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Appendix 1. Movements of the body

The illustrations below show the main movements of the body that are mentioned in this document.

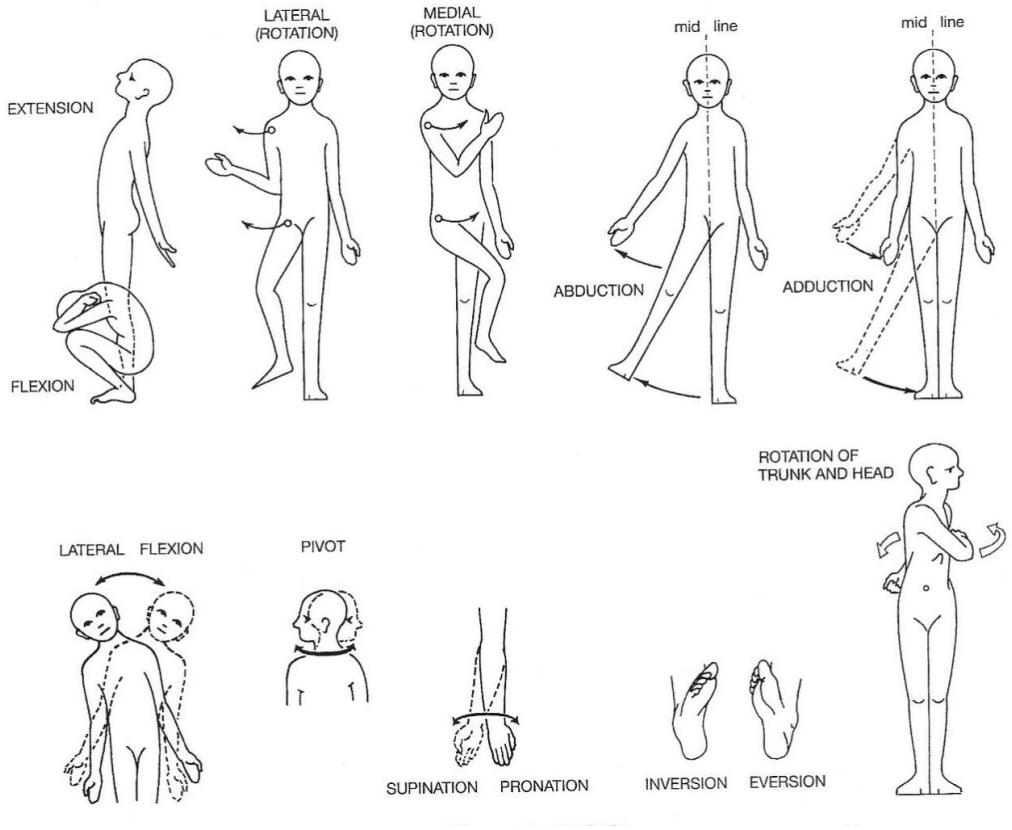


Fig A1.1 *Movements of the body; images courtesy of MacKinnon and Morris (20005, Fig. 1.4, p. 4).*

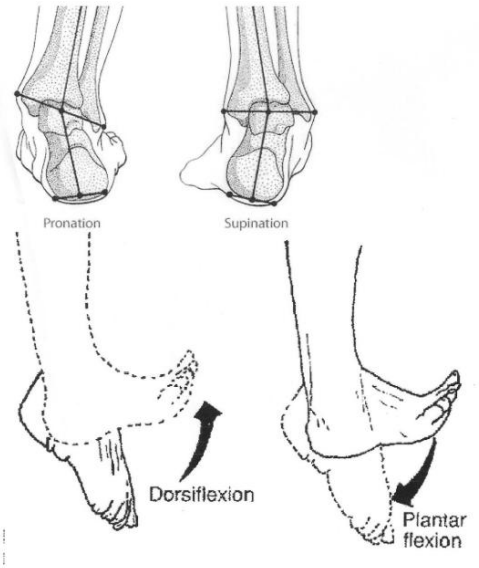


Figure A4.2 *Movements of the foot- pronation, supination, dorsi-flexion and plantar flexion.*

Appendix 2. Trauma patterning in maritime assemblages

The hazards inherent in specific lifestyles, occupations or activities have been explored extensively in modern specialist groups, particularly sportsmen (for example rodeo riders, basketball players, baseball pitchers). In archaeological populations, the availability of 'specialist' skeletal assemblages, as distinct from the general population, is very much more limited, with most burial assemblages containing a wide mix of occupations and lifestyles.

Seamen and marines were exposed to very specific hazards aboard ship, not shared by their terrestrial contemporaries. It is highly probable that trauma patterning was similar between mariner assemblages, however, particularly those in sailing fighting ships. Eleven 16th-19th century maritime skeletal assemblages were identified as potential comparable datasets, and also a review of trauma in 1970s North Sea trawlermen (Cross 1985).

The *Mary Rose* (1545)

The unexpected sinking of Henry VIII's flagship the *Mary Rose* off Spithead on 19th July 1545 caused the deaths of an estimated 385 crewmen, comprising seamen and soldiers (Stirland 2005a; Stirland 2005b) were trapped on board by anti-boarding netting and went down with the ship. When the *Mary Rose* was raised from the seabed in 1982, human remains of at least 179 individuals were discovered on multiple decks but, due to underwater taphonomic factors, the majority were disarticulated or semi-articulated. Ninety-two largely complete skeletons were re-assembled (Stirland 2005a). Although Stirland has undertaken very valuable analysis into activity-related changes in a sub-group that she interpreted as longbowmen, and has published two non-technical osteological reports (Stirland 2005a; Stirland 2005b), it is not clear whether the pathological conditions (including fractures) discussed in her works pertain to the entire assemblage or just to the 'articulated' skeletons. Fractures mentioned in her reports are

- 3 x nasal bones

- 13 x depressed cranial fractures
- 1 x sharp force trauma to the cranium (possibly a bodkin)
- 7 x ribs (four from one individual; one right first rib)
- 2 x sternum
- vertebrae (number unknown)
- 6 x L5 spondylolysis
- 1 x distal humerus (with osteoarthritis)
- 1 x humeral epiphysis (avulsion)
- 1 x ulna
- 5 x posterior acetabular fracture with dislocation (3 right, 3 left)
- 1 x femoral shaft (greenstick)
- 3 x left fibula (lateral malleolus)
- 1 x distal tibial shaft with proximal fibular fracture (spiral fracture)
- 6 x tibial avulsions (Osgood-Schlatter)
- 1 x calcaneaus
- 3 x metatarsal 5 (tubercle avulsions)

Osteochondritis dissecans was noted in

- 6 x femoral condyles
- distal humerus (number unknown)
- metatarsal 1 (number unknown)

Neither true nor crude prevalences of pathological lesions are explicitly stated, although in the case of fractures, the number and location on the skeleton is discussed. This has direct bearing on the potential for direct quantitative trauma comparisons with the 18th century R.N. assemblages.

Differing temporality and composition of the two groups also complicate direct comparisons. The *Mary Rose* assemblage predates the three 18th century assemblages by more than 225 years, during which interval the Royal Navy had greatly expanded its operations to a truly global scale. For many Georgian seamen, this involved far longer sea voyages and foreign stations (with attendant risks of greater trauma, scurvy and foreign diseases) than was probable in the *Mary Rose* crew, which principally operated in home waters (Gardiner and Allen 2005). Whilst the vast majority of the three late Georgian assemblages largely comprised seamen, with a 15-17% component of Royal Marines (Boston et al. 2008), contemporary accounts of the *Mary Rose* suggest that approximately half her crew were seamen and half soldiers, with a small complement of gunners (Stirland 2005a). With the exception of a group identified as longbowmen, it was not archaeologically possible to distinguish between soldiers and seamen. This has obvious implications for interpreting fracture patterning in terms of lifestyle.

Stable isotope analysis of $\delta^{13}C$ and $\delta^{18}O$ in 18 skeletons indicated that 33-60% of the *Mary Rose* crew had grown up in warmer, more southerly climes (Bell et al. 2009)- a claim contested by other researchers, who recognised only one non-native (Millard and Schroeder 2010). Although foreigners were a well-recognised component of the 18th century R.N., they usually comprised approximately 10-15% of a ship's company (Lewis 1960). Thus, the national composition of the two groups may differ.

Despite all the above limitations, the *Mary Rose* does have great comparative value in being the only large Royal Navy assemblage to have undergone detailed osteological analysis. Although undoubtedly there are differences in occupational composition, scale of seagoing operations and no doubt shipboard organisation, the activities required to sail a fighting ship did not change significantly in the intervening two hundred years. This makes it highly probable that many of the injuries and bony modifications associated with a seafaring life were common to 16th and 18th century R.N. seamen and possibly even seagoing soldiers.

***Vasa* (1628)**

The magnificent flagship of the Royal Swedish Navy, *Vasa*, sank on her maiden voyage in Stockholm harbour on 10 October 1628. Contemporary accounts indicate that 30-50 individuals drowned, mostly seamen and their families (During 1994; During 1997a). Historical research indicates that most 'seamen' were recent conscripts (principally agriculatural workers), who had limited seafaring experience, and whose skeletons are more likely to reflect terrestrial than maritime occupations (Hocker 2011, 31). The wreck of the *Vasa* was raised in 1961, and osteological analysis on skeletons found within the ship commenced in 1963. The human remains were buried but disinterred in 1989 and re-analysed. Two females (probably spouses or family members), 19 probable males, one unsexed adult and three unsexed adolescents were identified in this second analysis (*Ibid.*).

Twelve fractures were identified in seven males, and a left humeral shaft fracture in the adolescent 'female' (*Ibid.*). One young adult male (A) displayed healed fractures of the frontal, maxillary and nasal bones (the angle of the injuries suggested it may have been a single blow) and a 'fresh' right tibial shaft fracture (texts unclear if it was perimortem or healing). Healed fractures in other male skeletons included the parietal bone, clavicle, three ribs, and two fibulae ('twisting trauma') (During 1994; During 1997a). Unfortunately, no TPR values for pathological lesions were given.

Bilateral *osteochondritis dissecans* of the capitulum of the distal humeri was present in a 20-22 year old male (skeleton F). Discovered by the helm, this skeleton was dubbed the 'helmsman'. During (1997) speculated that repetitive and prolonged holding of the wheel would require locking the arms and may have imposed chronic stress on the elbow joints. This repeated microtrauma may have precipitated *osteochondritis dissecans*.

The VOC retourschip *Batavia* (1629)

The Dutch East Indian Company (VOC) ship *Batavia*, *en route* to Batavia, was wrecked off the coast of Western Australia in 1629. Survivors were marooned on the Abrolhos Islands whilst a small ship with the VOC official aboard sailed to Batavia for help. Undermerchant Jeronimus Cornelisz, left in

charge on the islands, rapidly instituted a reign of terror in which 125 people were murdered (Dash 2002; Franklin 2012). The mass grave of six of Cornelisz's victims was excavated on Beacon Island in stages between 1994 and 2001. The remains have recently been re-analysed (Franklin 2012). All four adults were male, one was an unsexed older adolescent and one was an infant of 6-8 months. All but the infant may well have been seamen. Possible scurvy was recognised, but no perimortem or antemortem trauma was identified. Hence, this group is of limited comparative value.

The *Swan* (1653)

One incomplete adult young male skeleton (aged 23-25 years) was recovered from the wreck of the *Swan*, a Cromwellian warship sunk off Mull in 1653 (Martin 2001). In keeping with 18th century seamen, this skeleton showed marked muscle attachment to the upper limb but very little to the lower limb (Black 2002). Pathological lesions noted on the *Swan* skeleton were an articular surface or facet on the inferior aspect of the acromium of the right scapula (humeral impingement to the shoulder joint); traumatic damage to the endplate of several lower thoracic and upper lumbar vertebrae; spondylolysis of L5, and mild rickets. An irregular uneven 'impingement facet' of the supero-posterior aspect of the right acetabular joint surface was also identified (*Ibid.*). The description is similar to acetabular compression lesions seen in 18th century R.N. skeletons of this study- probably the result of impact of the femoral head with the acetabulum with repeated landing on the feet following a jump or fall.

The *Kronan* (1676)

On 1 June 1676, the Royal Swedish warship *Kronan* exploded and sank before engaging the enemy Danish-Dutch fleet. Contemporary accounts record that of the 500 seamen and 350 soldiers onboard, only 42 survived (During 1997b). Excavation of the wreck in 1980 exposed the co-mingled remains of at least 260 individuals (Kjellistrom and Hamilton 2012). The human bone was remarkable for the very high rate of perimortem trauma. Sharp force trauma was present in at least 27 individuals, and was located on the skull, vertebrae, pelves, scapulae and particularly numerous

on the long bones (19.4% of femora; 9.8% of humeri) (During 1997b). In many cases, multiple blows were aimed repeatedly at a single small area, presumably with the 'victim' held in a fixed position (During 1997a and b). Cutmarks on the articular surfaces tentatively suggest dismemberment. During interpreted the perimortem injuries as blast trauma and interpersonal violence, occasioned by the explosion and panic on the ship's sinking. It may equally have been mutiny. Recent re-analysis of a sample of 20 affected elements found no evidence of blast trauma, but considerable perimortem sharp force trauma (Kjellstrom and Hamilton 2012; Kjellstrom and Hamilton 2013). It remains unclear if the lesions were inflicted just before death, as hypothesised by During (1997a), or were incurred post-mortem during retrieval of cannon from the wreck five years after her sinking. Although During alludes to ante-mortem fractures, there was no description thereof, and no skeletal report of the assemblage has been compiled (Kjesllistrom pers. comm., 2013).

English Harbour, Antigua (1793- 1822)

In 1997-8 small-scale excavations in the burial ground of the R.N. hospital overlooking English Harbour, Antigua, was undertaken by the University of Calgary. Thirty individuals were recovered from 26 graves, of whom nine were subadults (six younger than five years) and the remainder adult males (Varney 2009; Varney and Nicholson 1999). Facial morphology indicated that many adults were of African ancestry.

Carbon and nitrogen stable isotope analysis revealed that eight individuals with Caucasian features had consumed predominantly temperate C3 foodstuffs, whilst eight 'African' individuals had a more varied diet showing a far greater component of C4 plants. This supported the historical interpretation that the men of African ancestry were the 'King's Negroes', who laboured in the nearby dockyards of English Harbour, whilst the others were more probably R.N. seamen and marines, or even soldiers (*Ibid.*). However, it should be noted that carbon and nitrogen isotope values in an adult male with African morphological features (skeleton 103) buried at Haslar also suggested a significant C4 input in the diet, as they did in a Caucasian male (skeleton 844) of the

Plymouth assemblage (Roberts et al. 2012). This prolonged intake of mixed C3 and C4 foodstuffs suggested that either these individuals consumed R.N. victuals acquired from local West Indian or North American sources over a prolonged time period, or that these individuals were Americans (*Ibid.*). Thus, some of Varney's 'King's Negroes' with higher carbon values may well have been R.N. seamen.

No formal osteological report on the English Harbour assemblage has yet been compiled, but a more general paper (Varney and Nicholson 1999) indicated that healed fractures were identified in four of 11 individuals (two Caucasian and two African males). These included a hand, right clavicular and multiple right rib fractures in one older African male, and unspecified fractures from a fall in another. An older adult male with African traits had suffered fractures of the nasal bone x 1; radius and ulna, fibula and both styloid processes of the temporal bone and distorted ossified thyroid cartilage (Varney pers. comm. 2013). The only cited injuries to probable Caucasian seamen were an unspecified fracture from a fall in one, and an unspecified hand fracture in a second. Unfortunately, not all fractures were listed, and no TPR was given.

A second excavation of probable R.N. personnel took place on Galleon Beach near English Harbour in 2010, following the exposure of skeletal remains by Hurricane Earl in 2010. The small-scale excavation, headed by Dr Reg Murphy, Director of Heritage Resources, Harbour National Park, English Harbour, revealed the articulated remains of another 12 very poorly preserved coffined burials, probably some of the thousands of seamen or soldiers stationed in the West Indies in the French Revolutionary Wars who succumbed to yellow fever and malaria. A formal report is in progress.

Nelson's Island, Aboukir Bay, Egypt (1798 and 1801)

Ongoing excavations have revealed the skeletons of 30 casualties of the Battle of the Nile (1798) and the Egyptian campaign (1801), including R.N. seamen and officers, probable soldiers, two infants, an adult possible female and two possibly French seamen (Slope and Boston 2010). Two naval officers

had been buried within named coffins. Formal osteological analysis prior to reburial was not permitted by the Egyptian authorities, but some metrics (e.g. for stature) and demographic analysis (e.g. age and sex) was undertaken during fieldwork recording. No fractures or perimortem trauma were recognised in the course of excavation.

The Royal Naval Hospital, Deal, Kent (pre-1795 and 1812- 1869)

Workmen digging service trenches in the grounds of the Royal Marine Barracks, Deal, previously the site of the R.N. hospital burial ground (pre-1795), excavated four young children, three male and two unsexed adult skeletons (Anderson 2002). Two juveniles, three adult males, an adult female and an unsexed adult (dated 1812-1869) were recovered from another trench beyond the burial ground (Anderson 2002). Patients were predominantly seamen and marines, of whom a high proportion was admitted between 1795 and 1805 (*Ibid.*), but some soldiers and prisoners-of-war were also treated in the hospital. The presence of a female and subadults under five years indicates a more mixed group. Anderson described a saucer craniotomy and a case of osteomyelitis but makes no mention of fractures. Thus, this report has minimal comparative value in this study.

The *Earl of Abergavenny* (1805)

In February 1805 an East Indiaman, the *Earl of Abergavenny,* was wrecked on her outbound voyage on the Shambles Bank off Portland Bill near Weymouth. Over 250 seamen, soldiers and passengers (including one female) of the total 387 onboard were drowned. Underwater excavation by the Weymouth Underwater Archaeological Group from the 1970s, recovered 180 co-mingled human bone elements scattered across the wreck (Armitage 2002). No skeletal inventory or MNI was given, but three male pelves are mentioned in the skeletal report, and there were three crania of individuals aged 28-35 years (based on cranial suture closure and dental attrition), with 86.4% of the skeletal elements aged 16- 25 years (by epiphyseal fusion). There did not appear to be an attempt to sex the skulls or estimate age from the pelves. Adult stature was estimated as 5’3’’ to 5’11’’ (mean of 5’7’’), using Trotter and Gleser’s (1970) methodology on multiple elements (number not given).

There was no discussion of pathology, with the exception of the antemortem tooth loss of molars in three mandibles, and the identification of '*a very much (abnormally) developed pectoral ridge'* at the humeral insertion of the *M. pectoralis major* in one gracile individual (Armitage 2002, 5)- presumably a large enthesophyte. Armitage ascribed this lesion to strenuous activities of a sailor, such as lifting and pulling on ropes. Overall, this report has limited comparative value, as it describes only a very small, comingled dataset, lacks essential quantification (such as MNI) and fails to employ many standard methodologies. Minimal pathology was identified.

Ascension Island (1830s)

In 2009, a pilot excavation in a R.N. burial ground on Ascension Island, headed by Julie Roberts of Cellmark, exposed a single adult male burial presumed to be a R.N. seaman or marine. During the R.N.'s crackdown on the slave trade in the 1830s-40s, many R.N. seamen contracted tropical fevers off West Africa, died and were buried on the island (Karl Harrison 2011 pers. comm., 2011). This is probably one such casualty. No osteological report is forthcoming.

Modern British trawlermen (1970- 1976)

Medical logs from the British goverment's trawler support ship *Miranda*, which record the on- board treatment of 966 sick and wounded trawlermen in the arctic fishing grounds between 1970-1976, revealed that approximately two-thirds of cases were medical (many minor), whilst 340 men (35%) were treated for trauma (Cross 1985). Over 80% of injured trawlermen of known occupation worked on deck. Severity of injury varied considerably, but 81 fractures, five amputations, three dislocations and three palsies were noted in 71 patients. Hand injuries (including four traumatic amputations) were most common, mostly due to trapping a digit in machinery or between warps. Fourteen hands had suffered fractures (seven being compound). With the exception of one scaphoid fracture, these were of the phalanges or metacarpals. Open hand wounds were particularly prone to infection.

Although most head injuries were minor, there were two fractured skulls, two fractured mandibles, two badly displaced nasal septa and six broken teeth, as well as facial bruising, scalds and eye

injuries. One head injury following an engine room explosion was fatal. Another fatality was a drowning, possibly suicide. The Department of Trade statistics indicate that 55 of the 89 fatalities at sea in this period were the result of drowning (*Ibid.*).

Contusion of the chest wall was very common. In 19 individuals rib fractures were diagnosed, but only radiographically confirmed in nine. Complication of haemothorax and pneumothorax were present in two cases. Spinal injuries were all sustained by falls, or being buffeted by the elements whilst on deck. No vertebral fractures were recorded, but there were three whiplash injuries and one traumatic prolapsed intervertebral disc. Traumatic abdominal injuries were rare, comprising two minor pelvic fractures, an inguinal hernia following a fall, and a ruptured kidney in a deckhand had been thrown against heavy machinery.

Upper limb trauma comprised six radial and ulna fractures (including one Colles' fracture), one clavicular and one humeral shaft fracture, and a traumatic amputation of the humerus when the limb was trapped in a warp. Two shoulder dislocations were reduced aboard the *Miranda*. One individual suffered a radial palsy following a blow to the arm.

Lower limb fractures included two femora, a 'bumper fracture' of the knee, three tibia and fibula, and five involving the ankle joint. Most common ankle injuries were inversion strains, sometime resulting in fracture. Contusions, lacerations and several traumatic knee effusions were also recorded (*Ibid.*). Foot fractures included a compound fracture of the first metatarsal, and single foot with multiple phalangeal fractures.

There are considerable differences in craft, working environment, equipment and daily occupational tasks between modern trawlermen and 18th century R.N. seamen. This undoubtedly results in different trauma patterning. For example, modern trawlermen do not go aloft, or trim sails by heaving on ropes. Modern machinery has replaced sail power and mechanised many tasks, such as raising the anchor and tacking against the wind. Modern trawlers are often much smaller than many

of their 18th century counterparts, and stay at sea for much shorter periods. Nevertheless, both groups of seamen are exposed to inclement weather at sea, which results in falls, crush injuries, contusions and lacerations, hypothermia and most seriously, in drowning.

Appendix 3. Archaeological and historical background to the burial grounds

3.1. Introduction

The four skeletal assemblages that form the basis of this study were archaeologically excavated from the burial grounds associated with the Royal Hospitals Greenwich, Haslar and Plymouth. Site reports on both Greenwich projects have been compiled, but reports on the latter two projects are outstanding. This appendix provides a more detailed historical background to each burial ground, and description of the archaeological excavations undertaken, than is appropriate in the main body of this thesis.

This section examines historical sources for the scale, duration of use and subsequent disturbance of graves within the burial grounds, and as well as the composition of the burial assemblages. From the archaeological context, this section also examines the archaeological findings from watching briefs, evaluations and excavations undertaken within the burial grounds. This includes the circumstances of archaeological investigations, fieldwork methodology, truncation, soil conditions, and the differing nature of burial practices on the three sites.

3.2. Haslar Hospital, Gosport, Hampshire (1753- 1824)

Introduction

The grounds of Haslar Hospital, Gosport, contain one of the largest servicemen's cemeteries in Britain. Of more than 18,000 interments estimated from historical records (see Chapter 3), 48 of a total of 51 skeletons excavated by Cranfield University in 2007-2010 constitute the Haslar assemblage discussed in this thesis.

The hospital is located on Haslar peninsula, just south of Gosport (Fig. A3.1). To the south, the peninsula is bounded by the waters of Spithead, and to the north, by Haslar Creek. The eastern limit of the peninsula forms the western arm of the entrance to Portsmouth harbour. The hospital

precinct is enclosed by brick walls and wired fencing, the western limit of which encloses the Paddock.

Historical evidence for burial

Dating of the burials

Currently an open area of grassland within the hospital precinct to the south-west of the hospital, the Paddock has long been recognised as an area set aside for burial. Interments dated from the establishment of the hospital in 1753, and continued uninterrupted until the then Superintendent and Residential Commissioner Henry Garrett decreed a cessation of burial at the hospital in 1824 (Tait 1906). Garrett was appalled by the lack of respect shown to the dead before, during and after burial. For a brief period in the early 1820s, burial in the hospital grounds was prohibited, and Garrett arranged for patients to be interred within the parochial burial ground of the nearby village of Alverstoke. However, in 1826 the north-eastern area of the Paddock was enclosed by brick walls and was consecrated. Until its closure in 1859, it served as the sole burial ground of the hospital.

Today the cemetery is known as the Garden of Remembrance. After 1859, Clayhall cemetery, Alverstoke, replaced the Garden of Remembrance as the R.N.val cemetery of Haslar. To this day, the road between the Haslar Hospital and the Clayhall cemetery is known locally as 'Deadman's Mile' (Boston 2005).

Size and composition of the burial assemblage

Although the only available hospital burial registers postdate the Paddock burials (Alderson 1958), Hospital Musters provide considerable insights into the size and composition of the burial population. It principally comprises R.N. ratings, but also small numbers of naval officers, soldiers, foreign seamen and servants. Historical research indicates that more than 17,300 seamen and marines admitted from ships were buried in the hospital grounds (see Chapter 3). Most were

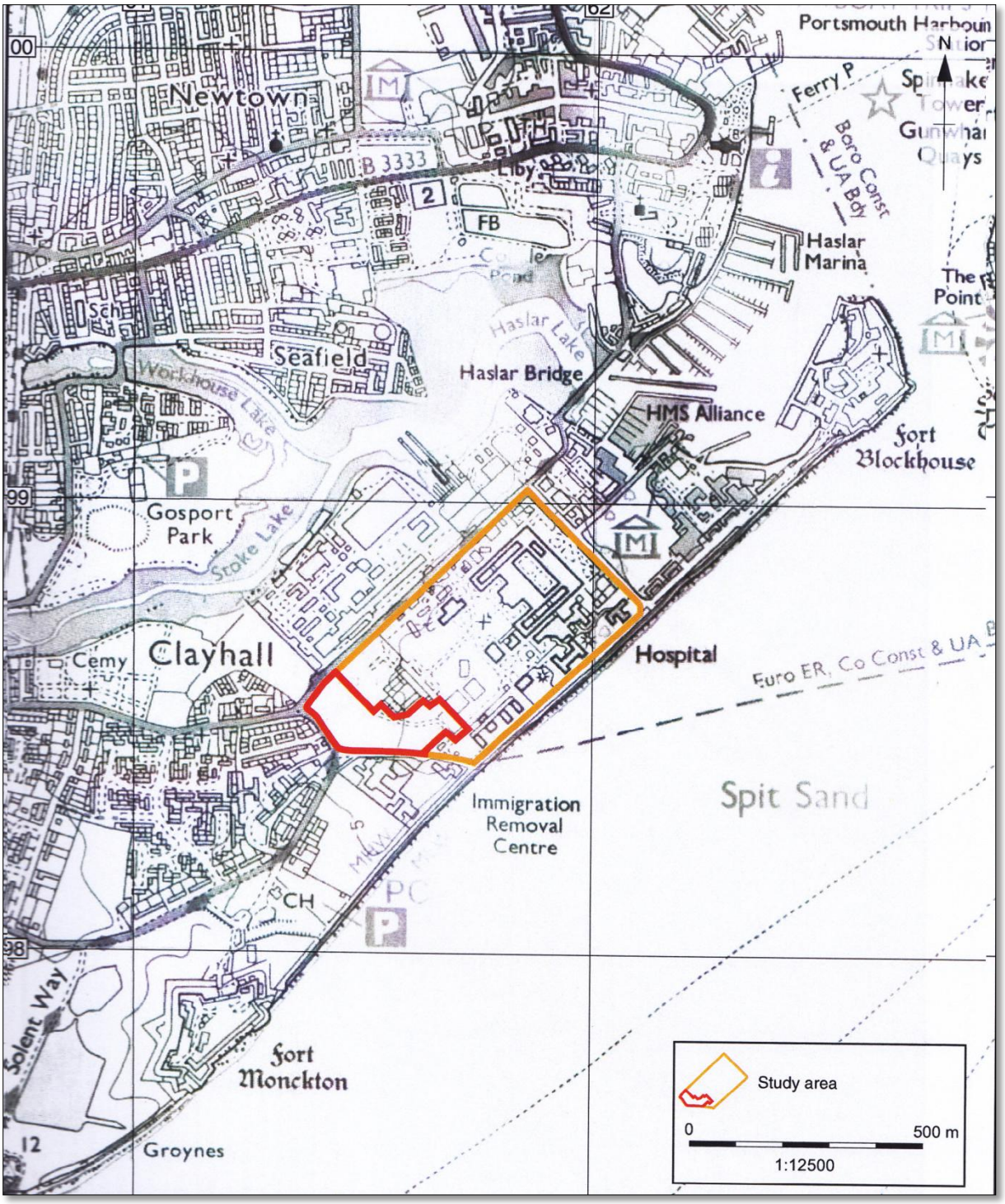


Figure A3.1 *Location of the study area on a modern map of Haslar peninsula. The area outlined by orange is the hospital grounds; the area in red is the Paddock (courtesy of Oxford Archaeology).*

hospital patients, but also occasionally included naval personnel who had died in ships moored at Spithead, or just prior to their arrival there (Haslar Hospital Musters 1792-1824). The overwhelming

majority listed in the Musters were ratings, but a few petty officers were also included (*Ibid.*). Commissioned officers who died in the hospital were commonly buried at private expense elsewhere, often in the parochial churchyards of nearby Alverstoke and Portsea. However, eight extant, albeit weathered tombstones placed against the south-eastern wall of the Garden of Remembrance predate its establishment, and are believed to have originally been in the Paddock. These include dedications to several lieutenants and one Captain Millard, a Trafalgar veteran and commander of the H.M.S. *San Juan* (Boston and Mahoney 2005).

Whilst most burials were of hospital patients, Haslar became the final resting place of several other groups of unfortunates. A specific tragedy involved the sinking of the *Royal George* off Spithead in 1782, where approximately 800 R.N. seamen lost their lives. Many of the drowned were washed ashore at Haslar and were buried in the Paddock, whilst others were recovered in Portsmouth harbour and buried in the town. It is uncertain how many people went down with the ship and were never recovered, and how many washed ashore at Haslar and were buried there (Tait 1906).

In addition to R.N. seamen and marines, small numbers of hospital servants, such as laundresses, nurses, groundsmen and administrators were interred at the hospital (Haslar Hospital Musters 1792-1824), the first two being very exposed to infectious diseases carried by patients or in their dirty linen. Certainly, one female skeleton was identified in the Haslar excavations but was not included in this analysis.

In 1809, 2,427 of a total of 28,000 British soldiers evacuated by ship from Corunna were temporarily quartered at Haslar (Crumplin and Starling 2005). An estimated 405 (17%) died of complications of wounds, privation and disease acquired on that gruelling campaign. Many more succumbed to typhus contracted aboard the overcrowded, louse-ridden transports, which returned them to England. This infection assumed epidemic proportions, and raged through Portsmouth and much of Hampshire with great loss of life (Crumplin and Starling 2005; McGrigar 2000).

Other interments at Haslar included small numbers of French, Russian and American prisoners-of-war, and a few crew members of Turkish men-of-war (Boston 2005). The last were buried in 1850 in a small separate area located immediately adjacent to Paddock (Tait 1906). The skeletons and headstones were later disinterred and relocated to Clayhall cemetery, Alverstoke, when the Zymotic Hospital was constructed in 1902 (Williams undated), and hence cannot form part of the skeletal assemblage.

Limits of the burial ground

A high brick wall of 18th century date demarcates the north-western limits of the Paddock from the rest of the hospital grounds. The Paddock formerly included the buildings and gardens of the Terrace, a row of three Georgian houses (founded in 1798) and the Garden of Remembrance (1856) (Fig. A3.2). Certainly, burials are reported to have been disinterred when the Terrace was constructed, and again when a portico was added to the Governor's house in 1904 (Tait 1906). Recent tenants of the Terrace described frequent disinterment of human bone during gardening and fox and badger digging (Boston 2005).

Historical reports of the early 19th-century record that the Paddock was '*thick with buried bodies and scattered tombstones*' (Lloyd and Coulter 1963, 224), and that it was common to unearth skeletons a few feet beneath the ground surface. Given the sheer number of interments known from the hospital musters, it is improbable that burials were confined to the original Paddock area, as was previously thought (e.g. by Tait (1906). This is even more improbable when recent archaeological evaluation (Boston 2005) revealed that only the northern half of the Paddock was utilised for burial, and that most graves were single interments (see below).

Numerous modern anecdotes of hospital groundsmen and administrators describe the discovery of human remains during construction work and landscaping much more widely within the hospital grounds (Boston 2005). This included plastic bags of human bone collected during the construction of the modern hospital wing, the Crosslink, in 1984. These were later reburied in the PaddocK

(Boston and Mahoney 2005). In 2010, Dr Andrew Shortland of Cranfield University and the author were shown photographs of disarticulated human bone and possible coffin grips reportedly from the Crosslink site.

To the south of the main hospital building, human remains were also discovered during groundworks for the present gatehouse on Haslar Way, opposite St Luke's Church, and the sentry post on Dolphin Way (Boston 2005). Burial within the 18th century hospital building itself is also suggested by the reported discovery of carefully laid out articulated skeletons beneath the floors of the basement of the northern hospital wing in modern times (Andrew Shortland 2013, pers. comm.).

Articulated human skeletons were also discovered beyond the hospital precinct to the north-west of Haslar Road, immediately west of the Gunboat Yard during construction of a new road (Boston 2005, 4). Unlike the basement burials, these individuals were densely packed together and did not appear to have been interred in separate graves. They assumed multiple body positions, including the vertical. Boston (2005) interpreted this as evidence of the dumping of corpses into the mudflats of Haslar Creek (possibly those who had died aboard ship), but an alternative explanation may be mass graves dug at times of contagious disease outbreaks, such as the Corunna typhus epidemic (Andrew Shortland 2011 pers. comm.). These interpretations have not as yet been supported by archaeological or historical research. This haphazard burial is in stark contrast to the orderly arrangement of single graves within the Paddock itself (see below).

Burial practices

Hospital musters (1792-1824) and payrolls (Haslar Hospital Payrolls 1802-1805) indicate that the vast majority of seamen and marines were buried at R.N. expense. However, towards the end of the Napoleonic Wars, an increasing but still small number of ratings are recorded as being buried by friends or family, most commonly by mothers or widows. Most were interred within local churchyards of Alverstoke and Portsea, but a minority elected to hold a private funeral in the hospital ground. The reason for this change is unclear, but may reflect the wider trend for

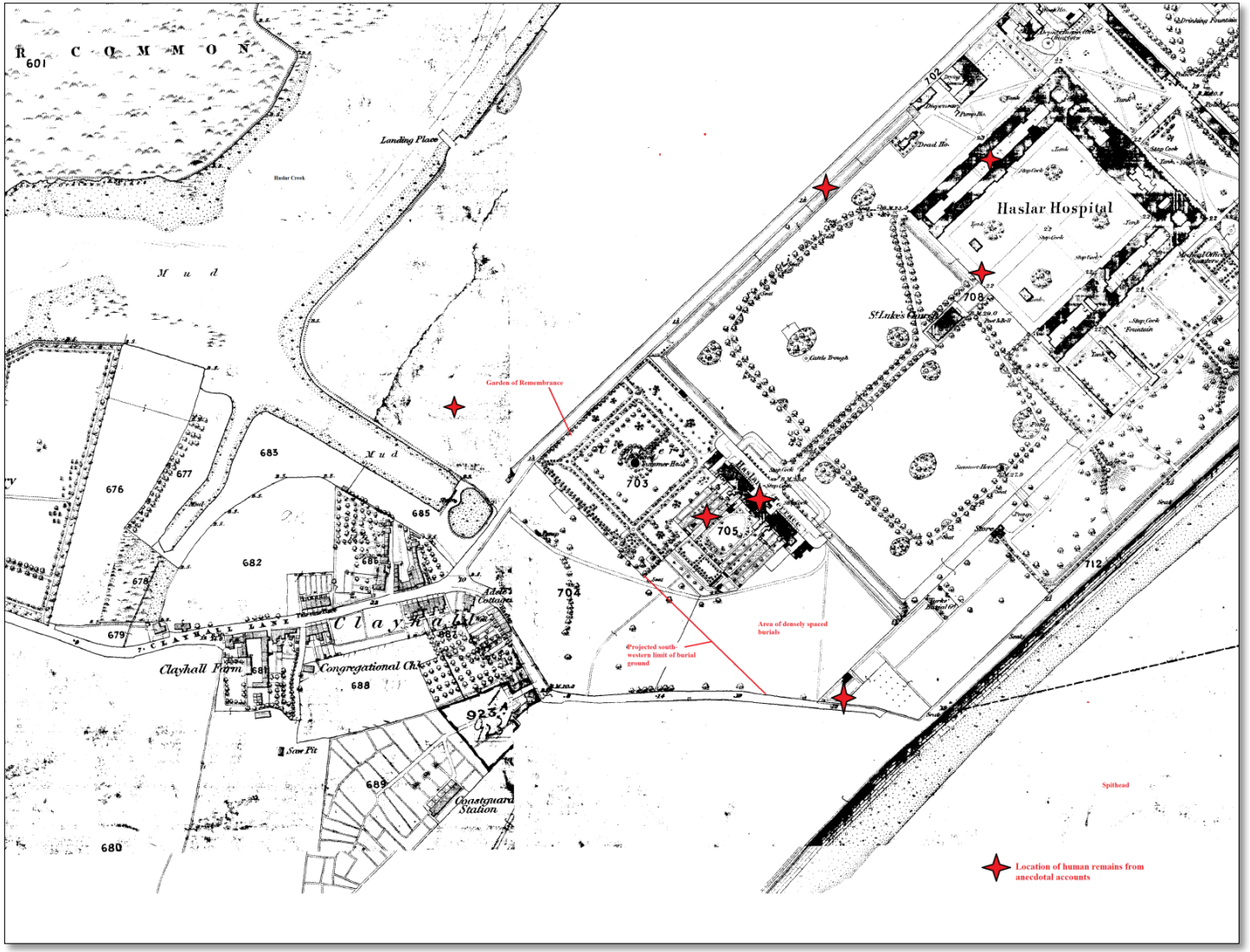


Figure A3.2 *Haslar Hospital showing the location of burials, the Paddock and the Memorial Garden, amended O.S. map 1867* (Sheet LXXXIII II)

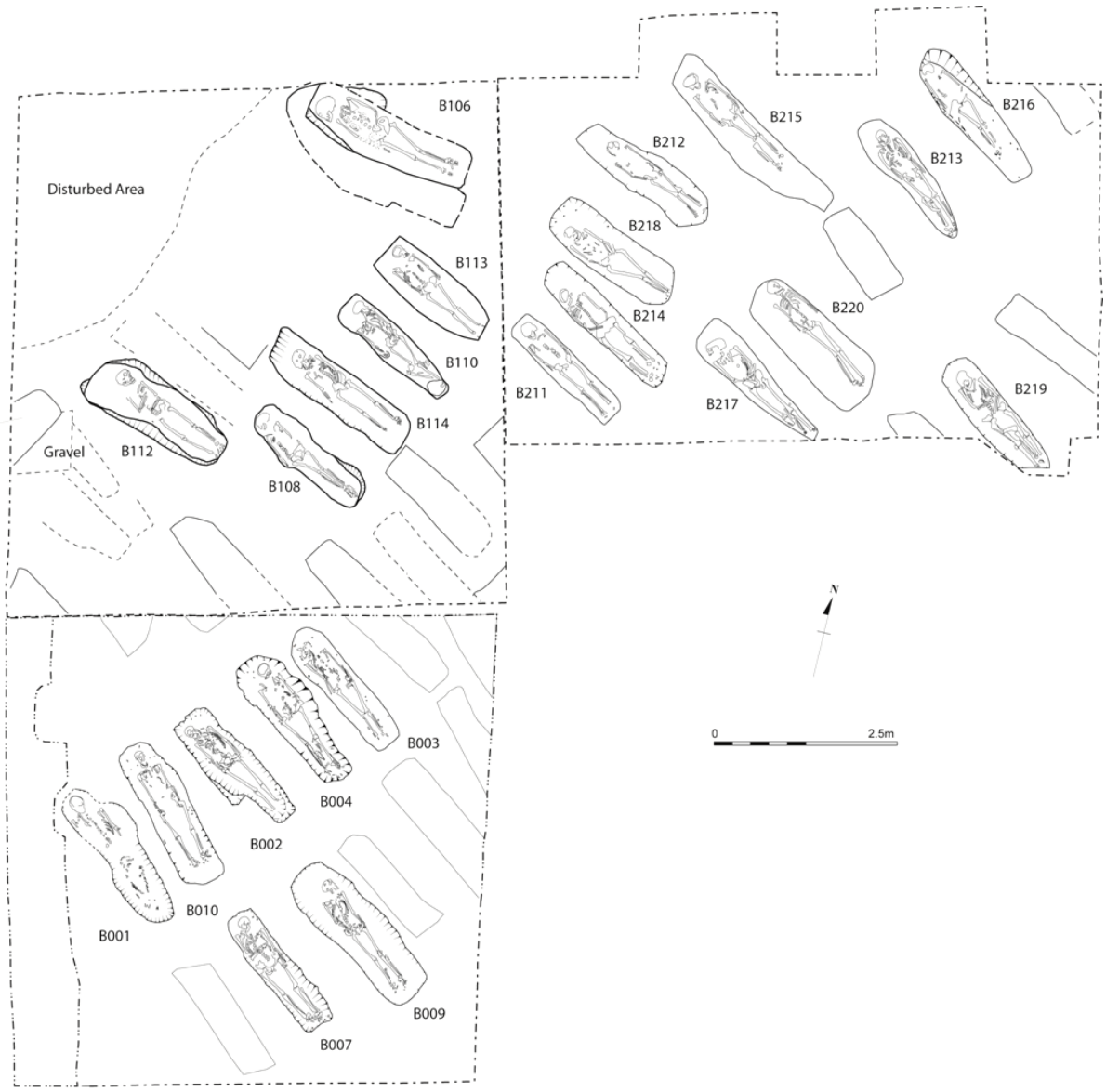


Figure A3.3 *Burials within the main trench of Cranfield University excavations of 2007-2009. The unexcavated quadrant was excavated in 2010 (courtesy of Cranfield University)*

increasingly elaborate funerary display and mourning ritual in the late Georgian period, which reached its zenith in the 1840s (Litten 1991). Even amongst the poor, giving the deceased a 'good send off' was an important signifier of one's grief, but also acted as a potent reflection of the mourners' social status and very respectability (May 1996). It is possible that private ratings' burials reflect this preoccupation amongst the mourners. A similar trend was also observed at Plymouth Hospital in the same period.

