone	Part	Side	% Present	Age	Sex	Comments
TOWARO03	1	foot	phalanx proximal	all	u	100	a	u	
TOWARO03	2	arm	scapula	blade	u	1	a	u	3 fragments
TOWARO03	2	hand	phalanx proximal	proximal 1/8	u	10	a	u	
TOWARO03	2	undetermined	undetermined	16 fragments	-	-	-	-	
TOWARO03	2	skull	cranium	fragment	u	1	a	u	
TOWARO03	2	skull	temporal	fragment	u	1	a	u	
TOWARO03	2	skull	lacrimal	all	u	50	a	u	
TOWARO03	2	skull	cranium	fragment	u	0.1	a	u	
TOWARO03	2	spine	thoracic vertebra	spinous process	-	5	a	u	
TOWARO03	2	foot	phalanx proximal	all	u	100	a	u	
TOWARO03	2	ribs	shaft	12 fragments	u	5	a	u	
TOWARO03	2	spine	cervical vertebra	fragment	-	20	a	u	right articular facets
TOWARO03	2	spine	cervical vertebra	central	-	60	a	u	left 3/4
TOWARO03	2	spine	cervical vertebra	2nd	-	100	a	u	posterior bridge
TOWARO03	2	hand	metacarpal	4th	r	60	a	u	shaft only
TOWARO03	2	skull	zygomatic process	all	u	5	a	u	
TOWARO03	2	foot	sesamoid	all	u	100	a	u	
TOWARO03	2	foot	navicular	all	l	100	a	u	
TOWARO03	2	hand	metacarpal	2nd	r	60	a	u	shaft only
TOWARO03	2	hand	phalanx intermediate	proximal 1/3	u	25	a	u	
TOWARO03	3	skull	tooth	2nd mandibular incisor	r	100	a	u	moderate wear, slight calculus
TOWARO03	4	skull	tooth	mandibular premolar	r	100	a	u	
TOWARO03	4	undetermined	shaft	4 fragments	-	-	-	-	
TOWARO03	6	skull	tooth	1st maxillary incisor	r	100	a	u	moderate wear, slight calculus
TOWARO03	6	skull	tooth	canine	u	50	a	u	root only
TOWARO03	7	undetermined	toe nail??	?	-	-	-	-	
TOWARO03	11	skull	lacrimal	partial	r	70	a	u	
TOWARO03	11	undetermined	undetermined	1 fragment	-	-	-	-	
TOWARO03	12	hand	metacarpal	2nd	r	95	a	u	
TOWARO03	12	ribs	head, neck, shaft	posterior 1/2, central rib	r	50	a	u	
TOWARO03	13	skull	parietal, frontal	fragment	u	5	a	u	blunt force trauma with twigpeel? On ectocranial and endocranial surface
TOWARO03	14	hand	phalanx	all	u	100	a	u	

			intermediate						
TOWARO03	14	skull	zygomatic process	all	l	1	a	u	cut perimortem on posterior part
TOWARO03	14	skull	mandible	condyle	r	1	a	u	
TOWARO03	14	ribs	shaft	first rib	l	50	a	u	
TOWARO03	14	ribs	shaft	3 fragments	u	1	a	u	
TOWARO03	14	skull	tooth	3rd molar	r	100	ya/y ma	u	
TOWARO03	14	skull	parietal, frontal	fragment	u	1	a	u	post-mortem breaks
TOWARO03	14	spine	thoracic vertebra	2 fragments	-	5	a	u	
TOWARO03	14	foot	intermediate cuneiform	all	l	90	a	u	
TOWARO03	14	foot	calcaneus	all	r	100	a	u	double articular facet
TOWARO03	15	skull	parietal	fragment	u	5	a	u	peri- or post-mortem edges?