When Garrett began his burial reforms at the Haslar in the 1820s, the Paddock was littered with tombstones (Tait 1906), but these were 'tidied away' when the Garden of Remembrance was opened. None are upstanding in the Paddock today, bar one much later grave, believed to be of chaplain Lt Randolf Capel, who is thought to have committed suicide in 1858, and hence was excluded from the consecrated ground of the Garden of Remembrance (Boston 2005). No recumbent memorials were discovered during excavation.

Archaeological investigations 2005- 2010

Introduction

To naval and architectural historians, the buildings and grounds of Haslar Hospital are of considerable interest. Within its precincts, there are no less than 64 listed structures (English Heritage Archaeology and Buildings Record 2005) of which many, including the main hospital building, are Grade II listed. In comparison, there has been a relative dearth of archaeological investigations, with the exception of a small watching brief undertaken by Southampton City Council Archaeological Unit in 2003, and small-scale trial trenching in the lawn in front of the Terrace in 2006 (Buxton 2006). Howeverr, neither excavation revealed burials.

Oxford Archaeology evaluation 2005

In 2005, Oxford Archaeology (OA) was commissioned by the Ministry of Defence (then landowners of the hospital) to undertake a desk-based assessment (Boston and Mahoney 2005) and

archaeological evaluation (Boston 2005) within the Paddock (NGR SZ6150 9849). The aim of the evaluation was to establish the scale, depth, extent and character of the burials in this area. This work was part of a much wider land value assessment in advance of the sale of the hospital and its grounds.

The OA evaluation comprised mechanical excavation of 11 trenches to the top of the archaeological horizon (0.3 m to 1.75 m beneath the present ground level) or to natural geology. The trenches were located across the Paddock, in order to best represent the archaeology across the entire area. In the main the archaeology comprised grave cuts. The number, depth, dimensions and orientation of the graves were recorded. A sample of 19 skeletons was excavated to reveal bone condition, number of burials per grave and associated grave goods and coffins. An osteological assessment was conducted with the skeletons *in situ*, but no skeletons were removed. Following the evaluation trenches were mechanically backfilled.

Burial environment and bone preservation

The evaluation revealed extensive modern deposition of building debris and made ground across the Paddock, becoming increasingly deep towards the south-west of the site. It became apparent that there was a considerable downward slope of the natural topography in this direction. A 1754 map of the Haslar peninsula, dating to immediately before construction of the hospital, and an 1867 Ordinance survey map (OS Sheet LXXXIII II) suggest the sinuous south-western limit of the Paddock had been a waterway or palaeochannel linking Haslar Creek to Spithead. The heavy clays found in the south-western half of the Paddock are consistent with this interpretation.

The geology of the north-eastern half of the Paddock was very different, comprising loose gravel and sand beds, interspersed with areas of dense orange clay-silts or brickearth. The latter geology was most evident in trenches closest to the Garden of Remembrance. The composition of these two soil

types was responsible for very different bone preservation of the skeletons in these areas, with considerably more leaching of the bone mineral in the acidic gravels.

Nature of the burials

All trenches in the north-western half of the Paddock contained neat rows of largely parallel and closely spaced graves on a south-west- north-east or north-west- south-east alignment, with the head of the grave away from the shoreline of Spithead (Boston 2005). These orientations were either parallel or at right angles to the orientation of the main hospital buildings and perimeter walls. The south-eastern limit of burials was broadly in a line with the back wall of the Garden of Remembrance. Wall footings on the same alignment were discovered in Trench 2 of the 2010 Cranfield excavation, strongly suggesting that this later wall (*c.*1826) followed the line of an earlier limit of the original burial ground. To the south of this line the natural topography dropped off fairly sharply to the south, and the geology of heavy clays and probable high water table would have made this area unsuitable for grave digging.

A total of 169 graves were revealed. Of those excavated, most were single interments, although one grave contained at least three individuals and another four. Both graves were located towards the southern limit of the burial ground.

Most of the dead were buried singly in shallow sub-rectangular graves at a depth of 0.38 m to 1.2 m below the present ground surface, the shallowest being located closest to the hospital. The shallowness of graves in this area concurred with findings during the excavation of a very large pipe trench in the north-western side of the Paddock in 1980 (South- East Geneology Society 1974). The pipe trench truncated numerous graves at a depth of 18 inches below ground level. Some skulls collected during the works were housed in the Institute of Nautical Medicine in Alverstoke until reburial with the rest of the Haslar assemblage in 2011. The pipe trench was identified in Trench 19 of the OA evaluation.

Contrary to the widely documented belief that the Haslar dead were buried only in their hammocks (Tait 1906; Revell 2000), most graves were sub-rectangular rather than cigar-shaped, and iron nails were located in the base of the graves- findings consistent with burial in plain wooden coffins. The graves were unfurnished, and there was a complete absence of the metal coffin fittings so ubiquitous in this period. This suggested that none of the excavated burials had been private interments. Indeed, the regularity of grave spacing, orientation and unadorned coffins strongly suggested all were regulation navy burials, possibly excavated as 'job lots'. This bulk burial approach is supported by the documented complaints by the chaplain of Alverstoke that his parochial duties were being interrupted by having to ride from his parish so frequently to bury the dead at Haslar. Refusal to perform the burial rite piecemeal lead to piles of unburied dead being left in the Paddock, to the disgust of nearby householders, who in turn complained to the Haslar authorities about the stench (Tait 1906).

Cranfield University archaeological excavations 2007- 2010

On the basis of results of the 2005 OA evaluation, a research excavation project headed by Dr Andrew Shortland of Cranfield University, Shrivenham, was undertaken, with fieldwork seasons in 2007 to 2010. A preliminary report on the first two years of excavation was compiled (Shortland 2007; Shortland et al. 2008), but the final report is still outstanding.

All human remains were reburied within the Paddock in May 2011.

Description of excavation

The Cranfield excavations comprised re-excavation and extension of Trench 19 of the OA evaluation, targeted as the location where skeletons were better preserved. Graves located entirely within the trenches were excavated and the skeletons recorded and removed and processed on site.

Further trenches were located close to the Garden of Remembrance, and in the north-eastern part of the Paddock. Trial trenches (1m x 2m) were excavated to north of the Paddock and south of the

Church of St Luke in the hospital gardens. No human remains were recovered from the trial trenches, but considerable disturbance by modern landscaping was evident.

Results of the excavation

In total, 51 articulated skeletons and a small quantity of charnel were excavated. The general nature of the grave arrangement in terms of depth, orientation and spacing concurred very closely with the OA findings (see above). Most graves contained a single inhumation, the exception being one grave located just beyond the southern wall, which contained a female and an adolescent possible male skeleton. In this trench, there was also rare evidence for grave intercutting of two pairs of graves, the earlier being staggered by parallel to one another. The latter showed slight disarticulation of elements strongly suggestive of early decomposition before interment. This may well have been one of the corpses left to putrefy until the Alverstoke vicar saw fit to conduct the funeral. A second example of grave intercutting occurred in the northern most Paddock trench, where the grave of craniotomised skeleton 103 cut an earlier burial. These were the only six graves where relative chronology could be established. There is no historical or archaeological evidence of the sequence of burial within the Paddock.

Iron nails associated with the skeletons indicated that most burials were coffined, and all but one was unfurnished. Remnants of surviving coffin wood have been identified as pine (Andrew Shortland pers. comm. 2009). There were no clothes fastenings to indicate that they were dressed when buried, but discrete patches of copper alloy staining on skeletal elements and a few pins suggest that they had been laid out in shrouds secured by pins. Attached to one pin was a fragment of loosely woven textile. This pin and textile was located near the left forearm of skeleton 215, the left radius and ulna of which showed active periostitis. This tentatively suggested a bandage over an infected wound.

The only individual to be buried with a personal item was skeleton 231, discovered with a bronze Anti-Slavery medallion, on one side depicting clasped hands, and on the other a kneeling chained slave and the Abolutionist motto '*Am I not a man and a brother?*'. These medals were issued around 1793 at the height of Wilberforce's campaign to abolish slavery (Catherine Sinnott 2012 pers. comm.), and gives a vivid insight into the personal convictions of this individual.

Bone preservation was very variable across the site. The best preserved skeletons were located in pockets of brickearth close the Garden of Remembrance and the southern limit of the burials. The worst bone preservation was found in the backfilled OA trench (primarily sand and gravels), which showed marked deterioration in the intervening two years. This is presumably due to increased temperature fluctuations and greater egress of oxygen during the two weeks of the OA evaluation, and changes in soil composition and compaction following re-instatement of the soil at the end of the evaluation. These deleterious effects on bone preservation were observed in all skeletons in the OA trench, including those that had not been exposed in 2005.

3.3. Stray Park cemetery, Plymouth (1762- 1824)

Introduction

Unlike Haslar and Greenwich, the earliest burial ground of Plymouth Hospital was not located within the hospital grounds but approximately a mile away at Stray Park (Fig. A3.4). Although there has been some debate about its precise location, documentary analysis by John Pamment-Salvatore (Exeter Archaeology 2008) has strongly identified it with a burial ground unexpectedly discovered in 2007 during ground works in a former car showroom at Athenaeum Place, on the corner of Athenaeum Lane and the Crescent (NGR: SX 4748 5428). The excavation area comprised approximately a tenth of the total area of the burial ground.

Exeter Archaeology was commissioned by the developer to undertaken an archaeological excavation in advance of redevelopment. Due to commercial issues, Exeter Archaeology completed most of the

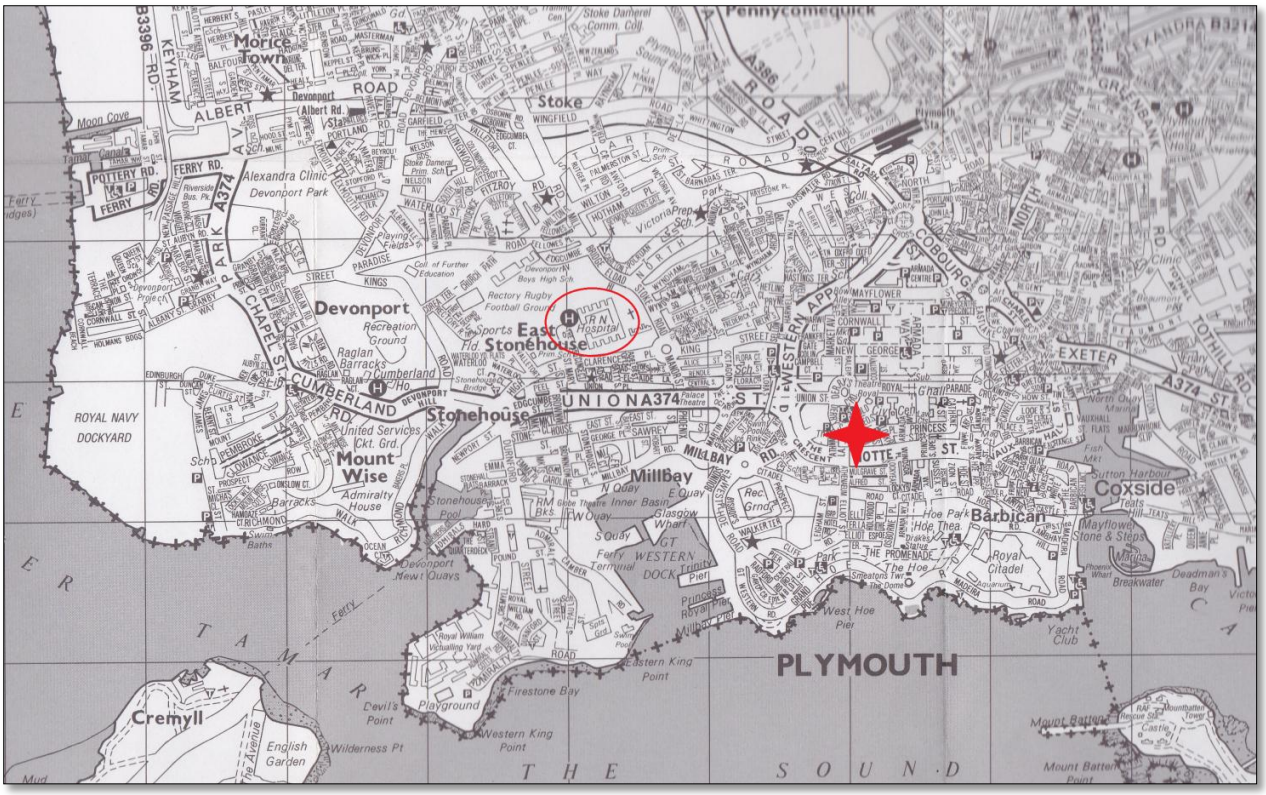
excavation but very little post-excavation synthesis was undertaken. Thus, digital plans were incomplete, and there is no site narrative on which to draw. The site description below is based on primary site records, such as context sheets, site photographs and incomplete plans, kindly supplied by Exeter Archaeology. The skeletons were processed in the Institute of Archaeology of Oxford University prior to analysis.

Historical background

Dating and location of Stray Park burial ground

Unlike the wide area over which the Haslar burials were distributed, Stray Park cemetery was very much more contained, comprising an estimated 1.03 acres (Exeter Archaeology 2008). The land described variously as 'Pinfold' or 'Stray Park' was never owned by the R.N., but was rented from the Major and Communality of the Borough of Plymouth in three consecutive leases of 21 years, beginning in 1764, and renewed in 1785 and 1806 (Commissioners for the Sick and Hurt Board and Major and Communality of the Borough of Plymouth 1785 and 1806). Thus, the burial ground was in use shortly after the hospital was founded, until No-Place Field replaced Stray Park as the Royal Hospital burial ground in 1824. The former was purchased by the R.N. in 1756 (Reese 1962), and was located immediately adjacent to the hospital (Pugh 1972).

Why Stray Park was preferred as the hospital burial ground for 62 years when the R.N. owed a more conveniently located piece of land is not immediately apparent, but may be due to the unusual geology in the former. Most of the surrounding geological substrate in Plymouth is impenetrable corn brash but the Athenaeum Lane area is located on clay- possibly an easier substrate for grave diggers to excavate (John Pamment-Salvatore 2011 pers. comm.).


Morice Town
Devonport
Stoke
Stonehouse
East Stonehouse
Mount Wise
Millbay
Coxside
Barbican
PLYMOUTH
Cremyll
ROYAL NAVY DOCKYARD
Devonport Recreation Ground
Devonport Park
Raglan Barracks
Cumberland
Admiralty House
Devonport New Quays
Millbay N Quay
Millbay E Quay
Inner Basin
W Quay
Glasgow Wharf
Ferry Terminal
WESTERN DOCK
Royal Citadel
The Hoe
West Hoe Pier
Eastern King Point
Western King Point
Firestone Bay
Devil's Point
Wilderness Pt
English Garden
Mount Batten
Mount Batten Point
THE SOUND
TAMAR
Ferry
Royal Hospital
Sutton Harbour
Mayflower Stone & Steps
Breakwater
Deadman's Bay
Yacht Club
Pennycomequick
Plymouth
Moon Cove
Canals
Alexandra Clinic
Playing Fields
Rectory Rugby Football Ground
Sports Fld
Coll of Further Education
Devonport Boys High Sch
Victoria Prep Sch
Stoke Damerel Comm. Coll
Stoke Damerel Prim Sch
Palace Theatre
Theatre Royal
Guildhall
Civic Centre
Museum
Art Gallery
Library
Post Office
Fish Mkt
Hoe Park
Hoe Thea.
Hoe Baths
Pier
Royal William Victualling Yard
Playground
Swimming Baths
Barracks
Admiralty House
Pool
Stonehouse Bridge
Stonehouse Creek
Ct. Grd.
United Services
Schs
Rec Grnd
Brakes
Aquarium
Dome
Yacht Club
Mount Batten Tower
Castle
Breakwater
Ferry
Pier
Quay
Wharf
Dock
Basin
Bks
Pool
Creek
Bridge
Gdns
Park
Hill
Road
Street
Avenue
Crescent
Terrace
Place
Square
Grove
Walk
Walkway
Promenade
Barracks
Hospital
Theatre
Museum
Library
Post Office
Fish Mkt
Civic Centre
Art Gallery
Coll
Sch
Schs
Prim Sch
Boys High Sch
Comm. Coll
Recreation Ground
Playing Fields
Sports Fld
Rectory Rugby Football Ground
Coll of Further Education
Devonport Park
Alexandra Clinic
Canals
Moon Cove

Capt Richard Creyke was one of the most successful and long standing governors of Plymouth Hospital (Pugh 1972; Reese 1962). The memorandum that he kept between 1795 and 1799 gives vivid insights into the daily administration of the hospital (Creyke 1795-1799). In entries for February 1796, he describes the problems of contracting an inexpensive but reliable gravedigger who would also convey the dead to the burying ground. Due to the distance, the cheapest quote by a Mrs Hodge of 1 shilling and sixpence per burial was rejected because she kept no horse, and must hire



Figure A3.6 *Tithe map of Plymouth 1848: the approximate location of Stray Park burial ground is denoted by the red outline.(Source: Plymouth and West Devon Public Records Office).*

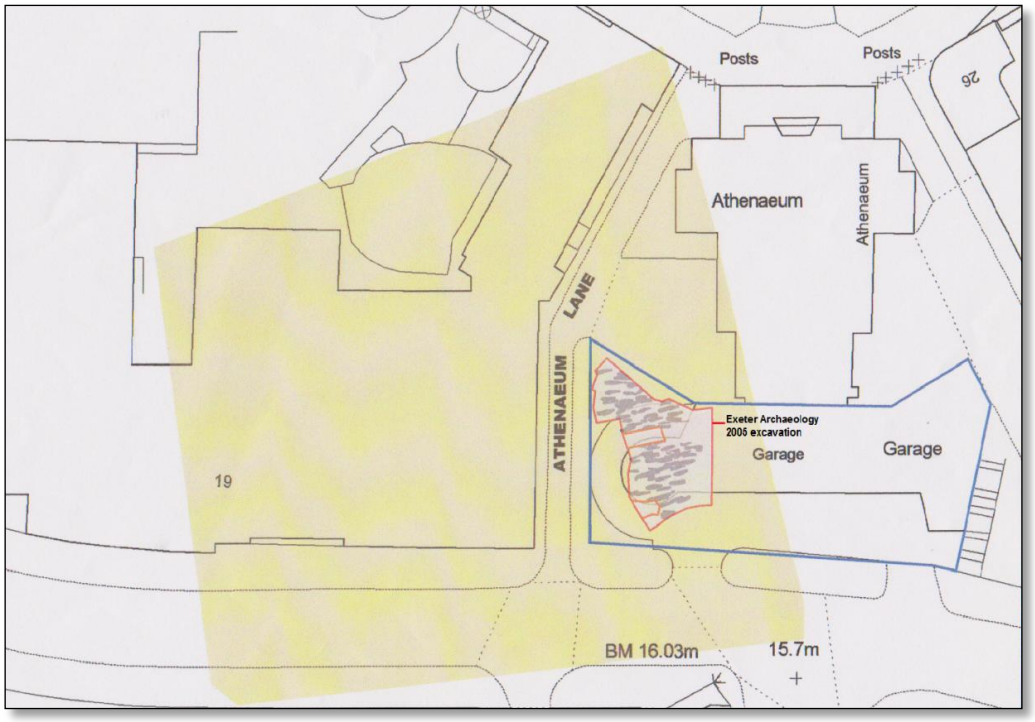


Figure A3.7. *Modern map showing the location of the Exeter Archaeology 2007 excavations. The buff shaded area is the total area of the burial ground projected from earlier plans (courtesy of Exeter Archaeology)*

one when needed. In consequence, he engaged a Mr Edey, but Creyke had to pay a penny and halfpenny more. One of the Sick and Hurt board stipulations was that burials must be six feet deep, which, commented Creyke, *'no labourer will undertake to do for less than a shilling'*. Due to extensive modern truncation in the area of the Exeter Archaeology burials, it is impossible to determine if this six-foot rule was obeyed.

Whilst Stray Park has long been recognised as the earliest burial ground of the Royal Hospital, some debate existed as to its precise location. It was described as lying within the Parish of St Andrew, but '*was not parochial but peculiar, as belonging exclusively to the Royal Naval Hospital at Plymouth*' (Pugh 1972, 20). Despite this distinction, the vicar of St Andrew's Church did officiate at seamen's funerals for a fee of one shilling and sixpence (Pugh 1972; Stray Park Plymouth Burial Register 1813-1814)- a similar arrangement to that that existed between the vicar of Alverstoke and Haslar Hospital.

Early maps of 1778/80 and 1784-6 of Plymouth identified an area lying south of the lane connecting Great George Street with Millbay Prison as the '*hospital burying ground*' (Exeter Archaeology 2008) and is shown on a slightly later map of 1820 (Fig. A3.5). During its most of its use as a burial ground, Stray Park lay within undeveloped land, much of it marshland. Dr Thomas Trotter, one time Governor of the Hospital, posthumously remembered as chief instigator of lemon juice rationing in the R.N. to combat scurvy (Vale and Griffith 2011), decried the lack of a decent burial ground for seamen and marines at Plymouth. In 1803 he wrote to Admiral Sir Roger Curtis

> *'Amidst the deficiencies of Plymouth Hospital a contiguous decent burial ground is much wanted. The present one is* ***a bit of wasteland*** *belonging to the Corporation of Plymouth, where seamen have such a dislike of being laid, that on dying, if they have any money as will defray the expense of being carried to a churchyard, they leave a Will to that effect. The regards of a grateful country ought not to quit the brave men in death: his cold remains should be interred with solemnity and guarded from insult: for these attentions inspire his living companions with a love of their country...'*
>
> (cited in Pugh 1972, 20).

From the turn of the 19th century, the area around Stray Park became more intensively built upon (Fig. A3.6). The Crescent and the Athenaeum (a public building containing a public library and lecture rooms) (Johnson 1827) were constructed over part of the burial ground in 1818-19 (Exeter Archaeology 2008). In this post-war period, burials numbers had dwindled to 16 to 48 per year (Plymouth Hospital Musters 1792-1824). In 1818, a small area of the burial ground was also recorded to have been taken to prevent a hedge at the north-eastern corner from projecting beyond the portico of the Athenaeum (Exeter Archaeology 2008).

In 1824, the Mayor and Commonality of Plymouth agreed to the demise of the burial ground in Lower Mill Prison Lane (the northern limit of the cemetery), leasing it to a Dr James Yonge for 1,000 years at a yearly rate of 20 shillings, in order to lay out a road communicating with Higher Mill Prison Lane. A condition of the lease was that the burial ground was never to be built upon penalty of forfeiture of the demise (Exeter Archaeology 2008).

This stipulation was clearly not adhered to, the area becoming very built up in the 19th and earlier 20th centuries, with several changes to the road systems. Local historian R. Worth described inhumations being disturbed during sewerage works in Athenaeum Street (Lane) in the late 19th century, as well as disinterment of skeletons in an 'excavation' in this area, the remains being reburied in Ford Park cemetery in 1897 (Exeter Archaeology 2008). Kearley (1881, 40) described that '*scarcely a yard of the ground in and around the Crescent can be disturbed but some human remains are turned up by the workman's shovel'.*

Plymouth suffered severe bombing during World War II, and this area of the city was particularly badly hit (*Ibid.*). In common with many parts of the city, rebuilding was slow, and several buildings in the immediate location of the Stray Park burial ground were still depicted as 'ruins' in the 1952 Ordinance Survey maps (1:2500 Plan SX4751), including the Athenaeum (*Ibid.*). Rebuilding of the area really only got underway in the mid-1960s, when the street layout was again altered and several old roads obliterated. Today, the burial ground lies beneath and to the east and west of Athenaeum Lane, and beneath and north and south of the Crescent. Its northern-most limit just abuts Derry's Cross (Fig. A3.7).

Around 1982, groundworks nearby (NGR: SX 4743 5429) disturbed human bones, pottery and leather shoes at a depth of 3-4 feet below ground level. It is suspected that there was considerably more unrecorded burial disturbance during basement construction in many other buildings in the vicinity (John Pamment-Salvatore pers. comm., 2010). It is uncertain how much of the original burial ground still survives.

Size and composition of the burial assemblage

Plymouth Hospital Musters indicate that 7,690 R.N. seamen and marines died in the hospital between 1764 and 1824 (Plymouth Hospital Musters 1792-1824). Most were interred at R.N. expense in Stray Park burial ground although, as at Haslar, in the 1810s and 1820s a small number

were buried at private expense in churchyards in nearby villages, such as Stoke Damerel and Stonehouse. The small scale of this private burial either refutes Trotter's claim that many seamen were so vehemently averse to burial in Stray Park that they saved money for a private funeral elsewhere, or that, whatever their sentiments, many just could not afford it.

Hospital musters did not include new R.N. 'recruits' dying aboard receiving ships moored in Plymouth harbour, nor marines dying in the Royal Marine Barracks at Stonehouse, who also were buried at Stray Park (Stray Park Plymouth Burial Register 1813-1814). Only two years of burial registers survive (January 1813 to December 1814). They date to the end of the Napoleonic Wars and the War of 1812 with America. It is impossible to know how representative these two years' registers are of earlier periods, but nevertheless they give interesting insights into the composition of the burial population in those two years (Table A3.1). Most of the 380 individuals listed were of known rank, of whom seamen and seaman boys comprised 71.9% of the group, marines and marine boys 25.8%, and an eclectic group of two assistant surgeons, two cooks, a carpenter, a pilot, a boatswain and a midshipman comprised the remainder (2.2%). The proportion of marines to seamen (26.2% to 74%) is much higher than was commonly found on board ship in this period (15-17%) (Floud et al. 1990; Fremont-Barnes 2005). This is probably due to the 34 deceased marines based at the nearby Stonehouse Barracks, one of the four main Royal Marine headquarters, barracks and recruiting centres of the period (Edwards 2005; Lavery 1989).

Table A3.1 Stray Park burial registers 1813-1814: composition of burial population (N = 380)

Rank	**Number**	**Percentage**
Seamen	247	65.00
Seamen boys	12	3.16
Marines	92	24.21
Marine boys	1	0.26
Warrant officers, idlers and midshipmen	8	2.11
American prisoners-of-war	2	0.53
Unknown	18	4.74
Total	**380**	**100.00**

Most seamen appear to have been transferred to the hospital directly from their ships, but in the burial registers a small proportion (4.2%) were listed under the hospital ship *Prince Frederick*. A larger component (7.9%) had been transferred either directly from the *Salvador del Mundo* or via the hospital. Captured from the Spanish in the Battle of St Vincent, the *Salvador del Mundo* had been an impressive first rater of 112 guns, but from 1803 to 1815 the ageing vessel was moored in Plymouth harbour, and functioned as a receiving ship for naval 'recruits' (Winfield 2005). Receiving ships held new 'recruits' until they were allocated to a ship. Conditions aboard were often filthy and overcrowded, and infectious disease, especially typhus, was rife (Adkins and Adkins 2008; Lloyd and Coulter 1963). It is uncertain what proportion of recruits had ever been to sea and, hence, how many of their skeletons reflect the rigours of naval life.

Two Americans, John Rose of the *Leyden* and Robinson of the *Akbar*, were undoubtedly seamen, but both had died as prisoners of war, presumably captured in the American War of 1812. Interestingly, they were buried amongst their erstwhile enemies, unlike other foes of the British, such as the French and Spanish. This inclusion suggests a more familiar attitude towards American seamen, one certainly held by Samuel Leech, who as a boy in 1812 serving aboard the frigate the H.M.S. *Macedonian*. After a bloody battle with the U.S. frigate the *United States*, the *Macedonian* surrendered to the American and was taken prisoner. Despite horrific casualties, Leech reported that afterwards British seamen and officers mixed convivially with their erstwhile enemies, even messing together (Leech 1857, 31). He concludes the passage with

'So close are the alliances of blood.... between England and America that it is to be earnestly desired they may never meet in mortal strife again. If either will fight, which is to be depreciates as a crime and a folly, let it choose an enemy less connected by the sacred ties of consanguinity'.

A separate section of the Stray Park Burial Register records that between the 14th and 31st of December 1813 44 French prisoners-of-war, received from transports and prison ships, were buried. Although the French funerals were conducted by the same vicar for the same fee, they were listed

quite separately. It is uncertain if these notions of separation or otherness were played out spatially in the burial ground.

The precise locations of the Royal Navy ratings and foreign prisoners-of-war burials are of considerable importance in determining the composition of the Athenaeum Place skeletal assemblage. Stray Park was leased in 1764 for the burial of '*for such as die in the King's Hospitals',* but the historians Worth and Whitfield, writing much later in 1890 and 1900, respectively, associated 'Strayer Park' with the nearby Westwell Street burial ground (in use from 1700- the 1850s) (Exeter Archaeology 2008, page unnumbered). Worth maintained that the ground '*now built over and known as the Crescent'* was the burial ground of French prisoners-of-war from the nearby Mill or Millbay Prison (Exeter Archaeology 2008, page unnumbered). Neither acknowledged that American and Spanish prisoners-of-war were also held in the Mill Prison (Cohen 1995). Nor did they cite their sources. Neither did Garland Coe (1989), who contradicts Worth in locating the R.N. burial ground of Stray Park '*roughly where the Crescent now stands*' and that '*in front of this, in the land occupied by Athenaeum Street* [to the south of the excavation area]*, were buried French prisoners-of-war who died in Millbay'* (Garland Coe 1989, no page numbers).

Still more confusing is an account by an anonymous 'Octagenerian' of Newcastle-upon-Tyne writing in the *Western Antiquary* of 1881-82*,* which supports and contradicts aspects of both Garland Coe and Worth's accounts. This worthy wrote

> *'The place that was the Crescent was formerly the burial ground for prisoners-of-war who died at Millbay Prison. I have witnessed the burials of many of them. They were taken from the prison gates to the grave in a cart made for the purpose drawn by a donkey belonging to old Samuel Fuge, who had the contract for the work. The upper part of the burial grounds was separated by a hedge from Dunsterville's rope walk that was between the ground and Mill Prison Lane, now Citadel Road'* [to the south of the Crescent between the Crescent and the Hoe]. (Anonymous 1881-1882, 107)

Much of this confusion about location may be due to the close proximity of Stray Park to the nearby Westwell Street burial ground (Exeter Archaeology 2008). Of course, it is possible that Stray Park

contained both foreign prisoners-of-war and R.N. ratings (as suggested by the 1813 and 1814 Stray Park burial records), which were spatially separated into distinct zones. If Garland Coe and the anonymous Octagenarian were correct in their assertions, the French burials lay close to or further south of Exeter Archaeology's excavation area.

The main purpose of the Octagenarian's account was to relate the affecting story involving a local boy and a Frenchman who had been buried in the grounds. A boy was in the burial ground one morning trying to catch birds with bird lime on a thorn bush. He hid in an open grave that already contained a coffin. In doing so, he was much alarmed and frightened by sounds emitting from the coffin beneath him. He ran down to the entrance gate of the burial ground, which stood near the site of the later Athenaeum, to summon help. Soon the coffin was opened to reveal a very alive and very relieved Frenchman. After convalescing in the Millbay Prison infirmary, the man was returned to France with an exchange of prisoners. On reaching home, he wrote to the Rev. Mends of the Batter Street Chapel, the letter enclosing five pounds. He requested the Reverend to find the boy, and to give him the money in thanks for saving his life. The Rev Mends duly did this, and the boy received annual instalments of five pounds until Frenchman's death four or five years later.

The above story gives some interesting insights. Firstly, the boy ran down to the entrance gate. Given the topography of the area, this suggests that the Frenchman's grave was south of the site of the Athenaeum and the Exeter Archaeology excavation. The account also indicated that, like R.N. ratings, prisoners-of-war were buried in wooden coffins, sometimes in multiple graves. In these features they were indistinguishable from R.N. ratings burials.

Athenaeum Place excavation 2007

Use of the burial ground

The Exeter Archaeology excavation of 2007 revealed approximately 170 articulated individuals. Unlike Haslar, the Stray Park burial ground had been very heavily utilised for burial, probably the consequence of its finite area. There was considerable intercutting of graves, such that few grave

cuts could be discerned (Fig. A3.7). As a result, a large number of skeletons were incomplete. Considerable charnel was also present, both within grave fills and in an overlying mixed soil layer 502 (possibly a levelling layer of previous construction on the site).

The site was mechanically excavated to the top of the burial horizon. Individual graves were then excavated by hand, recorded and removed. In view of health and safety concerns, a narrow strip of ground immediately adjacent to the modern road of the Crescent remains unexcavated, but probably still contains burials.

The upper levels in the excavation area had been truncated by building works. As such the original grave depths were unknown, and many more shallow burials were damaged. Indeed, many more may have been lost altogether (Exeter Archaeology 2008). The vast majority of skulls were crushed and incomplete. Nevertheless, overall bone preservation in the clay substrate was fair to good, although less compact bone, such as the vertebrae and ribs, was often fragmented.

Burial practice

Like Haslar, the dead had been laid out supine and extended in unadorned single break wooden coffins, archaeologically identified by clear outlines of decomposed wood and iron nails. Multiple interments were much more common here than at Haslar. Burial orientation followed the more traditional Christian west-east orientation, but graves equally may be aligned parallel to the burial ground's southern limit. Unfortunately, these features of burial practice did not distinguish between prisoner-of-war and R.N. rating burials.

Discrete patches of copper alloy staining on several skeletons and two copper alloy pins suggest that at least some corpses had been wrapped in a shroud. As at Haslar, there was a lack of clothes fastenings. The exceptions were three gilded copper alloy buttons with adhering textile, two in the double grave of skeletons 670 and 671, and one with skeleton 991. The former two buttons were most distinctive, being inscribed with a fouled anchor motif on the obverse, and the letters H, T and

D on the boss plate on the reverse. Gilded buttons bearing the fouled anchor motif were first issued in the R.N. in 1774 (Pamment-Salvatore 2010 pers. comm.). The letters probably signify the manufacturers Hammond, Turner and Dickenson. Dickenson joined as a partner in the firm Hammond, Turner and Son of Birmingham in 1796 (Osborne 1840), thereby providing a *terminus post quem* for this burial.

Although the lowerdeck did not have an official uniform at this time (Adkins and Adkins 2008), similar buttons do appear to have been worn by R.N. seamen. In his memoir, Samuel Leech described how he deserted from the vanquished H.M.S. *Macedonian* in New York, and feared being recognised as a British seaman on account of his buttons, '*the bright anchor buttons, which shone on my best suit, presented an insuperable objection. For how could I appear.... with the badge of the British service on my coat?*' (Leech 1857, 33). Leech circumvented this difficulty by prevailing on his landlady to cover the buttons with blue cloth. Copper alloy buttons depicting a fouled anchor have also been recovered from a late 18th century R.N. wreck off Bermuda. The excavators believed them to been royal marine uniform buttons (Watt and Krivor 1995).

The buttons associated with skeletons 670 and 671 offer the best archaeological evidence that the area of the Exeter excavation did indeed contain R.N. burials. The presence of several cases of unhealed amputations, including discarded limbs, also supports the interpretation that these were the dead from Plymouth Hospital. Whether the excavated skeletal assemblage also contains French or Spanish prisoner-of-war remains slightly uncertain but, given the antipathy felt by British seamen to these enemies, it is unlikely that they would have been buried together. However, some American seamen, both fighting for and against the British, may well have been buried there.

3.4. Greenwich Hospital, Greenwich, South-East London (1749-1857)

Introduction

Two developer funded excavations were undertaken to the south of the original hospital buildings within the ratings' burial ground of the Royal Hospital Greenwich in recent years (Figs A3.8 and A3.9). The first was an excavation by Oxford Archaeology (OA) in 1999- 2001, in which 104 skeletons were recovered (Boston et al. 2008). The second was a watching brief by Pre-Construct Archaeology (PCA) in 2009- 2010 (Pre-Construct Archaeology 2011), in which 17 skeletons were excavated. Of these, 94 skeletons from the OA excavations and six from the PCA watching brief constitute the Greenwich assemblage of this study.

Historical context to the burial ground

The ratings' burial ground, also referred to as the Old Burial Ground, was located to the rear of the original 17th century hospital buildings, in an area formerly known as Goddard's Ground (Fig. A3.8). Originally a 3.5 acres, the burial ground was extended to 4.5 acres in 1783 (Bold 2000), encompassing the open area between Romney Road and Greenwich Park. The burial ground is estimated to have contained 20,000 burials (Newell 1984), but subsequent construction work within the burial ground has disturbed many. The Greenwich School Infirmary (1777-1783) was constructed in the western part of the grounds, then a dining hall of Greenwich School to the south-east, and in the 1870s, the London to Greenwich railway cut east-west across the northern half of the burial ground, which lead to the disinterring of an estimated 1,400 skeletons (Newell 1984). When the Devonport Building was constructed in 1926-29, a further 4,000 burials were exhumed and reburied in Mount Pleasant graveyard (*Ibid*.). Extensive landscaping within the burial ground may have truncated further burials (Boston et al. 2008). Today the burial ground is bounded by King William's Walk to the west, the Devonport Building to the north, the National Maritime Museum to the east,

and the northern limit of Greenwich Park to the south. The ratings' burial ground was spatially separate but adjoining the officers' burial ground and mausoleum to the east.

The Old Burial Ground was the second of three graveyards of the Hospital, and dates to its heyday. By 1747, the first hospital burial ground on Maze Hill, 600 m to the east of Goddard's Ground, was overcrowded, causing a '*great nuisance'* to local residents, who *'desired it to be shut up'* (Newell 1984, 73) and a new burial ground set aside. The Hospital Board decreed that in the new burial ground, the irregular, shallow grave digging seen at Maze Hill was to be replaced by regularly ordered graves dug to a depth of eight feet (2.45 m) (*Ibid.*). Due to subsequent landscaping, it is impossible to accurately determine the original depths of the graves in the OA excavations, but surviving grave depths were often 2- 2.5 m (Boston et al. 2008).

The orderliness of the burial ground anticipated by the Board was not much in evidence by the late 1740s when, despite landscaping, tree planting and grassing, the burial ground was described as being in a '*rude and disorderly state due to quantities of rubbish being thrown there during the building of the infirmary*' (Newel 1984, 100). Certainly a layer of construction debris (6004) was discovered in the OA excavation.

In the 18th century, local residents complained of the frequencies of burials, and that the graves were larger and kept open longer than was usually practiced- on average for three weeks (Bold 2000). This suggests multiple interments. The practice of placing between two and four burials per grave was evident in both the OA and PCA excavations. However, what was not discovered, were much larger mass graves, reportedly containing 18 coffins arranged two abreast to a depth of 16 feet, with a minimum four inches of soil between each layer (Bold 2000).

Like Haslar and Plymouth, the dead were kept usually in a 'dead house' or mortuary until burial. At Greenwich Hospital, burial took place on Tuesdays and Fridays, when the dead were conveyed from the dead house in the basement of the Infirmary, across the infirmary courtyard to the burial ground



Figure A3.8. *Location of the Royal Hospital Greenwich in Greenwich, South-East London (courtesy of Pre-Construct Archaeology)*

(Bold 2000). Pensioners were buried by the hospital chaplain, some being more compassionate than others. In his stinging critique on the corruption and misgovernance of Greenwich Hospital in 1778,

Baillie levelled one of his most ferocious criticisms at the hospital's two young able bodied chaplains, who had had a special carriage, an enlarged sedan chair, made to convey them to the graveyard. It was carried by aged pensioners, who had to wait at the graveside in all weathers, whilst the young chaplain officiated from the shelter of his chair (Newell 1984).

By the early 19th century, the Old Burial Ground was becoming full- just when the hospital was at its height (Bold 2000). Space was made in 1817 by removing some of the wooden coffins, but by 1847, the senior medical officer Dr Liddell feared that '*the effluvia of a graveyard, crowded beyond parallel... might endanger the health and safety of all...*' (Bold 2000, 196). Despite his concerns, it continued to be used until the 1st of September 1857, after which pensioner burials took place at Mount Pleasant, to the east of the hospital. The only surviving burial records post-date the Goddard Ground burial ground.

Oxford Archaeology excavations

OA was commissioned by the developer to undertake an archaeological excavation and watching briefs in advanced of piling works for the construction of a conference centre and student accommodation adjacent to the Devonport Building on King William's Walk (NGR: TQ 3850 7760), and watching briefs on service trenches and the site of an electrical sub-station (Boston et al. 2008) (Figs A3.10 and 11). Only those skeletons affected by piling for the conference centre were removed in the main trench (designated Areas 1 and 2), but on mechanical stripping of the footprint of the whole building, 164 graves were revealed. An additional 25 graves in the substation trench (3.4 x 4.1m) were recorded, and two in service trenches. Service trenches to the west of the Devonport building did not reveal human remains or graves, presumably because these had been cleared when the building was constructed in 1926-9.

Results of the excavations

All but three of the excavated skeletons were removed from the main trench of the excavation, two contiguous areas designated Areas 1 and 2. The western half of Area 1 and all of Area 2 contained

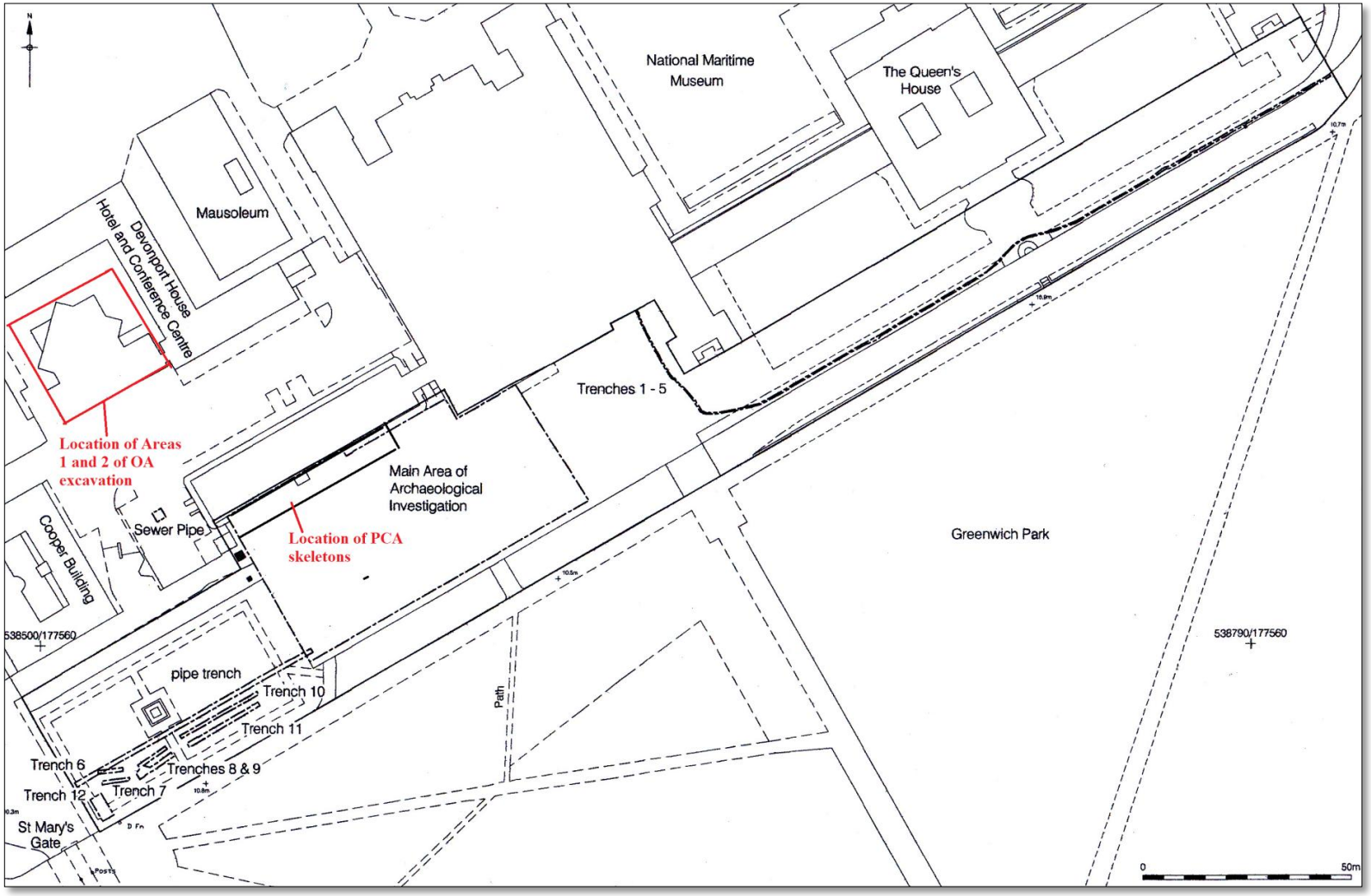


Figure A3.9. *Greenwich Hospital: location of Oxford Archaeology and Pre-Construct Archaeology excavation areas (adapted from PCA 2011 plan)*

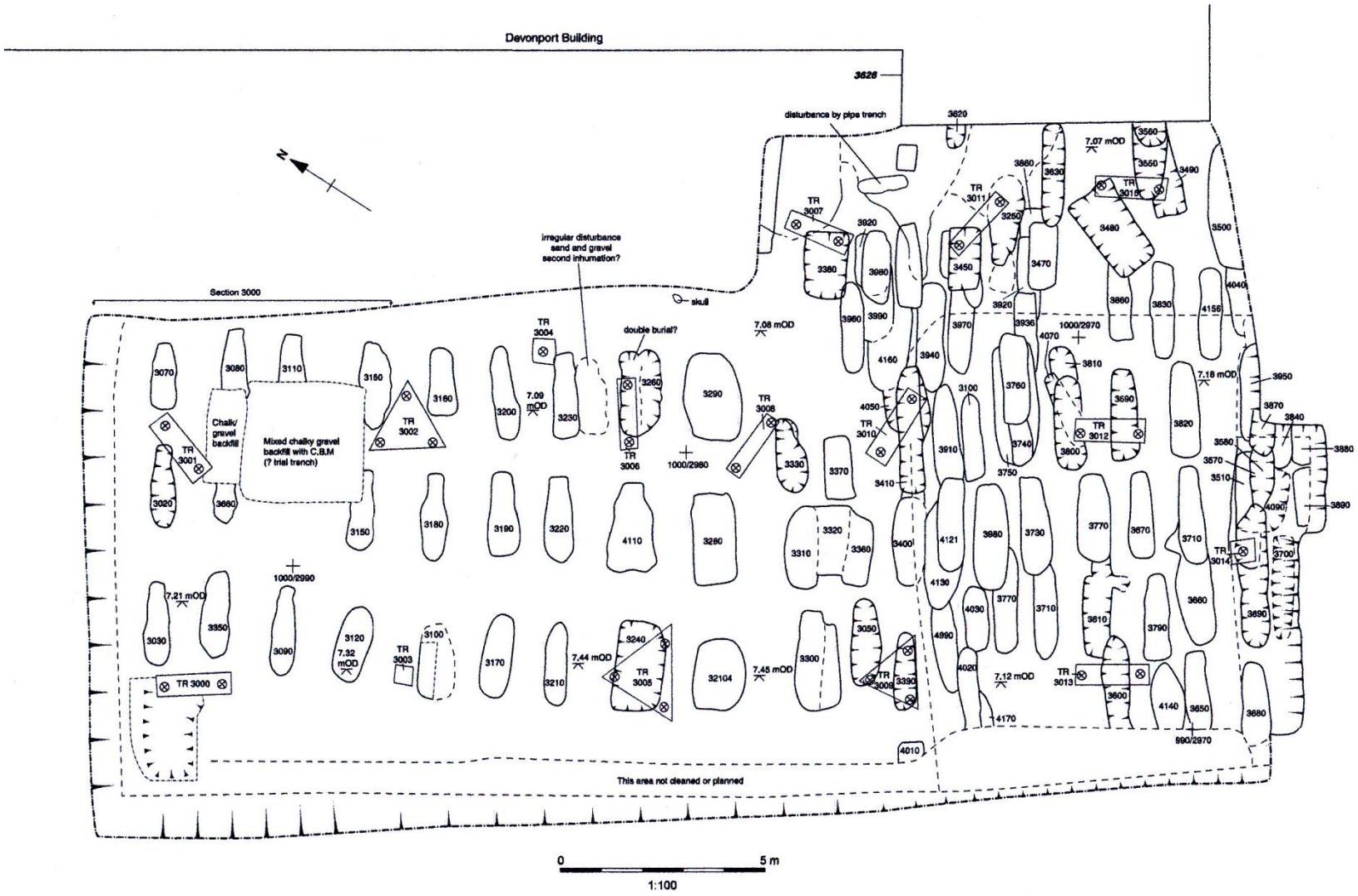


Figure A3.10 *Plan of Area 1 of the OA excavations. The graves with hashers were excavated (courtesy of Oxford Archaeology).*

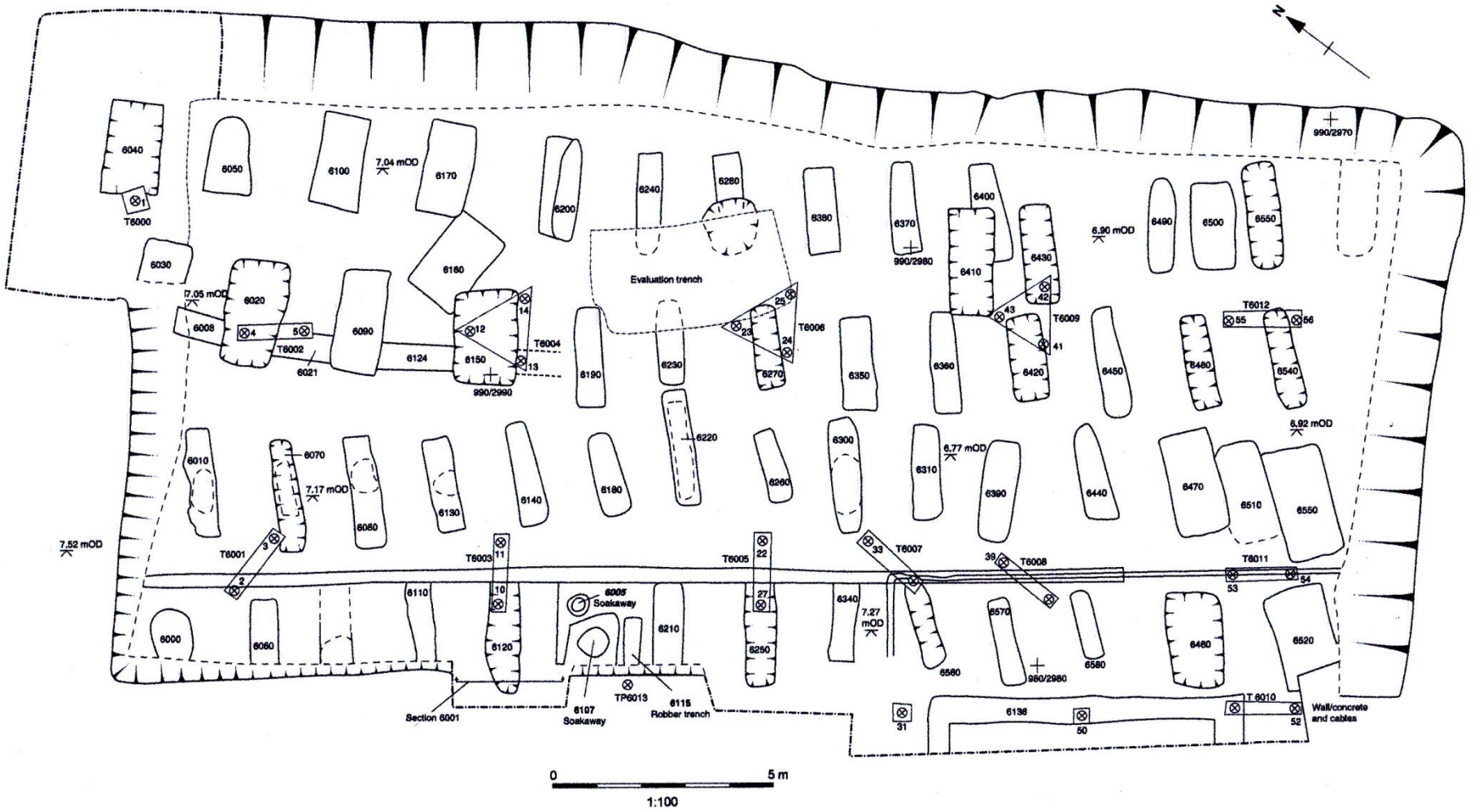


Figure A3.11 *Plan of Area 2 of Oxford Archaeology excavation. The graves with hashers were excavated (courtesy of Oxford Archaeology)*

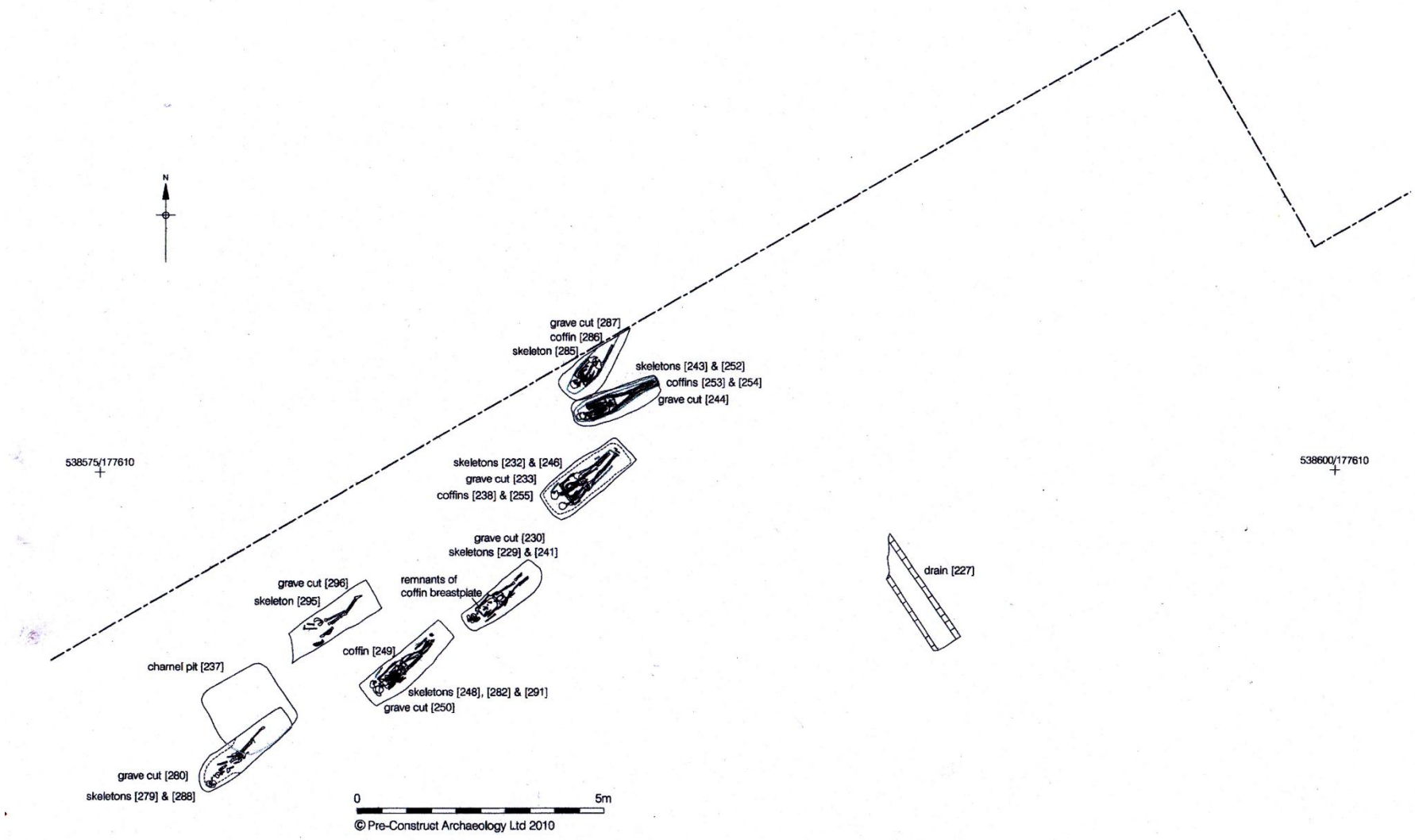


Figure A3.12 *Plan of burials in main trench of PCA excavation (courtesy of Pre-Construct Archaeology)*

three or four neat rows of well spaced graves, which were laid out north-west- south-east, aligned on the hospital buildings and perimeter walls (Boston et al. 2008). There was nothing to suggest the overcrowding that so alarmed Dr Liddell. However, in the eastern half of Area 1, these neat rows could just be discerned, but moderate intercutting by later graves was evident. The arrangement of these later graves was very much more haphazard, with areas of dense burial, and areas with none. The densest burial activity was located at the extreme south-eastern edge of Area 1, closest to the eastern limit of the burial ground. This intercutting strongly suggested a less organised second phase of burial towards the margins. Considerable grave intercutting was also present in the substation trench, located more centrally in the graveyard to the south of Areas 1 and 2. Here graves were neatly parallel, but so densely packed and intercut that there was little undisturbed ground remaining between them. The ground level was mechanically reduced to the level of impact, but only one skeleton required removal (skeleton 2005). Two skeletons (1565 and 1572) were excavated from a service trench located to the south-west of the main trench. Skeleton 1565 lay directly above 1572- probably a double burial.

Most graves were of single breadth and contained one to three coffined burials stacked one above the other. Six double graves contained four burials, in which two pairs of burials lay side-by-side directly above another pair. Due to careful excavation and the presence of an osteologist on site there was very little mixing of elements between skeletons. Most skeletons were older males, but there were also eight females (probably nurses, laundresses or other servants) and two adolescents (probably Greenwich School pupils). The women and children were not buried separately, but within the same graves as older males, presumably pensioners. This differs from female burials from the PCA excavation (see below).

Like Haslar and Plymouth, the Greenwich burials lacked metal or bone fastenings to indicate clothing, but copper alloy shroud pins and verdigris staining on bone elements suggested that corpses were shrouded. The only ‘personal artefact’ to be discovered was a stretch of decayed

leather beneath the spine and right side of the torso area of skeleton 6037, which was probably a truss worn for 'rupture' (hernia) (Boston et al. 2008). Burials were laid out supine and extended within single break wooden coffins. Many were decorated with a range of iron coffin furniture in varying combination of breastplates, grips, grip plates and upholstery studs in the style of the day. Due to severe breastplate corrosion, no individuals could be named (Boston et al. 2008). Although consistent with poorer civilian coffins, the Greenwich coffins were much more elaborate than those of Plymouth and Haslar, suggesting that they had been privately purchased, possibly with pensioners' savings or by friends and wives.

Pre-Construct archaeological watching brief

Introduction

In 2009- 2010, PCA was commissioned by the National Maritime Museum to undertake a series of archaeological investigations within the original grounds of Greenwich Hospital, the main trench being located immediately south-west of the National Maritime Museum building, bordering Greenwich Park (centre at NGR: TQ 3858 7758) (Figs A3.9 and 12). This was approximately 40 m south-east of the OA excavations.

Results of the excavation

Seven south-west- north-east orientated graves were located in narrow strip of the northern part of the main trench (Pre-Construct Archaeology 2011). The lack of more southerly graves within the main trench strongly suggested that this was the south-western limit of the burial ground, probably bounded by an earlier road. Indeed, southern-most graves 230 and 250 cut the northern edge of the road surface (*Ibid.*). Part of the swimming pool constructed for the rehabilitation of pensioners in 1833 was also discovered in the main trench to the south-west of the graves. The swimming pool was oval with a central island. Pensioners with difficulty walking could be supported by a rope slung

between an orderly on the poolside, and one standing on the island, and could ambulate around the pool aided by the rope and the buoyancy of the water (Pre-Construct Archaeology 2011).

Seventeen fairly complete skeletons and a small quantity of charnel were revealed in the graves, with each grave containing between one and four coffined inhumations. These graves were broadly parallel, and orientated on a similar alignment to the graves revealed in the OA excavations. They were clearly aligned on the orientation of the hospital building and boundary walls, rather than assuming the west-east orientation of Christian burial so ubiquitous in this period.

All the burials were interred within wooden coffins, some decorated with metal coffin fittings. This suggested that, although these coffins were probably purchased privately, these individuals chose burial within the hospital grounds. This is particularly interesting, as my osteological analysis revealed that eight skeletons were female or probable females (skeletons 229, 232, 241, 243, 252, 282, 285 and 291) and that the sex of one gracile individual (246) was ambiguous. The graves of these female burials were spatially clustered together, and with the exception of one male (248) these graves contained only females. The female coffins had been decorated with iron upholstery studs, grips, grip plates and breastplates, whilst the male coffins in graves 280 and 296 were unadorned, tentatively suggesting R.N. issue coffins, as seen at Plymouth and Haslar Hospitals. Shroud fastenings, such as copper alloy pins and rings (probably cartwheel buttons), were also restricted to the female burials. This suggested that the females were buried at private expense but with permission to be buried in the hospital graveyard. This was probably a small cluster of retired hospital workers, such as laundresses and nurses.

Only eight skeletons were osteologically sexed as male (248, 279, 288, 293 and 295A-D), and all were older adults- quite probably Greenwich pensioners. They were recovered from three graves (250, 280 and 296), the last two containing only male individuals. The head end of grave 296 had suffered disturbance, with many elements from the upper arms and torso recovered as disarticulated bone in grave fill 294. A skull fragment showed changes characteristic of Paget's disease. 'Charnel pit' 237,

adjacent but apparently not cutting grave 296, contained a more complete skull with Paget's disease, as well as three other near complete skulls and upper arm and torso elements. These were consistent in size and colour to the elements in grave 296. It is highly probable that these separate features contained the remains of the same four individuals, and have been treated as such in the osteological analysis.

In addition to earlier truncation, considerable mixing of skeletal elements had occurred during excavation of the multiple burials, such that in many cases it was impossible to assign elements confidently to a specific skeleton. Bone preservation was very variable- ranging from very good to destroyed. Those skeletons where association had become too tenuous were excluded from the osteological analysis, as were poorly preserved and female skeletons. As a result only eight males formed part of the Greenwich assemblage in this thesis.

3.5. Discussion

Consideration of historical documentation on the hospital burial grounds has provided important insights into the dating and composition of all four skeletal assemblages. Although non- R.N. individuals were buried in these grounds, including foreign seamen held as prisoners-of-war, British soldiers and hospital servants, these individuals comprised a minority of the total assemblage of each burial ground, and numerically were unlikely to have considerable influence on the osteological analysis as a whole. Where it was possible to indentify non- seamen, such as subadults at Greenwich and females in all three groups, these have been excluded from the osteological assemblage in this study. This was not possible with males, all of whom were included.

At Haslar and Plymouth, individuals were placed in shrouds and laid out supine and extended within plain wooden coffins. The complete lack of coffin fittings at this time was usually reserved for pauper burials (Litten 1991), but this anonymous and inexpensive mode of burial appears to have been all that was offered by the R.N. Some Greenwich pensioners had similarly plain coffins, but others

showed more ostentation, suggesting that some coffins were privately purchased, probably by wives or even themselves.

Unlike the ubiquitous Church of England practice of west-east burial, graves in all three hospitals were aligned on perimeter walls and existing buildings, probably reflecting a typically naval preoccupation with order. Parts of Greenwich and most of Haslar burial grounds displayed more of this order in terms of regularly spaced rows of graves, but where use of the burial ground became too heavy, less systematic arrangement was identified. In Plymouth, the extent of intercutting was so marked that it was impossible to determine if any regularity of grave layout had ever existed, other than that the graves consistently were broadly aligned west-east in line with the southern boundary.

Due to the absence of *in situ* headstones and legible breastplates, no individuals could be identified. Dating of two burials from buttons and an Abolutionist medallion gave very approximate dates of the 1790s or later, but otherwise little historical or archaeological information was available to date either individuals or parts of the burial grounds more precisely. Thus, dating rests almost entirely on the known years that each graveyard was in use.

3.6. Conclusion

This appendix has outlined the historical background to the three burial grounds, giving important insights into their years of use and burial assemblage composition. It has also highlighted the limitations and contradictions inherent in both the historical and archaeological data. Nevertheless, this analysis has indicated that the overwhelming majority of burials were R.N. seamen and marines, and that they represented only two or three generations of seamen who saw active service between the mid-18th and early 19th centuries. As such, together they comprise a relatively homogenous group, whose skeletons should reflect the very specific lifestyle and dangers aboard R.N. ships in the Age of Fighting Sail.

Appendix 4. Primary historical sources consulted

Abbreviations: BOD= Bodleian Library Oxford; PCM= Portsmouth City Museum, Porsmouth; PWDRO= Plymouth and West Devon Records Office, Plymouth; NA= National Archives, Kew.

Location	Reference	Name of document	Years	Information sought
Haslar Hospital				
BOD		Blane 1799 *Diseases incident to seamen*	1755-1763	No of hospital admissions; DD Rates and percentages
NA	ADM102/377	Death of Seamen	1756-1764	No. of deaths
NA	ADM102/387 & 389	Hospital Pay Lists	1802- 1805	Number of deaths/ month; officiating vicar's fee
NA	ADM102/ 273-304	Hospital Musters	1792- 1824	Annual deaths; mortality rates; diagnosis on admission; fate
PCM		SE Geneological Society recording of gravestones in Memorial Garden	1750s-1856	A few tombstone inscriptions date to use of Paddock as burial ground
PCM		Burial Records in Memorial Garden	1826-1856	Post-dates Paddock burials
Plymouth Hospital				
BOD		Blane 1799 *Diseases incident to seamen*	1755-1763	Number of hospital admissions; DD Rates and percentages
PWDRO	1408/47 & 48	Lease of Stray Park burial ground by Commissioners for Sick and Hurt Seamen from Mayor and Commonality of Borough of Plymouth for 21 years	1785; 1806	Confirmation that it was still used for RN burials
PWDRO	Bishop Transcript Microfiche 2237	Stray Park Burial register	1813-1814	Number of burials/ yr; ship; date of burial; rating ; 2 x American PoW; 44 French PoW; vicar & cost of burials
PWDRO	1995	Minute books of Governor Capt Creyke	1795-1799	Considerable detail on daily running, monthly patient reviews; no of DD; undertaker arrangements
NA	ADM102/601-629	Hospital Musters	1792- 1824	Number of patients; mortality rates; detail of injury or disease
Commercially available database		Ayshford Trafalgar Roll database	1803-1820s	Admission of 904 Trafalgar veterans to Plymouth Hospital; death numbers; cause of death; length of stay in hospital
Greenwich Hospital				
NA	Wilcox's database	Database based on pensioner Entry Books	1749- 1763	Age, disability, rating of each pensioner
NA	ADM73/463	Register of Graves at Royal Hospital	1857-1860s	Name and number of individuals in Maze Hill cemetery
Commercially available database		Ayshford Trafalgar Roll database	1805-1850s	Proportion of Trafalgar veterans who became in-pensioners; injuries sustained; age-at-death; length of stay
All three hospital assemblages				
NA	ADM101	Sea surgeon's journals	1750s-1820s	Case by case record of diseases and injuries treated aboard ship
NA	ADM96	Marine Description Books	1756-1824	Marine recruitment register detailing place of origin, stature, physical appearance, occupation prior to RN

Appendix 5. The biomechanics of fracture production

Like all other systems of the body, the human skeleton must meet multiple, often contradictory physical needs. Bones must be strong enough to support the body and withstand tendon and ligament pull associated with locomotion and other activities, but light enough to allow this movement. Thus, to minimise weight, bulk and metabolic requirements associated with large size, skeletal elements are designed to provide adequate strength with the minimal amount of 'material' (Drapeau and Streeter 2006). However, under certain stresses, this strength may prove inadequate. Whether a bone under stress is able to withstand the force or whether it fails, producing a fracture, depends on a wide range of variables, including intrinsic factors, such as biochemical composition of bone as a tissue, the structure and morphology of the affected bone or bones, and extrinsic factors, including the properties of the applied force, such as its magnitude, direction, duration and area spread (Berryman and Jones Haun 1996; Galloway 1999; Hipp et al. 1992).

These factors all determine whether bone will deform temporarily under mechanical loading (elastic deformation), will deform permanently (yield) or fail (fracture). Elastic deformation is known as strain, and is limited to approximately 3% in bone (Galloway 1999).

Biochemical composition of bone

Bone tissue is principally composed of an inorganic bony matrix of calcium hydroxyapitate ($Ca_{10}(PO4)_6OH_2$) and protein, of which collagen forms the greatest part. In healthy bone, proportions of hydroxyapitate to collagen are 65% to 35% (Schenk 1992). Wet bone also contains a small amount of water, amorphous polysaccharides, cells (osteoblasts and osteoclasts), nerves and blood vessels (Galloway 1999).

Hydroxyapatite imparts rigidity and strength to the skeleton necessary for the structural support of soft tissues, and is responsible for bone's ability to withstand compressive forces. Even modest reductions in bone mineral density will result in significant reduction in the amount of strain bone

may tolerate before it yields and finally fails (Galloway 1999). Thus, demineralised osteoporotic bone may fracture under relatively little stress (e.g. Colles' and neck of femur fractures incurred from falls from standing height) (Van Staa et al. 2001).

Bone's rigidity limits its ability to flex in response to applied forces. Collagen does impart a limited degree of flexion, however, and the ability of bone to withstand tensile (stretching) forces (Galloway 1999; Marieb 1995).

Subadult bone has a proportionally higher collagen content and lower mineral density than adult bone, resulting in greater resistance to tensile (stretching) forces. Thus, children's bones, subjected to stress, may not fracture completely, but become permanently distorted (as in bowing of the tubular bones) (Stuart-Macadam et al. 1998) or suffer greenstick fractures, where the bone cracks but otherwise remains intact (Roberts and Manchester 2005). Such a bony response is uncommon in adult trauma where the bone is less flexible. This brittleness may be exacerbated in certain pathological conditions, such as scurvy, in which defective collagen leads to the formation of bony infractions or tiny cracks from relatively minor trauma, such as a knock to the shin (Maat 2004; Maat and Uyterscaut 1984).

Cortical and trabecular bone loading

There are two types of bony tissue: compact or cortical bone and trabecular bone (also known as cancellous or spongy bone). The different microstructures and densities of these two bone types impart to them different mechanical properties, including their ability to resist different types of mechanical loading (Galloway 1999). In practice, predicting how an individual element behaves under stress is complicated by the fact that most elements are comprised of both trabecular and cortical bone, in differing proportions in different parts of the element. For example, the cranial vault comprises a trabecular bone core (the diploë) sandwiched between an inner and outer table of

compact bone. A similar structural arrangement is present in flat bones, such as the pelves, sternum and ribs.

In long bones, the central lumen or marrow cavity of the shafts or diaphyses contains trabecular bone and yellow bone marrow, but the diaphysis is principally composed of a thick cylinder of cortical bone. In contrast, the epiphysis (ends of the element) and metaphysis (the area of flaring between the diaphysis and epiphysis) are largely composed of trabecular bone covered by a thin layer of compact bone. Trabecular bone is much less dense and lighter in weight than cortical bone, due to its more open structure of tiny bony struts or trabeculae interspersed with red marrow. It is within the red marrow that red blood cell production or erythropoeisis takes place. This vital function is limited in the long bones (bar the femoral and humeral heads), with most erythropoeisis occurring in the spongy bone of the sternum and pelves of adults (Marieb 1995), and the cranial diploë of subadults (Lewis 2000).

In most elements, the compact outer bone layer is encased within a thin double outer membrane, the periosteum. The periosteum comprises a fibrous outer layer of dense irregular connective tissue and an osteogenic inner layer consisting principally of bone cells: osteoclasts and osteoblasts (see below) (Marieb 1995). The periosteum is richly supplied with nerve fibres, lymphatic and blood vessels, which enter the bone via nutrient foramina. The periosteum adheres closely to the surface of the underlying cortical bone through attachment by Sharpey's fibres, tufts of collagen fibres that extend from the fibrous outer layer into the bone matrix. These are exceptionally dense at the insertion points of tendons and ligaments- points of considerable strain (*Ibid*.).

Microstructure of bone and loading

As a material, bone is not anisotrophic (not able to resist stresses equally in all directions) (Galloway 1999; Hipp et al. 1992)- a property largely due to its complex microstructure. Cortical or compact bone is a densely packed, solid tissue of high mineral density, capable of withstanding high compressive loads. Much of its strength is due to mineral rich, closely packed microscopic units

called osteons. Osteons are cylindrical units comprised of concentric lamellae surrounding a central Haversian canal, which itself contains small blood vessels and nerves that supply vital nutrients and innervation to bony tissue. Transverse canals, known as Volkmann's canals, allow cross-linking of the blood supply between the Haversian canals of adjacent osteons (Marieb 1995) and ultimately to the wider cardiovascular system via nutrient foramina and blood vessels within the periosteum.

The lamellae form the matrix of the osteon, and are principally composed of inorganic mineral with some collagen. Within each lamella, the collagen fibres are orientated in the same direction, but fibres in adjacent lamellae always run in the opposite direction. This alternative patterning allows the osteon to withstand twisting forces (torsional stress), and is responsible for the tensile strength of gross bony tissue (Marieb 1995).

Osteoclasts and osteoblasts are cells lying within lacunae between the lamellae, connected together by tiny canals or canaliculi in the bony matrix. These cells are responsible for the destruction and generation of bony tissue, respectively, thereby maintaining a slow but continuous turnover of bone over an individual's lifetime. The rate of this turnover is influenced by many variables, such as age, use and some pathological conditions (Hedges et al. 2007), and varies considerably between and even within a single element (Marieb 1995). For example, the adult distal femoral epiphysis is fully replaced every five to six months (*Ibid.*), whilst the shaft's turnover is far greater than 10 years (Hedges et al. 2007). By contrast, average adult trabecular bone turnover is much shorter: 18% per year, compared to 3% of cortical bone (Valentin 2003).

During normal homeostasis, the balance between bony resorption and deposition may shift to be predominantly osteoclastic (resorptive) or osteoblastic (depositional). The mechanism controlling these shifts is complex, but is largely under the influence of the hormones parathyroid hormone and calcitonin. Both function to regulate a constant blood calcium level, the former stimulating osteoclastic activity to breakdown the bony matrix, releasing calcium; and the latter, which inhibits this process and promotes calcium deposition in the bony matrix (Marieb 1995).

Mechanical factors, such as repeated muscle loading and gravity, also stimulate bony remodelling in response to mechanical stress, changing bony architecture. For example, bone under mechanical stress from repeated strenuous muscle loading may thicken and become more compact around the point of tendon insertion. There may also be torsion of bony parts (such as the humeral head) in response to strenuous repeated loading of specific muscle groups (Rhodes and Knusel 2005). Changes in bone thickness and morphology in response to muscle loading was first described by Julius Wolff in 1892 (Frost 2004). Wolff's Law underlies a growing body of research into activity-related changes in the skeletons of past populations and modern specialist groups, such as professional sportsmen (*Ibid.*).

The physiology underpinning Wolff's Law is not well understood, but a mechanism based on threshold levels of loading established during skeletal growth and development (the mechanostat) has been postulated (Frost 2004). This mechanism envisages a negative feedback loop, in which disproportions in mechanical loading are detected and corrected for via a series of set points delineating a normal threshold level. Strain greater than this threshold initiates remodelling, through the inhibition of osteoclastic activity and reduced bony resorption, and results in hypertrophy of the bone under stress. Osteoclastic inhibition also results in smaller more densely packed osteons, capable of resisting higher strain magnitudes, as the cement lines between these secondary osteons assist in arresting the propagation of microcracks, and ultimately resist tissue failure (Schlecht et al. 2012).

Conversely, where muscle loading is reduced or absent for prolonged periods (as in the bedridden or paralysed), and falls below the lower threshold level of the mechanostat, osteoclastic activity is no longer repressed, resulting in markedly reduced bone mass through demineralisation (disuse osteoporosis) and atrophy (wasting) of the affected elements (Schlecht et al. 2012). Microscopically, osteons become greater in size and reduce in number (Currey 2002) with large areas of cortical bone

becoming porous (more like trabecular bone). The net mechanical effect is a dramatic lowering of the bone's ability to resist stress (Schlecht et al. 2012), leaving it very vulnerable to fracture.

Trabecular bone has a much less compact structure and is less mineral dense than cortical bone, comprising thin interconnected struts of bone infilled with marrow tissue. As a result, it is generally able to tolerate less than half the compressive stress than cortical bone (Hipp et al. 1992). The amount of strain at the point of fracture is much greater than at the point of yield, due to trabecular bone's ability to compress (Hipp et al. 1992). Small bent and broken struts of bone fill in the marrow spaces between the struts, allowing greater compression and distortion than is possible in compact cortical bone. Trabecular bone has approximately the same strength under tensile forces as under compressive forces (Hipp et al. 1992).

Trabecular structure is not uniform, however, with certain areas being more compact and mineral dense than others. Thus, direction of loading is highly significant in determining the mechanical strength of a particular area of trabecular bone under stress (Galloway 1999).

Whole bone structure, geometry and loading

Whilst biochemical composition, microstructure and macrostructure of bony tissue are seminal factors in bone biomechanics, so too are the internal geometry and gross morphology of whole bones. In addition, bony elements do not exist in isolation but articulate with other elements, and are connected by cartilage and soft tissue into larger units, which themselves influence strain and fracture patterning.

Cortical bone thickness and mineral density are determined by a complex interplay of genetics, age, sex and use (Peck and Stout 2007). As such, these properties vary considerably between individuals, but also between and within elements of the same skeleton. Weightbearing long bones of the lower limb generally have higher mineral density than their upper limb equivalents, but are also larger and have a greater thickness of cortical bone (Galloway 1999). Higher mineral density imparts greater strength, and larger dimensions allow for dissipation of a force over a wider area (Galloway 1999).

This size effect also may be seen in vertebral bodies. Bodies become progressively larger from head to sacrum in order to accommodating increased vertical loading down the spinal column. Similarly, marginal osteophytes (bony outgrowths) around joint surfaces serve to increase the surface area for articulation, thereby spreading the load more effectively over a larger area. Thus, some researchers (Rogers and Waldron 1995) have argued that osteophytes are an adaptive response, and should not necessarily be regarded as pathological.

The normal architecture of whole bones does much to impart strength to points vulnerable to failure. Cortical bone is thickest at points of greatest stress, such as the midshaft of long bones where bending forces are greatest; and curved bones are the thickest at the point where they are most likely to buckle (Marieb 1995). Cortical bone is stronger and stiffer in the longitudinal than the transverse plane due to the longitudinal arrangement of osteons within the bone's microstructure (Behiri and Bonfield 1989; Hipp et al. 1992). As long bone diaphyses are less able to resist transverse loads and twisting forces (Galloway 1999), in practice, transverse, oblique and spiral fractures are very much more common than longitudinal ones (Behiri and Bonfield 1989).

Long bones may be loaded from several directions by axial compression, bending and torsion. The tubular structure of long bone diaphyses (a cylinder of cortical bone encircling the marrow cavity) is much more effective at accommodating these varied forces than a solid cylinder (Galloway 1999; Hipp et al. 1992).

An attempt at predicting bone strength under loading and fracture patterning must consider the individual geometry of whole bones but also the composite geometry of multiple bony elements and attached soft tissue in that region (Hipp et al. 1992). Bones (with the exception of the hyoid) all articulate with other bones, and are held together by a variety of cartilage and soft tissue structures, such as joint capsules, ligaments, fascia and muscle. Two examples demonstrating the effects of composite geometry on fractures are the ribcage and the cranium (see below).

The nature of mechanical loading and implications for bone failure

The amount of stress generated in bone is directly proportional to the magnitude of the force applied to it, and inversely proportional to the area over which the force is applied (Galloway 1999). Thus, a person falling from height onto their feet will suffer more severe trauma than one landing horizontally, where the force is dissipated over a larger area (Christensen 2004).

As a foreign object strikes the human body, kinetic energy from this object is transferred to the tissues from the point of impact. High energy blows will result in extensive injury at the site of impact, but also remotely, as the energy of the impact travels through adjacent bone and soft tissue. A classic example is the contra-coup injury associated with a severe blow to the head, in which kinetic energy from a blow transfers to the brain, displacing it forwards until it rebounds off the opposite side of the skull. This rebound causes cerebral contusion (bruising) and oedema (swelling); tearing of the meningeal blood vessels with resultant intracranial haemorrhage, and sometimes skull fracture at the pole diametrically opposite to the point struck (Goggio 1941). Heaving fractures of the skull after severe head injury are another example of kinetic energy transfer from the initial point of impact.

The rate, duration and frequency of loading are also significant variables (Galloway 1999). Bone subjected to rapid loading or a high strain rate (as occurs with strenuous activity) requires higher loads to result in failure but, when it does, it will respond as a very brittle material, with extensive fracturing. Rapid loading is usually associated with rapid unloading, preventing a crack from extending, however (Galloway 1999).

Bone can withstand a greater load if the load is applied at a slow rate, with greater deformation or yield before failure (Berryman and Jones Haun 1996; Galloway 1999). Where low grade forces are delivered over a prolonged period, however, stress or fatigue fractures may result through micro-fracturing, leading ultimately to failure (Lovell 1997). Examples are spondylolysis, some cases of *osteochondritis dissecans* and avulsion fractures (Aufderheide and Rodriguez-Martin 1998).

Modes of loading and fracture types

Although it is not always possible to identify the type of stress from the resultant fracture after callus formation and healing, attention to fracture types may give insights into common traumatic stresses experienced by a population (Ortner 2003), in this case by R.N. seamen.

Directionality of a force and the loading mode has a significant influence on the type of fracture generated. Modes of loading include tension (stretching), compression (compaction), sheering (sliding), angulation (bending) and rotation/torsion (twisting) (Galloway 1999). Controlled biomechanical experiments have identified transverse fractures associated with tensile forces; oblique fractures with compression; butterfly fractures with bending, and spiral fractures with torsion (Hipp et al. 1992). In reality, when a force acts on bone it often combines two or more of these loading modes, with less predictable results.