TOWARO03	16	skull	cranium	fragment	u	0.1	a	u	old post-mortem edges
TOWARO03	17	hand	phalanx proximal	all	u	100	a	u	
TOWARO03	17	ribs	head and neck	fragment	l	3	a	u	
TOWARO03	17	hand	phalanx proximal	all	u	100	a	u	
TOWARO03	17	foot	phalanx intermediate	all	u	100	a	u	
TOWARO03	17	foot	intermediate cuneiform	all	l	100	a	u	
TOWARO03	17	spine	thoracic vertebra	spinous process	-	10	a	u	
TOWARO03	17	ribs	shaft	10 fragments	u	1	a	u	
TOWARO03	18	skull	cranium	fragment	-	0.1	a	u	
TOWARO03	19	foot	metatarsal	1st	r	100	a	u	
TOWARO03	20	ribs	shaft	2 fragments	u	10	a	u	
TOWARO03	21	spine	lumbar vertebra	5th	-	50	a	u	
TOWARO03	22	leg	patella	all but inferior part	r	75	a	u	
TOWARO03	23	spine	thoracic vertebra	1st or 2nd	-	100	a	u	porosity, osteophytes at left rib facet
TOWARO03	24	hand	phalanx proximal	all	u	100	a	u	
TOWARO03	25	hand	metacarpal	5th	l	95	a	u	
TOWARO03	25	foot	phalanx proximal	all	u	100	a	u	
TOWARO03	26	skull	parietal	fragment	-	1	a	u	old post-mortem edges?
TOWARO03	27	leg	patella	all	r	100	a	u	very large, slight rectus femoris enthesopathy
TOWARO03	28	foot	calcaneus	all	r	100	a	u	slight enthesopathy for Achilles tendon
TOWARO03	29	ribs	shaft	11th rib	l	80	a	u	
TOWARO03	30	foot	metatarsal	5th	r	90	a	u	
TOWARO03	31	ribs	angle	fragment	r	10	a	u	eroded
TOWARO03	32	foot	phalanx proximal	1st	l	100	a	u	same foot
TOWARO03	32	foot	metatarsal	1st	l	100	a	u	same foot
TOWARO03	32	foot	metatarsal	2nd	l	100	a	u	same foot
TOWARO03	32	foot	metatarsal	3rd	l	75	a	u	same foot

TOWARO03	32	foot	metatarsal	4th	l	75	a	u	same foot
TOWARO03	32	foot	metatarsal	5th	l	50	a	u	same foot
TOWARO03	32	foot	cuboid	all	l	100	a	u	same foot
TOWARO03	32	foot	phalanx proximal	2nd	l	100	a	u	same foot
TOWARO03	32	foot	phalanx distal	1st	l	100	a	u	same foot
TOWARO03	32	foot	phalanx proximal	3rd	l	100	a	u	same foot
TOWARO03	32	foot	sesamoid	all	l	100	a	u	same foot
TOWARO03	33	foot	phalanx intermediate	all	u	100	a	u	
TOWARO03	33	foot	metatarsal	5th	l	100	a	u	
TOWARO03	34	hand	metacarpal	3rd	l	100	a	u	
TOWARO03	35	spine	cervical vertebra	c7?	-	90	a	u	
TOWARO03	35	spine	cervical vertebra	c1, 3 fragments	-	75	a	u	
TOWARO03	36	skull	tooth	1 maxillary incisor	l	100	a	u	short root, moderate wear, slight calculus, DEH
TOWARO03	36	skull	tooth	3rd molar	l	100	ad	u	root 3/4 complete, 15-16 years
TOWARO03	37	foot	intermediate cuneiform	all	r	100	a	u	
TOWARO03	37	foot	intermediate cuneiform	all	l	100	a	u	
TOWARO03	37	ribs	shaft	fragment	u	1	a	u	
TOWARO03	37	foot	metatarsal	4th	l	100	a	u	
TOWARO03	37	foot	phalanx proximal	all	u	100	a	u	
TOWARO03	38	ribs	1st	all but sternal end	r	90	a	u	
TOWARO03	39	spine	lumbar vertebra	neural arch , superior body	-	60	a	u	
TOWARO03	40	ribs	head, neck, shaft	4 fragments	l	20	a	u	
TOWARO03	41	skull	tooth	maxillary canine	l	100	a	u	moderate wear, deh, flecks of calculus
TOWARO03	42	pelvis	pubic ramus	2 fragments	r	5	oma	u	35-39
TOWARO03	42	spine	sacrum	s1	l	1	a	u	articular facets
TOWARO03	43	hand	hamate	all	r	100	a	u	
TOWARO03	43	foot	medial cuneiform	all	l	100	a	u	
TOWARO03	43	foot	medial cuneiform	fragment	l	70	a	u	
TOWARO03	44	ribs	head, neck, shaft	3 fragments	l	30	a	u	osteophytes at tubercles, central rib
TOWARO03	44	hand	metacarpal	4th	r	100	a	u	spade mark
TOWARO03	44	hand	phalanx proximal	all	u	95	a	u	
TOWARO03	44	hand	phalanx proximal	all	u	100	a	u	
TOWARO03	45	arm	radius	all	l	100	a	u	head eroded, pair
TOWARO03	45	arm	ulna	all	l	100	a	u	bone excavation for brachialis, enthesopathy at olecranon, bent laterally at distal 1/3, fractured?, 240mm=statur

									e 162.9
TOWARO03	46	skull	maxilla	1/2	r	50	ya	u	little wear, am fracture first molar, 3rd molar small, slight calculus, deh on canine & premolars, palate tori; 876543
TOWARO03	47	foot	talus	all	l	100	a	u	
TOWARO03	47	foot	talus	all	l	100	a	u	
TOWARO03	48	skull	tooth	maxillary 1st incisor	l	100	a	u	moderate wear, deh, flecks of calculus
TOWARO03	50	spine	thoracic vertebra	right 3/4	r	100	a	u	
TOWARO03	51	ribs	11th rib	fragment	l	80	a	u	
TOWARO03	52	hand	phalanx proximal	all	u	100	a	u	
TOWARO03	53	spine	thoracic vertebra	central vertebra	-	100	a	u	
TOWARO03	54	spine	cervical vertebra	central	-	100	a	u	c4/c5, transverse foramen bipartite
TOWARO03	54	spine	cervical vertebra	c7	-	100	a	u	
TOWARO03	54	spine	thoracic vertebra	central vertebra	-	100	a	u	t4?
TOWARO03	55	spine	lumbar vertebra	almost all	-	90	a	u	ossification of nucleus pulposus
TOWARO03	56	foot	medial cuneiform	all	r	100	a	u	
TOWARO03	57	foot	lateral cuneiform	all	r	100	a	u	
TOWARO03	58	hand	metacarpal	4th	r	50	a	u	proximal 1/2
TOWARO03	58	foot	phalanx proximal	central part	u	50	a	u	
TOWARO03	58	undetermined	long bone	shaft fragment	-	-	-	-	
TOWARO03	59	arm	scapula	almost all	r	70	a	u	8 fragments
TOWARO03	60	ribs	shaft	fragment	u	20	a	u	
TOWARO03	60	spine	sacrum	coccyx	-	1	a	u	
TOWARO03	61	foot	phalanx proximal	all	u	100	a	u	
TOWARO03	62	skull	tooth	mandibular canine	l	100	a	u	deh, several lines, slight wear
TOWARO03	62	skull	suture	fragment	u	0.01	a	u	peri-mortem twigpeel
TOWARO03	62	hand	phalanx intermediate	all	u	100	a	u	
TOWARO03	62	ribs	neck and angle	fragment	r	10	a	u	
TOWARO03	62	ribs	shaft	4 fragments	u	1	a	u	
TOWARO03	62	foot	metatarsal	5th	l	75	a	u	shaft only
TOWARO03	63	foot	phalanx distal	1st	u	100	a	u	
TOWARO03	63	undetermined	undetermined	fragment	-	-	-	-	
TOWARO03	64	ribs	shaft	3 fragments	u	1	a	u	
TOWARO03	64	foot	phalanx intermediate	fragment	u	100	a	u	5th digit?