Compression involves the squeezing of bone, which decreases the dimension of the tissue in line with the force. For example, a direct blow delivered transversely to a long bone shaft will cause compression at the point of contact and, if large enough, will cause an oblique fracture (Hipp et al. 1992). Compressive forces are commonly generated in falls, where the force of impact on landing is either direct (e.g. a crushed calcaneus from landing on the heel) or transferred up the body to cause indirect compression injuries (e.g. burst fractures of the vertebral bodies).

Tensile forces stretch or 'pull apart' bone, and may result in transverse fractures (Hipp et al. 1992) and avulsion fractures.

Bending fractures are the most common type of long bone fractures and are often complicated by other modes of loading (Ortner 2003). When a bone is bent, it is subjected to compressive forces at the point of impact, and tension on the opposite side. As cortical bone accommodates compression better than tension, bone first fails on the latter side (Galloway 1999). Trabecular bone has equal initial strength under compressive and tensile forces and responds differently.

Shear forces tear tissue apart by sliding some portions of tissue across others. Shear forces combined with compression are responsible for a change in direction of a fracture. When combined with twisting, these are classified as torsional or rotational loads. In torsional fractures the force is directed in a spiral or twisting direction, as when one end of a limb is fixed and the other rotates, causing a spiral fracture (Ortner 2003).

Appendix 6. Common fractures by element

This appendix decribes the most common fracture types by element, and explores the common mechanism of injury and aetiology, based on modern clinical and forensic literature.

Skull: cranium and mandible

Cranial trauma is commonly divided into cranial vault and facial injuries. Injuries to both areas are frequently due to blunt force trauma, but sharp force trauma and projectile trauma may create characteristic entry and exit wounds and contra-coup injuries.

In blunt force trauma, the component plates of the **cranial vault** do not respond to loading in isolation, but are greatly influenced by the globular geometry of the vault, as well as areas of greater strength due to bony buttressing and different cross-sectional thickness of the bony plates across the cranium (Gurdjian et al. 1950; Knight 1996). Thin plates are reinforced by bony buttresses at the petrous part of the temporal bone, the greater wing of the sphenoid, the sagittal ridge, the occipital protuberance and the glabella. The most vulnerable thin areas lie in the parieto-temporal, lateral-frontal and lateral- occipital zones (Knight 1996).

The globular geometry allows momentary deformation of the cranium- the so-called 'struck hoop' effect. When the cranial vault is struck, there is a transient area of inbending or intrusion at the point of impact. This results in compensatory bulging or extrusion elsewhere, as the force is transmitted around the cranium, causing momentary flattening. If the force is great enough, fracture may occur under compressive forces at the point of impact and intrusion, but also more remotely at points of extrusion under tension (i.e. at the margins of the deformation). Commonly, the inner table fractures first in the former, and the outer table in the latter, resulting in a depressed comminuted fracture (*Ibid.*).

The way in which a cranium fractures under blunt force trauma is largely determined by the velocity of the blow. If the velocity is above a critical value, a neat hole is produced by the injuring object (Gurdjian et al. 1950), often reflecting its cross-sectional shape. In these circumstances there is

usually little or no distant deformation. With higher energy injuries, fractures may radiate from the point of impact, or more remotely, often follow the lines of structural weakness, or may surround or extend from the area of impact (concentric and radiating fractures). Fractures may commence at a distance, due to compensatory deformation, and run back towards the impact site. In younger individuals, unfused or incompletely fused cranial sutures are lines of structural weakness, and may open under the force of a blow (diastasis) (Knight 1996).

Due to the anatomical and structural properties of the cranium, blows to certain areas constantly give rise to fractures in specific localities (Knight 1996). For example, a heavy impact to the crown or side of the head often leads to a vault fracture of the base of the skull (sometimes a hinge fracture). This fracture develops remotely due to compensatory deformation. A blow to the occiput may produce a fracture/s that typically passes vertically or obliquely downwards just to the side of the midline of the posterior cranial fossa, and extending to the foramen magnum (*Ibid.*).

The distinctive cranial features of sharp force trauma and low velocity projectile trauma have been discussed above.

Facial fracture distribution in part reflects the structural strength of the component elements of the face (Knight 1996), but also the culturally determined targeting of specific facial features in assaults (Walker 1997). Like the cranial vault, bony buttressing and variable thickness is present in the facial bones, leading to considerable variation in their ability to resist loading. In head-on road traffic collisions, the thin prominent nasal bones can resist loading of 30G, followed by the zygoma (50G), the mandibular condyle and ramus (70G), the mental eminence and midline of the maxilla (100G), and the supra-orbital area (200G) (Luce et al. 1979). This variation in strength may, in part, explain the overwhelming predominance of nasal fractures, followed by zygomatic and mandibular fractures, in many post-medieval and modern Western populations.

N**asal fractures** are by far the most common facial fracture, and may involve the nasal bones, septum (vomer and vertical plate of the ethmoid) and the superior or frontal process of the maxillae, depending on the direction and magnitude of the impact.

Although nasal deviation may be manually corrected soon after injury, Harrison (1979) comments on the frequency with which the deformity recurs after treatment, leaving the patient somewhat disfigured (nasal deviation or depression) and often with impaired drainage and air flow though one or both nostrils.

Septal fractures have been noted in approximately 40% of modern nasal pyramid fractures (Hwang et al. 2006). Osteologically, recognition of vomer and vertical ethmoid plate fractures is impaired by poor preservation, poor visualisatiion and displacement from soil pressure. Thus, these fractures often go under-reported.

Mandibular fractures are one of the more common facial fractures. The mandible forms part of a ring structure; often a fracture on one side is balanced by a fracture on the other, commonly a ramus fracture on one side and a condylar fracture on the other (Lovell 1997). As discussed above, the mental eminence can resist greater loading than the condyles and ramus, and consequently fractures occur more commonly in the latter locations. Un-united mandibular fractures are often difficult to identify osteologically due to the difficulty in identying early healing of trabecular bone. The difficulty in immobilising the mandible completely delays or prevents union.

Hyoid

Hyoid fractures are strongly suggestive of strangulation (Ubelaker 1997), but have also been associated with high level falls, with neck muscle bleeds, and hyoid bone fractures have been found in 33% of people subjected to falls from more than 10 m in one modern study (Turk and Tsokos 2004).

Vertebrae

Vertebrae may fracture through a single direct or indirect blow, in response to repeated loading or association with pre-existing disease (Galloway 1999).

Direct blows to the vertebrae predominantly cause spinous process fractures, such as a fall onto the back, and are relatively uncommon (Zmurko et al. 2003). Most vertebral fractures are from indirect blows. Vertebrae most commonly fail under referred vertical compressive forces, such as landing on the feet or buttocks from a fall, with the force travelling up the spinal column, or in a blow to the head with it travelling downwards (Galloway 1999). Healthy vertebrae can withstand a compressive load of 500lb, but if this is exceeded, the end plates will fracture and the intervertebral disc (which is stronger than bone) will be forced into the end plate. If loading continues there is an often explosive fracture of the body (a burst fracture) (*Ibid.*).

The sinuous S-shape of the spinal column allows for considerable flexibility and shock absorption during locomotion, bending and load-bearing. All vertebral joints accommodate flexion and extension, whilst the lower cervical and thoracolumbar joints also allow lateral movement and limited rotation. Flexion and extension is greatest at C1 and C2, C5-C7 and T12-L2 where the curves change direction, making them amongst the most common sites of vertebral fractures. Thoracolumbar junction fractures account for half of these (Galloway 1999).

In osteoporotic vertebrae, very minor loading may cause vertical collapse of the body, either evenly across the whole body (crush fracture) so vertebral height is reduced uniformly across the body, or asymmetrically, resulting in wedging (wedge fracture). The latter often results in kyphosis (abnormal anterior spinal curvature or hunchback) or scoliosis (abnormal lateral curvature). **Crush fractures** are strongly associated with osteoporosis in trabecular bone affecting post-menopausal females today, whilst **wedge fractures** affect both sexes over the age of 60 years, and involve both trabecular bone and cortical bone loss (Steinbock 2003). Such fractures are often associated with bony degenerative changes indicative of joint stress, such as marginal osteophytosis, new bone formation and macro-

porosity on the end plates (*osteochondrosis deformans*), fine porosity and eburnation. The age-related nature of many wedge fractures is particularly relevant to the older Greenwich pensioner assemblage. Scorbutic-related osteoporosis has also been implicated in thoracic and lumbar vertebral collapse (vertical crush, wedge and cod-fish fractures) and severe debility in modern Bantu groups of South Africa (Seftel *et al.* 1966), and may well have caused similar fractures in scorbutic seamen. Pathological fractures also occur in predominantly lytic conditions, such as tuberculosis (Pott's spine) and metastatic carcinoma.

Vertebral body compression and collapse may develop as a result of **stress fractures** from repeated loading (such as carrying heavy weights), jarring of the spine (e.g. snowmobiler's fractures), or from repetitive actions, such as hyperflexion of the lower neck resulting in C7 body fractures (so-called Milker's neck) (Capasso et al. 1999). Another activity-related fracture is the **Clay shoveller's fracture** of the spinous processes of C7 and T1, an avulsion fracture from repeated contraction of the rhomboid and trapezius muscles during prolonged shovelling (Knusel et al. 1996), or acutely through sudden hyperflexion or hyper-extension of the neck on impact in high energy trauma (Zmurko et al. 2003).

Spondylolysis is discussed in the main body oft he thesis.

Ribs and sternum

The **ribs** are the most common location for fractures in archaeological populations (Waldron 2009), are the fifth most common in modern Britons (Van Staa *et al.* 2001), and are observed in 60-70% of hospital admissions for blunt chest trauma in 1997 (Lovell 1997). These high prevalences are in spite of the elasticity of the ribs, which allows for considerable inbending before fracture, and the wider composite structure of the thoracic cage (ribs, cartilage and vertebrae), which, in itself, is elastic.

Like the vertebrae, ribs may fracture as a result of direct and indirect trauma, may incur stress fractures from repeated loading from work, and may fracture under minor stress (such as coughing or vomiting) when osteoporotic (Lovell 1997) or scorbutic (Seftel et al. 1966). Most blunt force rib

fractures result from interpersonal violence, falls and other accidents. Sharp force trauma may also be present particularly as small notches or cut marks on the inferior and superior rib surfaces, where the assailant has attempted to stab the victim between the ribs. Surgical sharp force trauma (sawing and scalpel cut marks) may also be present on the ribs when the chest is opened for dissection.

The biomechanics of rib fracturing is complicated by the complex structure of the rib cage and associated soft tissue, such that in some cases a rib may fracture at a point other than the point of impact (Love and Symes 2004). Thus, laterally located rib fractures (at or near the rib angle) often follow antero-posterior compression, while anterior fractures near the sternum, and posterior fractures near the spine occur when the force comes from the side. Posterior fractures close to the vertebral ends also often occur when direct force is applied from behind (Brickley 2006; Galloway 1999; Lovell 1997).

The fifth to ninth ribs are most commonly fractured (Galloway 1999). The first three ribs are protected by the pectoral girdle, and thus fractures here tend to indicate high energy trauma. First rib fractures are rare and are frequently associated with multiple life-threatening injuries, but have also been induced by occupational stresses involving lifting heavy loads and overhead use of the upper limbs (*Ibid.*). The scapular blade overlays and protects much of the posterior aspect of the upper and middle ribs (unless in abduction), whilst the floating ribs suffer fewer fractures, being small and only extending a few centimetres from the spine (Brickley 2006; Matos 2009). Unlike more superior ribs, the lowest three ribs do not suffer compression, and fractures are more often associated with rotational injuries (Galloway 1999).

Rib fractures are classified as transverse or oblique, the former being the more common and the result of a blow to the chest (Galloway 1999). Due to post-depositional breakage, recognising perimortem fractures of ribs in archaeological material is particularly difficult. Complete ante-mortem fractures are usually identified by raised thickening of the shaft due to callus formation, and occasionally by overlap or mal-alignment of the broken ends, although marked mal-union is

relatively uncommon due to anatomical 'splinting' by adjacent ribs. Incomplete buckle fractures are even more osteologically enigmatic and probably very under-reported (Love and Symes 2004).

Multiple rib fractures may be associated with a single event, especially when in a similar location on adjacent ribs, but this is difficult to establish in well-healed cases. Where there are two or more fractures per rib on multiple adjacent ribs, or in ribs on either side of the sternum, a flail chest will result. Inward collapse of the flail segment during inspiration is a life-threatening condition, which may lead rapidly to respiratory failure (Sirmali et al. 2003). Such injuries are incurred from violent frontal compression of the chest, such as being stamped upon, or being thrown against another object with considerable force (Galloway 1999).

Although painful, most rib fractures in themselves are benign, and only cause serious complications when they lead to a flail segment, or when the broken ends puncture the underlying pleura, lungs or blood vessels, or, in the case of lower ribs, the liver or spleen (Sirmali et al. 2003). Pneumothorax (air in the pleural space), haemothorax (blood in the pleural space) and haemopneumothorax (both air and blood in the pleural space) are serious complications, leading to lung collapse, and sometimes death (Hinds 1987). Pneumothorax has been associated with 37.2% of chest trauma cases in one recent study, whilst haemothorax was associated with 26.8%, and haemopneumothorax with 15.3% of such cases (Sirmali et al. 2003). Other soft tissue injuries in chest trauma, such as lung contusion and pleural effusion, may occur with or without rib fracture, and may also seriously compromise respiratory function and survival (Hinds 1987).

Sternal fractures are relatively rare, but are most commonly the result of a direct blow to the chest, causing a transverse fracture. This may occur by stamping on the chest of a supine victim, or when an unrestrained driver hits the steering wheel in a motor vehicle collision (Galloway 1999). Rib fractures are often also present.

Pelvis

The pelvic or innominate bones are robust and able to withstand great stress, and in healthy bone only fail under considerable force. The ring structure of the pelvic girdle (including the innominates and sacrum) allows for redistribution of stress across the structure but, much like the mandible, a fracture at one point frequently leads to a second fracture elsewhere. This is also true for the ring structure of the obturator foramina (Galloway 1999). Pelvic fractures may be relatively benign unless displacement occurs. Where soft tissue disruption occurs, however, extensive haemorrhage may be present, and perforation or tearing of genito-urinary and enteric structures almost inevitably results in life-threatening peritonitis, and frequently in death (Lovell 1997).

Acetabular fractures account for a fifth of all pelvic fractures in patients today (Galloway 1999). Fracture-dislocation of the hip joint occurs when the head of the femur is driven through the floor of the acetabulum as a result of a heavy blow on the lateral side of the femur due to a serious fall, causing a comminuted fracture (Lovell 1997). Less extreme fractures involving just a section of the acetabular rim or joint surface may occur as a result of referred force from impact on the knees or feet (as in a passenger hitting the dashboard with the knees during a motor vehicle collision; or landing on the feet following a fall). The angulation of the femur relative to the pelvis on impact determines which part of the acetabulum is fractured (Swionkowski 1992). For descriptive purposes, four fracture types based on location and structure of the acetabulum are classified: (1) posterior lip fracture, (2) posterior or ilioischial column fracture, (3) transverse fracture and (4) anterior or iliopubic column fracture (Judet et al. 1964). These fractures may occur singly or in combination-independently or in association with acetabular flange lesions, as identified in the *Mary Rose* skeletons (Stirland 1991), and with supra-acetabular cysts (Mays 2005). See Chapter 6 for discussion.

Clavicle

Clavicular fractures may be the result of a direct blow, but more commonly are associated with a fall onto an outstretched hand, the impact being transmitted up the arm to the scapula and so to the

clavicle. The force transmitted to the clavicle is very dependent on the position of the arm on impact, abduction accounting for more severe fractures (Galloway 1999). The S-shape and cross-sectional geometry of the clavicle accentuates loading and renders the element liable to fracture. It is anchored in position by powerful ligamentous and tendon attachments on both the medial and sternal end, leaving the mid-shaft largely clear of attachments. It is in middle and lateral third that the clavicle most commonly fractures, with inferior and medial displacement of the lateral fragment (Lovell 1997). Since reduction is not normally achieved, and immobilisation incomplete (usually supporting the upper limb in a sling), healed clavicular fractures often exhibit some deformity (*Ibid.*).

Scapula

Scapular fractures are relatively uncommon but are usually the result of direct trauma (Blondiaux et al. 2012). The wide expanse of the body and the superficial location of the scapula overlaying the ribcage makes it vulnerable to crushing from a blow from the rear, but the body does receive considerable protection from the large muscles that overlie it and, due to its 'floating nature', often moves away rather than fracturing on impact (Galloway 1999). Body fractures may be comminuted but are rarely displaced, due to the muscle bulk holding the bone fragments in place. Penetrating trauma directed from behind may easily perforate the body at the point of impact (*Ibid.*).

The acromial and corocoid processes are more vulnerable to fracture than the body, and are commonly the result of a direct blow (Galloway 1999). Both processes may also fracture as a result of upward impaction of the humeral head (often from a fall onto an outstretched arm). Glenoid cavity fractures are almost always due to the impact of the humeral head, and largely located on the inferior margin (commonly a Bankart fracture) (Kirtland et al. 1988; Petrovecki et al. 2008). Due to the complex anatomy of the shoulder joint, fractures of these parts often result in muscle tearing and shoulder dislocation. Avulsion fractures of the labrum also occasionally occur (*Ibid.*).

Humerus

Upper limb bones most commonly fracture as a result of falls. Reflexes often cause the upper limb to be extended outwards so that the hands will break the fall, or if the upper limbs are flexed at the elbow, the entire forearm is used (Glencross and Stuart-Macadam 2001). The impact on landing is transmitted up the arm, in severe cases resulting in multiple arm fractures, muscle tearing and shoulder dislocation. Humeral fractures thus may be associated with fractures lower down in the arm, such as a Colles' fracture. Referred impact of a fall with abduction and rotation of the upper limb may cause shoulder dislocation and fracturing of the greater tubercle and the acromium, as the former does not clear the latter on impact.

The shoulder is a complex and fairly unstable joint, due to the lack of rigid bony enclosure at its articulation with the scapula. The rotator cuff muscles provide some limitation to the extent of subluxation (partial **dislocation**) or luxation (complete dislocation), but muscle tears and dislocation are not infrequently associated with humeral and scapular fractures. Hill-Sachs defects of the postero-lateral aspect of the humeral head develop in an anterior dislocation due to the impact of the humeral head against the anterior rim of the glenoid fossa, and they are often associated with fractures of the greater tubercle and inferior lip of the glenoid fossa. In posterior dislocations, the impact of the humeral head against the glenoid rim may cause large impression fractures on the humeral head (Kirtland et al. 1988).

A direct blow to the shoulder, such as fall onto it, may cause comminuted fracturing of the **humeral head**, when it is driven into the glenoid fossa of the scapula. In addition to indirect and direct blows to the shoulders, bilateral humeral head fractures are known to occur in severe muscle spasm associated with convulsive seizures and electrocution (Galloway 1999). In adults the most common humeral fractures involve the neck and greater tubercle and the mid-proximal shaft, the former being particularly associated with osteoporotic post-menopausal women (Lovell 1997). Many of these fractures self-stabilise due to impaction.

Fracture distribution in the humerus is very age-specific. **Humeral shaft fractures** are most commonly located in the middle third of the element, and are usually due to falls. Severe bending of the bone results in transverse fracturing, while rotation of the arm during the blow causes a spiral and, less commonly, an oblique fracture (Galloway 1999). In the young and the old, spontaneous spiral fractures may result from torsional stresses induced by strong muscle contraction, for example in arm wrestling (Ibid.). Incomplete shaft fractures (greenstick, toric and bowing deformation) are also common in childhood, comprising half of all upper limb fractures (Glencross and Stuart-Macadam 2001; Stuart-Macadam et al. 1998). Due to advanced remodelling they are often difficult to identify in adult skeletons. Osteoporotic shaft fractures are increasingly common in elderly osteoporotic women today (Court-Brown and Caesar 2006).

Supracondylar, epicondylar and **condylar fractures** of the distal humerus most commonly affect children in the first decade of life and are often incomplete. Supracondylar fractures are most often the result of indirect force when falling onto an outstretched arm (particularly whilst climbing), and involve posterior displacement of the metaphysis 5-7cm above the level of the joint surface (Galloway 1999; Lovell 1997). The height of the fall is critical. In falls of greater than 5m, elbow fractures become more extensive, involving both the distal humerus and the olecranon. Industrial accidents are also commonly cited as modern causes of injury (*Ibid.)*. The mechanism of injury commonly involves hyper-extension of the elbow during the impact. In adults, a direct blow to the elbow (e.g. in falling backwards) is the most common cause of both epicondylar and olecranon process fractures *(Ibid.*).

Condylar fractures are relatively uncommon fractures to the distal joint surface of the humerus. However, in subadults, damage to the growth plate may result in element shortening and abnormal angulation of the distal condyles (Galloway 1999).

Condylar fractures are usually caused by transmitted forces from the forearm during a fall, or indirectly from avulsion by the collateral ligaments. The capitulum (lateral distal joint surface) is

usually involved, whereas the trochlea (the medial distal joint surface) is usually associated with epicondylar fractures. Displacement is not uncommon in the former, and complications involve deformity, non-union and secondary osteoarthritis (Lovell 1997).

Epicondylar fractures most commonly involve the medial epicondyle. Although they may be the result of a direct blow to the distal humerus, they are more commonly an avulsion fracture. Older children and adolescents are more prone to develop medial epicondylar avulsion fractures that adults, leading to non-fusion of the epiphysis and epicondylar atrophy (Knusel 2011). An avulsed fragment may enter the joint, causing chronic stiffness, reduced function and secondary osteoarthritis (Lovell 1997). Fractures in medieval males have been associated with weapon training from a young age (Knusel 2011).

Ulna

Ulnar fractures are not particularly common, but mid-shaft fractures, so-called **parry fractures**, have received considerable osteological attention (e.g. (Judd 2008; Jurmain 1999) due to their supposed association with parrying a blow to the face with the raised forearm, and consequently the biocultural implications of interpersonal violence to an individual or group. Indiscriminate classification of ulnar shaft fractures as 'parry' or 'nightstick' fractures has led to criticism by several authors (Judd 2008; Jurmain 1999; Lovell 1997), as ulnar fractures may also involve the ipsilateral radius, and are not necessarily due to interpersonal violence. Jurmain (1999, 219) describes a parry fracture as an '*isolated fracture of the ulnar shaft- usually in the middle or distal third produced by a blow, and NOT involving the radius'*. Parry fractures are typically transverse and, due to anatomical 'splinting' by the intact radius, typically show minimal mal-alignment ($<10^{o}$) in any plane, or horizontal apposition from the diaphysis ($<50^{o}$) (Judd 2008).

Proximal ulnar fractures are more common in adults, and are usually due to a direct blow to the olecranon process (Lovell 1997), falls with the elbow flexed, or falls combined with powerful contraction of the *M. Triceps brachii*, resulting in transverse or oblique fractures originating at the

trochlea or semi-lunar notch (Galloway 1999). Olecranon process fractures range from slight infractions to comminution, the latter usually the result of high velocity direct trauma to the elbow. Coronoid process and radial head fractures are also frequently associated with comminuted olecranon process fractures. Simple oblique fractures may involve far less force, and are often due to hyper-extension of the elbow, with the fracture line beginning at the midpoint of the trochlear notch and travelling distally (*Ibid.*). Small fractures to the tip of the olecranon process may be caused by avulsion by the *M. Triceps brachii* (*Ibid.*). Thus, precise location of the fracture to the olecranon process is central to determining its aetiology. Complete olecranon process fractures do not heal well without extensive wiring, and non-union is common.

Distal ulnar fractures and dislocations are closely associated with distal radial fractures, and are commonly the consequence of falling onto an outstretched hand. Fractures of the styloid process are the principal distal ulnar fracture. As there is little direct contact between the styloid process and the carpals except in extreme loading, fracturing of the former is indicative of considerable force, such as a fall from a height (Galloway 1999), and is associated with 53-61% of Colles' fracture in modern studies (Mays 2006).

Radius

Radial neck fractures and displacement occur more commonly in children, but **radial head** fractures are most prevalent in younger adults, where they are usually incomplete (Galloway 1999). They manifest as wedge, impaction or comminuted fractures. They usually result from a fall onto an outstretched hand when the forearm is pronated and the elbow flexed. The radial head may be driven into the humeral capitulum, fracturing it. Olecranon process fractures may accompany the injury if valgus forces are applied (*Ibid.*).

Radial shaft fractures occur most commonly in children, four to ten times more commonly in the distal portion (Galloway 1999). Whilst many are greenstick in children, adult fractures are usually

complete (oblique, transverse and occasionally butterfly) and occur in the middle third of the shaft. They are indicative of high energy trauma (*Ibid.*).

The close proximity of the **distal radius** to the scaphoid and lunate bones results in loading to the wrist being transmitted to the radius, resulting in fracture (Galloway 1999), the most common form being the Colles' fracture. Distal radial fractures are one hundred-fold more common than proximal fractures in modern Western populations, largely due to the association of distal fractures with falls from a standing height in osteoporotic post-menopausal women (Buhr and Cooke 1959; Court-Brown and Caesar 2006; Singer et al. 1998; Van Staa et al. 2001), patterns which are often misleadingly applied to males (see Chapter 7).

Common fractures of the distal radius include:

- **Colles' fracture**: This is a bending fracture located approximately 2 cm proximal to the distal articular surface, with the distal fragment displaced posteriorly and usually impacted (Lovell 1997). Most commonly the result of a fall onto an outstretched pronated arm, the dorsal surface is placed under compression, and the ventral under tension, the latter leading to a transverse fracture with 'crumbling' of the posterior surface. This results in posterior dislocation of the distal part (Galloway 1999). This fracture is often associated wth ulnar styloid fractures, and may result in residual limitation of movement, reduced grip strength and pain (Mays 2006).
- **Smith's fracture**: This is known as a reverse Colles' fracture, being similarly located and transverse, but results in anterior displacement of the distal fragment (*Ibid*.).
- **Barton's fracture**: This third major distal radial fracture begins on the distal articular surface and extends onto the dorsal surface of the metaphysis. It is produced by dorsi-flexion and pronation of the forearm over the wrist, and is technically a shearing injury. A volar Barton's fracture begins on the articular surface and extends posteriorly (*Ibid.*).

- **Chaffeur's fracture** or **Hutchinson's fracture:** This also involves the distal articular surface, being a fracture of the radial styloid process, incurred due to a blow that drives the scaphoid into the process. Joint surface impaction occurs with avulsion of the radiocarpal ligaments or radial collateral ligament. The fracture usually extends from the scaphoid articular surface laterally to the radial metaphysis, or from the junction of the scaphoid and lunate articular surfaces (*Ibid.*).

The hand bones

Scaphoid fractures comprise 70% of all hand fractures, the scaphoid being particularly vulnerable to impaction with the radius and triquetral during loading. These are most commonly due to a fall on an open palm, but may also be a punching injury (Galloway 1999). Scaphoid fractures are often complicated by avascular necrosis with delayed or non-union, and osteoarthritis (Lovell 1997). **Lunate fractures** are the second most fractured carpal, these injuries being predominantly chip or avulsion injuries (Galloway 1999). **Triquetral fractures** are third most common, due to shearing forces, or a chisel-like impact of the ulnar styloid process during loaded dorsiflexion (as in a fall onto an outstretched hand). Being small and laterally placed, **pisiforms** are rarely fractured. They may be injured by an outstretched dorsiflexed hand, by a direct blow or due to avulsion, cracking or comminution (*Ibid.*). Isolated **trapezium** fractures are rare, but saddle joint fractures accompany 15% of Bennett's fractures of the first metacarpal (Galloway 1999) (see below).

Metacarpals and hand phalanges are particularly vulnerable to injury, due to their smallness compare to the loading and handling they often bear, their involvement in thwarting and delivering blows, and in breaking falls. Fractures of the **metacarpals** account for 20% of modern hand fractures, and are particularly high in young adult males (Galloway 1999), where first and fifth metacarpal fractures predominate. Metacarpal fractures are categorised as head, neck, shaft, head and basal fractures, the shaft accounting for 40% of injuries, 25% of the neck, and the remainder involving the articular surfaces of the head and base (*Ibid.*).

Neck fractures often result from punching with a closed fist, and are fairly common in modern populations, whilst head fractures are rare. In the second and fifth metacarpals, shaft fractures are usually located in the distal shaft and neck, whilst third and fourth metacarpal fractures often are midshaft, and break simultaneously (Galloway 1999).

Metacarpals are particularly prone to damage from longitudinal compression impact, and if the force transmits along the length of the element, this will cause basilar fractures (Lovell 1997). An example is a **Bennett's fracture** of the proximal joint surface of the first metacarpal, which sometimes is associated with fracturing of the saddle joint of the trapezium. Metacarpal and phalangeal fractures are not always offensive, however, and may equally be defensive injuries from direct blows (Galloway 1999).

Avulsion fractures through forceful contraction of the *M. Carpi radialis brevis* tendon are located at the base of the third metacarpal, the styloid process being particularly vulnerable (Tsiridis et al. 2001). These may be complete or incomplete, and should not be confused with congenital absence of the styloid.

Manual phalanges tend to exhibit spiral or transverse shaft fractures, and crushing or comminution of their bases. Crushing of fingers between two objects is not uncommon, with trapped fingers sometimes resulting in traumatic amputation. Due to poor preservation and recovery, phalangeal fractures of both hands and feet are probably under-reported in archaeological assemblages.

Femur

Femoral head fractures are rarely seen in archaeological assemblages (Lovell 1997) or in modern young adults, but rates increase rapidly in elderly women (Singer et al. 1998). In younger adults, the fractures are indicative of high energy impact, such as a fall from a great height, and are often associated with acetabular fractures and posterior hip dislocation. In subadults, trauma to the proximal epiphyseal growth plate may result in head dislocation (e.g. Perthes' disease) and/or necrosis of the head (Aufderheide and Rodriguez-Martin 1998).

Modern medical discussion on femoral fractures is dominated by **neck fractures**, due to their high prevalence in sedentary, osteoporotic, post-menopausal women. This is not particularly relevant to this study, however. In males, particularly active young males, femoral neck fractures are the consequence of major trauma, such as a fall from a height onto an extended lower limb, where the force of impact is transmitted up the lower limb to the femoral neck, which is the point of greatest weakness. Whilst neck fractures are particularly vulnerable to avascular necrosis and non-union, impaction fractures of the neck usually unite without surgical intervention, but may cause slight shortening and rotation of the affected limb (Lovell 1997).

Greater trochanteric fractures are generally seen in modern septo- and octogenerians, but may occur at any age from a forceful direct blow from the side or behind (Galloway 1999).

In young to mature adults, the **femoral shaft** is amongst the most heavily mineralised area in the skeleton and, as such, a fractured shaft is indicative of very high energy trauma, such as falling from a great height or automobile accidents (Galloway 1999). In this age group, most fractures occur in the mid-third of the shaft (62.5%), where bending forces are greatest, followed by the distal third (21.2%) and the proximal third (16.3%) (*Ibid.*). They are becoming increasingly common in older osteoporotic patients in recent decades, however (Court-Brown and Caesar 2006).

Shaft fractures are due to a direct or indirect blow. Approximately half are comminuted, with the remainder a mixture of transverse, oblique and spiral, and occasionally butterfly. Compound fractures carry a high risk of osteomyelitis (Galloway 1999). Complications are particularly serious, including life-threatening haemorrhage and fat embolism (described above), and may also involve local nerve damage and impaired function. Powerful muscle spasms of the *M. Quadraceps femoris* and adductor muscles on and following fracture cause overlap, rotation and/or angulation of the broken ends. This is almost impossible to reduce without anaesthetic (Johnson 1992; Wells 1967). Thus, femoral malunion should not be taken as evidence of surgical incompetence in the past (*Ibid.*).

Complications include limb shortening, abnormal gait and secondary osteoarthritis of the hip, knee and vertebral joints (Lovell 1997).

Distal fractures comprise a third of all femoral fractures in modern populations, and are most common in younger adult males and older females. **Supracondylar fractures** are largely the result of osteoporosis. In younger adults, **condylar fractures** are indicative of a high energy anterior blow to a flexed knee (Galloway 1999).

Patella

Patellar fractures may be caused by avulsion injuries or by a direct anterior blow to the knee as it strikes the femoral condyle. They account for 1% of all fractures in modern populations (Galloway 1999). The patella lies within the tendon of the *M. Quadraceps femoris*. Sudden forceful contraction of the muscle (e.g. in a stumble) may cause avulsion fractures at the apical or basilar poles, sometimes tearing away a fragment of bone (*Ibid.*).

Direct blows may cause simple transverse or vertical, stellate or comminuted fractures, depending on the nature of the applied force. The first two are most common (*Ibid.*).

Tibia

The knee joint is an unstable synovial hinge joint, which is very vulnerable to direct (particularly lateral) and indirect injury (particularly from rotational forces). Bony knee trauma includes avulsion fractures, and crushing or complete separation of parts of the tibial plateau (Knusel 1995). These fractures may be associated with tearing of the meniscal cartilage that overlies the bony joint surface, as well as inflammation and damage to the bursa and ligaments that contain and support the joint (MacKinnon and Morris 2005).

The tibial eminence may be avulsed by sudden contraction of the **anterior cruciate** ligament, but this injury is relatively uncommon and seen primarily in sporting injuries in living individuals aged 10-20 years (Galloway 1999). Even rarer is avulsion of the posterior cruciate ligament. Cruciate ligament

tearing results in joint instability and often subluxation. Following anterior cruciate rupture, antero-lateral tibial rotation caused by subluxation with varus (towards the midline) and axial forces, may result in an associated avulsion fracture of the posterior portion of the lateral plateau, due to tearing of the lateral capsular or lateral meniscotibial ligaments. The former causes a **Segond fracture**, an oval-shaped fragmentation on the lateral margin just superior to the fibular head (Galloway 1999). Other **rim avulsion fractures** occur from tension on the capsular and ligamentous tissue of the knee joint under severe valgus (away from midline) or varus (towards the midline) stress. One is the iliotibial band, which inserts on the Gerdy's tubercle of the anterior tibia, which produces avulsion fractures of the tubercle or antero-lateral plateau margin (Galloway 1999).

Compression fractures of the rim may follow rupture of the medial or lateral collateral ligaments, which increases compression on the contra-lateral side (Knusel 1995). Larger plateau fractures may result from direct medial or lateral blows to the knee, by axial compression loading (as in landing onto the feet following a fall), or by a combination of the two. Fractures may involve depression or crushing of one or both joint surfaces, complete separation of a segment or wedge, or vertical or oblique splitting of the joint surface and metaphysis (*Ibid.*). Most tibial plateau fractures are caused by abduction (movement away from the midline) of the tibia whilst still under compression by the femur, resulting in a contra-lateral crushing of the lateral joint surface (*Ibid.*).

Avulsion of the **tibial tuberosity** is found in children and adolescents before the tubercle is completely fused to the metaphysis. These avulsion fractures occur with powerful contraction of the patellar ligament of the *M. Quadraceps femoris* during hyper-extension of the knee, with rotation of the tibia (often in low level falls). **Osgood-Schlatter's disease** is a specific acute avulsion injury to the tubercle affecting children (boys between 10 and 14 years), in which part of the tubercle is torn away, and fails to re-unite. This may leave a flattened profile to the anterior proximal metaphysis. Alternatively, the bone fragment may re-attach to the epiphysis or tibial metaphysis (Ortner 2003), producing a distinctive nodular appearance (Capasso et al. 1999). Although usually rare in skeletal

assemblages, 11 left and 12 right lesions were noted in the *Mary Rose* assemblage (total tibia numbers not given) (Stirland 1991; Stirland 2005a). This high number was ascribed to harsh labour conditions aboard ship from a young age, particularly gunnery practice (Capasso et al. 1999).

Most **diaphyseal fractures** of the tibia also involve the fibula and archaeological populations often show gross deformity and shortening due to unsuccessful reduction. Most injuries are sporting injuries incurred by adult males aged less than 30 years, and older adults (largely women with osteoporosis) (Galloway 1999).

Direct blows to the shaft tend to produce transverse fractures at roughly the same level on the tibia and fibula, but simultaneous axial loading of weight-bearing increases compressive forces on the shaft, and affects how the shaft will fracture. Oblique fractures tend to occur when the leg is not weight-bearing, when one part of the element is moving and the other is fixed (Galloway 1999). Rotational forces may also act on the tibial shaft, for example when the foot is fixed firmly on the ground and the trunk and/or leg are turning. Rotational forces may result in a paired spiral fracture, commonly distal tibial and proximal fibular oblique fractures (Lovell 1997).

Boots often affect the location of lower leg fractures, the shaft fracturing just above the supportive sleeve. This is most dramatically demonstrated in boot-top injuries in skiers, where the top of the boot acts as a fulcrum over which the shaft is bent, sometimes resulting in marked comminution (Galloway 1999).

Due to the lack of soft tissue overlaying the antero-medial aspect of the tibial shaft, shaft fractures may easily break the skin, becoming compound, with the attendant risk of infection.

Due to the strength and close association of ankle structures, **distal tibial fractures** are frequently accompanied by tendinous and ligamentous tearing and distal fibular fracture. Most distal tibial injuries occur when the foot is in contact with the ground and held down by the weight of the body (essentially fixed), and part of the body is rotating.

Malleolar and joint surface fractures are very diverse in prsentation, because of tthe structural complexity of the ankle joint, compressive loading from weight-bearing, the position of the foot relative to the shaft on impact, and the varied direction and magnitude of the applied force (Galloway 1999). The most significant ligamentous complex of the ankle joint is the syndesmosis of five ligaments that holds together the fibula and tibia, and the tibia and fibula to the talus and the calcaneus (Trafton et al. 1992). The medial and lateral malleoli and several powerful ligaments fix or lock around the talus of the ankle joint, preventing almost any abduction and adduction (MacKinnon and Morris 2005). These bony extensions are liable to fracture when the talus is badly jarred (Galloway 1999), and ligamentous damage also occurs. The strength of the medial or deltoid ligament is such that in excessive eversion (outward-turning) of the foot, it is the medial malleolus that completely fractures before the ligament ruptures. In contrast, in inversion (foot turned inwards) injuries, it is the thinner lateral ligament that gives way before the bone (MacKinnon and Morris 2005). As the leg is normally angled slightly over the centre of the ankle joint, compressive forces will act on one side of the ankle, and tension on the other. Because bone withstands compressive forces better than tensile ones, the latter fails first. When the side under tension collapses, the surviving bone is subject to the whole tensile force and the whole axial load, also causing failure of that side (Galloway 1999).

Malleolar and distal fibular shafts may fracture through direct crushing, but more commonly when weight-bearing takes place suddenly with the foot is held in an abnormal position (as in a stumble or fall onto the foot with severe twisting). Laug-Hansen's classification of these injuries describe firstly the position of the foot (supination/pronation) and the second part is the force that was applied to produce the injury (e.g. external rotation, abduction and adduction) (Trafton et al. 1992). Mechanisms of ankle injury are illustrated in Appendix 1.

For example, **supination-adduction injuries** occur when the the foot is flat on the ground but adducted/ inverted. This is the most common mechanism of injury in ankle fractures. This injury

usually results from unanticipated weight-bearing on the lateral border of the joint (e.g. a stumble on uneven ground), which places the lateral aspect of the ankle joint under tension. Most commonly, the lateral collateral ligament ruptures (sprain), or is avulsed with a portion of the lateral malleolus. This fibular avulsion fracture is characteristically transverse and located distal to the plafond (tibial joint surface). In more severe cases, rupture or avulsion of the lateral ligament destabilises the ankle joint, causing the medial aspect of the joint surface to impact with the talar dome, resulting in crushing of the medial joint surface and vertical sheering of the medial malleolus, originating at the level of the plafond. However, the characteristic vertical sheer fracture of the medial malleolus may occur in the absence of lateral ligament rupture and lateral malleolus avulsion, if there is pre-existing laxity in the ligament (*Ibid.*). Dome fractures of the talus also may occur in supination-adduction injuries (Trafton et al. 1992).

Supination-external rotation is another very common mechanism of ankle injury, responsible for 40-75% of malleolar fractures (*Ibid.*). During supination-external rotation, failure of structures occurs in a characteristic sequential order: (1) the anterior inferior tibio-fibular ligament, (2) the lateral malleolus, (3) the posterior inferior tibio-fibular ligament, (4) medial side of the ankle mortise (the composite articular arch formed by the tibia, fibula and talus), (5) deltoid ligament, or alternatively, avulsion of the medial malleolus. The fibular fracture is characteristically spiral or oblique, and is usually located at the level of the plafond, but may occur more proximally on the distal shaft. The medial malleolar avulsion fracture is transverse, and crushing of the joint surface is not marked (*Ibid.*).

Pronation-abduction injuries account for 5-21% of modern malleolar fractures (*Ibid.*). These are essentially a reverse of supination-abduction injuries, in that the lateral malleolus is injured first. The sequence of events is as follows: (1) abduction causes tension on the medial aspect of the joint, resulting either in rupture of the deltoid ligament or, alternatively, a transverse avulsion fracture of the medial malleolus, (2) rupture of the antero-inferior and postero-inferior tibio-fibular ligaments,

(3) transverse or comminuted bending fracture of the fibula, and sometimes impaction of the lateral plafond (Trafton et al. 1992).

Pronation-external rotation injury occurs when the foot is pronated and externally rotated, and comprises 7-19% of malleolar fractures (*Ibid.*). Pathognonomic for this injury is a spiral or oblique fracture of the fibula located more proximally on the distal shaft, superior to the plafond. The typical sequence of damage is (1) initial failure on the medial side, with rupture of the deltoid ligament, or vertical avulsion of the medial malleolus; (2) the anteroinferior tibiofibular ligament rupture; (3) a spiral or oblique fracture of the distal fibular shaft, which typically runs antero-proximally to postero-distally (the reverse of supination-external rotation injury), (4) disruption of the postero-inferior tibiofibular osteo-ligament complex, which holds together the distal tibia and fibula (*Ibid.*).

Fibula

The fibula is a much more slender and weak element than the tibia, and being laterally located is more vulnerable to direct lateral trauma. It is intimately associated with the tibia through proximal and distal ligament attachments (particularly at the ankle joint) and the interosseus ligament which extends between the elements for most of their length. The fibula plays virtually no role in the knee joint, but forms an important lateral strut to the ankle joint. Thus, many indirect fibular fractures are closely associated with trauma to the tibia and ankle complex (Galloway 1999; Trafton et al. 1992).

Proximal fibular fractures are rare but may occur when the fibular head is avulsed (by the lateral collateral ligament or *M. biceps femoris tendon*) as a part of wider trauma to the knee joint (e.g. lateral tibial condylar fractures). Isolated simple or comminuted fractures to the head tend to be the result of direct blows, but bilateral injuries are known in people having epileptic seizures and in parachute jumpers (Galloway 1999).

Shaft fractures are usually the result of direct blows (transverse fracture) or by indirect rotational forces on the ankle joint that transfer up the lower leg. Maisonneuve fractures of the proximal diaphysis occur when the element is markedly externally rotated at the ankle joint, but this rotation

is limited by the ligamentous attachment on the fibular head, causing stress in the proximal shaft. This fracture is associated with significant ligamentous damage to the ankle joint. Failure of the interosseus ligament may dictate the location of indirect shaft fracture, early rupture being more distal, and late rupture more proximal. Pott's or Dupruytren's fracture describes a distal shaft fracture, but this is sometimes expanded to include an associated tibial shaft fracture (Galloway 1999).

The plane of the oblique fibular shaft fracture may give clues to the direction of loading or bending. When the fibula is abducted, tension increases medially and fracturing begins inferiorly on the medial side, rising superiorly as it moves laterally across the bone. Comminution is common on the lateral margin where bending is most marked. With rotation, the load is usually posteriorly located, placing the anterior fibula under tension. Fractures are orientated antero-inferior to postero-superior, with comminution posteriorly (Galloway 1999).

The more common mechanisms of ankle injury and **distal fibular fractures** using Laug-Hansen's classification system are discussed above. Although supination-adduction injuries may cause lateral malleolar avulsion fractures (transverse, at the level of the plafond), supination-external rotation injuries are significantly more extensive. These are typically oblique or spiral fractures beginning postero-distally at the level of the plafond, and extending anteriorly and posteriorly through the distal shaft. The fracture separates the lateral malleolus from the distal shaft (typically 6-7 cm superior to the tip), the latter remaining fixed in position by the tibio-fibular ligaments. Avulsion fractures, known as a Wagstaffe's fracture, may occur on the anterior fibula, but have also been associated with supination-external rotation injuries. Fibular fractures in **pronation-abduction** injuries are typically transverse or oblique and laterally comminuted, and are located 0.5-1 cm above the distal articular surface, orientated infero-laterally to supero-medially. **Pronator-external rotation** fractures are spiral or oblique and begin proximally along the anterior portion and run

distally to the posterior margin. These fractures typically are located between the 'surgical neck' and the distal fibular shaft (Trafton et al. 1992).

The foot bones

The talus forms the transition point between the leg and foot, through which axial forces (particularly weight-bearing) act. The talus is also critical for flexion and extension of the ankle, inversion and eversion of the foot, and is active in the push-off mechanism during walking and running. Accommodating such wide range of movement makes it vulnerable to damage from a range of stresses (Galloway 1999).

Talar dome fractures may result from crushing, but also from shearing in which a small wafer of bone and cartilage are removed (*osteochondritis dissecans*). Plantarflexion of the foot induces posterior lesions, and dorsiflexion, anterior ones. The medial and lateral margins may fracture in forced eversion and inversion of the foot *(Ibid.*).

Talar neck fractures account for half of modern talar fractures. They occur most commonly when the foot is under compression and impacts with a substrate (Galloway 1999). They may also occur with extreme dorsiflexion of the foot, or by a direct blow from above (e.g. when something heavy is dropped on the foot).

Vertical fracture of the **talar body** may occur in falls from a moderate height through compression and shearing forces. Crush fracturing of the talus and calcaneus also occurs with falling onto the heel. Fractures of the lateral tubercle are well recognised in modern snowboarders (Galloway 1999), whilst complete or incomplete fractures of the lateral tubercle of the posterior process (so-called **Shepherd's fractures** (Shepherd 1882) are known in modern ballet dancers, basketball players and footballers (Hillier et al. 2004; Judd and Kim 2002), but otherwise are uncommon in modern populations (Galloway 1999). Shepherd's fractures, colloquially known as nutcracker fractures, occur when the lateral tubercle of the posterior process is crushed between the distal tibia and the calcaneus during hyperplantar flexion or forced inversion of the foot (Judd and Kim 2002).

(Palmer 1948)Osteologically, it is often difficult to distinguish a complete Shepherd's fracture from the inherited trait *os trigonum* (Galloway 1999). In accordance with modern medical diagnosis (Judd and Kim 2002), those lesions that show an irregular fracture surface were recognised as Shepherd's fractures in this study, in order to discriminate these lesions from the smooth rounded margin of *os trigonum*.

The **calcaneus** is a robust bone, whose internal structure readily withstands axial forces of weight-bearing transmitted through the heel to the ground. It is vulnerable to massive loading when landing on the heel. In falls of over 4m, vertical crushing and fragmentation may occur (Palmer 1948). In such cases, most injuries are bilateral, and are often associated with indirect fractures elsewhere in the body (e.g. vertebral burst fractures and ring fractures of the *foramen magnum* of the skull) (Galloway 1999). Calcaneal crush fractures account for 60% of all major tarsal injuries (*Ibid.*). Intra-articular fractures (joint depression fracture or tongue-type fractures) are two subtalar examples, and may be associated with more extensive secondary fractures, some extending onto the calacaneo-cuboid joint (Lovell 1997). More anteriorly, fractures involving the anterior process are often avulsion injuries, but forceful abduction or forced dorsi-flexion of the forefoot may induce fractures of the anterior articular facet with the cuboid (Galloway 1999)

The **navicular, cuboid and cuneiforms** are relatively immune to fracture except in high energy impacts, but occasionally avulsion fractures may be present. Weights falling or rolling on the dorsum of the foot may cause crush fractures of the tarsals, metatarsals and phalanges.

Of the **metatarsals**, the fifth is most frequently fractured in modern populations, followed by the third, second, first and fourth (Galloway 1999). Multiple neck and shaft fractures are often seen in a blow across the dorsum of the foot, or in a fall. Oblique shaft fractures may also be produced by indirect force, where the forefoot is fixed whilst the hindfoot twists. Fracture to the head and base are relatively rare (*Ibid.*). Fractures to the base of the hallux may also result in sesamoid bone fractures. Avulsion fractures are known in all metatarsals, but are most well recognised in the fifth.

The base of the fifth may be avulsed in sudden twisting injury (Lovell 1997). Avulsion fractures (most commonly of the second and third metatarsals but also known in the first and fifth) may be induced by the stress of untoward exertion, such as sustained marching in new army recruits (Galloway 1999).

Being peripheral, **foot phalanges** are vulnerable to vertical crush injury from objects falling on them, and from longitudinal compression forces from 'stubbing' the toe (chip fractures to the base) (*Ibid.*). Ankylosis of the phalanges may occur as a result of injury, but must be distinguished from congenitally fused phalanges of the fourth or fifth digit (Barnes 2008). The former often appear flattened and deformed, whilst the latter retain their normal morphology, albeit being fused. Like hand phalanges, the under-representation of foot phalanges in the archaeological record probably results in erroneously low fracture rates.

Appendix 7. Osteological evidence of adult scurvy

Recent work on infantile scurvy has greatly increased awareness of the disease in subadults (Brickley and Ives 2006; Brickley and Ives 2008), but the recognition of scorbutic lesions on dry adult bone is more problematic. Maat's work on Dutch whalers buried in the permafrost of Spitsbergen has been seminal in our recognition of adult scurvy, but he was fortunate enough to have preserved soft tissue displaying distinct haemorrhaging in the tooth sockets and joints (Maat 1982; Maat 2004; Maat and Uyterscaut 1984). On dry bone, the diagnosis of adult scurvy is less clear.

Vitamin C is vital to a number of key metabolic processes, not least the formation of collagen, iron and folate absorption from the gut, bone mineral haemostasis, the immune response and the clotting cascade (Taylor 1981). Collagen is one of the main structural building blocks of many tissues of the body. Defective collagen (due to aberrant hydroxillation of lycine and prolene) (Koon and Collins 2010), results in impairment of the structural integrity of many bodily tissues, not least blood vessel walls. One of the most overt features of scurvy is the generalised tendency to bleed, manifesting as pettechiae and purpura (bruising) on the skin, swelling and bleeding of the gums, as well as internal haemorrhage (French 2003).

The trapping of blood against bone, particularly beneath large muscle masses, illicits a periosteal reaction (Ortner 2003). Skeletally, this manifests as discrete areas of periostitis, often on multiple elements. In childhood scurvy, this occurs most commonly beneath the *M. Temporalis* and rotator cuff muscles, resulting in periostitis on the greater wing of the sphenoid and posterior maxilla, and the blade of the scapula (*Ibid.*). Similar active bony lesions have been noted on the skulls of a considerable number of adults of the Plymouth and Haslar assemblages, together with periosteal changes elsewhere on the body.

What becomes apparent in the R.N. skeletons is that many individuals manifested with a suite of bony lesions that independently would not be sufficiently diagnostic of scurvy, but found together

make a more convincing diagnosis. In the skull, several bony changes are often found in concert. These are **endocranial new bone formation**, particularly following the sagittal sinus of the parietal and frontal bones, and on the cruciate of the occipital bone (possible intracranial haemorrhage); ectocranial new bone of orange-peel appearance which extends in a broad band from the coronal suture to the external occipital meatus (also recognised by Stirland (2005a) as possibly scorbutic), increased **porosity of the hard palate**, excessive **new bone formation around the crypts** of erupting teeth (mostly M3) in younger individuals, new bone deposition on the ectocranial surfaces of the greater wing of the sphenoid, the posterior maxilla, and in the orbits. In scurvy, bleeding behind the eyeball may ossify, forming plaques overlying the normal bone of the **orbit**, and may superficially resemble *cribra orbitalia* (Brickley and Ives 2008), but healed lesions are more often identified by vascular indentations in the bone surface of the eye socket.

Another common location of new bone deposition was along the line of the blood vessel entering the **nutrient foramen** of several elements, most commonly the myelo-hyoid and mental foramina of the mandible, and the nutrient foramen of the tibial shaft- presumably the result of bleeding from those blood vessels.

On the post-cranial skeleton, 'scorbutic lesions' include new bone deposition on multiple bones, commonly long bones of the lower limb (particularly the posterior proximal femoral shaft), although distal metaphyses of the radius and ulna and metacarpal shafts have also been involved. Ortner (2003) also associated this pattern of deposition with scurvy. In the Haslar and Plymouth assemblages, the posterior proximal femur, particularly lateral to the *linea aspera* was a common location of **periostitis,** possibly the result of blood trapping beneath the hamstrings. The most commonly affected element is the tibial shaft, particularly the posterior aspect of the shaft and the distal metaphysis. The predilection for the posterior aspect may be the result of pooling of blood in the dependant part of the limb of a recumbent individual. Unfortunately, the lower leg is generally very susceptible to injury, vascular insufficiency and infection, and being covered by only a thin layer

of soft tissue, the tibial shaft is by far the most common bone to develop periostitis. Although **ulcers** and infection may be secondary to, or exacerbated by scurvy, their aetiology equally may be completely unrelated (e.g. trauma and tropical ulcers). Thus, multiple element involvement is paramount in diagnosing scurvy.

Osteopaenia may also result from prolonged or repeated scurvy, although this is difficult to distinguish from taphonomic processes in archaeological bone (Brickley and Ives 2008). Loss of bone mineral does result in a greater tendency for bone to fracture. In scorbutics, radiographically observable bony infractions may occur from relatively minor trauma, such as knock to the shin. There is also a greater tendency for transverse rib fracture (Ortner 2003) and possible bi-concave compression fractures to the vertebral bodies (Joffe 1961).

The high prevalence of **Schmorl's nodes** on vertebral bodies of the Plymouth assemblage may be the result of heavy mechanical loading of the spine from a young age. Alternatively, it may also be due to weakening of the intervertebral disc (composed principally of collagen) associated with scurvy, resulting in a greater tendency to herniate. Schmorl's nodes are impressions on the vertebral body from such a herniation. In an osteopaenic vertebral body, it seems likely that such an impression will form more readily. Of course, it is most probable in this assemblage that Schmorl's nodes were formed by the combination of mechanical loading of the spine on already weakened vertebrae and discs. (McCormick 1954). Lind (1753) was convinced of the aetiological role of scurvy in the development of intervertebral disc lesions, just as it affects other cartilaginous tissues in the epiphyseal plates, costal cartilage and synovial joints. In post-mortem examinations at Haslar, Lind noted scurvy's effect on costal cartilage '*so as to sometimes separate them [the ribs] altogether from their connection with the breastbone*' (Lind 1753, 244), and that the knee joint was particularly affected. He also quotes from the great anatomist Thomas Willis's 1667 '*Tracus de Scorbuto'* in which he describes '*a crackling of the bones moving the joints. Even upon turning in bed, by rubbing of the vertebrae on one another, a considerable noise was perceived, like the rough handling of a*

skeleton' (*Ibid.,* 370). It is thus very probable that many Schmorl's nodes in the R.N. assemblages have an underlying scorbutic aetiology. Unfortunately, most vertebral bodies of the Haslar assemblage were too poorly preserved for such analysis. The advanced age of the Greenwich pensioners may confuse the aetiology of Schmorl's nodes associated with scurvy with those from a lifetime of strenuous physical activity.

Defective collagen synthesis may also affect tendon and ligaments, and may be implicated in laxity of these structures, leading to a high rate of subluxations of the shoulder and hip seen in these assemblages. Similarly, the high rate of **flat-footedness** or *pes planus* in this group (n> 8) may also have a scorbutic component.

Thus, the diagnosis of scurvy is based on the presence of a suite of the above changes. Undoubtedly, individual lesions may be attributable to other aetiologies, but found together they are very suggestive of this common disease of seafarers.



Figure A.7.1*: Top: Active periostitis on the posterior aspect of the proximal femur of Haslar 09. Bottom left: Ectocranial orange-peel porosity on the cranial vault of Plymouth 757, showing the clear lateral limits along the temporal line. Bottom left: Active periostitis on the right calcaneus of Plymout 715, beaeth the perioneal ligament.*

Appendix 8. Plymouth and Haslar Hospital- admissions, deaths and mortality rates (1756- 1824) in the historical context of the R.N.

Data for Haslar and Plymouth Hospitals calculated from Blane (1799), Death of Seamen at Haslar Register (1753- 1764) and Hospital Musters (1792- 1824). Historical data taken from Rodger (2006) and Adkins and Adkins (2006; 2008).

Haslar Hospital				Plymouth Hospital			Historical context		
Year	Annual Deaths	Hospital admissions	Mortality rate	Annual Deaths	Hospital admissions	Mortality rate	Wars	Theatre of operations	Naval engagements
1756	411	7682.2	5.35				France (Seven Years War)	India; Minorca	Loss of MInorca
1757	394	7364.5	5.35				France (Seven Years War)	India; W. Indies	
1758	467	8729.0	5.35				France (Seven Years War); Spain	India; W. Indies; Senegal; Normandy landings	Cartagena; Cuddalore
1759	184	3439.3	5.35				France (Seven Years War)	Martinique; Guadeloupe; India; Le Havre; Canada	Minden; Lagos; Pondicherry; Heights of Abraham, Quebec; Quiberon Bay
1760	196	3663.6	5.35				France (Seven Years War)	Canada; Isle of Man	
1761	130	2429.9	5.35				France (Seven Years War)	India; France	Pondicherry; Belle Isle
1762	1092	20411.2	5.35				France (Seven Years War); Spain	W Indies; Newfound-land; Phillipines	Martinique; Havana; Manila
1763	1045	19532.7	5.35				Peace of Paris (end of Seven Yr War)		
1764	951	29718.8	3.2	32.4	829.6	3.91	Peace		
1765	71.7	2240.6	3.2	32.4	829.6	3.91	Peace		
1766	71.7	2240.6	3.2	32.4	829.6	3.91	Peace		
1767	71.7	2240.6	3.2	32.4	829.6	3.91	Peace		
1768	71.7	2240.6	3.2	32.4	829.6	3.91	Near peace		
1769	71.7	2240.6	3.2	32.4	829.6	3.91	Near peace		
1770	71.7	2240.6	3.2	32.4	829.6	3.91	Peace		
1771	71.7	2240.6	3.2	32.4	829.6	3.91	Near peace	Falklands (war averted with Spain)	
1772	71.7	2240.6	3.2	32.4	829.6	3.91	Peace		
1773	71.7	2240.6	3.2	32.4	829.6	3.91	Near peace		
1774	71.7	2240.6	3.2	32.4	829.6	3.91	Near peace		
1775	71.7	2240.6	3.2	32.4	829.6	3.91	American War of Independence	America	Bunker Hill, Boston
1776	71.7	2240.6	3.2	32.4	829.6	3.91	American War of Independence	America	New York; Boston
1777	71.7	2240.6	3.2	32.4	829.6	3.91	American War of Independence; France	America	Philadelphia, Saratoga

Date	Haslar			Plymouth			Historical context		
Year	Annual Deaths	Hospital admissions	Mortality rate	Annual Deaths	Hospital admissions	Mortality rate	Wars	Theatre of operations	Naval engagements
1778	627.4	10509.2	5.97	221.8	5526.4	4.01	French	America; India; W Indies	Ashant; Pondicherry; Dominica; St Lucia
1779	627.4	10509.2	5.97	221.8	5526.4	4.01	Spanish; French	Caribbean; E Mediterranean; Plymouth	Senegal; Gilbralta; Martinique; Savannah
1780	627.4	10509.2	5.97	221.8	5526.4	4.01	Spanish; Dutch; French	Caribbean; India ; Atlantic	Moonlight Battle; Martinique; Mangalore; Azores; Mobile
1781	627.4	10509.2	5.97	221.8	5526.4	4.01	Spain; Dutch; French; America	W. Mediterranean (Gilbralta; Minorca); N. Sea; Channel; Caribbean (Pensacola); S. Africa; USA; India; W. Atlantic	Jersey; St Eustatius; Cape Henry; Gilbralta; Porto Praya; Saldanha Bay; Dogger Bank; Chesapeake; Yorktown; Negapatam; Bay of Biscay
1782	627.4	10509.2	5.97	221.8	5526.4	4.01	Dutch; French: Spanish	E. Mediterranean; India; W. Indies; W. Atlantic	Trincomalee; Basseterre Roads; Sadras; the Saintes; Provedien; Bahamas; Negapatam; Gilbralta; Cape Spartel
1783	115.7	2504.3	4.62	130.9	2522.1	5.19	Peace of Versailles (Spain, France; America)	India	Caddalore
1784	115.7	2504.3	4.62	130.9	2522.1	5.19	Peace with Holland		
1785	115.7	2504.3	4.62	130.9	2522.1	5.19	Peace		
1786	115.7	2504.3	4.62	130.9	2522.1	5.19	Peace		
1787	115.7	2504.3	4.62	130.9	2522.1	5.19	Peace		
1788	115.7	2504.3	4.62	130.9	2522.1	5.19	Peace		
1789	115.7	2504.3	4.62	130.9	2522.1	5.19	Peace		
1790	115.7	2504.3	4.62	130.9	2522.1	5.19	Near peace (Nootka Sound incident with Spain)		
1791	115.7	2504.3	4.62	130.9	2522.2	5.19	Near peace		
1792	45	1327	3.39	21	859	2.44	Near peace (French Republic & Austria at war)		
1793	330	5654	5.84	122	6188	1.97	French Republic	E Mediterranean; W Indies	Toulon

	Haslar			Plymouth			Historical context		
Year	**Annual Deaths**	**Hospital admissions**	**Mortality rate**	**Annual Deaths**	**Hospital admissions**	**Mortality rate**	**Wars**	**Theatre of operations**	**Naval engagements**
1794	496	8949	5.54	164	4237	3.82	French Republic	Mediterranean; W Indies	Corsica; Martinique; St Lucia; Guadaloupe; Bastia; Glorious First of June; Port-au-Prince; Calvi
1795	473	8087	5.85	165	3569	4.63	French Republic	W Atlantic; Malaysia; S Africa	Cape Noli; Ile de Groix; Malacca; Trincomalee; Cape of Good Hope
1796	459	6474	7.09	219	2859	4.69	Spain; French Republic	S Africa; Mediterranean	Saldanha Bay; Corsica
1797	442	7414	5.96	173	5195	3.33	Dutch; French: Spanish	Indonesia (Bali); W Indies; Wales; Canaries (Tenerife); W Atlantic; Channel	Battle of St Vincent; Trinidad; Fishguard (French landing); San Juan Puerto Rico; Camperdown
1798	242	5388	4.49	206	5928	3.48	Dutch; French: Spanish	W Europe; Central and W Mediterranean; Egypt; Ireland	Ostend; Malta; Battle of the Nile; Minorca
1799	256	4629	5.53	199	5599	3.55	French Republic	Egypt; Holland	
1800	312	4755	6.56	281	6358	4.42	French Republic	Ferrol; Malta	Ferrol; Valetta
1801	303	3245	9.34	296	5245	5.64	Napoleonic Wars begin; Spain	Egypt; Denmark/ Baltic; E Atlantic; W. Mediterranean	Copenhagen; Algesira; the Straits; Alexandria; Boulogne
1802	196	2144	9.14	101	2328	4.34	Napoleonic Wars; Peace of Amiens		
1803	117	1296	9.03	111	1485	7.47	Napoleonic Wars (France)		
1804	140	1667	8.4	282	3808	7.41	Napoleonic Wars (France)	E. Atlantic	Diamond Rock; Pulo Aor; Cadiz
1805	150	1981	7.57	224	3877	5.78	Napoleonic Wars (France & Spain)	W Indies; Mediterranean	Trafalgar
1806	174	2201	7.91	344	3782	9.10	Napoleonic Wars	S. Africa; W Indies; Argentina	Cape of Good Hope; San Domingo; Maida; Buenos Aires
1807	222	2219	10	197	2261	8.71	Napoleonic Wars	Argentina; Denmark; Madiera	Copenhagen; Buenos Aires

	Haslar			Plymouth			Historical context		
Year	**Annual Deaths**	**Hospital admissions**	**Mortality rate**	**Annual Deaths**	**Hospital admissions**	**Mortality rate**	**Wars**	**Theatre of operations**	**Naval engagements**
1808	223	2207	10.1	253	2621	9.64	Napoleonic Wars	Portugal; Baltic	Hangő Head
1809	236	2872	8.22	226	2865	7.89	Napoleonic Wars	Portugal; W Indies; E Atlantic; Holland; India	Corunna; Martinique; Senegal; Basque Roads; Walcheren
1810	324	3675	8.82	229	3289	6.96	Napoleonic Wars	Caribbean; Mediterranean; Moluccas; Indian Ocean	Guadalope; Amboyna; Reunion; Banda Neira; Grand Port; Mauritius
1811	328	6534	5	193	2889	6.69	Napoleonic Wars	Java; Peninsula campaign	Lissa; Java
1812	249	3380	7.37	223	3083	7.23	Napoleonic Wars; America	America	Detroit; Constitution captures Guierretiere
1813	230	3338	5.51	200	3243	6.17	Napoleonic Wars; America	America	Shannon-Chesapeake action
1814	231	3400	5.5	215	3975	5.41	Napoleonic Wars; America	America	Washington; Plattsburg
1815	205	2759	7.43	159	2265	7.02	Napoleonic Wars	America	New Orleans; Waterloo
1816	113	1332	8.48	50	815	5.99	Peace		
1817	61	768	7.94	48	529	9.07	Peace		
1818	36	763	7.42	37	423	8.75	Peace		
1819	43	770	5.58	33	417	7.91	Peace		
1820	63	862	7.31	16	316	5.06	Peace		
1821	45	702	6.41	24	458	5.24	Peace		
1822	42	741	5.67	25	532	4.7	Peace		
1823	35	739	4.74	20	576	3.47	Peace		
1824	47	881	5.33	25	724	3.45	Peace		
Total	**16,848**	**31,0337**	**5.43**	**7,822**	**154,544**	**5.06**			

Appendix 9. Trauma cases in sea surgeon's journals 1793- 1818

The following list comprises a sample of trauma cases recorded in the surgeons' journals of those ships that deposited patients in Haslar and Plymouth Hospitals between 1793 and 1818. The records have been downloaded from the National Archives website (http://www.nationalarchives.gov.uk/search/search_results.asp.) The Archive reference is given after each entry.

Fractures

Falls from a height

William Stephens seaman fell from the maintop down on the quarterdeck between seven and eight this morning the injury done to his head was so great as to deprive him instantly of life and to render any assistance from me useless; 14 September 1815; Vilette Harbour (ADM 101/117/5A/2/Folio 10).

George Carr, aged 32, seaman; fell from the foretop when assisting to reef topsails and broke his fall by some ropes, before he reached the deck. He was taken up in a state of insensibility from which he soon recovered. On examination the neck of the os firmosis was found fractured, the ankle of the same side was much bruised as also the shoulder and arm. Put on sick list, 8 February 1810 at sea. Discharged 6 August 1810 invalided (ADM 101/86/3E/2/Folios 15-16).

Timothy Buskley, aged 27, seaman; transverse fracture of the tibia and fibula by a fall down the hatchway ladder. The bones, at the same part, had been fractured twice before; put on sick list, 27 February 1801 at sea, discharged 12 June 1801 to duty (ADM101/84/6A/Folio 19).

Richard Cross, aged 29, able seaman, taken ill at Hamoaze; fractured arm by a fall on deck and fractured his right humerus; taken ill 28 January 1798, discharged 20 February 1798 to duty (ADM101/93/2B/2/Folio 8).

[Henry] Mattas, aged 24, ordinary seaman, taken ill at sea; bruised his shoulder and fractured his clavicle by a fall; taken ill on 10 July 1798, discharged 29 July 1798 to duty (ADM101/93/2C/3/Folio 20).

William [Birds], aged 35, able seaman, taken ill at Plymouth Sound; fractured of his left arm by a fall down the forehatchway; taken ill on 23 May 1798, remains on care 26 May 1798 (ADM 101/93/2B/6/Folio 26).

Joseph Lawrence, aged 25, ordinary seaman; fractured rib as a result of falling from the main deck into the hold in the act of taking his hammock down; put on sick list, 22 July 1806 at Hamoaze; discharged 23 July 1806 to Plymouth hospital (ADM 101/93/1A/1/Folio 10).

Thomas Baker, aged 32, seaman; fell from the gangway into the waist in a state of inebriety was quite senseless when taken up. On examination the left os fimoris was found fractured and a contusion on the right side about the fifth or sixth rib. Put on sick list, 2 October 1810 at sea. Discharged [date not given] (ADM 101/86/3E/2/Folios 23-24).

William Field, aged 18, landsman; taken ill on 13 July 1809 off Brighton; fell from the topsail yard upon deck with suspected fracture of the cranium; discharged 30 July 1809 to duty (ADM 101/84/5/Folios 3-4).

George Barron, aged 24, seaman; taken ill at St John's harbour Newfoundland;; fall from the gangway into the waste striking the right leg against a gun carriage and fracture the tibia; taken ill, 23 September 1806; discharged 30 October 1806 to duty at sea (ADM 101/105/4/3/Folio 32/case 53).

Martin Hasey, aged 30, seaman; taken ill at Spithead; disease or hurt; fell down the main deck ladder fractured the sixth rib on the right side and several contusion about the body; taken ill, 15 November 1806 (ADM 101/105/4/3/Folio 38/case 63).

James Grafton, Seaman, aged 20; fell on the [...] major of the left thigh, excruciating pain in the joint and incapable of moving it in any direction. Taken ill, 9 September 1797. 'Continued not well' (ADM101/98/3A/1/Folio 7).

James Griswell, aged 31, seaman; fell from the main top and was taken up in a state of insensibility, the only external mark of violence was a small wound on the right supercilium, no fracture nor depression could be ascertained. A quantity of blood was discharged from the nose and right ear. Put on sick list, 22 June 1810 at sea. Died 22 June 1810 (ADM 101/86/3E/2/Folio 22).

Falls from standing height

John Phillip Baptiste, aged 24, Seaman; fracture of the tibia and fibula of the right leg, with luxation of the foot outwardly, occasioned by a heavy lurch of the ship throwing him off his legs, the right leg getting jammed between the casks and on the ship's righting, one cask gave way and rolled over his leg. Taken ill, 3 November 1801, at sea. Discharged to duty, 2 January 1802 (ADM101/115/3A/7/Folio 43).

John Watts, aged 26, able seaman, taken ill at sea; fractured leg received by getting up a [cas?] of bar in a gale of wind; taken ill on 9 June 1798, sent 22 June 1798 to Plymouth hospital (ADM101/93/2C/2/ Folio 10).

Joseph [Rennick], aged 26, Seaman; fracture of the right tibia, by a fall on shore. Taken ill, 2 December 1801, Bearhaven. Discharged to duty, 3 February 1802 (ADM101/115/3A/7/Folio 44).

Michael Burn, Seaman, aged 30; fractured left patella by a fall from his hammock. Taken ill, 6 December 1797, [Hamoaze]. Discharged to Plymouth Royal Hospital, 11 December 1797, fractured knee (ADM101/98/3A/2/Folio 15).

Henry Nottingham, aged 52, seaman; taken ill at Spithead; fracture of the fifth rib on the right side by slipping on the lower deck; taken ill, 13 November 1806; discharged 28 November 1806 to duty at Spithead (ADM 101/105/4/3/Folio 37/case 62).

John Edwards, aged 28, Seaman; fracture of the ulna of the left arm, by a fall on shore and his arm striking a stone. Taken ill, 19 November 1801, Bearhaven. Discharged to duty, 3 January 1802' (ADM101/115/3A/7/Folio 43).

John Fearn, aged 23, Seaman; ankle much swelled, inflamed and painful, with a small, contused wound below each malleollus, occasioned by slipping his foot in a small scuttle near the head and in which position he fell to the deck. Taken ill, 23 May 1801, off Brest. Discharged to Plymouth Hospital, 25 October 1801 [folio 42] (ADM101/115/3A/6/Folio 34).

Thomas Gayner, aged 26, landsman, taken ill at Cawsand Bay; fractured arm was brought on board by the Cambridge's boat he had received a fall three days ago when on shore both the bones of his right arm were fractured; taken ill on 14 September 1798, sent 14 September 1798 to hospital at Plymouth (ADM101/93/2D/1/Folio 3).

Crush injuries

Joseph Collier, aged 22, seaman, taken ill at Portsmouth; contusion of the left foot from a shot falling on it; taken ill on 6 December 1816, discharged 10 December 1816 to duty' (ADM101/117/ 5B/Folio 29).

[Jeremiah] Cosgrave, aged 30, ordinary seaman, taken ill at sea; bruised foot by a fall of one of 32 pound shot on his foot; taken ill on 9 June 1798, discharged 19 June 1798 to duty (ADM101/93/2C/2/Folio 10).

John Hooper, aged 50, Seaman; severe contusion and laceration of the integuments of the right hand with fracture of the index finger, occasioned by his hand having been squeezed between a gun and the sill of the port. Taken ill, 4 January 1802, Spithead. Discharged to Haslar Hospital, 4 January 1802' (ADM101/115/3A/7/Folio 46).

Edward Lampley, aged 35, ordinary seaman, taken ill at sea; a Black man on exercising the great guns the carriage wheels got upon his foot and bruised his foot and great toe; taken ill on 13 July 1803, sent 15 August 1803 to hospital at Plymouth (ADM101/97/2/3/Folio 14-16).

William Lord, aged 41, private marine, taken ill off Brest; amputated finger by getting his hand in the block of the fore brace; taken ill on 21 August 1798, sent 12 September 1798 to Plymouth hospital (ADM101/93/2C/4/ Folio 30).

Interpersonal violence

Blunt force trauma

James Gear, aged 36, Private Marine; fracture of the bones of the fore arm, by a blow with the barrel of a musket. Taken ill, 24 October 1801, Cawsand Bay. Discharged to duty, 7 December 1801 (ADM101/115/3A/7/ Folio 43).

Folio 24: Edward Jones, Seaman, aged 37; fracture of the os [male] [os malare?], from a fight with a ship mate. Taken ill, 25 February 1798. Discharged 26 February 1798 (ADM101/98/3A/3/Folio 24).

Projectile Trauma

John Hamlet, Private [Marine]; musket ball through the right hand, blowing off the middle finger. Taken ill, 27 June 1798, off Cadiz. No date of discharge recorded. While answering a call of nature he put down his gun which slipped and went off as he tried to catch it (ADM101/98/3A/4/Folio 33).

William Smith, aged 46, ordinary seaman; taken ill on 24 August 1809 off Brighton; wounded by a splinter in the middle finger of right hand in action with an enemy privateer; discharged to Haslar hospital on 24 September 1809 (ADM 101/84/5/Folio 5).

Fractures of unknown cause

Joseph Green, aged 14, Boy; transverse fracture of the left femur, near about its centre, the limb rather shorter by the divided ends of the bone being displaced. Taken ill, 23 November 1801, Bearhaven. Discharged to duty, 2 February 1802 (ADM101/115/3A/7/Folio 43).

Michael McKennally, aged 28, able seaman, taken ill at Hamoaze; fractured leg; date taken ill 25 February 1798, sent 25 February 1798 to hospital at Plymouth (ADM101/93/2B/3/Folio 12).

William [Birds], aged 35, able seaman, taken ill at Hamoaze; fractured arm, the fractured bones united without trouble but he complained that he could not use his hand and had much pain in his wrist which appeared to be

distorted as he had made no complaint of his wrist at a time of accident and he had the perfect use of his hand I concluded that the apparent distortion was of his own making, I therefore as soon as the bones were perfectly united discharged him to his duty which however he never attended to do he obstinately kept his hand either in a sling or in his bosom declaring that he had no use in it, I was at last obliged to carry him to Plymouth Hospital where he was invalided; whether there really was any partial dislocation or the whole was owning to his own obstinacy in not doing his hand in one particular position I cannot tell his character on the ship was that of a drunken, riotous, worthless blackguard, case stated in the preceding journal; continued from 23 May 1798, discharged to duty afterwards invalided (ADM101/93/2C/1/Folio 3).

Thomas Serres, aged 24, captain of the main top; fractured left knee; put on sick list, 27 November 1814. Discharged 30 January 1815 to duty (ADM 101/112/1/6/Folio 20).

Paul Brian, aged 30, able seaman; fractured humerus of right arm; put on sick list, 3 August 1806 at Hamoaze; discharged 16 September 1806 to duty (ADM 101/93/1A/1/Folio 12).

James Mathews, aged 40, carpenter's yeoman; fractured cubit; put on sick list, 29 July 1806 at Hamoaze; discharged 27 August 1806 to duty (ADM 101/93/1A/1/Folio 11).

John Truby, aged 28, gunner's mate; severe contusion and fractured maxillary bone; put on sick list, 18 October 1806 at sea; died 28 January 1807 (ADM 101/93/1A/2/Folios 32-35).

Jonathan Dayly, Seaman; fracture of lower jaw. Taken ill, 20 May 1813. Discharged to duty 26 June 1813 (ADM 101/125/3/4/Folio 16).

Christopher Golding, Seaman; compound fracture of middle finger. Taken ill, 31 January 1814. Discharged to duty 24 February 1814 (ADM 101/125/3/12/Folio 39).

Peter Hoskesson, aged 31, seaman; taken ill on Homeward Bound; severe contusion of the right forearm with a transverse fracture of ulna; taken ill, 15 May 1806; discharged 29 June 1806 to duty (ADM 101/88/5/3/Folio 19).

Luxations

Frederick Cash, Seaman, aged 35; luxation of the right femur. Taken ill, 7 February 1814. Discharged to duty 1 March 1814. Injured by a blow from the anchor (ADM 101/125/3/12; Folio 40).

‘James Vaughan, aged 28, able seaman, taken ill at Spithead; dislocated humerus by a fall from the main deck into the orlop; taken ill on 28 April 1799, discharged 18 May 1799 to duty’ (ADM101/93/2D/6/Folio 30).

Folio 14: Patrick McGee, aged 40, able seaman, taken ill at Cawsand Bay; dislocation of the clavicle by a fell down the fore hatchway; taken ill on 24 June 1798, discharged 12 July 1798 to duty (ADM101/93/2C/2/Folio 14).

Amputations

Maurice Fowley, aged 28, ordinary seaman; amputated finger due to a severe contused wound of the fore finger, which later turned gangrenous, of his left hand in the act of lowering the lower deck ports. The parts were brought together and retained with adhesive plaster, compress and bandage; put on sick list, 18 June 1806 at Plymouth harbour; discharged 29 June 1806 to Plymouth hospital (ADM 101/93/1A/1/Folio 1).

Daniel Daily, aged 26, landsman; amputated toe; put on sick list, 1 October 1806 at sea; discharged 21 October 1806 to duty (ADM 101/93/1A/2/Folio 26).

Thomas Fisher, aged 30, able seaman; amputated fingers; put on sick list, 28 October 1806 at sea; discharged 13 January 1807 to duty (ADM 101/93/1A/2/Folios 36-37).

Michael Molloy, Seaman; loss of left thumb at second joint by the topgallant yard. Taken ill, 3 March 1814. Discharged to duty 24 March 1814 (ADM 101/125/3/13/Folio 41).

Charles Davidson, aged 27, quartermaster; amputated finger; put on sick list, 28 October 1806 at sea; discharged 18 January 1807 to duty (ADM 101/93/1A/2/Folio 36).

William [Peacock], Seaman; amputated little finger of right hand at second joint. Taken ill, 17 January 1814. Discharged to duty 1 February 1814 (ADM 101/125/3/12/Folio 38).

William Campbell, aged 32, captain of the hold, taken ill at sea; finger jammed with cask, amputated the first joint and applied adhesive plaster; taken ill on 13 July 1803, discharged 31 July 1803 to duty (ADM101/97/2/3/ Folio 13).

Dissection

Robert Do[ault], Private Marine, aged 35; catarrhal symptoms and a very hard cough with erratic pains in the heart. Taken ill, 27 May 1813. Died 20 June 1813. Description of chest cavity from dissection, large discharging abscess found and signs of a long standing disease (ADM 101/125/3/4/Folio 17).

Soft tissue trauma

Falls

Michael Rooke, aged 32, able seaman, taken ill at Hamoaze; bruised leg hurt his right leg by a fall; taken ill on 11 May 1798, remains on care 26 May 1798 (ADM 101/93/2B/6/Folio 24).

Michael Rooke, aged 32, able seaman, taken ill at Hamoaze; bruised leg hurt his right leg by a fall; taken ill on 11 May 1798, remains on care 26 May 1798 (ADM 101/93/2B/6/Folio 24).

[Alfred] Burnes, aged 23, able seaman, taken ill at Cawsand Bay; bruised his left side by a fall against one of the guns; taken ill on 19 September 1798, discharged 23 September 1798 to duty (ADM101/93/2D/1/Folio 4).

Rane Mahoney, aged 30, able seaman, taken ill at Hamoaze; ulcer on his leg received a contusion on his leg by a fall down the hatchway; taken ill 8 January 1798, sent 15 January 1798 to hospital at Plymouth (ADM101/93/2B/1/Folio 5).

Folio 4: Edward Mahoney, aged 22, able seaman, taken ill at Hamoaze; bruised arm and shoulder received by a fall; taken ill on 31 December 1797, discharged 11 January 1798 to duty (ADM101/93/2B/1/Folio 4).

William [Bryane], aged 26, private marine, taken ill at Hamoaze; bruised side by a fall; taken ill on 9 May 1798, sent 18 May 1798 to hospital at Plymouth (ADM101/93/2B/5/Folio 24).

R Rokins, aged 28, seaman; fell upon one of the quarterdeck carronades which tore open the scalp. Put on sick list, 29 August 1807 off Cape Finisterre. Discharged 7 September 1807 to duty (ADM 101/86/3B/1/Folio 5).

William Laurance, 'niger', Landsman, aged 29; hurt loins and right leg from fall. Taken ill, 29 January 1798. Hamoaze. Discharged to Plymouth Hospital, 2 February 1798, contused leg (ADM101/98/3A/3/Folio 22).

Mr William Haswell, aged 40, carpenter, taken ill at sea; fall on the deck; taken ill on 13 July 1803, discharged 17 July 1803 to duty (ADM101/97/2/3/Folio 13).

James Harwood, aged 26, landsman, taken ill at Hamoaze; bruised knee by a fall with a small tumour on the patella; taken ill on 3 April 1798, remains on care 26 May 1798 (ADM101/93/2B/4/Folio 18).

John Hinton, aged 28, able seaman, taken ill at Hamoaze; bruised knee by a fall into the fore cockpit; taken ill on 3 April 1798, discharged 11 April 1798 to duty (ADM101/93/2B/4/Folio 18).

Thomas Price, aged 26, private marine, taken ill off Brest; bruise his loins by falling down the cockpit ladder; taken ill on 23 July 1798, discharged 25 July 1798 to duty (ADM101/93/2C/4/Folio 22).