TOWARO03	64	hand	metacarpal	3rd	r	100	a	u	
TOWARO03	65	ribs	head	fragment	u	1	a	u	
TOWARO03	65	foot	metatarsal	4th	l	90	a	u	all but head
TOWARO03	66	foot	metatarsal	4th	l	100	a	u	muscular
TOWARO03	66	hand	metacarpal	5th	r	70	a	u	shaft only,

									muscular
TOWARO03	67	ribs	head, neck, shaft	central	r	30	a	u	
TOWARO03	67	hand	metacarpal	5th	l	100	a	u	
TOWARO03	67	skull	tooth	maxillary 2nd premolar	r	100	a	u	slight wear, slight calculus
TOWARO03	67	foot	metatarsal	2nd	l	90	a	u	no head
TOWARO03	67	foot	lateral cuneiform	all	r	100	a	u	
TOWARO03	67	leg	patella	all	l	100	a	u	smaller
TOWARO03	67	leg	patella	all	l	100	a	u	very large, moderate enthesopathy for rectus femoris
TOWARO03	67	hand	phalanx proximal	all	u	100	a	u	
TOWARO03	68	hand	phalanx intermediate	all	u	100	a	u	
TOWARO03	68	arm	scapula	blade fragment	u	1	a	u	
TOWARO03	69	foot	metatarsal	4th	l	95	a	u	head eroded
TOWARO03	70	foot	metatarsal	2nd	l	100	a	u	same foot
TOWARO03	70	foot	metatarsal	3rd	r	100	a	u	one foot
TOWARO03	70	foot	phalanx proximal	all	u	100	a	u	
TOWARO03	70	spine	cervical vertebra	c2	-	100	a	u	
TOWARO03	70	foot	phalanx distal	1st	u	100	a	u	
TOWARO03	70	spine	cervical vertebra	c2	-	100	a	u	
TOWARO03	70	foot	metatarsal	4th	r	100	a	u	one foot
TOWARO03	70	ribs	shaft	4 fragments	u	1	a	u	
TOWARO03	70	foot	medial cuneiform	all	r	100	a	u	one foot
TOWARO03	70	foot	calcaneus	all	r	100	a	u	one foot, peroneal tubercle, inferior enthesopathy
TOWARO03	70	foot	metatarsal	5th	l	100	a	u	same foot
TOWARO03	70	foot	metatarsal	3rd	l	100	a	u	same foot
TOWARO03	70	foot	metatarsal	1st	l	100	a	u	same foot
TOWARO03	70	foot	talus	all	l	100	a	u	same foot, double anterior facet
TOWARO03	70	skull	parietal	fragment	u	2	a	u	
TOWARO03	70	spine	thoracic vertebra	central vertebra	-	70	a	u	neural arch, left part of body
TOWARO03	70	foot	metatarsal	4th	l	100	a	u	same foot
TOWARO03	70	hand	capitae	all	l	100	a	u	one hand
TOWARO03	70	undetermined	undetermined	5 fragments	-	-	-	-	
TOWARO03	70	skull	frontal	orbit	r	1	a	u	old post-mortem damage, possible blade injury?
TOWARO03	70	skull	cranium	fragment	u	0.5	a	u	
TOWARO03	70	skull	frontal	fragment	u	5	a	u	
TOWARO03	70	skull	parietal	fragment	r	2	a	u	
TOWARO03	70	hand	phalanx intermediate	all	u	100	a	u	one hand
TOWARO03	70	hand	pisiform	all	l	100	a	u	one hand
TOWARO03	70	hand	phalanx proximal	all	u	100	a	u	one hand
TOWARO03	70	hand	phalanx proximal	all	u	100	a	u	one hand

TOWARO03	70	hand	metacarpal	5th	l	100	a	u	one hand
TOWARO03	70	spine	thoracic vertebra	lower vertebra	-	30	a	u	right body 1/2, large osteophyte
TOWARO03	70	hand	triquetral	all	l	100	a	u	one hand
TOWARO03	70	hand	phalanx intermediate	all	u	100	a	u	one hand
TOWARO03	905	arm	ulna	distal shaft	r	30	a	u	
TOWARO03	905	undetermined	undetermined	fragment	-	-	-	-	
TOWARO03	905	arm	clavicle	shaft fragment	u	7	a	u	
TOWARO03	917	skull	tooth	mandibular premolar	l	100	a	u	no wear
TOWARO03	917	skull	tooth	mandibular 2nd incisor	r	100	a	u	moderate wear, slight calculus
TOWARO03	lower bones	hand	phalanx proximal	all	u	100	a	u	
TOWARO03	lower bones	hand	metacarpal	5th	r	100	a	u	
TOWARO03	lower bones	hand	metacarpal	4th	r	100	a	u	
TOWARO03	lower bones	hand	metacarpal	4th	l	100	a	u	
TOWARO03	lower bones	hand	phalanx intermediate	all	u	100	a	u	
TOWARO03	lower bones	hand	phalanx intermediate	all	u	100	a	u	
TOWARO03	lower bones	hand	phalanx intermediate	all	u	100	a	u	