George Ferguson, Seaman, aged 27; contusion and incontinence of urine from falling from a gangway when drunk. Taken ill, 19 January 1798. Discharged to Plymouth Hospital, 20 January 1798 (ADM101/98/3A/3/Folio 21).

Samuel Say, Seaman, aged 33; contused shoulder and loins, from a fall. Taken ill, 30 December 1797. Discharged to duty, 2 February 1798 (ADM101/98/3A/3/Folio 22).

John Davy, aged 20, private marine, taken ill off Ushant; contusion on his face and forehead by falling down the main hatchway his right cheek was much bruised and a small tumour above his right eye; taken ill on 26 September 1798, discharged 28 October 1798 to duty (ADM101/93/2D/1/Folio 6).

[John] Evens, aged 25, able seaman, taken ill off Brest; bruised side by falling against one of the guns; taken ill on 2 August 1798, discharged 3 August 1798 to duty (ADM101/93/2C/4/Folio 27).

Jacob Nanson, Seaman, aged 25; contused loins, from a fall down the hatchway, slight pain, weakness and incontinence. Taken ill, 13 December. Discharged to Canton [Hospital Ship], 14 December 1797, contused loins (ADM101/98/3A/Folio 15).

William Kirwin, Ship's [Corporal], aged 34; contused loins, from a fall while [securing] a man committing riot between decks. Taken ill, 17 December 1797. Discharged to Canton [Hospital Ship], 19 December 1797 (ADM101/98/3A/Folio 16).

William Fox [Vox], Landsman, aged 25; contused loins, from a fall in the hold. Taken ill, 17 December 1797. Discharged to Canton [Hospital Ship], 19 December 1797, contused loins (ADM101/98/3A/2/Folio 16).

Thomas Dailey, aged 26, marine, taken ill at Plymouth Sound; bruised side by a fall; taken ill on 23 May 1798, discharged 26 May 1798 to duty (ADM 101/93/2B/6/Folio 26).

Daniel Harrington, aged 21, able seaman, taken ill at Hamoaze; contusion received on the back part of his head by a fall; taken ill on 15 December 1797, discharged 20 December 1797 to duty (ADM101/93/2B/1/Folio 3).

Thomas Eyles, aged 40, able seaman, taken ill at Hamoaze; bruised knee received by a fall from the gangway into the waist; taken ill on 31 December 1797, discharged 24 February 1798 to duty (ADM101/93/2B/1/Folio 4).

Michael Dair, Seaman, aged 25; fell from the lower deck into the hold, much bruised particularly about the head. Taken ill, 13 January 1798. Discharged to Plymouth Hospital, 13 January 1798 (ADM101/98/3A/2/Folio 20).

William Lock, aged 28, able seaman, taken ill at sea; bruised loins by a fall down the main hatchway into the orlop; taken ill on 2 July 1798, discharged 23 July 1798 to duty (ADM101/93/2C/3/Folio 16).

Jonathan Hobbes, Seaman, aged 20; fell on one of the guns by which he bruised his penis, with 'compleat [paraphysis]', much swelled and painful, stricture and difficulty in making water. Taken ill, 21 August 1797, off Ushant. Discharged to duty 29 August 1797 (ADM101/98/3A/1/Folio 5).

Joseph Hardy, aged 22, able seaman, taken ill at Hamoaze; lame knee by a fall; taken ill on 29 October 1797, discharged 4 November 1797 to duty (ADM101/93/2A/6/Folio 32).

Rubin Travers, aged 28, able seaman, taken ill at Hamoaze; bruise on his right side by a fall; taken ill on 20 November 1797, discharged 24 November 1797 to duty (ADM101/93/2A/6/Folio 33).

Hugh Relly, aged 56, ordinary seaman, taken ill at Hamoaze; bruise by a fall from the gangway; taken ill on 11 November 1797, sent 12 November 1797 to hospital at Plymouth (ADM101/93/2A/6/Folio 34).

Thomas Shiers, Seaman, aged 27; tumor on the left arm from an injury from a fall. Taken ill, 13 October 1797. Discharged to duty 24 October 1797 (ADM101/98/3A/1/Folio 10).

John Davies, aged 50, Seaman; Contusion [of the right thigh and hip from a fall]. Taken ill, 25 February 1800. Discharged to Plymouth Hospital 7 August 1800. Given a smart ticket 26 May, did duty as a sentinel at the magazine until 7 August when, with Dr Trotter's approval, he was sent to Plymouth Hospital to be invalided (ADM101/107/1/1/Folio 7).

J. Harper, aged 38, boatswain; contusion as a result of falling from the main deck down the fore hatchway to the lower deck; put on sick list, 27 August 1806 at Cawsand Bay; discharged 5 September 1806 to duty (ADM 101/93/1A/2/Folio 20).

Thomas Davis, aged 32, private; wounded head after falling down the after main deck ladder; put on sick list, 1 September 1806 at sea; died 23 September 1806 (ADM 101/93/1A/2/Folios 22-23).

Charles Headly, Quarter Master, aged 51; sprained right foot and slightly sprained left foot. Taken ill, 25 May 1813. Discharged to Plymouth Hospital, 14 July 1813. Fell from the main yard to deck, spraining both feet and bruising himself badly. Granted a smart ticket but rejoined the ship (ADM 101/125/3/4/Folio 16).

William [Porsden?]; fell from the maintopsail yard hurting his [back?]. Put on sick list, [?]. Discharged 29 June 1803 to the Royal Hospital at Plymouth (ADM 101/82/3G/1/Folio 3).

John Moore, aged 32; pain in upper part of the breast, slight cough, difficulty of breathing having previously fell down the hatchway into the cable tier bursting a blood vessel. Put on sick list, 24 November 1803. Died 26 November 1803 (ADM 101/82/3G/1/Folio 13).

Thomas Starkey, aged 23, private, marine; fell from the main deck to the lower deck, the dorsal vertebra came in to contact with the gratings of the hatchway. Put on sick list, 5 December 1809 at Spithead. Discharged 23 December 1809 to Haslar hospital (ADM 101/86/3E/1/Folio 6).

William Davies, aged 26, ordinary seaman; taken ill at St Hillier; fell down the fore hatchway as a result of drink last night and complain of pain in the hip joint; taken ill on 1 June 1804, sent 1 June 1804 to [Haslar] hospital (ADM 101/88/1/2/Folio 7).

James Ford, Marine, aged 45; contused back, slight abrasion of the skin but deep seated pains, [injury gained] by falling down the ladder into between decks. Taken ill, 10 May 1804. Discharged to duty 30 May 1804 (ADM 101/112/5/1/Folio 3).

Folio 2: William Emmery, aged 26, seaman; fell from the forecastle into the waist wounding his arm. Put on sick list, 13 November 1809 at Spithead. Discharged 20 January 1810 to duty (ADM 101/86/3E/1; Folio 3).

James Price, marine, taken ill at Malta; accident after a drink fell down the hatchway; taken ill on 19 October 1815, discharged 19 October 1815 to hospital at Malta (ADM 101/117/5A/2/Folio 12).

[John] Smith, aged 34, quarter master, taken ill at sea; wounded by a fall down the foreladder and received two large lacerated wounds; taken ill on 13 December 1815, discharged 27 December 1815 to duty (ADM 101/117/5A/3/Folio 17).

[John] White, aged 35, seaman, taken ill at Spithead; accident fell from the main rigging and struck the chains and went into the water; taken ill on 23 December 1815, discharged 4 January 1816 to duty (ADM 101/117/5A/3/Folio 18).

James Mangold, aged 42, seaman, taken ill at Portsmouth; wound brought into the bay in an insensible state fell out of his hammock and struck the back part of his head against one of the shaft lockers; taken ill on 31 December 1815, discharged 14 January 1816 to duty (ADM 101/117/5A/3/Folio 18).

William Hill, aged 35, seaman, taken ill at Portsmouth; fell from the gangway between the ship and hulk he appeared half drunk; taken ill on 12 January 1816, discharged 13 January 1816 to hospital at Portsmouth (ADM 101/117/5A/3/Folio 19).

Henry Brown, aged 23, marine, taken ill at Portsmouth; brought on board the hulk from the Rivoli where he had been sentry got drunk and fell down one of the mast holes by which he received a wound over the right parietal; taken ill on 17 January 1816, discharged 18 January 1816 to hospital at Portsmouth (ADM 101/117/5A/3/Folios 19-20).

[John] Walker, marine, taken ill at Portsmouth; accident fell down the after hatchway into the spirit room of the hulk received a concussion; taken ill on 18 January 1816, discharged 19 January 1816 to hospital at Portsmouth (ADM 101/117/5A/3/Folio 20).

George Woodcock, aged 26, able seaman; fell from the spar to the lower deck of the *Braave* hulk. Put on sick list, 14 November 1813. Discharged 29 November 1813 to HMS Prince, HMS Shannon being paid off (ADM 101/120/3B/2/Folios 13-14).

Robert Hunter, aged 27, seaman; fell from the gangway into the waist at a time when he had gonorrhoea by which the testicles were injured and pain and swelling and inflammation to a great degree were the immediate attendants. Put on sick list, 26 July 1807 at the Great Nore. Discharged 17 August 1807 to duty (ADM 101/86/3B/1/Folio 1).

John Partrye, aged 36, seaman; fell down one of the hatchway by which he received hernia of the scrotal kind in the right side. Put on sick list, 11 August 1807 at Spithead. Discharged 13 August 1807 to Haslar hospital (ADM 101/86/3B/1/Folio 3).

Crush injuries

William Lyon, aged 24, able seaman, taken ill at Hamoaze; bruised his foot by a fall of a block; taken ill on 11 November 1797, discharged 14 November 1797 to duty (ADM101/93/2A/6/Folio 33).

Agostino Sposita, aged 34, Seaman; laceration and contusion of the hand, by it's being jammed in the main topsail sheet block by the running of the halyards. Taken ill, 2 June 1801, Cawsand Bay. Discharged to duty, 26 June 1801. (ADM101/115/3A/6/Folio 35).

Lyle Cotton, aged 12, Boy; Contusion by a large wooden screw falling on his belly. Taken ill, 1 May 1800 off Ushant. Discharged to Plymouth Hospital 11 May 1800. Described as a weak delicate boy, subject to fevers, colds, worms etc and is seldom out of the sick list (ADM101/107/1/1/Folio 8).

Robert Bicknell, aged 43, armourer; amputated finger resulting from a very contused wound of the forefinger of his left hand and also of the middle finger accompanied with a contusion of the hand which was caught between the boat and hulks side; put on sick list, 18 June 1806 at Hamoaze; discharged 18 August 1806 to Plymouth hospital (ADM 101/93/1A/1/ Folios 2-3).

Contusion and bruising

Owen Slater, aged 28, ordinary seaman, taken ill at Baltic; leg contused by the cable two months ago caused a sloughing of most of the cellular substance from the tuberosity of the tibia; sent 13 November 1809 to [Sheerness] hospital (ADM 101/93/3/2/Folio 19).

James Carroll, aged 27, seaman; severe contusion across his loins by a cask of flour slipping out of its slings. Put on sick list, 23 September 1805. Sent 29 September 1805 to Gibraltar Hospital (ADM 101/106/1B/7/Folio 28).

Accidental blunt force trauma

John Derricks, aged 23, private marine; taken ill at Portsmouth Harbour; blow from broken beam? Over the right eye and now afflicted with a severe and painful opthalmia [ophthalmia]; taken ill, 8 September 1806 (ADM 101/88/5/4/ Folio 24).

James Love, aged 28, able seaman; taken ill off the River Tagus; pain in the left testicle with swelling extending up the spermatic cord from a blow; taken ill, 30 May 1808; discharged 31 August 1808 to duty (ADM 101/89/2/1/Folio 11).

Richard Taylor, aged 22, Seaman; scrotum enlarged and painful, from a blow with a clue of a sail, pyrexia. Taken ill, 17 July 1801, off Brest. Discharged to duty, 4 August 1801 (ADM101/115/3A/6/Folio 40).

William Hughes 2nd, aged 30, able seaman, taken ill at Plymouth Sound; contusion on his left hip and the lower part of his belly by the stopper of the anchor; taken ill on 1 June 1798, sent 22 June 1798 to Plymouth hospital (ADM101/93/2C/2/Folio 7).

Cuts, wounds and lacerations

Thomas Sharlock, aged 26, able seaman, taken ill at sea; wounded foot by stepping on a glass; taken ill on 17 July 1798, discharged 22 July 1798 to duty (ADM101/93/2C/3/Folio 21).

James Mailey, aged 24, private marine, taken ill at Hamoaze; wounded foot cut his foot by stepping on a broken glass; date taken ill 26 February 1798, discharged 28 April 1798 to duty (ADM101/93/2B/3/Folio 12).

Daniel Daley, landsman; ulcer due to having a nail run in his foot; put on sick list, 1 July 1806 at Hamoaze; discharged 22 August 1806 to duty (ADM 101/93/1A/1/Folios 4-5).

Charles Bushie, aged 28, private; ulcer on leg received on 4 July 1806 when on the Alexander in getting her guns out; put on sick list, 11 July 1806 at Hamoaze ; discharged 11 July 1806 to Plymouth hospital (ADM 101/93/1A/1/ Folio 8).

Stephen Kennedy, aged 24, seaman; wounded foot caused by falling down the fore ladder onto a quart bottle which broke; put on sick list, 4 October 1806 at sea; died 8 October 1806 at 4pm (ADM 101/93/1A/2/Folio 27).

Thomas McAbelia, Seaman; lacerated hands. Taken ill, 16 February 1814. Discharged to duty 13 March 1814 (ADM 101/125/3/12/Folio 40).

Robert Hackles, Marine, aged 22; lacerated scalp, sloughing and erysipelas. Taken ill, 4 February 1814. Discharged to Plymouth Hospital, 20 February 1814, while ship was in port (ADM 101/125/3/12/Folio 39).

Mr Parkinson, Midshipman; disease or hurt, lacerated and contused wound on scalp. Taken ill, 16 February 1814. Discharged to duty 4 March 1814 (ADM 101/125/3/13/Folio 40).

William Hepburn, aged 28, seaman; thumb lacerated by a block. Put on sick list, 13 November 1809 at Spithead. Discharged 4 January 1810 to duty (ADM 101/86/3E/1/Folios 1-2).

Griffith Jones, seaman; wound on his right foot by the same accident as above case [a barrel of flour being lifted and slipped out of its slings]. Put on sick list, 23 September 1805. Sent 10 November 1805 to Gibraltar Hospital (ADM 101/106/1B/7/Folios 28 and 31).

Mr Davison, master, taken ill at sea; fell down on deck in consequence of the ship rolling very much received a contused and lacerated wound over the *os. occipitis*; taken ill on 16 December 1815, discharged 22 December 1815 to duty (ADM 101/117/5A/3/Folio 17).

[John] Brown, aged 29, seaman, taken ill at Portsmouth; wound brought into the bay in a state of intoxication has got a large lacerated wound over the upper of the right parietal; taken ill on 25 December 1815, discharged 4 January 1816 to duty (ADM 101/117/5A/3/Folio 18).

Joseph Frankling, aged 21, marine of the 3rd class; taken ill at Spithead; wound of the right hand by the ramrod passing between the metacarpal bones of the fore and middle fingers; taken ill, 10 October 1808; returned 23 December 1808 to do centinels [sentinels] duty (ADM 101/89/2/2/Folios 20-21).

Interpersonal violence

Eight more men were wounded in this attack, one was struck by a grape shot in the face; another was wounded by a grape shot on the scapula; a marine was wounded by a musket ball in the throat, the trachea was wounded, the ball was extracted and the wound healed in two days; two had musket balls through the *vastus externus* muscle; one man received a musket ball in the thigh; one was wound by grapeshot in the breast; another had a bayonet through the thigh; all have recovered. I [also] performed two amputations on the wounded Russians and dressed twenty four wounds all of them done well except one man that had a grape shot through the thorax, it broke to pieces, three ribs passed under the lungs and struck in the opposite side under the skin, this patient in this deplorable state lived two days (ADM 101/93/3/2/ Folios 14-15: 13 September 1809).

Sharp force trauma

Patrick Reiley, aged 40, able seaman, taken ill at Hamoaze; wounded shoulder cut with a razor by one of his mess mates when on shore; taken ill 23 January 1798, discharged 28 January 1798 to duty (ADM101/93/2B/2/Folio 7 and 8).

Bernard Cross, aged 29, able seaman, taken ill at Hamoaze; wounded in the face and had two cuts in his left shoulder given him by Thomas Lace with a knife the seaman who wounded him was tried at Exeter and sentenced to two years imprisonment; taken ill on 10 December 1797, discharged 23 December 1797 to duty (ADM101/93/2B/1/Folio 3).

James Maker, Seaman, aged 40; wounded in the Achilles tendon, by falling against a man with a knife. Taken ill, 16 June 1798. Discharged 9 July 1798, as a centinel [sentinel] (ADM101/98/3A/4/Folio 32).

John Thompson, aged 14, boy, taken ill off Brest; wounded thigh he run his knife into his thigh by accident; taken ill on 28 July 1798, discharged 10 August 1798 to duty (ADM101/93/2C/4/Folio 23).

Thomas Brown, aged 20; struck in the abdomen by a handspike that was jammed in a gun. Put on sick list, [?]. Discharged 29 June 1803 to the Royal Hospital at Plymouth (ADM 101/82/3G/1/Folio 4).

Charles Cox, aged 24, seaman; taken ill on Homeward Bound; various contusion cannot be ascertained he has two long deep incised wounds on the occiput penetrating to the pericranium; taken ill, 23 May 1806 (ADM 101/88/5/3/Folio 19).

Joseph Frankling, aged 21, marine of the 3rd class; taken ill at Spithead; wound of the right hand by the ramrod passing between the metacarpal bones of the fore and middle fingers; taken ill, 10 October 1808; returned 23 December 1808 to do centinels[sentinels] duty (ADM101/89/2/2/Folio 20-21).

Henry Westbrook, aged 39, able seaman, taken ill at Hamoaze; wounded hand by a knife; taken ill on 8 November 1797, discharged 19 November 1797 to duty (ADM101/93/2A/6/Folio 33).

John Taylor, aged 25, landsman; wounded throat, in a fit of despair brought from an idea of impending punishment plunged a packet knife into his neck with an intent to put an end to his existence; put on sick list, 30 September 1806 at sea; discharged 11 October 1806 to duty (ADM 101/93/1A/2/Folio 26).

John Cheshire, aged 34, boatswain mate, taken ill at Cawsand Bay; wounded throat in a fit of frenzy occasioned by drinking he attempted to cut his throat; taken ill on 24 June 1798, discharged 5 July 1798 to duty (ADM101/93/2C/3/Folio 14).

Wound aetiology not specified

George Jackson, aged 24, seaman; disease or hurt, received slight wound during the action on 21 October, which was becoming a foul sloughing sore. Put on sick list, 19 November 1805. Sent 2 December 1805 to Plymouth Hospital (ADM 101/106/1B/9/Folio 32).

Blunt force trauma

Robert Driscoll, Seaman, aged 27; received a severe beating on shore and is prone to rheumatic complaints. Taken ill, 1 January 1798. Discharged to Canton [Hospital Ship], 5 January 1798, fever (ADM101/98/3A/2/Folio 16).

Richard Connor, Seaman, aged 30; head swollen and contusions all over his body. Taken ill, 19 December 1797. Discharged to Canton [Hospital Ship], 19 December 1797. Found in his bed in a public house on shore after a violent beating in an affray with some of his companions (ADM101/98/3A/2/Folio 16 and 17).

Scalds and burns

Michael Cullen, aged 22, able seaman, taken ill at Hamoaze; scalded his left thigh and groin by a kettleful of boiling water poured over him by accident when on shore; taken ill on 3 December 1797, discharged 8 February 1798 to duty (ADM101/93/2B/1/Folio 2).

Jacob Warfield, Seaman, aged 25; [scalded] received contents of kettle full of boiling water on the back of his right leg. Taken ill, 8 October 1797. Discharged to duty 9 November 1797 (ADM101/98/3A/1/Folio 9).

Charles Oliver, aged 32, ordinary seaman; taken ill at, Cawsand Bay; scald from the naval down both legs from his falling in to the copper; taken ill, 10 February 1809 (ADM101/89/2/2/Folio 35).

William Haynes; disease or hurt, scalded foot. Taken ill, 15 May 1813. Discharged to duty 7 June 1813 (ADM 101/125/3/4/Folio 15).

Master Thompson, Midshipman, aged 14; transparent cornea above the right pupil and tunica albuginea. Taken ill, 24 January 1814. Discharged to duty 4 February 1814. Burnt by a candle pushed in to his only good eye (ADM 101/125/3/12/Folio 39).

John Burdett, Seaman, aged 17; scald on right foot which degenerated to a sloughing ulcer. Taken ill, 16 February 1814. Discharged to [Plymouth] hospital, 20 February 1814 (ADM 101/125/3/12/ Folio 40).

T Tucker, aged 36, seaman; was burnt on the foot by a spark of fire from the forge when passing it. Put on sick list, 17 August 1807 at St Helens. Discharged 20 October 1807 to duty (ADM 101/86/3B/1/ Folio 3).

Charles Oliver, aged 32, ordinary seaman; taken ill at, Cawsand Bay; scald from the naval down both legs from his falling in to the copper; taken ill, 10 February 1809 (ADM 101/89/2/2/ Folio 35).

Soft tissue injuries of unknown cause

John Riley, aged 32, sergeant marine, taken ill at Cawsand Bay; lumbago; taken ill on 17 September 1798, sent 20 September 1798 to hospital at Plymouth (ADM101/93/2D/1/Folio 4).

Samuel Sanders; lacerated wound of the right forefinger. Taken ill, 30 January 1798. Discharged 16 February 1798 (ADM101/98/3A/3/Folio 23).

Mr [Tasrner], aged 21, midshipman, taken ill off Brest; sprained ankle with a good deal inflamed; taken ill on 10 August 1798, discharged 13 August 1798 to duty (ADM101/93/2C/4/Folio 29).

James Harwood, aged 31, able seaman, taken ill at Hamoaze; lame knee, case stated in the preceding journal; continued from 3 April 1798, sent 23 June 1798 to Plymouth hospital (ADM101/93/2C/1/Folio 2).

Edward Grant, aged 44, able seaman, taken ill at Hamoaze; lacerated wound, case stated in the preceding journal; continued from 19 May 1798, discharged 6 June 1798 to duty (ADM101/93/2C/1/Folio 3).

William Dailey, aged 26, private marine, taken ill at Hamoaze; bruised side, case stated in the preceding journal; continued from 23 May 1798, discharged 8 May 1798 to duty (ADM101/93/2C/1/Folio 3).

Samuel Campell, aged 40, able seaman, taken ill at Hamoaze; lame hand; date taken ill [?], invalided 15 November 1797 (ADM101/93/2A/6/Folio 34).

Peter John, aged 21, able seaman, taken ill at Hamoaze; bruised shoulder and right arm; taken ill on 20 November 1797, discharged 25 November 1797 to duty (ADM101/93/2A/6/Folio 34).

William Sweet, Seaman, aged 25; sprained tendon in the arm. Taken ill, 30 June, Plymouth. Sent to Plymouth Hospital for survey, 30 August (ADM101/98/3A/1/Folio 3).

Joseph Denner, aged 40, Seaman [employed as a sweeper]; Contused Hand and then Scorbutic. Taken ill, 3 May 1800. Became scorbutic 13 June, feverish 17 June. Died 23 July 1800 (ADM101/107/1/1/Folio 17-18).

James Flanmell, taken ill at Plymouth; pleurisy in consequence from a severe blow in the side I bled him and ordered a purging draught to be taken in the morning; taken ill on 5 May 1799, discharged 18 May 1799 to duty (ADM101/85/4A/1/Folio 8)

Samuel Jones, taken ill at Plymouth; contusion of the right arm with much swelling; taken ill on 19 May 1799, discharged 29 May 1799 to duty (ADM101/85/4A/1/Folio 8).

John Kent, aged 24, able seaman, taken ill at Hamoaze; lame arm from a bruise; taken ill 16 January 1798, discharged 28 January 1798 to duty (ADM101/93/2B/2/Folio 7).

Edward Grant, aged 46, able seaman, taken ill at Hamoaze; contusion and lacerated wound on his forehead; taken ill on 19 May 1798, remains on care 26 May 1798 (ADM 101/93/2B/6/Folio 25).

James Robinson, aged 43, private, taken ill at Hamoaze; large transverse wound across his left arm; taken ill on 1 December 1797, discharged 5 January 1798 to duty (ADM101/93/2B/1/Folio 2)

James Draper, aged 22, able seaman, taken ill at Hamoaze; sprained hand; taken ill on 14 December 1797, discharged 20 December 1797 to duty (ADM101/93/2B/1/Folio 3).

John Stopp, aged 23, able seaman, taken ill at Hamoaze; sprain; taken ill 7 January 1798, discharged 11 January 1798 to duty (ADM101/93/2B/1/Folio 5).

Thomas Smith, aged 32, landsman, taken ill at Hamoaze; lame knee from a bruise; taken ill on 14 April 1798, discharged 26 April 1798 to duty (ADM101/93/2B/5/Folio 20).

James Farney, aged 28, able seaman, taken ill at Cawsand Bay; bruised on his left knee; taken ill on 15 September 1798, discharged 22 September 1798 to duty (ADM101/93/2D/1/Folio 4).

Edward Rockford, aged 31, able seaman, taken ill at sea; received a blow on his right thigh the part appeared swelled; taken ill on 23 September 1798, discharged 28 October 1798 to duty (ADM101/93/2D/1/Folio 5).

Alan Bristow, 'niger', aged 35; received a blow to the upper part of the sternum which became painful and swollen. Taken ill, 20 June 1798, off Cadiz. No date of discharge recorded (ADM101/98/3A/4/Folio 32).

William Wright, aged 35, able seaman, taken ill at sea; blood or hurt on the *os frontis*; taken ill on 6 July 1803, discharged 13 July 1803 to duty (ADM101/97/2/3/Folio 13).

John Thomas, aged 31, landsman; divided *tendo achilles*; put on sick list, 6 November 1806; discharged 10 November 1806 (ADM 101/93/1A/2/Folio 37).

Joseph Elliot, Seaman, aged 37; sprained left knee. Taken ill, 17 May 1813. Discharged to Plymouth Hospital 20 July 1813, by order of surveying officers. Granted smart ticket and invalided from hospital in November. Surveyed on ship because since no disease was evident it was thought he may have been feigning illness, but for his previous good character he would not have been believed (ADM 101/125/3/4/Folio 16).

Henry Reynolds; contused face, eyes etc. Taken ill, 7 June 1813. Discharged to duty 17 June 1813 (ADM 101/125/3/4/Folio 18).

William Luvin, aged 20, seaman; contusion on the anterior part of the tibia. Put on sick list, 27 November 1809 at Spithead. Discharged 30 November 1809 to Haslar Hospital (ADM 101/86/3E/1/Folio 5 or 16).

Abnormal bone growth

Joshua Barton, ship's cook; taken ill at Portsmouth Harbour; a Large deposit of ossific matter which much enlarged the shoulder and appears to be a source of irritation; taken ill, 25 July 1806; sent 26 July 1806 to the Hospital Haslar (ADM 101/88/5/4/Folio 23).

Appendix 10. Morphological features on the skull and pelvis used in sex determination (after Buikstra and Ubelaker 1994; Ferembach *et al.* 1980)

Trait	Female	Male
Skull		
Overal cranial shape	gracile, rounded, lighter	robust, angular, heavier
Glabellar profile	smooth	prominent/ ridged
Frontal slope	vertical	inclined
Frontal and parietal tuberosities	marked	reduced or absent
Zygomatic process of frontal bone	narroww	broad
Supraorbital ridges	slight	prominent
Orbital outline	circular, with sharp edges	quadrangular, blunt edges
Nasal bones	small, less protuberant	large, more protuberant
Zygomatic bone	short, smooth lower margin	tall, roughened lower margin
Temporal ridges	slight	marked/ ridged
Suprameatal crests	short	extended posteriorly
Mastoid process	small, inflected below vault (curved inwards)	large, vertical
Nuchal area	smooth	ridged
External occipital protuberance	small	large
Occipital and mandibular condyles	small	large
Pterygoid plates	small	large
Canine eminence	indistinct	distinct
Palate	small, short, parabolic arch	large, long, U-shaped
Mandibular ramus (anterior-posterior)	narrow	broad
Mandibular ramus	straight posterior border	flexed posterior border
Depth from incisors to mentum/ anterior symphyseal depth	short	long
Mental protuberance	small and rounded	large and projecting
Lower margin of mandibular corpus	thin	thick
Mandibular angle	obtuse, smooth-edged	everted edge (gonial flaring)
Lower first molar	often four- cusped	often five-cusped
Pelvis		
Overall structure	slight muscle attachments	prominent muscle attachments
Overall shape (anterior view)	low and broad	high and narrow
Pelvic inlet	broad, oval or eliptical	narrow, heart-shaped
Iliac crest (vertical view)	sinuous, gently curved	angulated, sharply curved
Iliac blade (anterior view)	flared laterally	more vertical
Iliac tuberosity	discrete, pointed or absent	broad, mounded
Greater sciatic notch	U-shaped, obtuse (> 60^{o})	V-shaped, acute (*c.* 30^{o})
Auricular surface	narrow, on an elevated platform	widee, in the same plane as iliac surface
Pre-auricular sulcus	often present	absent
Post-auricular sulcus	large and wide	small and narrow
Acetabulum	small, faces antero-laterally	Laterge, faces more laterally
Pubic symphyseal height	short	tall

Trait	Female	Male
Pubic ramus	long	short
Sub-pubic angle	broad, U-shaped	narrow, V-shaped
Pubic tubercle	sharp, further from symphysis	blunt, closer to symphysis
Inferior pubic ramus	gracile, tapers superiorly	broad, less tapered
Ventral arc	present	absent
Sub-pubic concavity	present	absent
Medial ischiu-pubic ridge	present	absent
Obturator foramen	small, wide, triangular	large, tall, ovoid
Ischial tuberosity	small	large
Ischial spine	shorter, less intrusive	more prominent and intrusive
Sacral ali width	broader than the body of S1	narrower than the body of S1
Anterior sacral curvature	extends from S3 to S5	extends from S1 to S5
Sacral auricular surface	extends from S1 to S2	extends from S1 to S3

Appendix 11. Craniofacial morphological features used to determine ancestry in the R.N. skeletons

Feature	Caucasian	Mongoloid	Negroid
Overall skull morphology	small, rounded	large, rounded	large, long
Cranial length	long	short	long
Cranial breadth	narrow	broad	narrow
Cranial height	medium to high	medium to high	low
Sagittal contour	rounded	arched	flat
Parietal bossing	small to medium	large, rounded	small
Oval window visible	short to high	high	low
Cranial suture complexity	simple	complex, multiple Wormian bones	simple
Inca bone present	not present	present	not present
Crown morphology	longus capitus	keeled skull	post-bregatic depression
Face general morphology	long, narrow	flat, rounded	prognathic
Facial height	short to high	high	low
Facial breadth	narrow to wide	very wide	narrow
Prognathism	not present	nil to medium	pronounced
Orbital shape	angular	rounded	angular
Interorbital breadth	intermediate	narrow	wide
Nasal aperture width	narrow to medium	narrow to medium	wide
Nasal root	high depressed	medium, nasal overgrowth	low, little or no depression
Nasal root contour	steepled	tented	quonset hut
Inferior nasal spine	sharp	dull	troughed
Anterior nasal spine	long, broad or sharp	small, sharp to dull	short, rounded, almost absent
Zygomatic arch	slight, retreating	pronounced, anterior and inferior projection	slight, retreating
Zygo-maxillary suture	S-shaped	straight	S-shaped
Dental arch	parabolic- narrow to medium	elliptical- broad U-shape	hyperbolic- wide, rectangular
Palatine suture	bulging	straight	bulging
Gonial angle	straight	everted	straight
Mandibular ramus	slanted vertically	wide, ascending	pinched, ascending
Chin morphology	prominent	blunt, vertical	blunt, vertical
Shovelled incisors	missing- occassionally present	present	not present
Molar crowns	Carabelli's cusp	enamel extension	crenulated

***Figure A11.1**: Selected craniofacial morphological variations indicative of ancestry in the three R.N. assemblages*



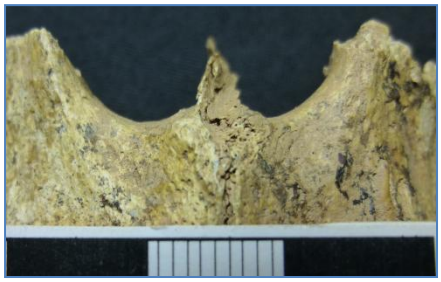


***Left**: Anterior view of the cranium of Haslar 103 showing several traits of negroid/ African ancestry: quoinset hut nasal root, nasal guttering, wide nasal aperture, and low facial height.*
***Right**: Lateral view of the cranium of Plymouth 100 showing marked prognathism, a nasal guttering, a low nasal bridge and long, low cranial vault, typical of African ancestry.*





***Left:** Crenulated molars and wide rectangular dental arcade of the mandible of Haslar 303- typical of African ancestry.*
***Right**: Rectangular dental arcade of the maxillae of Plymouth 938- typical of African ancestry.*

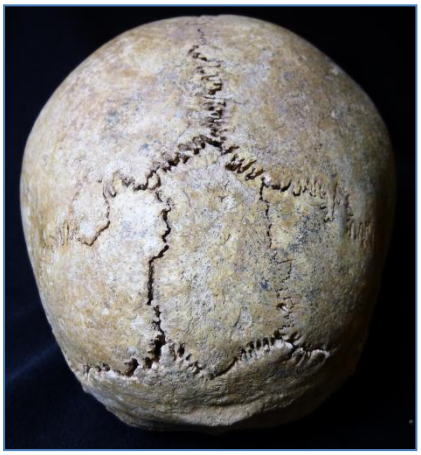




***Left:** Nasal guttering in Plymouth 938- typical of African ancestry.*
***Right**: Anterior view of the cranium of Plymouth 757, displaying nasal guttering, wide nasal aperture and short anterior nasal spine indicative of African origins, but the round orbits, cranial vault keeling and tented nasal root contour more typical of Mongoloid/ Far Eastern ancestry.*



***Left**: Lateral view of the right femur of Plymouth 938, showing a flat anterior curvature of the shaft- a feature typical of African ancestry.*



***Left:** Posterior aspect of the cranium of Plymouth 523, showing a tripartite Inca bone and Wormian bones in the lambdoid suture. These traits are much more common in people of Mongoloid ancestry.*
***Right:** Skull of Greenwich 6058 showing mixed Caucasian and Mongoloid traits: the prominent mental eminence, angular orbits and narrow, sharp, nasal aperture of the former, and the gonial eversion, prominent zygomas, straight zygomatic sutures and short anterior nasal spine of the latter.*

Appendix 12. Stature estimation from maximum long bone length

Haslar	(N = 49)							
Element	No of elements	Lowest value (cm)	Highest value (cm)	Mean length (cm)	Stature minimum (cm)	Stature maximum (cm)	Mean stature (cm)	Mean stature (feet)
L humerus	16	315	356	330.60	167.47	178.87	172.16	5'6½''
R humerus	15	301	353	330.50	163.16	179.17	172.23	5'6½''
L radius	8	227	268	241.25	164.82	180.31	170.22	5'6''
R radius	9	218	256	238.56	161.41	175.78	169.18	5'5½''
L ulna	7	250	281	260.86	164.7	178.02	170.57	5.60
R ulna	3	258	277	270.00	169.51	176.54	173.95	5'7''
L femur	26	418	508	457.73	160.89	182.31	170.21	5'6''
R femur	23	424	504	457.61	162.32	181.36	170.17	5'6''
L tibia	16	326	405	368.50	160.77	180.68	171.14	5'6⅛''
R tibia	11	330	402	375.91	161.78	179.92	172.86	5'7''
L fibula	5	345	370	357.60	164.24	170.94	167.62	5'5''
R fibula	5	337	395	365.60	162.1	177.64	169.76	5'5¾''
Plymouth	**(N = 151)**							
Element	No of elements	Lowest value (cm)	Highest value (cm)	Mean length (cm)	Stature minimum (cm)	Stature maximum (cm)	Mean stature (cm)	Mean stature (feet)
L humerus	60	300	362	323.87	162.85	181.95	170.7	5'6''
R humerus	61	295	363	327.11	161.31	182.25	171.07	5'6⅛''
L radius	47	220	257	237.3	161.73	175.64	168.23	5'5''
R radius	51	231	260	239.94	166.33	177.29	169.47	5'5½''
L ulna	27	234	280	256.85	160.63	177.65	168.89	5'5⅛''
R ulna	33	243	286	261	163.96	179.87	170.24	5'6''
L femur	45	399	495	450.71	154.54	179.22	168.58	5'5⅛''
R femur	40	392	495	451.83	153.06	179.22	168.81	5'5½''
L tibia	56	351	401	362.7	167.07	179.67	169.79	5'5¾''
R tibia	50	321	408	365.66	156.32	181.44	170.51	5'6''
L fibula	14	330	440	355.5	160.22	176.84	166.81	5'4¾''
R fibula	20	308	393	355.55	153.01	177.1	166.84	5'4¾
Greenwich	**(N = 100)**							
Element	No of elements	Lowest value (cm)	Highest value (cm)	Mean length (cm)	Stature minimum (cm)	Stature maximum (cm)	Mean stature (cm)	Mean stature (feet)
L humerus	69	288	369	321.35	155.99	183.49	169.3	5'5½''
R humerus	66	295	363	310.17	159.25	182.25	170.2	5'6''
L radius	54	216	267	235.48	160.66	179.94	167.81	5'5''
R radius	67	209	268	235.84	158.01	180.31	167.9	5'5''
L ulna	46	214	288	253.63	153.23	180.61	167.64	5'5''
R ulna	54	216	292	254.7	153.97	179.87	168.07	5'5''
L femur	85	392	493	445.78	156.37	183.74	167.45	5'5''
R femur	83	393	510	443.53	156.61	182.79	166.89	5'4¾
L tibia	80	301	418	357.83	154.47	183.96	168.7	5'5⅛''
R tibia	79	304	416	357.48	155.23	183.45	168.61	5'5⅛''
L fibula	30	316	410	354.83	156.47	181.66	166.79	5'4¾''
R fibula	25	314	395	347.68	155.93	177.64	164.96	5'4''

Appendix 13. Skeletal catalogue of the Haslar skeletons (N= 49)

Skeleton	Site Code	Age Category	Age range (years)	Sex	Stature (cm)	Skeletal Pathology
001	HAS07	8	>18	male		Occiput possible but doubtful penetrating trauma; R auditory meatus porosity- possible extrenal ear infection; ectocranial orange-peel porosity- possible scurvy; ivory osteomata; R knee DJD
002	HAS07	4	35-45	male	178	Occiput penetrating injury with early healing and possible surgical intervention; L ribs active periostitis; R & L tibia active periostitis
003	HAS07	3	20-30	male	171	L & R tibia & L radius periostitis, L & R posterior maxilla, GWoS new bone- probable healed scurvy
004	HAS07	8	>25	male	169	R maxilla chronic sinusitis; L orbit & L GWoS healed new bone- possible scurvy; L fibula possible rickets, possibly occupational change
007	HAS07	3	18-25	male	178	L tibial shaft probable #; L & R tibia, femur & fibula moderate rickets; Eagle's Syndrome; multiple congenital anomalies; L & R tibia active periostitis
009	HAS09	2	16-19	probable male		R humeral perimortem head sharp force trauma (possible tomahawk wound); R humerus, L & R radius, femur, tibia, fibula, L scapula active periostitis, endocranial healing new bone - probable active scurvy; L & R ribs active periostitis
010	HAS07	8	> 18	male	170	L & R tibiae periostitis, ectocranial orange-peel porosity- probable healed scurvy
102	HAS09	5	35-45	male	171	R tibial plateau osteochondritis dissecans; saucer craniotomy; L GWoS, occiput & frontal bone healing endocranial new bone porosity; ectocranial orange-peel porosity, L orbital lesion new bone, L & R tibia periostitis- probable healed scurvy
103	HAS08	4	30-35	male	168 (negroid)	R scapula possible #; craniotomy; L & R tibiae, L fibula, R ulna & radius periostitis, ectocranial orange-peel porosity- probable healed scurvy; R os acromiale; slight DJD
104	HAS08	3	18-22	male		L maxilla sinusitis; occiput endocranial healed new bone
106	HAS08	4	25-30	male	169	L calcaneus possible #; craniosynostosis- pronounced dolichocrany (CI 54.2); endocranial active new bone ++; L & R cribra orbitalia; ectocranial orange-peel porosity- possible healed scurvy; L ribs active periostitis; L tibia possible rickets
107	HAS08	8	<42	probable male		L parietal small penetration with internal bevelling -probably taphonomic

Skeleton	Site Code	Age Category	Age range (years)	Sex	Stature (cm)	Skeletal Pathology
108	HAS08	3	25-42	male		L & R tibia, femur, L ulna active periostitis, endocranial active new bone, ectocranial orange-peel porosity, R orbital lesions- probable active scurvy; L & R tibiae moderate rickets
110	HAS08	4	25-30	male	168	L parietal depressed #; L & R nasal #s; L & R acetabula impaction #s; R ribs x 2 #s; SDJD; R distal femur active periostitis; SDJD
111	HAS08	2	17-20	male	171	Nil noted
112	HAS08	8	>25	male	166	L & R tibiae & fibulae, MT5, talus & calcaneus, L humerus active periostitis, ectocranial orange-peel porosity- probable active scurvy
113	HAS08	2	15-19	subadult sex unknown		L & R femur & tibia mild rickets; L & R cribra orbitalia +++; L & R femur, tibia & L ilium healed & active periostitis- probable scurvy
114	HAS08	4	25-30	male	169	C7 spinous process healed #; L5 spondylolysis; R acetabulum possible impaction #; L5 lytic lesions- possible TB; Schmorl's nodes; DJD
211	HAS09	4	23-30	probable male	165	Torticollis; L zygoma possible sharp force trauma & inflammation/ infection; L & R ribs healed periostitis; L & R cribra orbitalia; ectocranial orange-peel porosity- possible healed scurvy; Schmorl's nodes
212	HAS09	3	20-30	male	167	Frontal sinus abscess with cloaca in endocranium, associated with endocranial new bone; ectocranial orange-peel porosity, L & R ulna, femur, tibia, fibula, iliacs, L radius, L MCs, L & R MTs active periostitis, mandible new bone- probable active scurvy, possible pulmonary osteoarthropathy
213	HAS09	4	25-30	probable male	176	Torticollis with abnormally small, round head (cranial length 179 mm, breadth 125 mm); C1 & 2 slight OP
214	HAS09	4	25-35	male		Mandible x 3, L & R maxilla x 3, L & R zygoma x 2, L & R radius, R olecranon, L scaphoid, L femur healed and healing #s with non-union, R humerus # with gross mal-alignment, non-union & pseudoarthrosis; L temporal TMJ, R hand PP & R tibial plateau #s; hyoid possible #; L ulna OA; L & R orbital lesions, R femur, L & R tibia well healed periostitis- possible healed scurvy; L & R tibia slight rickets
215	HAS09	2	16-18	probable male		L radius & ulna active periostitis; L & R cribra orbitalia; L & R femur probable healed periostitis; R temporal probable healed focal infecton on ectocranial surface

Skeleton	Site Code	Age Category	Age range (years)	Sex	Stature (cm)	Skeletal Pathology
216	HAS09	2	15-17	subadult sex unknown		L & R cribra orbitalia; L cribra femora; L tibia periostitis possible ulcer; L mandible & L & R maxilla healed new bone- possible scurvy, probable dental disease
217	HAS09	4	25-30	male	172	Amputated R tibia unhealed; L & R cribra orbitalia, ectocranial orange-peel pitting- possible healed scurvy; R maxilla sinusitis
217A	HAS09	8	>18	adult sex unknonw		L humeral amputation (mid-proximal shaft), unhealed
218	HAS09	2	16-19	male	(negroid)	L & R cribra orbitalia; L & R femur & tibia healed periostitis; L GWoS active new bone; L distal 1st PP (foot) lateral deviation
219	HAS09	5	35-45	male	182	T1 clay shoveller's # ; R MC1 Bennett's #; L distal tibia large enthesophyte ankle injury; L hand MP lytic joint surface- possible infection or gout; L & R cribra orbitalia; R TMJ DJD/OA; multiple joint surfaces DJD; R femur, L & R tibia periostitis-possible healed scurvy; Schmorl's nodes
219A	HAS09	8	>18	adult unknown sex		R distal femoral amputation; R tibia active periostitis
220	HAS09	3	20-25	male		Dissection- sawn clavicles; L talus Shepherd's #; endocranial active new bone; L & R possible slight rickets; L & R cribra orbitalia; L foot DP1 lateral deviation; R acetabulum inferior lipping ++; Schmorl's nodes
221	HAS09	5	35-45	male		Occiput probable perimortem #; L rib x 3 #s; L scapular body #; R capitate possible #; R clavicle #; L radial head possible osteochondritis dissecans; ectocranial orange-peel porosity, R posterior maxilla new bone, L & R orbital lesions, endocranial healed new bone- probable healed scurvy; multiple joints DJD; Schmorl's nodes
231	HAS09	3	20-25	probable male	161	L tibial plateau osteochondritis dissecans; L & R ilium, R femur, L & R tibia & fibula, R MTs healed & healing periostitis, endocranial active new bone, ectocranial orange-peel porosity, L & R orbital lesions- probable active scurvy; L & R ribs active periostitis; ivory osteoma; L & R Eagle's syndrome; Schmorl's nodes
301	HAS10	5	35-45	male	172	R MC1 Bennett's #; L & R orbital lesions, L & R tibia periostitis, ectocranial orange-peel porosity- probable healed scurvy; L Eagle's syndrome; Schmorl's nodes

Skeleton	Site Code	Age Category	Age range (years)	Sex	Stature (cm)	Skeletal Pathology
302	HAS10	6	45+	male		L & R distal tibiae, fibulae, calcanei, MTs, R radius active periostitis, ectocranial orange- peel porosity active scurvy; R rib healed periostitis; ivory osteomata; L MT-PP joint osteochondritis dissecans
303	HAS10	6	45+	male	172	R lunate #; R MT1 osteochondritis dissecans; L iliac, R ulna, R radius, L & R tibia, fibula, calcaneus, MTs, L foot PP1 active periostitis- probable active scurvy; widespread slight DJD; L & R flatfooted; Schmorl's nodes
304	HAS10	6	45-60	male	168	L nasal #; caries sicca, osteomyelitis & gummatous lesions on multiple long bones & Chalcot knee joints- classic treponemeal disease, probably tertiary syphilis; DJD; L & R cribra orbitalia; Schmorl's nodes
305	HAS10	6	40-50	male	173	R distal radial #; L distal ulna possible #; L navicula possible #; multiple elements slight DJD; L & R tibia healed periostitis, ectocranial orange-peel porosity, possible cribra orbitalia- probable healed scurvy
306	HAS10	8	> 18	male		L & R femur, tibia moderate rickets; L & R femur, tibia periostitis, abnormal small round skull shape and very long face- possible developmental abnormality or inherited syndrome; R maxilla sinusitis
307	HAS10	4	25-35	probable male	171	L & R femur, L tibia periostitis, L mandible new bone, endocranial healed new bone, ectocranial orange-peel porosity, L femur Pelkin spur- probable healed scurvy; L foot PP active peiostitis; L maxilla sinusitis
308	HAS10	4	25-35	probable male	171	R distal femur joint surface possible impaction #; L & R orbital lesions, ectocranial orange-peel porosity- possible scurvy
309	HAS10	4	25-30	male		L ribs active periostitis; bone-former- enthesophytes & ossified cartilage- aetiology uncertain; L & R orbital lesions, ectocranial orange-peel porosity; endocranial healed new bone; L & R flatfooted; Schmorl's nodes
321	HAS10	2	16-19	subadult sex unknown		Nil noted
322	HAS10	8	>18	adult sex unknown		L & R tibia & fibula healed and active periostitis
323	HAS10	2	15-17	subadult sex unknown		L tibia Osgood-Schlatter's disease; L5 spondylolysis; L & R distal humerus, L distal femur & possible L patella osteochondritis dissecans; ectocranial orange-peel porosity- possible scurvy; Schmorl's nodes

Skeleton	Site Code	Age Category	Age range (years)	Sex	Stature (cm)	Skeletal Pathology
324	HAS10	4	25-35	male	162	L & R nasal #s; vomer possible #; L 1st & 12th rib #s; L MC1 Bennett's #; L trapezium #; L & R MC3 #s; L3 spondylolysis; R knee trauma- possible haemarthrosis, anterior cruciate rupture & distal femur osteochondritis dissecans; R humerus possible #; L & R femur, tibia, fibula, L ulna, R humerus active periostitis, L & R posterior maxilla new bone, ectocranial orange-peel porosity- probable active scurvy; endocranial healed new bone; L & R cribra orbitalia; L & R ribs active periostitis; Schmorl's nodes; possible Hutchinson's incisors; bifid rib
326	HAS10	8	>18	male		Endocranial active new bone; ectocranial orange-peel pitting- possible scurvy
327	HAS10	3	18-23	male	161	L 7 R maxilla sinusitis healed; L & R cribra orbitalia, ectocranial orange peel pitting- possible healed scurvy
TP2	HAS08	8	>15	adult sex unknown		Nil noted
TP4	HAS08	3	18-25	male		L 11th rib #;L & R acetabulum possible impaction #s; L & R tibia & fibula periostitis, L & R mandibles & L zygoma new bone, L & R orbital lesions- probable healed scurvy; Schmorl's nodes

Appendix 14. Skeletal catalogue of the Plymouth assemblage (N= 151)

Skeleton	Site Code	Age Category	Age range (years)	Sex	Stature (cm)	Skeletal Pathology
100	EA6102	6	45+	male		Frontal bone depressed cranial #; torticollis; CV slight OP; possible R facial palsy
506	EA6102	4	30-40	probable male		R tibia distal joint surface #; L talus incomplete Shepherd's #; L & R tibia & fibula periostitis & possible ulcers
509	EA6102	3	18-30	probable male		R talus incomplete Shepherd's #; unsided MC4 or 5 healed #; L & R scapula, femur, tibia, fibula, MT5, R clavicle, radius, L calcaneus active periostitis, endocranial active new bone- probable active scurvy; L & R ribs active periostitis; Schmorl's nodes
510	EA6102	8	>18	adult sex unknown		L navicular #; L & R tibiae, fibulae marked periostitis/ osteitis- probably infection, possible ulcer/ ossified haematoma; L foot possible flat-footed
520	EA6102	5	35-45	male		Frontal depressed #; L & R nasal, maxilla & vomer #s; C7 #; R MC1 Bennett's #; L clavicle #; L femur osteochondritis dissecans & haemarthrosis; R femur unhealed amputation; L knee OA +++; L & R radius, ulna, femur, clavicles, L tibia, fibula, calcaneus & MTs active periostitis, ectocranial orange-peel porosity- probable active scurvy; L & R ribs healed periostitis; R rib active periostitis; R Eagle's syndrome; Schmorl's nodes
521	EA6102	3	18-23	probable male		Saucer craniotomy; unsided hand PP healing fracture; ectocranial orange-peel porosity, R orbit new bone, L arm bones active & healing periostitis- probable active scurvy
523	EA6102	2	15-17	subadult-sex unknown		R parietal depressed #; L 7 R femur, fibula, L clavicle periostitis, L & R maxilla, L mandible, GWoS new bone- probable healed scurvy; R ribs active periostitis; maxillary sinusitis healed; L maxilla large abscess in hard palate; Schmorl's nodes
528	EA6102	5	35-45	male		R radial head osteochondritis dissecans; L & R orbits new bone, ectocranial orange-peel porosity- possible healed scurvy; L maxilla sinusitis; slight SDJD; Schmorl's nodes
531	EA6102	3	18-22	probable male		R ribs x 12 marked active periostitis; R scapular body large lytic lesion- possible TB; L & R orbital lesions, ectocranial orange-peel porosity- possible healed scurvy; L maxilla healing sinusitis; L & R os acromiale
534	EA6102	5	35-45	probable male	165	Schmorl's nodes

Skeleton	Site Code	Age Category	Age range (years)	Sex	Stature (cm)	Skeletal Pathology
538	EA6102	3	20-30	probable male		Nil noted
540	EA6102	3	18-27	possible male		R talus Shepherd's #
544	EA6102	4	25-30	probable male	169	R acetabulum slight flange lesion & slight impaction #; L tibia healing periostitis ++; R MC1 bony outgrowths- possibly enthesophytes; L & R feet slightly flat-footed; Schmorl's node
547	EA6102	5	35-45	male		R femur healed amputation with bony outgrowths & long-standing periostitis; L MT1 crush #; L sesamoid #; ectocranial orange-peel porosity, parietals endocranial new bone healed, L tibia healed periostitis- probable healed scurvy; R maxilla healed sinusitis
551	EA6102	5	40-50	male	179	R patella #; T10- L3, sacrum & possibly MT1 & 5 joints- TB; L & R ribs healed periostitis; R MC1 possible soft tissue lesion; ectocranial orange-peel porosity, R tibia & fibulae healed periostitis- probable healed scurvy; R Eagle's syndrome; Schmorl's nodes; L mandible large abscess, infection & dental filling (black metal)
554	EA6102	4	25-35	male	167	Schmorl's node
564	EA6102	3	18-30	probable male		Saucer craniotomy; R tibia & MT1 perimortem fine cutmarks; R tibia healing periostitis; R tibia slight rickets; L & R maxilla healed sinusitis; L maxilla new bone in nasal aperture; L & R orbital lesions; L tibia sight rickets
565	EA6102	8	>18	adult sex unknown		R femur, L & R tibiae & fibulae active osteitis/ osteomyelitis- probable syphilis
569	EA6102	4	25-35	male		L & R nasal #s; R rib #s x 3; L & R maxilla sinusitis; R hand MP & L distal radio-ulnar joints possible erosive arthropathy; ectocranial orange-peel porosity, R femur slight periostitis- possible healed scurvy; Schmorl's nodes
570	EA6102	5	40-45	male		R ribs x 5 #s; L & R maxilla active sinusitis; L & R ribs healing periostitis; L olecranon slight OA; cranial vault thickening - possible Paget's;L & R orbital lesions, ectocranial orange-peel porosity, R femur healed periostitis - probable healed scurvy; Schmorl's nodes
571	EA6102	8	>18	possible male		R humerus healing proximal shaft amputation; R clavicle healed #; R scapula glenoid fossa possible inflammation/ haemarthrosis
573	EA6102	5	35-45	male		Ectocranial orange-peel porosity- possible healed scurvy; L & R maxilla sinusitis; L humerus healed periostitis & possible ossified haematoma; Schmorl's nodes

Skeleton	Site Code	Age Category	Age range (years)	Sex	Stature (cm)	Skeletal Pathology
575	EA6102	2	12-14	subadult-sex unknown		Nil noted; stunted for age (by 2-4 years)
578	EA6102	6	40+	possible male	163	L distal humerus osteochondritis dissecans; L ribs active & healed periostitis; L tibia & fibula healed periostitis; L tibia slight rickets; L hip DJD; L os acromiale
581	EA6102	3	20-25	male		C5 decapitated post-mortem; manubrium, 3 x rib shafts, R scapula fine cutmarks- possible radical forequarter resection or removed post-mortem as specimen; R MC1 healing Bennett's #; R foot PP1 and sesamoid #s; R acetabulum impaction #; L & R cribra femoris; Schmorl's nodes
584	EA6102	3	17-20	male	163	L & R maxilla sinusitis; L tibia periostitis, ectocranial orange-peel porosity- probable healed scurvy; Schmorl's node
590	EA6102	5	35-45	probable male		R MC1 Bennett's #; L MC5 shaft #; unsided ribs x 4 #s; L acetabulum possible lip #; R trapezium & MC1 OA; L hip marginal DJD of acetabulum & femoral head; Schmorl's nodes
593	EA6102	4	25-30	probable male		Nil noted
596	EA6102	4	25-35	male		L & R nasal #s; ectocranial orange-peel porosity, L & R sphenoids endocranial new bone, L & R orbital lesions- possibe healed scurvy; Schmorl's nodes
599	EA6102	3	20-25	male		R rib x 1 #; L & R active & healed rib periostitis; L & R orbital lesions; frontal & parietal bones possible healed endocranial lesions; Schmorl's nodes
602	EA6102	5	35+	male	174	R MC1 shaft #; R femur marked enthesophyte; L ribs active periostitis; R radius & L tibia active periostitis; L & R femur, L & R tibia healed periostitis; 'cribra orbitalia', ectocranial porosity- probable healed scurvy; ivory osteomata; feet slightly flat-footed; Schmorl's nodes
605	EA6102	4	22-30	male	165	Ectocranial orange-peel porosity, orbital lesions, posterior maxillae new bone, L & R tibia, R fibula healed periostitis- probable healed scurvy; Schmorl's nodes
611	EA6102	5	35-45	male		R parietal slight depressed #; orbital lesions, L & R femur active & healed periostitis- possible scurvy; Schmorl's nodes
614	EA6102	2	14-16	subadult-sex unknown		L femur, L & R tibiae & fibulae healed periostitis, orbital lesion possible healed scurvy

Skeleton	Site Code	Age Category	Age range (years)	Sex	Stature (cm)	Skeletal Pathology
617	EA6102	6	45-50	male	168	Unsided rib #; L1 wedge #; L6 lumbarisation; sacrum possible adolescent rickets; R os acromiale; ectocranial orange-peel porosity- possible scurvy; ivory osteomata; Schmorl's nodes
620	EA6102	5	35-45	probable male	174	L acetabulum slight flange lesion; ectocranial orange-peel porosity, orbital lesions, L & R femur, tibia, fibula healed periostitis- probable healed scurvy; R MC1 periostitis/ osteitis probable localised infection; Schmorl's nodes
623	EA6102	4	30-35	probable male	166	T8 Scheuerman's kyphosis; L & R femora healed periostitis- possible scurvy; Schmorl's nodes
624	EA6102	1	11-13	subadult-sex unknown		L below- knee amputation healing; L & R maxilla active sinusitis, posterior maxillae & GWoS new bone, L tibia & fibula active periostitis- probable healing scurvy; growth stunting
627	EA6102	4	25-30	possible male		Nil noted
630	EA6102	4	30-35	male		L rib x 3 #s; ectocranial marked orange-peel porosity- possible healed scurvy
633	EA6102	3	20-30	male		R femur unhealed amputation; L parietal #; R mandlible # & osteomyelitis; R ilium probable projectile trauma; L ilium fine cutmarks; L & R acetabulum #s; R humerus #; R MC3 #; R hand DP #; R maxilla hard palate large abscess; ectocranial orange-peel porosity- possible scurvy
636	EA6102	6	40+	male	169	Frontal bone depressed #; cranium possible Paget's disease; L & R orbital lesions, L tibia & fibula active marked periostitis, possible ulcer; R tibia healed periostitis; Schmorl's nodes
639	EA6102	8	>18	possible male		R rib x 1 healing #
642	EA6102	6	45+	male		Unsided ribs x 4 #s; L MC5 #; TV spinous processes x 2 #; L & R femur, tibia & fibula healed periostitis- probable healed scurvy; Schmorl's nodes
645	EA6102	2	15-17	probable male		R cribra orbitalia; possible porotic hyperostosis; Schmorl's node

Skeleton	Site Code	Age Category	Age range (years)	Sex	Stature (cm)	Skeletal Pathology
648	EA6102	2	16-18	probable male		L & R talus incomplete Shepherd's fractures; L humeral capitulum osteochondritis dissecans; L & R glenoid cavity possible osteochondritis dissecans; L orbital lesion; L & R tibia slight rickets; R foot MP-DP ankylosis- possibly congenital; Schmorl's nodes
651	EA6102	3	18-20	probable male	175	Occiput perimortem projectile trauma- possibly pistol-shot; L & R femur & R tibia very well healed periostitis- possible scurvy
654	EA6102	2	16-18	subadult-sex unknown		Ectocranial orange-peel porosity,L & R orbital esions possible healed scurvy; R maxilla sinusitis; Schmorl's nodes
657	EA6102	4	25-35	probable male		R talus Shepherd's fracture healing; L & R maxilla sinusitis; ectocranial orange-peel porosity- possible scurvy
661	EA6102	5	35-45	male	173	R humeral head & glenoid cavity #s with OA and anterior luxation; R acromium #; R rib x 2 #s; L rib x 2 #s; R MT5 #; L 7 R tibia & fibula healed periostitis; L & R flat-footedness
662	EA6102	8	>18	probable male		R distal femoral amputation unhealed (medical waste); R tibia and fibula ununited butterfly #s with necrosis of tibial shaft- probable projectile trauma; MT2-5 well healed periostitis
668	EA6102	5	35-45	male		Frontal bone cranial #; L & R sphenoid & occiput possible lytic lesions (but may be taphonomic)
670	EA6102	3	20-30	male	164	R acetabulum possible impaction #; occiput healed new bone; ectocranial orange-peel porosity- possible healed scurvy
671	EA6102	4	25-35	male	162	R MC1 #; R tibia distal joint surface #; L calcaneus #; R tarsals abnormal articulation- possible chronic dislocation & soft tissue tearing; L & R flat-footed; L & R humerus, tibia, L ulna, radius, fibula healed periostitis, possible endocranial new bone, ectocranial orange-peel porosity- probable healed scurvy
674	EA6102	5	35-50	male	155	L & R nasal #; T8- 12 crush #s & OA; R ribs x 3 healed #s; L rib healing #; R MC3 incomplete #; R MC1 Bennett's #; R ribs healed & active periostitis; ivory osteoma; R MT1 possible gout; ectocranial orange-peel porosity, L & R orbital lesions, L & R tibia periostitis- probable healed scurvy; Schmorl's nodes
677	EA6102	2	15-17	subadult-sex unknown		Profound growth stunting (consistent with Maresh 8 years)

Skeleton	Site Code	Age Category	Age range (years)	Sex	Stature (cm)	Skeletal Pathology
680	EA6102	4	25-35	male	164	L rib x 1 possible #; R rib active periostitis; ectocranial & L zygoma orange-peel porosity, & R orbita lesions, R femur, L & R tibia & fibula healed periostitis- probable healed scurvy; Schmorl's nodes
685	EA6102	3	20-25 y	male	157	Porotic hyperostosis; Schmorl's nodes
688	EA6102	2	15-17	subadult-sex unknown		Endocranial new bone healed; Schmorl's nodes
692	EA6102	8	>18	adult sex unknown		R Rib 3 healed #; R ribs x 2 abnormal articulating processes- probable congenital anomaly; R acromio-clavicular joint OA
693	EA6102	8	>21	possible male		Nil noted
697	EA6102	8	>23	possible male		L talus healing Shepherd's #; L distal humerus osteochondritis dissecans with OA; R ischium healing 'weaver's bottom' enthesopathy; L & R femur, tibia & fibula healed periostitis- probable healed scurvy
698	EA6102	5	30-40	male		Porotic hyperostosis; CV & TV bodies- osteophytosis; ectocranial orange-peel porosity, L & R orbital lesions, R femur & tibia healed periostitis- probable healed scurvy; Schmorl's nodes
701	EA6102	2	17-19	subadult-sex unknown		R femur well healed periostitis
702	EA6102	4	21-46	probable male		R MC1 Bennett's #; R tibia & fibula osteomyelitis; R femur erosive knee joint lesions- probable Charcot's knee; L & R tarsals & L PP1 active new bone & joint erosion-infection, possible syphilis
704	EA6102	5	35-45	male		L talus incomplete Shepherd's #; R fibular midshaft thickening- possible osteoma or well aligned #; ectocranial orange-peel porosity, R tibia healed periostitis- probable healed scurvy; Schmorl's nodes
707	EA6102	4	30-35	male	166	R radius probable volar Barton's #; R ulna possible styloid #; L & R femur & tibia well healed periostitis- possible scurvy; Schmorl's nodes

Skeleton	Site Code	Age Category	Age range (years)	Sex	Stature (cm)	Skeletal Pathology
709	EA6102	3	17-21	probable male		Unsided ribs active periostitis; Schmorl's nodes
710	EA6102	3	18-25	adult sex unknown		R tibia & fibula active periostitis
711	EA6102	2	17-19	male		Endocranial new bone healing, L & R orbits, R posterior maxilla new bone healing; L & R femur & tibia healing periostitis- probable active scurvy; R rib active periostitis; maxilla & mandible infection from peri-apical abscesses; Schmorl's nodes
713	EA6102	5	35-45	probable male		Decapitated at C1 & 2; L femur amputation unhealed; L humerus healed spiral shaft # with deformation; T8 & 10 slight wedge #s; unsided rib #; L5 spondylolysis; L os acromiale; L tibia possible haematoma; slight DJD; Schmorl's nodes
715	EA6102	8	>18	adult sex unknown		R femur amputation unhealed- distal part (medical waste); R leg & foot active periostitis; R MT1 proximal joint surface- possible osteochondritis dissecans, possible developmental
718	EA6102	8	>18	possible male		R foot PP possible #; R fibula possible ossified haematoma; L & R femur, tibia & calcaneus healed periostitis- probable healed scurvy
721	EA6102	4	25-35	male	173	L rib fractures x 3; L talus incomplete Shepherd's fracture; R tibia & fibula healed periostitis
724	EA6102	3	25-30	male		Ectocranial orange-peel porosity, endocranial new bone active, L & R scapula, L humerus, L & R radius, R ulna, L femur active periostitis- probable active scurvy; ribs active periostitis; Schmorl's nodes
727	EA6102	6	40-50	male	167	L MC1 shaft # with secondary OA; R MC1 Bennett's #; T8 & possibly T9 crush #s; L fibula #; L & R acetabulum impaction #s; generalised slight DJD; Schmorl's nodes
730	EA6102	2	15-17	probable male		L maxilla sinusitis; Schmorl's nodes
731	EA6102	3	18-22	subadult-sex unknown		R ilium large supra-acetabular cyst; R tibia possible ossified haematoma

Skeleton	Site Code	Age Category	Age range (years)	Sex	Stature (cm)	Skeletal Pathology
735	EA6102	6	45+	male	172	Proliferative systemic disease of unknown aetiology involving all major long bones, L & R ilium, vertebral bodies- possible Paget's, possible syphilis; L & R MT abnormally short- bradydactyly; L os acromiale
738	EA6102	3	18-23	possible male		R clavicle #; L orbit cribra orbitalia; ectocranial orange-peel porosity- possible scurvy; Schmorl's nodes
740	EA6102	4	25-35	male	169	L parietal depressed #; R talar head #; L ribs active periostitis; sacrum & L5 congenital anomaly; L1 lytic lesion-possible TB; ectocranial orange-peel porosity, occiput endocranial new bone, L & R femur, tibia, L fibula periostitis- probable healed scurvy
742	EA6102	4	20-30	male	167	L & R humeral condyles osteochondritis dissecans; L medial cuneiform & navicular possible oteochondritis dissecans; L & R maxilla sinusitis; L & R maxilla severe abscess & oral infection; sacrum adolescent rickets; Schmorl's nodes +++
745	EA6102	3	18-25	male	167	T2 or 3 body #; endocranial active new bone; ectocranial orange-peel porosity ++, L & R orbits, L & R posterior maxilla active new bone, R scapula, R ulna, L & R tibia, fibula active periostitis- probable active scurvy; L & R maxilla sinusitis healed; L & R rib active periostitis; L & R feet flatfooted
748	EA6102	5	35-45	male		R rib fractures x 2; unsided rib #s x 2; L glenoid cavity & humeral head possible joint inflammation/ haemarthrosis; R ribs active periostitis; R hand PP periostitis/ osteitis; widespread slight DJD; Schmorl's nodes
752	EA6102	3	18-23	male		Ectocranial orange-peel porosity; L & R orbital lesions- possible scurvy; T5-7 possible Scheuerman's disease; Schmorl's nodes
754	EA6102	6	45+	male	173	L & R nasal #; R rib x 1 #; L talar #; ectocranial orange-peel porosity, L & R tibia & fibula healed periostitis- probable healed scurvy; Schmorl's nodes
757	EA6102	6	45+	male	161	L & R nasal #s; R talus Shepherd's #; L MT5 #; T7 body #; sternum sharp force trauma; L MT5 probable #; R shoulder possible subluxation; L acetabulum rim # & flange lesion; frontal bone lytic lesion possible TB; L ribs active periostitis; L & R feet flatfooted
758	EA6102	4	25-35	probable male		L & R acetabular flange lesions; ectocranial orange-peel porosity; L & R femur, L tibia healed periostitis- probable healed scurvy; Schmorl's nodes
759	EA6102	4	30-35	probable male		L acetabulum impaction # with supra-acetabular cyst formation; Schmorl's nodes

Skeleton	Site Code	Age Category	Age range (years)	Sex	Stature (cm)	Skeletal Pathology
762	EA6102	5	35-45	male	170	L5 spondylolysis
764	EA6102	4	25-30	probable male		R talus incomplete Shepherd's #; L & R tibiae, R femur well healed periostitis with possible ulcers- possible healed scurvy
768	EA6102	4	25-35	male		Ectocranial orange-peel porosity, posterior maxilla new bone- possible active scurvy; L and R ribs active periostitis; L & R maxilla sinusitis
772	EA6102	8	>18	subadult-sex unknown		L MT5 probable # with periostitis; L tibia & fibula osteomyelitis; L femur cribra femoris
777	EA6102	4	30-35	probable male	169	L tibia and fibula healed periostitis; Schmorl's nodes
781	EA6102	3	19-25	male		L & R orbits cribra orbitalia; L & R femur & tibia well healed periostitis- possible healed scurvy
784	EA6102	2	15-17	subadult-sex unknown		L5 spondylolysis; L ribs active periostitis; R cribra orbitalia
786	EA6102	4	25-30	male		Unsided rib x 2 #s; ectocranial orange-peel porosity- possible scurvy; R maxillary sinusitis; Schmorl's nodes
792	EA6102	3	25-35	male	169	R nasal & superior maxilla #s; R acetabulum impaction #; R talus body #; R MT1 #; ectocranial orange-peel porosity- possible healed scurvy; Schmorl's nodes
794	EA6102	4	25-30	probable male		L radius, R femur, L & R tibia & R fibula active periostitis- possible syphilis
797	EA6102	8	>18	adult sex unknown		Nil noted
802	EA6102	8	>18	adult sex unknown		R femoral shaft amputation distal (medical waste)
804	EA6102	4	25-30	male		Frontal depressed #; R glenoid fossa, L patella inflammation/ haemarthrosis; endocranial active new bone; ectocranial orange-peel porosity. L & R orbital lesions, L femur, R tibia & fibula healing periostitis- probable healing scurvy; R & L ribs active periostitis; TV x 2 lytic lesions possibly TB; Schmorl's nodes

Skeleton	Site Code	Age Category	Age range (years)	Sex	Stature (cm)	Skeletal Pathology
808	EA6102	2	15-17	subadult-sex unknown		Schmorl's nodes
810	EA6102	4	30-34	probable male	163	L rib x 1 #; L5 spondolysis/ spondylothesis; lower leg periostitis; L & R femur, tibia slight rickets; L & R tibia & fibula healed periostitis; Schmorl's nodes
814	EA6102	4	25-30	male	161	L & R talus Shepherd's # healing; L & R scapula, humerus, ilium, femur, L clavicle, ischium & R tibia active periostitis- probable active scurvy; L ribs active periostitis; L & R femur & tibia slight rickets; Schmorl's nodes
815	EA6102	4	25-35	male	169	R talar head #; L & R tibia & R fibula healed periostitis
825	EA6102	8	>18	possible male		R ulnar styloid #; R acetabular impaction # with supra-acetabular cyst formation; L foot PP1 crush # with OA; R tibia active periostitis; generalised DJD
830	EA6102	3	18-23	probable male		Nil noted.
832	EA6102	3	18-30	male		Ectocranial orange-peel porosity- possible scurvy
835	EA6102	8	18-30	adult sex unknown		R humerus distal metaphysis #; R radial head #; R distal humerus osteochondritis dissecans; R shoulder possible chronic dislocation/ superior impingement; R ribs well healed periostitis
844	EA6102	5	35-45 y	male		R 1st foot DP crush # & amputation; R temporal healed sharp force trauma; L & R humerus, ulna, radius, ilium, feemur, tibia, fibula, L MT1, L & R MT5, L hand PP active periostitis, L GWoS new bone, L & R orbits new bone; endocranial new bone- probable active scurvy; thickened skull; L rib periostitis active; R elbow DJD +++ & medial eipcondylar enthesopathy; L & R femur mild rickets
845	EA6102	5	35-45	male		R MC1 shaft #; L & R tali Shepherd's #s; L MT1 head crrush #; unsided foot phalanges # & ankylosis; L5 lytic lesions- possible TB/ brucellosis; R ribs healed periostitis; L & R femur, tibia & fibula, L ulna periositis- probable healed scurvy; Schmorl's nodes
849	EA6102	2	17-19	probable male		L & R femur slight rickets

Skeleton	Site Code	Age Category	Age range (years)	Sex	Stature (cm)	Skeletal Pathology
858	EA6102	4	25-29	probable male	175	L & R tibia & femur healed periostitis; R femur possible ossified haeaatoma/ ulcer- possibe healed scurvy; Schmorl's nodes
862	EA6102	3	20-30	male		R humerus healing osteochondritis dissecans; L femur healed periostitis- possible scurvy; Schmorl's nodes
864	EA6102	5	40-50	male	177	L MC4 healed #; R acetabulum impaction #; L & R femur & tibia slight rickets; ectocranial orange-peel porosity, L tibia periostitis- possible heaed scurvy; R trapezium large cysts- aetiology unknown; Schmorl's nodes
866	EA6102	2	16-18	probable male		T8 Scheuerman's kyphosis; Schmorl's nodes
868	EA6102	8	>18	adult sex unknown	168	L femur probabe greenstick #; R proximal fibula possible #; Schmorl's nodes +++
870	EA6102	5	35-45	male		L talus Shepherd's #; ectocranial orange-peel porosit, L orbit new bone, L & R tibiae healed periostitis- possible healed scurvy; R rib healed periostitis; T9 Scheuerman's disease; Schmorl's nodes
874	EA6102	4	30-34	male		R MC1 shaft #; L distal tibia osteochondritis dissecans; L & R ribs active periostitis; L & R ulna, R radius, L & R femur, tibia & fibula healed periostitis- probable healed scurvy; L tibia and fibula healing periostitis; Schmorl's nodes
875	EA6102	5	30-40	male		L femoral amputation unhealed; L patella # healing; R frontal abscess in diploe & frontal sinuses; R rib periostitis active; ectocranial orange-peel porosity; L & R orbits, mandible new bone- probable healing scurvy; L & R tibiae healed periostitis
878	EA6102	3	17-19	probable male	170	L acetabulum impaction #; L femur & tibia periostitis- possible healed scurvy; multiple long bones increased porosity & new bone at epiphyseal lines- active metabolic disease (unknown aetiology)
881	EA6102	2	16-18	subadult-sex unknown		L humeral condyle crush #; L ulna olecranon # with cysts in joint surface; T9 Scheuerman's disease; Schmorl's nodes
897	EA6102	2	15-17	subadult-sex unknown		L tibia slight rickets

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904	EA6102	4	25-35	male		L & R tali Shepherd's fractures; L5 spondylolysis; L & R femur, tibia & fibula: marked periostitis/ osteitis & possible ulcers; TV & LV Schmorl's nodes +++; porotic hyperostosis, L & R cribra orbitalia; Schmorl's nodes
906	EA6102	4	30-40	male	166	R parietal depressed #; L scapula penetrating trauma; unsided foot PP shaft #; L & R maxilla active sinusitis; ectocranial orange-peel porosity; R & L orbital lesions, L & R femur, tibia & fibula, R ulna periostitis- probable healed scurvy; Schmorl's nodes
907	EA6102	4	25-35	male	173	R patella #, L talus Shepherd's #; L acetabulum impaction #; unsided foot MP & DP ankylosis probable crush #; R foot PP1 possible #; L & R ribs active periostitis; Schmorl's nodes
909	EA6102	4	25-35	male		Sternum sharp force trauma healed; ectocranial orange-peel porosity, endocranial possible new bone healed, L & R maxilla, mandible, L zygoma new bone, L & R clavicle, calcaneus, R tibia periostitis- probable scurvy; L & R ribs active periostitis; R MT1 erosive lesions- possible gout; Schmorl's nodes
910	EA6102	5	35-40	male	166	L scapula penetrating trauma; unsided ribs x 2 #s; L femur greater trochanter crush #; R MC1 Bennett's #; L5 neural arch #; L3 spondylolysis; R trapezium possible #; L & R maxilla sinusitis; ectocranial orange-peel porosity- possible scurvy
913	EA6102	4	25-30	probable male		L & R cribra orbitalia; Schmorl's nodes
914	EA6102	8	>16	adult sex unknown		L below knee amputation (distal part- medical waste); L tibia possible sharp force trauma with necrosis & periostitis; L talus incomplete Shepherd's #
916	EA6102	5	40-45	probable male	164	L PP foot crush #; R PP foot #; lower TV x 3 #s; ectocranial orange-peel porosity; L & R orbital lesions; L & R femur, tibia, fibula, R scapula active periostitis- probable active scurvy; L & R femur & tibia rickets; C4-6 OA; ivory osteomas; ribs active periostitis
923	EA6102	3	18-23	adult sex unknown		L & R ribs active periostitis; mulberry molars & Hutchinson's incisors- congenital syphilis; Schmorl's nodes

Skeleton	Site Code	Age Category	Age range (years)	Sex	Stature (cm)	Skeletal Pathology
925	EA6102	3	17-20	probable male		Endocranial new bone, ectocranial orange-peel porosity, L & R orbital lesions, L clavicle, sternum active new bone- probable active scurvy or syphilis; R ribs active periostitis; Schmorl's nodes; mulberry molars- congenital syphilis; Schmorl's nodes
927	EA6102	4	25-35	male		L acetabular rim # healing & flange lesion; R acetabular impaction #; L & R cribra orbitalia; ectocranial orange-peel porosity- possible scurvy; Schmorl's nodes
928	EA6102	3	19-23	male	179	Frontal bone sharp force trauma; R humerus possible greenstick or spiral #; L humerus osteochondritis dissecans; L & R scapula, humerus, radius, ulna, MCs, sternum active periostitis, L & R mandible, posterior maxilla active new bone, endocranial new bone, L & R orbit lesions- probable active scurvy; L & R maxilla sinusitis; R rib active periostititis; Schmorl's node
938	EA6102	5	35-45	male		R tibia distal joint #; L & R acetabulae possible impaction #s with supra-acetabular cysts; L & R tibiae marked healed periostitis with possible ulcers
950	EA6102	5	35-45	male	177	R tibia distal joint surface #; R tibia & fibula possible sharp force trauma; L distal tibia possible osteochrondritis dissecans; L & R tibiae healed periostitis
951	EA6102	2	14-16	subadult-sex unknown		Nil noted
954	EA6102	4	25-35	male	167	L & R femur & tibia healed periostitis; Schmorl's nodes
955	EA6102	4	25-35	male	170	L & R tibiae & fibulae slight rickets; Schmorl's nodes
957	EA6102	4	25-35	male	170	L acetabular rim #
960	EA6102	4	25-30	male	173	R temporal depressed #; frontal bone sharp force trauma; L patella #; L calcaneus #; L talus Shepherd's #; L navicular #; R tibia periostitis/ osteitis & ossified haemotoma/ ulcer; L mandible osteomyelitis; ectocranial orange-peel porosity- possible healed scurvy; Schmorl's nodes

Skeleton	Site Code	Age Category	Age range (years)	Sex	Stature (cm)	Skeletal Pathology
962	EA6102	2	16-18	male		R calcaneus #; L proximal tibia possible osteochondritis dissecans; R distal ulna osteochondritis dissecans; L & R humeri bowing- possible infantile rickets; L1 neural arch lytic lesion- aetiology unknown; ectocranial orange-peel porosity- possible scurvy; Schmorl's node
963	EA6102	4	25-30	male		L MT3 healed #; ectocranial orange-peel porosity, posterior maxillae new bone- possible healed scurvy; L & R hallux lateral angulation of PP- DP; Schmorl's node
975	EA6102	2	14-17	subadult- sex unknown		Schmorl's nodes
976	EA6102	5	40-44	male		R MC1 healed shaft #; L & R femoral condyles & tibial plateau erosive joint disease- possible Chalcot joint, probable TB; hyperostosis frontalis interna; Schmorl's nodes
979	EA6102	8	>18	adult sex unknown		Nil noted
980	EA6102	8	>18	adult sex unknown		L & R tibiae & fibulae active periostitis
984	EA6102	4	25-30	male		L & R acetabulum impaction #s
991	EA6102	8	>18	adult sex unknown		L tibia healed #; L & R tibia healed periostitis; L & R MT-PP joints OP++

Appendix 15. Skeletal catalogue of the Greenwich assemblage (N= 100)

Skeleton	Site Code	Age Category	Age range (years)	Sex	Stature (cm)	Skeletal Pathology
1565	KWK99	6	60+	male	163	L & R nasal #s; L ulna olecranon #; L distal fibula #; L distal tibia #; L & R acetabulum impaction #s; unsided ribs x 6 #s; possible trauma to sternum; DISH; L & R femur, tibia, fibula periostitis- probable healed scurvy; DJD; Schmorl's nodes
1572	KWK99	6	50+	male	169	L & R nasal #s, L & R superior maxillary #s; vomer probable #; R ribs x 2#s; L frontal bone lesion- possible abscess or #; L5 spondylolysis; OA; lower leg periostitis & possible ulcers, orbital lesions- probable healed scurvy; Schmorl's nodes
246	NMI09	6	60+	adult unknown sex		L nasal bone #; vomer possible #; T6 wedge # & ankylosis of T5-7 & kyphosis; L & R acetabulum possible impaction #s; CV, L acromio-clavicular joint, & LV OA; L rib x 3 healing periostitis; L tibia healed periostitis; Schmorl's nodes
248	NMI09	6	45+	probable male	165	L & R nasal & R maxilla #s; unsided rib x1 #; enthesophyte joining L tibia & fibula; L rib x 8 periostitis healed & active; L tibia & fibula periostitis; TMJ, CV & LV OA; ectocranial orange-peel porosity; orbital lesions- possible scurvy; Schmorl's nodes
295A	NMI09	6	60+	male	173	L MT2 #; L acetabular rim #; R acetabulum anterior flange lesion; R distal ulna probable #; L & R MT1-PP OA; ankylosis of L sacro-iliac joint; L & R femur, tibia & R fibula moderate healed periostitis- probable infection and ulcers
295B	NMI09	5	35-45	male	157	R MC1 Bennett's #; R MT1-PP OA
295C	NMI09	5	35-45	male	176	L Rib 11 #; L & R acetabula impaction #s; L & R femur moderate rickets; L & R tibiae & L fibula well healed periostitis; R rib x 1 healed periostitis
295D	NMI09	6	50+	probable male	167	L tibia amputation healed; L MT1-PP possible #; L & R patellae osteochondritis dissecans; L & R femur, ulna, L tibia & L calcaneus periostitis- possible healed Infection or scurvy; L tibia healing periostitis
3016	KWK99	6	40+	male	174	R neck of femur #; L1 wedge #; CV DJD; LV DJD/ erosive arthropathy; L & R orbital lesions; L & R tibia & fibula healed periostitis- possible healed scurvy; ivory osteomata; possible localised anterior scalp infection; hard palate bony outgrowth
3019	KWK99	5	35-45	male	163	L & R nasal, L & R maxilla, R zygomatic process, GWoS, L MC3, L distal tibial js, L & R tali, L navicular #s; L humerus, R ulna L acetabulum impaction- possible #s; L distal humerus osteochondritis dissecans; L & R tibia & fibula periostitis; cervical rib; Schmorl's node