TOWARO03	lower bones	hand	phalanx intermediate	all	u	100	a	u	
TOWARO03	lower bones	hand	phalanx intermediate	all	u	100	a	u	large muscle attachments
TOWARO03	lower bones	hand	phalanx proximal	all	u	100	a	u	
TOWARO03	lower bones	foot	metatarsal	4th	l	100	a	u	
TOWARO03	lower bones	foot	phalanx distal	1st	u	90	a	u	
TOWARO03	lower bones	foot	phalanx distal	1st	u	90	a	u	
TOWARO03	lower bones	hand	phalanx proximal	all	u	100	a	u	
TOWARO03	lower bones	hand	phalanx proximal	all	u	100	a	u	
TOWARO03	lower bones	hand	lunate	all	l	100	a	u	
TOWARO03	lower bones	foot	metatarsal	2nd	r	90	a	u	
TOWARO03	lower bones	spine	thoracic vertebra	upper	-	40	a	u	part of body, left transverse facet, spinous process
TOWARO03	lower bones	hand	phalanx proximal	1st	u	100	a	u	
TOWARO03	lower bones	spine	cervical vertebra	central	-	100	a	u	severe djd, osteophytes & porosity left superior facet
TOWARO03	lower bones	undetermined	undetermined	fragment	-	-	-	-	
TOWARO03	lower bones	pelvis	ilium	fragment	u	1	a	u	
TOWARO03	lower bones	sternum	superior	fragment	-	2	a	u	
TOWARO03	lower bones	skull	tooth	canine	r	100	a	u	large cavity, considerable wear, slight

									calculus
TOWARO03	lower bones	skull	sphenoid	fragment	u	1	a	u	
TOWARO03	lower bones	skull	cranium	7 fragments	u	1	a	u	
TOWARO03	lower bones	leg	tibia	shaft	u	2	a	u	
TOWARO03	lower bones	ribs	angle	1st	l	10	a	u	
TOWARO03	lower bones	hand	triquetral	all	r	100	a	u	
TOWARO03	lower bones	foot	metatarsal	3rd	r	100	a	u	
TOWARO03	lower bones	hand	scaphoid	all	r	100	a	u	
TOWARO03	lower bones	foot	metatarsal	4th	l	10	a	u	
TOWARO03	lower bones	hand	trapezoid	all	l	100	a	u	
TOWARO03	lower bones	hand	trapezoid	all	l	100	a	u	
TOWARO03	lower bones	hand	trapezoid	all	l	100	a	u	
TOWARO03	lower bones	hand	capitae	all	l	100	a	u	
TOWARO03	lower bones	hand	capitae	all	r	100	a	u	
TOWARO03	lower bones	hand	trapezium	all	l	100	a	u	
TOWARO03	lower bones	hand	scaphoid	all	l	100	a	u	
TOWARO03	lower bones	ribs	neck and angle	fragment	r	10	a	u	slight porosity at tubercle
TOWARO03	lower bones	foot	phalanx proximal	all	u	100	a	u	
TOWARO03	lower bones	foot	metatarsal	2nd	l	70	a	u	
TOWARO03	lower bones	foot	metatarsal	5th	r	100	a	u	
TOWARO03	lower bones	foot	phalanx proximal	all	u	100	a	u	
TOWARO03	lower bones	foot	phalanx proximal	all	u	100	a	u	
TOWARO03	lower bones	foot	phalanx proximal	all	u	100	a	u	
TOWARO03	lower bones	foot	cuboid	all	l	100	a	u	
TOWARO03	lower bones	foot	phalanx proximal	all	u	100	a	u	
TOWARO03	lower bones	foot	phalanx proximal	all	u	100	a	u	
TOWARO03	lower bones	foot	phalanx proximal	1st	u	100	a	u	
TOWARO03	lower bones	foot	medial cuneiform	all	l	100	a	u	
TOWARO03	lower bones	foot	phalanx intermediate	4th	u	100	a	u	
TOWARO03	lower bones	foot	metatarsal	3rd	l	100	a	u	
TOWARO03	lower bones	foot	metatarsal	3rd	l	100	a	u	
TOWARO03	lower bones	foot	metatarsal	4th	l	100	a	u	
TOWARO03	lower bones	foot	phalanx proximal	all	u	100	a	u	
TOWARO03	lower bones	foot	phalanx intermediate	5th	u	100	a	u	
TOWARO03	lower bones	foot	lateral cuneiform	all	r	100	a	u	

TOWARO03	lower bones	foot	phalanx intermediate	2nd	u	100	a	u	
TOWARO03	lower bones	foot	lateral cuneiform	fragment	l	80	a	u	
TOWARO03	lower bones	foot	lateral cuneiform	fragment	l	80	a	u	
TOWARO03	unstrat	skull	tooth	maxillary first incisor	r	70	a	u	slight calculus, moderate wear, tooth root fractured peri-mortem?
TOWARO03	unstrat	skull	hyoid	all but right 1/2	u	100	a	u	
TOWARO03	unstrat	foot	sesamoid	all	u	100	a	u	
TOWARO03	unstrat	foot	phalanx intermediate	all	u	100	a	u	
TOWARO03	unstrat	spine	thoracic vertebra	spinous process	-	4	a	u	
TOWARO03	unstrat	hand	metacarpal	3rd	r	u	a	u	shaft only
TOWARO03	unstrat	foot	sesamoid	all	u	100	a	u	
TOWARO03	unstrat	foot	sesamoid	all	u	100	a	u	
TOWARO03	unstrat	leg	tibia	shaft fragment	u	1	a	u	periosteal inflammatory lesion
TOWARO03	unstrat	foot	phalanx proximal	all	u	100	a	u	
TOWARO03	unstrat	foot	phalanx proximal	all	u	100	a	u	
TOWARO03	unstrat	foot	phalanx proximal	all	u	100	a	u	
TOWARO03	unstrat	foot	phalanx proximal	shaft	u	80	a	u	
TOWARO03	unstrat	foot	phalanx proximal	shaft	u	80	a	u	
TOWARO03	unstrat	foot	phalanx proximal	shaft	u	80	a	u	
TOWARO03	unstrat	spine	thoracic vertebra	body fragment	-	4	a	u	
TOWARO03	unstrat	foot	phalanx intermediate	all	u	100	a	u	
TOWARO03	unstrat	foot	phalanx distal	all	u	100	a	u	
TOWARO03	unstrat	foot	lateral cuneiform	all	r	100	a	u	
TOWARO03	unstrat	foot	lateral cuneiform	all	l	100	a	u	
TOWARO03	unstrat	foot	lateral cuneiform	all	r	20	a	u	
TOWARO03	unstrat	foot	metatarsal	2nd	l	20	a	u	proximal end only
TOWARO03	unstrat	foot	phalanx proximal	shaft	u	80	a	u	
TOWARO03	unstrat	hand	pisiform	all	l	100	a	u	
TOWARO03	unstrat	skull	zygomatic process	all	r	1	a	u	cut a fronto-sphenoid superior part, peri-mortem
TOWARO03	unstrat	hand	phalanx distal	all	u	100	a	u	large osteophyte
TOWARO03	unstrat	hand	phalanx distal	1st	u	100	a	u	
TOWARO03	unstrat	hand	phalanx distal	all	u	100	a	u	
TOWARO03	unstrat	hand	phalanx distal	all	u	100	a	u	
TOWARO03	unstrat	hand	phalanx proximal	all	u	100	a	u	
TOWARO03	unstrat	hand	phalanx proximal	all	u	100	a	u	
TOWARO03	unstrat	hand	phalanx proximal	all	u	100	a	u	
TOWARO03	unstrat	hand	metacarpal	5th	l	100	a	u	

TOWARO03	unstrat	hand	triquetral	all	r	100	a	u	
TOWARO03	unstrat	ribs	shaft	5 fragments	u	5	a	u	
TOWARO03	unstrat	hand	trapezium	all	l	100	a	u	
TOWARO03	unstrat	spine	thoracic vertebra	articular facet	-	20	a	u	
TOWARO03	unstrat	hand	capitae	all	l	100	a	u	
TOWARO03	unstrat	hand	hamate	all	r	100	a	u	
TOWARO03	unstrat	hand	hamate	all	l	100	a	u	
TOWARO03	unstrat	hand	hamate	all	l	100	a	u	
TOWARO03	unstrat	hand	hamate	all	l	100	a	u	
TOWARO03	unstrat	undetermined	undetermined	30 fragments	-	-	-	-	
TOWARO03	unstrat	skull	tooth	fragment	u	5	a	u	peri-mortem fracture
TOWARO03	unstrat	skull	lacrimal	all	u	1	a	u	
TOWARO03	unstrat	skull	nasal	all	-	0.1	a	u	post-mortem breaks
TOWARO03	unstrat	skull	cranium	8 fragments	u	1	a	u	
TOWARO03	unstrat	hand	scaphoid	all	r	100	a	u	