Skeleton	Site Code	Age Category	Age range (years)	Sex	Stature (cm)	Skeletal Pathology
3024	KWK99	4	30-35	male	167	L & R rib periostitis active & healed; R hand PP periostitis; L & R pterygoids & GWoS porosity, L & R femur well healed periostitis- possible childhood scurvy; R foot PP healing periostitis
3029	KWK99	5	35-45	male	174	Frontal bone depressed #; L fibula #; L talus osteochondritis dissecans; L & R tibiae & L fibula healed periostitis; GWoS macroporosity, L & R orbital lesions- probable healed scurvy; L & R femur slight rickets
3032	KWK99	6	60+ years	male		R mandible & zygoma healed sharp force trauma with secondary infection & R condyle atrophy- probable nerve palsy; L neck of femur #; L femur extreme atrophy & osteopaenia- possible nerve palsy or paralysis; L pelvis osteopaenia; OA neck & hands; R femur, tibia, fibula possible rickets; R tibia healed periostitis; L & R hands, R MT1 OA; R femur, tibia & fibula possible slight rickets; Schmorl's nodes
3035	KWK99	6	50+	male	170	L & R nasal #s; L & R acetabulum impaction #s; T11 possible crush #; R tibial periostitis/ osteitis; L tibia, L & R fibula periostitis; OA neck; generalised slight DJD; ivory osteoma; Eagle's syndrome; Schmorl's nodes
3039	KWK99	6	40-65	probable male	165	L & R nasal #s; R parietal depressed #; L fibula #; R MT5 #; R acetabulum impaction #; R ilium supracetabular cyst; L & R maxilla sinusitis; R tibia & fibula healed periostitis; elbow, hands, knees OA; generalisaed DJD; Schmorl's nodes
3044	KWK99	6	60+	probable male	166	R MC1 Bennett's #; R MC2 & 3 #s; R clavicle #; L & R ulna styloid #s; L & R distal radius possible #s; R elbow, hands, feet OA; SDJD
3045	KWK99	6	40-50	male	160	L & R nasal #s; vomer #; L distal tibia possible #; R femoral amputation with osteomyelitis; R pelvis osteopaenia; L & R acetabulum impaction #s; L tibia and fibula healed periostitis; Schmorl's nodes
3051	KWK99	6	40-60	probable male	167	R & L nasal #s; vomer #; R distal tibia & fibula #s; R acetabular rim #, impaction # & supra-acetabular cysts; R foot DP crush # & traumatic amputation; L & R femur, tibia & fibula moderate to marked rickets; L & R foot flat-footed; L & R cribra orbitalia; Schmorl's nodes
3057	KWK99	6	50-60	male	168	L nasal & superior maxilla #s; R calcaneus possible crush #; L rib x 1#; OA elbows, clavicles & neck; L4 & 5 SDJD; bone-former

Skeleton	Site Code	Age Category	Age range (years)	Sex	Stature (cm)	Skeletal Pathology
3061	KWK99	5	30-40	male	162	L & R nasal #s; R rib x1 #; L & R scapular bodies possible #s - possible crutch use; R tibia & fibula amputation healed but osteopaenic; L & R femur, L tibia & fibula healed periostitis, L & R cribra orbitalia; ectocranial orange-peel porosity- probable healed scurvy; DJD; Schmorl's nodes
3068	KWK99	6	45-60	male	184	L & R nasal #s; vomer #, L parietal #; L MC1 Bennett's #; L 12th rib #; L hand PP3 possible #; L & R ribs active periostitis; L & R tibia & R fibula periostitis, ectocranial orange-peel porosity, L & R orbital lesions- probable healed scurvy; neck, hands OA; DJD; Schmorl's nodes
3083	KWK99	6	50+	male	170	L hand PP1 #; # L fibula #; L femur, L & R tibiae healed periostitis; L tibia possible ulcers/ haematomas- possible scurvy; R MC1 probable benign tumour (osteochondroma); Schmorl's nodes
3086	KWK99	4	30-40	male		R acetabulum possibe impaction #; R distal tibia probable #; L femoral healed amputation with healed & active periostitis; R foot MP-DD ankylosis- probable synphalangism; Schmorl's nodes
3098	KWK99	6	60+	male	175	L nasal #; L & R MC1 probable #s; L foot PP #; T1 clay-shoveller's #; L tibial plateau possible TB abscess; T1- L3 Pott's spine wiith marked kyphosis; L & R rib abscesses & periostitis- TB; L & R tibia periostitis, ectocranial orange-peel porosity, orbital lesions- probable healed scurvy; L & R os acromiale
3099	KWK99	5	40-50	male	169	R MC1 Bennett's #; R Rib 11 #; L6 arch #; L & R acetabulum flange lesions; R acetabulum possible impaction #; L fibula probable fibrous dysplasia; R ribs healed & active periostitis; L MT-PP1 OA & possible Hallux valgus; L fibula periostitis; Schmorl's nodes
3101	KWK99	6	60+	male	164	R nasal #; R maxilla #; unsided ribs x 5 #s; L scapular body #; R acetabulum impaction #; R talus Shepherd's #, R 1st foot PP #; R talus & R distal tibia osteochondritis dissecans; L & R femur rickets; elbows & neck OA; Schmorl's nodes
3102	KWK99	5	35-45	probable male		R fibula & tibia osteitis/ periostitis; L & R humeri periostitis- possible treponemal disease (yaws or syphilis)

Skeleton	Site Code	Age Category	Age range (years)	Sex	Stature (cm)	Skeletal Pathology
3103	KWK99	6	50+	male	163	L & R nasal, L & R zygoma, L clavicle, R MC1 Bennett's, R proximal femur, R tibial plateau, L rib x 6 #s; R rib # x 4 & OA; L patella possible #; ; R shoulder dislocation & paralabral cysts; rib healed periostitis; wrists, hands, feet, spine, R shoulder OA; L tibia ulcer, L & R femur, tibia periostitis, orbital lesions- probable healed scurvy; porotic hyperostosis; L & R femur & tibia slight rickets; Schmorl's nodes
3105	KWK99	6	50+	male	171	L & R nasal #s; R MC3 #; R MT3 #; R distal tibia #; coccyx #; craniotomy; ; neck OA; SDJD with OP+++ & kyphosis; sacrum adolescent rickets; L femur, L & R tibia & fibula periostitis- probabe healed scurvy; Schmorl's nodes
3106	KWK99	6	40-50	probable male	163	R shoulder dislocation; L acetabulum possible rim #; craniotomy; L & R MT-PP joints erosive arthropathy possible Reiter's disease; C3 & 4 marginal OP+++; L & R femur, R tibia & fibula, R MT4 healed periostitis; R distal ulna, R MC1 OA; L & R tibia slight rickets; Schmorl's node
3107	KWK99	6	50+	male	166	L & R nasal #s; L & R maxilla #; R ulna #; L clavicle #; L x 2 & R x 2 rib #s; R MC3 #; TV #; L MT1 osteochondritis dissecans;L & R MT-PP, C1-3 OA; SDJD; ectocranial orange-peel porosity, L & R femur, tibia, fibula, scapula periostitis, endocranial new bone- probable healed scurvy; ivory osteoma; Schmorl's node
3108	KWK99	5	35-45	male	174	T6 & 7 bodies crush #s; multiple upper & lower limb long bones, calcanei, MTs, R scapula active & healed periostitis; endocranial new bone healed, orbital lesions healed & active scurvy; L & R ribs marked active periostitis; L & R femur cribra femoris; Schmorl's nodes
3115	KWK99	6	60+	male		T12 # & ankylosis of T11-L1; R MC2 #; L rib x 8 healed & healing #s; R patella possible #; C2 body possible #; parietals caries sicca, L & R humerus periostitis/ osteitis, L & R ulna & radius, R MC3 periostitis- syphilis; L wrist, neck OA; L rib active periostitis; L & R maxilla sinusitis; R femur, L & R tibia & fibula, L & R mandible healed periostitis, L orbit possible new bone- probable healed scurvy; L & R posterior maxilla ectocranial active new bone; Schmorl's nodes
3119	KWK99	6	40+	male	174	R fibula possible greenstick #; L & R tali incomplete Shepherd's #s; craniotomy; L & R feet erosive joint disease- possible gout, possible rheumatoid arthritis; L & R femur, tibia & fibula healed periostitis, ectocranial orange-peel porosity- probable healed scurvy; R ribs active periostitis; Schmorl's nodes

Skeleton	Site Code	Age Category	Age range (years)	Sex	Stature (cm)	Skeletal Pathology
3139	KWK99	6	40-50	probable male		L navicular # & OA; R talus dome #; L distal tibia crush #; L distal tibia & talar dome osteochondritis dissecans; L & R tibia, R fibula & femur healed periostitis- probable healed scurvy; L4 & 5 OA; L & R knee joints marked OP; SDJD; Schmorl's nodes
3143	KWK99	5	35-45	male	166	L & R nasal, L zygoma x 2, T11, L & R MC3, R ribx 2, L PP hand, L MT1, 2, 4, 5, L navicular x 2, R MT5 avulsion, R scaphoid, capitate, trapezium, L tibial plateau avulsion #s; R tibial avulsion; L3 spondylolysis; healed periostitis & ulcers; L & R ribs active periostitis; L & R knee possibe bursitis & haemarthrosis; orange-peel porosity, L & R orbital lesions, L & R femur & tibia healed periostitis with possible ulcers; L & R cribra femoris; R fibular shaft bowed- possiby activity-related; Schmorl's nodes
3144	KWK99	6	50+	probable male	168	R ulna olecranon #; L talus #; L rib x 7, R rib x 4 #s; T1 #; T12 wedge # & T11-L1 ankylosis; L talus incomplete Shepherd's #; L & R acetabular impaction #, & R rim #; CV, MT-PP, sesamoid & acromio-clavicular OA; generalised DJD; ectocranial orange-peel porosity, L & R orbital lesions, tibial & fibula periostitis- probable healed scurvy; L & R maxilla sinusitis; Schmorl's nodes
3148	KWK99	6	60+	male	177	R tibia & fibula malaligned #s & osteopaenia ++; R tibia distal joint surface #; R rib 12 #; L shoulder posterior luxation- reverse Hill-Sachs #; frontal bone depressed #; L & R maxilla chronic sinusitis; R DP1-PP joint OA; Schmorl's nodes
3151	KWK99	6	40-60	male	170	L maxilla, L & R parietals depressed #, L & R clavicles, L MC3, L ribs x 5, R rib x 3, R clavicle, R MC3, R distal femur, R patella #s; L radius & ulna possible greenstick #s; caries sicca, multiple long bone periostitis- syphilis; possible healed scurvy; L elbow, hands, hallux & R knee OA
3152	KWK99	4	25-35	probable male	168	L & R nasal #s; R rib x 1 #; R acromium probable #; L5 spondylolysis; L & R ribs active periostitis; L ribs healed periostitis; L & R femur, tibia, fibula periostitis, ectocranial orange-peel porosity, L & R orbital lesions, L & R tibia & fibula periostitis- probable healed scurvy; ; C5-7, R MT-PP OA; T5 & 6 OP+++ & ankylosis; Schmorl's node

Skeleton	Site Code	Age Category	Age range (years)	Sex	Stature (cm)	Skeletal Pathology
3159	KWK99	6	40-60	male	164	L & R nasal #s; R maxilla #; vomer #; L zygomatic arch #; R shoulder luxation & pseudoarticulation on scapular neck; R humerus # & myositis ossificans tramatica; R acromium #, R Bankard's #; R ribs x 4 #; L clavicle #; craniotomy; endocranial new bone, ectocranial orange-peel porosity- possible healed scuvy; R TMJ, shoulders, neck OA; DJD; torticollis
3162	KWK99	6	50+	male	165	R shoulder subluxation; R scapula Bankart's # & osteochondritis dissecans; R ulna #; L talus Shepherd's #; L & R maxilla sinusitis; L & R ribs healed periostitis; wrists, L shoulder, elbow & neck OA; L sacro-iliac joint ankylosis; L & R femur moderate rickets; Schmorl's nodes
3164	KWK99	4	30-40	male	170	R nasal #; L tibia, L fibula, L patella #s; L ribs active periostitis, R ribs healed periostitis; L & R orbits healed cribra orbitalia; ectocranial orange-peel porosity, L tibia & femur healed periostitis- probable healed scurvy
3168	KWK99	8	>18	probable male		R fibula #; L femur greenstick #; L L tibial plateau #; L & R talus Shepherd's #s; MC3 possible styloid #; L wrist DJD, possible dislocation; L & R tibia, fibula, femur periostitis- possible healed scurvy; MT-PP OA or Hallux valgus; tibiae slight rickets
3176	KWK99	5	35-45	male	175	L & R nasal #s; L foot PP probable #; L glenoid cavity osteochondritis dissecans; L & R tibia, R MT5 & R rib x 1 active periostitis; L & R femur, tibia, fibula healed periostitis, ectocranial orange-peel porosity- scurvy; R hand DP OA; DJD
3177	KWK99	6	40-50	male	174	R tibia plateua & shaft, R fibula, L acetabular rim, L rib x 1, L hand DP x 2#s, L anterior iliac crest avulsion/ large muscle tear; L rib x 1 active periostitis; L & R tibia & fibula healed periostitis; L sacro-iliac joint ankylosis; CV X 1 & L DP1 OA
3182	KWK99	6	50+	male	158	DISH with T7-12 ankylosis & enthesophytes ++; OA neck, L hand; ectocranial orange-peel porosity, R orbital lesion-possible healed scurvy; R hand PP5 possible benign neoplasm; L hands, feet, CV, LV, acromio-clavicular joints OA; DJD; Schmorl's node
3187	KWK99	5	40-50	male	178	L & R acetabular flange lesions; L iliac crest possible avulsion; sacrum healed new bone- possible pelvic infection; L & R femur & L tibia periostitis, ectocranial orange-peel porosity- probabe healed scurvy; generalised DJD

Skeleton	Site Code	Age Category	Age range (years)	Sex	Stature (cm)	Skeletal Pathology
3189	KWK99	6	60+	male	167	L & R nasal #s; ectocranial orange-peel porosity, L & R tibiae & fibulae healed periostitis- probable healed scurvy; L & R tibia & fibula slight rickets
3191	KWK99	6	50+	male	164	L & R talus #s; R Rib 11 #; R PP #; R tibial crest possible compresssion #; L tibia distal osteochondritis dissecans; ectocranial orange-peel porosity +++, L orbital lesion, L tibia periostitis- possible healed scurvy; R MC2 & PP healed periostitis; L & R rib healed & healing periostitis; neck, hands, feet OA; Schmorl's nodes
3194	KWK99	6	40-60	male		R fibula #; R rib x 1 #; L & R talus Shepherd's #s; L foot PP possible #; craniosynostosis- scaphocephaly; mandible, L & R GWoS, L radius, L & R humerus, ribs, pelvis, scapula, femur, TV, LV, sacrum thick, active new bone, L & R hands, feet more subtle new bone deposition- possible pulmonary hypertrophic osteoarthropathy; cribra orbitalia; CV & upper TV DJD & OA; Schmorl's nodes
3202	KWK99	6	40-60	male	164	L nasal #; coccyx 1 #; R ribs x 2 #; R MC3 styloid #; L femoral shaft large enthesophyte; boneformer; hand & MT-PP joint OA; ectocranial orange-peel porosity, L & R tibia & femur periostitis, orbita - probable healed scurvy; bone-former; T10 Scheumann's kyphosis; Schmorl's nodes
3208	KWK99	6	40-50	male	163	L radius Colles, L & R distal fibula, R distal tibia, L & R talus, R MC3 #s, L1 wedge #, OP++ & kyphosis, MC3 OA; L & R lower legs secondary periostitis/ osteitis & ossified haematoma; ectocranial orange-peel porosity, orbital lesions- probable healed scurvy; Schmorl's nodes
3211	KWK99	6	50+	male	164	R nasal #; L & R acetabular impaction #s; R talus Shepherd's #; L scapula #; L radial head # & OA; L distal humerus possible #; R foot PP1 #; unsided ribs x 6 #s; L distal tibia osteochondritis dissecans; L & R femur rickets +; ectocranial orange-peel porosity, R orbital lesion, L & R tibia periostitis- probable healed scurvy; L & R femur slight rickets; neck, L & R elbows OA; Schmorl's nodes
3212	KWK99	5	35-45	male	172	R MC1 Bennett's #; endocranial healing new bone; L & R rib healed periostitis; R foot possibly flat-footed; Schmorl's nodes
3213	KWK99	6	45-60	male	171	L ribs x 3 #; R MC1 Bennett's #; R trapezium possible # & OA; R talus incomplete Shepherd's #; vomer possible #; L tibia ossified haematoma; L & R femur, tibia, R fibula healed periostitis, ectocranial orange-peel porosity, R orbital lesion- probable healed scurvy; SDJD; Eagle's syndrome; marked Schmorl's nodes

Skeleton	Site Code	Age Category	Age range (years)	Sex	Stature (cm)	Skeletal Pathology
3218	KWK99	5	35-45	male	161	L & R nasal #s; L & R acetabulum impaction #s; T8 & 9 wedging- Scheuerman's kyphosis; L femur distal osteochondritis dissecans; L femur periostitis & osteitis; R scapula healed periostitis; L maxilla sinusitis; R os acromiale; R C-MC1, R MT-PP OA; SDJD; Schmorl's nodes
3229	KWK99	6	50+	male		R nasal #; vomer #; frontal bone depressed #; L & R femur shaft #s with overlap, osteomyelitis & malaignment; L tibial plateau #; T7 wedge #; L rib x 3 #s with pseudo-arthrosis of Rib 12 & healed periostitis; S1 spinous process healing #; R foot PP amputation, probably truamatic; L & R tibia & fibula osteitis, L & R ulna & radius periostitis, caries sicca- tertiary syphilis; R rib periostitis; orange-peel porosity, R zygoma new bone/ porosity- possible healed scurvy; sacrum, sternum & L & R tibia- probable adolescent rickets; neck, clavicles OA; ivory osteomas; several midline defects including possible cervical rib; Schmorl's nodes
3241	KWK99			male	166	L & R nasal, vomer, L maxilla, R sphenoid, R clavicle, R proximal humerus, L & R distal radius, ulnar styloid, L MC1 & 2, R proximal femur, R talus, R distal tibia, R pisiform, L ribs x 8, R ribs x 9, R tibia, R talus, R foot PP #s; T8, T12, L2, 3, 5 burst #s & kyphosis; R triquetral, R parietal possible #s; L fibula possible ossified haematoma; neck OA; L & R femur, tibia, MTs, fibula healed periostitis; ectocranial orange-peel porosity; L & R orbital lesions, L & R anterior & posterior maxilla, R mandible new bone & porosity- probable healed scurvy; L & R rib healed periostitis; Schmorl's nodes
3243	KWK99	6	45-60	male	171	R radius Colles' #; R ulnar styloid # with OA; R acromio-clavicular possible subluxation; R clavicle possible #; C3 & 4 OA ++, possibly secondary to #; R rib active & healed periostitis; L & R humerus, femur, tibia, fibula, L MTs periostitis- probable healed scurvy; L & R tibia slight rickets; Schmorl's nodes
3253	KWK99	6	40+	male	168	R nasal #; R rib #; L MC4 possible #; L & R shoulder subluxation/ superior impingement; T11- L1 dripping candlewax OP & ankylosis, bone-former- DISH; L & R clavicles, neck, ribs OA; porotic hyperostosis; Schmorl's nodes

Skeleton	Site Code	Age Category	Age range (years)	Sex	Stature (cm)	Skeletal Pathology
3255	KWK99	5	40-50	male	171	L & R nasal #s; R clavicle #; L MC1 Bennett's # with OA; L calcaneus #; R talus incomplete Shepherd's #; cranium classic marked caries sicca, but periostitis only on proximal femur- syphilis; L & R orbits new bone, endocranial healed new bone, L femur periostitis, L & R femur possible Pelkin spurs- possible healed scurvy; L & R maxilla sinusitis; SDJD; Schmorl's nodes
3258	KWK99	6	35-50	male	162	R scaphoid #, necrotic; R rib x 1 #; L ribs x 2 #; R proximal fibula #; R humerus, R MC5 possible #s; L talus osteochondritis dissecans; L & R ribs active periostitis; L tibia, talus osteochondritis dissecans; L & R femur, tibia, fibula periostitis & Pelkin spurs- healed scurvy; neck, R scaphoid OA; SDJD; Schmorl's nodes
3261	KWK99	4	30-35	male		R nasal #; L hamate #; L foot PP #; R femoral amputation with osteomyelitis & osteopaenia; L pelvis osteopaenia; R rib active periostitis; ectocranial orange-peel porosity, L & R orbital lesions, R tibial periostitis- probable healed scurvy; Eagle's syndrome; Schmorl's nodes
3265	KWK99	6	50+	probable male	159	T6 spinous process #; L & R hands & feet severe gout; L & R orbital lesions- possible scurvy; L & R distal radius & L tibia active periostitis; L & R femur, ulna slight infantile rickets; R scaphoid, neck OA; SDJD; Schmorl's nodes
3268	KWK99	6	40-50	male	168	R scapula Bankart's #; L & R shoulders subluxation & superior impingement; L radius Colles #; L MC5 #; L talus #; L & R rib healed & active periostitis; DJD; L maxilla sinusitis- dental abscesses penetrating sinuses; ectocranial orange-peel porosity, endocranial healed new bone, L & R orbital lesions, L & R humerus, radius, femur, tibia & R ulna healed periostitis- probable healed scurvy; Schmorl's nodes
3269	KWK99	6		male	162	L & R posterior parietal & L temporal bones sharp force trauma; R parietal depressed #/ well-healed spall; R parietal & GWoS vertical linear #; L & R nasal, L rib x2, R ribs x 2 ; L5 crush, sternum, L MT5 #s; L tibial partial avulsion; L & R wrist OA; neck, L & R TMJ, TV, LV DJD; L & R maxilla sinusitis; ectocranial orange-peel porosity, L & R orbital lesions, L & R femur, tibia periostitis- probable healed scurvy; Schmorl's nodes

Skeleton	Site Code	Age Category	Age range (years)	Sex	Stature (cm)	Skeletal Pathology
3272	KWK99	5	35-45	male	161	L & R nasal #s; L maxilla healing penetrating injury with active bone; R maxilla possible #; L mandible #; L rib x 2#s, R rib x 1#; L foot MP-DP crush # & ankylosis; L & R maxilla sinusitis; R rib x 2 healed periostitis; neck, thumbs, R elbow, hallux OA; L7 DJD; ectocranial orange-peel porosity, R orbital lesions, L & R fibula, L tibia periostitis- probable healed scurvy; Schmorl's nodes
3274	KWK99	5	35-45	probable male	155	L patella #; R ribs healed periostitis; R parietal healed endocranial new bone; R maxilla sinusitis; L & R cribra orbitalia, ectocranial orange-peel porosity, L & R femur & tibia periostitis- probable healed scurvy; DJD; Schmorl's nodes
3276	KWK99	8	18-45	male	158	L nasal #; L & R MC1 probable #s; L foot PP #; T1 clay-shoveller's #; L tibial plateau possible TB abscess; T1- L3 Pott's spine wiith marked kyphosis; L & R rib abscesses & periostitis- TB; L & R tibia periostitis, ectocranial orange-peel porosity, L & R orbital lesions, femur, L & R tibia & fibula healed periostitis; R tibia possible ossified haematoma/ ulcer
3385	KWK99	6	40-60	probable male	163	L MC3 OA, SDJD & OA; endocranial new bone healed; L tibia rickets; Schmorl's node
3628	KWK99	6	40+	male	0	L & R nasal #s; hyoid possibe #; R glenoid cavity Bankart's #; R humerus Hill-Sachs #; R shoulder subluxation, possibly due to reduced glenoid cavity area; R clavicle probable #; L & R cribra orbitalia; L & R ribs healed periostitis; ivory osteoma; Schmorl's nodes
3632	KWK99	6	45+	male	0	L rib 2 #; R scapula granular bone deposition on glenoid articular surface- possible haemarthrosis; L rib 3 healing periostitis; endocranial healed new bone, posterior maxilla healed new bone, L & R possible oribital lesions- possible healed scurvy; shoulders, L TMJ DJD; Schmorl's nodes
6003	KWK99	6	40-60	male	156	R parietal depressed #; L tibia & fibula #s with marked overlap & shortening; L patella #; L & R acetabular flange lesions; R femur, R & L tibia & fibula healed periostitis, ectocranial orange-peel porosity- probable healed scurvy, L & R maxilla sinusitis
6014	KWK99	5	35-50	male	168	L & R nasal #s; unsided ribs x 3 healing #s with active periostitis; ectocranial orange-peel porosity, L & R orbital lesions; L tibia healed periostitis- possible healed scurvy; SDJD

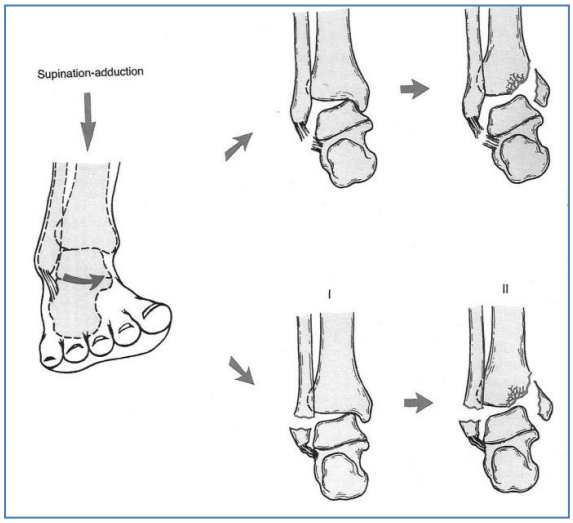
Skeleton	Site Code	Age Category	Age range (years)	Sex	Stature (cm)	Skeletal Pathology
6016	KWK99	6	50+	male	166	R nasal #; vomer possible #; L & R talus Shepherd's #s; L MC1 shaft #: L acetabular flange lesion; L acetabulum possibe impaction #; ectocrania orange-peel porosity, L orbital lesions, L & R femur & tibia periostitis-probable healed scurvy; L & R femur & tibia moderate rickets; T5-12 SDJD; L4-5 & acromio-clavicular joints OA; Schmorl's nodes
6017	KWK99	5	40-50	male	169	L & R nasal #s; vomer possible #; R distal fibula #; R distal tibial #; L calcaneus #; L navicular #; R Ribs x 3 healing #s; L hand PP #; ectocranial orange-peel porosity, L & R femur, tibia & fibua periostitis- probable healed scurvy; T12-L2 possible Scheuerman's disease; Schmorl's nodes marked
6019	KWK99	6	60+	probable male	156	L & R nasal bone #s; L distal humerus possible sharp force or projectile trauma; L distal femur osteochondritis dissecans/ #; ectocranial orange-peel porosity, L & R femur & tibia periostitis- probable healed scurvy; MT4 bradydactyly; neck, wrists, L C-MC1 OA; Schmorl's nodes
6023	KWK99	6	50+	male	176	L & R nasal #s; L maxilla #; R maxilla #; L & R auditory meatus largely occluded- possible deafness; ectocranial orange-peel porosity, L & R orbital lesions, L & R anterior maxilla new bone, L & R femur & tibia, L humerus & ulna healing periostitis- probable healing scurvy; L & R maxilla reactive bone in response to several severe dental abscesses; sacrum space-occupying lesion- possible benign tumour; neck, L C-MC1 OA
6035	KWK99	5	40-49	male	168	L & R nasal #s; L superior maxilla #; R rib #s x 4; L5 spondylolysis; ectocranial orange-peel porosity, L & R orbital lesions, L & R humerus, femur & tibia & L fibula healed periostitis- probable healed scurvy; Schmorl's nodes
6037	KWK99	6	50+	probable male		L nasal #; L femoral shaft probable # & associated enthesopathies ++; R talus incomplete Shepherd's #; R rib x 1 #; L rib x 1 #; L5 spondylosis; R acetabular flange lesion; ectocranial orange-peel porosity, L & R tibia & fibula periostitis- probable healed scurvy; neck, R MT-PP1 OA
6053	KWK99	6	45-60	male	168	L frontal bone #; L & R nasal #s; L & R maxilla #s; R patella #; R tibia possible ilial band avulsion #; L distal fibula #; L distal tibia #; L calcaneus possible #; ectocranial orange-peel porosity, L & R femur, tibia periostitis- pobable healed scurvy; CV OA; T8-11, L & R sacro-iliac joint ankylosis- possible ankylosing spondylitis; Schmorl's nodes

Skeleton	Site Code	Age Category	Age range (years)	Sex	Stature (cm)	Skeletal Pathology
6056	KWK99	6	50+	male	170	L & R nasal #s; L MC4 #; R MC5 #; R talus Shepherd's #; caries sicca, L & R humerus, clavicle, scapula, femur, tibia, fibula, ribs, xyphoid process periostitis/osteitis-treponemal disease, probably teriary syphilis; L & R femoral condyles osteochondritis dissecans or Charcot's joint of syphilis; L & R orbital lesions; Schmorl's nodes
6058	KWK99	6	60+	male	179	L & R nasal #s; L GWoS & frontal bone #; L rib 11 #; L medial cuneiform #; L & R tibia & fibula marked periostitis/osteitis; R tibial plateau #, granular deposition on femoral & tibial joint surfaces- possible haemarthrosis, marked hypervascularity of juxta-articular area & metaphysis of tibia- knee joint trauma with secondary OP & OA; L olecranon possible # & secondary OA; L & R tibia & fibula marked spiculated periostitis/osteitis; feet healing periostitis; L ribs healing periostitis; endocranial healing new bone; L & R orbital lesions, L & R femur healed periostitis- possible healed scurvy; L elbow, R knee, L & R feet, T11- R rib 11 OA; L foot MP-PP ankylosis-probably developmental; R fibula bowed- possibly occupational; Schmorl's nodes
6063	KWK99	6	50+	male	168	L & R nasal & maxilla, L clavicle, L radius, R fibula, L & R MT4 & 5, L & R talus Shepherd's #s; L & R acetabulum impaction #s; L & R supra-acetabular cysts; R patella possible #; L distal tibia osteochondritis dissecans; endocranial healed new bone; porotic hyperostosis; L & R femur & tibia periostitis; L os acromiale; neck, R knee, L & R elbow, L wrist, R ankle OA
6073	KWK99	6	60+	male	160	L & R nasal, R clavicle, R medial malleolus, R distal fibula, L lunate #s; L & R clavicle, femur, tibia healed periostitis, ectocranial orange-peel porosity & zygoma, maxilla & mandible new bone- probable healed scurvy; L os acromiale; L parietal lytic lesion-possible TB; MT1 & 2 erosive arthropathy- possible gout/TB; R orbit space-occupying lesion- possible tumour or cyst; L cribra femoris; L MT-PP OA, SDJD; Schmorl's nodes
6078	KWK99	6	40+	probable male	168	L nasal & maxilla #s; ectocranial orange-peel porosity, L & R orbital lesions, L & R tibia & fibula, L femur periostitis- probable healed scurvy; L & R MT-PP joints marked erosive arthropathy- probable gout; bone-former

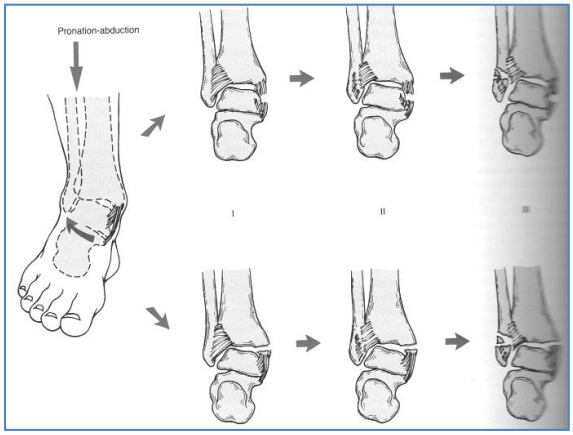
Skeleton	Site Code	Age Category	Age range (years)	Sex	Stature (cm)	Skeletal Pathology
6082	KWK99	6	50-60	male	170	L & R nasal #s; L parietal depressed #; R Rib x 1 #; L distal tibia & fibula #s; L MT1 #; R scaphoid # & OA; R patella possible #; sacrum adolescent rickets; R rib active periostitis; ivory osteoma; ectocranial orange-peel porosity; L & R cribra orbitalia, L & R tibia periostitis- probable healed scurvy; ivory osteoma
6085	KWK99	6	60+	male	166	R fibula #; L ulna parry #; R radius Barton's #; R rib x 1 #; L MT5 possible #; R knee possible anterior cruciate ligament avulsion; T5-12 ankylosis, enthesophytes ++- possible ankylosing spondylitis or DISH; L & R maxilla sinusitis; L maxilla porosity secondary to severe dental disease; endocranial new bone, ectocranial orange-peel porosity, L & R femur & tibia periostitis- probable healed scurvy; ivory osteoma; DJD
6089	KWK99	5	35-45	male	166	L nasal & superior maxilla #s; R trapezium #; L calcaneus #; L hand possible amputation (but no cutmarks present); L & R tibia & fibula, L radius & ulna, calcaneus active thick periostitis, zygomas & orbital ridges porosity- systemic disease; L ribs healed periostitis; R MP-DP ankylosed; Schmorl's nodes
6092	KWK99	6	40+	male	161	L & R nasal bone #s; L superior maxilla #; vomer #; L frontal bone depressed #; R distal tibial #; ectocranial orange-peel porosity, L & R orbital lesions, L & R femur, tibia periostitis- probable healed scurvy
6094	KWK99	6	50+	probable male		L femur # with malignment & overlap; R distal fibula #; L MT2 #, R MC4 #; L MC3 avulsion #; L4 spondyloysis & trauma to L3-5; L & R acetabular impaction #s; R MT 2-4 healed periostitis; MT5 periostitis; R rib osteitis; L tibia & fibula active periostitis; R tibia & fibula possible ulcers; L & R tibia slight rickets; L & R maxilla sinusitis
6096	KWK99	6	50+	male	179	L & R nasal #s; vomer possible #; L clavicle possible #; L foot PP1 crush #; L & R acetabular flange lesions; ectocranial orange-peel porosity, L & R orbital lesions; R femur, L & R tibia, R fibula periostitis- probable healed scurvy; OA neck; Schmorl's node
6098	KWK99	6	50+	male	168	L frontal bone depressed #; R talus Shepherd's #; L & R tibia slight rickets
6103	KWK99	6	60+	male	172	L & R nasal #s; L clavicle non-united # with pseudoarthrosis & possibe acromio-clavicular dislocation; L rib1 #; R rib x 1 #; neck, LV, L MC1-P, R PP-MP, L clavicle, R hand OA; L & R MT3 & lateral cuneiform joint lesions- idiopathic; ectocranial orange-peel porosity, L & R femur, tibia periostitis- probable healed scurvy; Schmorl's nodes

Skeleton	Site Code	Age Category	Age range (years)	Sex	Stature (cm)	Skeletal Pathology
6105	KWK99	6	50+	male	158	L & R nasal & vomer #s; L MC3 styloid #; R ribs x 4 #; L rib x 1 #; L & R femur, tibia & fibula slight to moderate rickets; ectocranial orange-peel porosity, L & R orbital lesions, L & R femur & tibia periostitis- probable healed scurvy; neck, L & R clavicle & hands OA; ivory osteoma; L zygoma space-occupying lesion- unknown aetiology; Schmorl's node
6113	KWK99	6	60+	male	169	L & R nasal #s; R calcaneus x 2 #s, R foot MP-DP # & ankylosis; enlarged lobular conchi; L mandible infection secondary to extreme periodontal disease; L & R maxilla localised infection secondary to multiple peri-apical abscesses; ectocranial orange-peel porosity, L & R tibia periostitis- probable healed scurvy; neck & R sacro-iliac joint OA with ankylosis, LV, L elbow OA; Schmorl's nodes
6142	KWK99	6	50+	male	175	R nasal & superior maxilla #s; vomer possible #; L clavicle #; L rib x 3 #s; ectocranial orange-peel porosity slight, orbital lesions, L & R tibia, R fibula healed periostitis, L & R zygoma new bone- probable healed scurvy; neck & L acromio-clavicular joint OA; Schmorl's nodes
6146	KWK99	6	45+	male	175	L & R nasal #; L superior maxilla #; L ulna olecranon #; L & R talus Shepherd's #s; R lunate #; R acetabular flange lesion slight; L & R femur slight rickets; L & R tibia well healed periostitis; DJD
6151	KWK99	6	40+	male		L & R nasal #s, R maxilla healed penetrating trauma; L1, 4 & 5 #s; L clavicle #; R ulna olecranon #; R rib x 4 #s; R zygoma possible #; R elbow & knee OA; L temporal styloid #; R temporal bone Eagle's syndrome; caries sicca, L & R zygoma porosity, R maxilla healing new bone, hard palate reactive & lytic changes, L & R humerus, L & R ulna, L radius, L & R femur, R tibia periostitis/osteitis- treponemal disease, probably tertiary syphilis; Schmorl's nodes

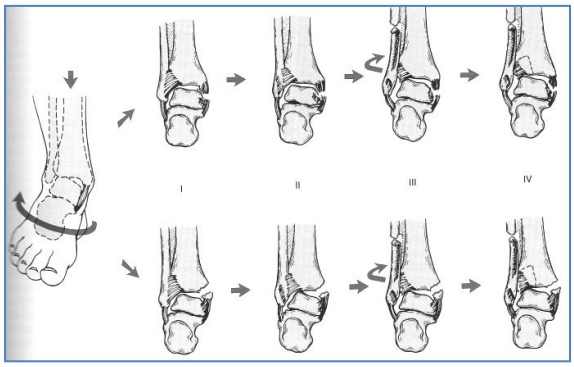
Appendix 16. Mechanisms of ankle injury



Supination- adduction

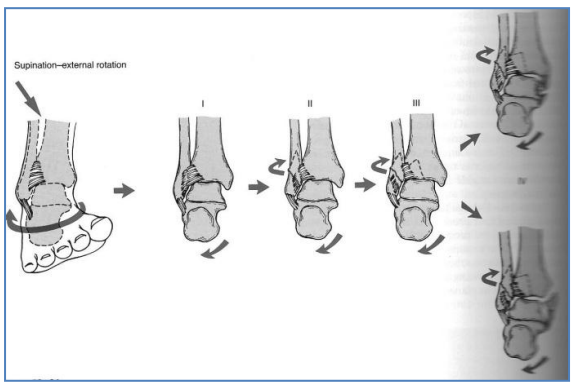


Pronation adduction



Pronation- external rotation

Images courtesy of Trafton et al. (1992, p. 1892-1897)



Supination external rotation

Appendix 17. Traumatic injuries recorded in the Haslar and Plymouth musters

The following tables detail the distribution of soft tissue lesions and amputations recorded in the Haslar and Plymouth musters in the years 1792- 1796, 1800 and 1810-1811.

Table A17.1 *Amputations recorded in the Haslar and Plymouth musters (n= 173).*

Element	Haslar	Plymouth	Total	% of amputations of known location (n= 148)
ankle	14	27	41	27.70
arm	28	9	37	25.00
elbow	24	6	30	20.27
finger	18	3	21	14.19
foot	4	7	11	7.43
hand	4		4	2.70
hip	2		2	1.35
knee	1		1	0.68
leg	1		1	0.68
shoulder			0	0.00
thigh			0	0.00
Not specified	12	13	25	
Total	**94**	**65**	**173**	**100.00**

Table A17.2 *Wounds recorded in the Haslar and Plymouth musters (n= 934).*

Element	Haslar	Plymouth	Total	% of wounds of known location
head	92	27	119	19.54
leg	65	24	89	14.61
hand	42	36	78	12.81
foot	35	11	46	7.55
arm	31	8	39	6.40
thigh	26	10	36	5.91
finger	21	7	28	4.60
loins	21	5	26	4.27
back	21	2	23	3.78
shoulder	11	6	17	2.79
face	15	1	16	2.63
knee	11	5	16	2.63
breast	7	8	15	2.46
eye	8	4	12	1.97
abdomen	8	2	10	1.64
ankle	9	1	10	1.64
side	5	2	7	1.15
throat	5	2	7	1.15
neck	4	2	6	0.99
thumb	3	2	5	0.82
hip	3		3	0.49
ribs		1	1	0.16
jaw				0.00
Not specified	150	175	325	
Total	**593**	**341**	**934**	**99.99**

Table A17.3. *Contusions recorded in the Haslar and Plymouth musters, n= 1648.*

Element	Haslar	Plymouth	Total	% of contusions of known location (n= 900)
loins	144	52	196	21.78
back	101	42	143	15.89
head	96	47	143	15.89
side	34	21	55	6.11
breast	28	24	52	5.78
foot	29	13	42	4.67
knee	25	17	42	4.67
leg	27	14	41	4.56
thigh	19	11	30	3.33
finger	19	8	27	3.00
ankle	20	5	25	2.78
hand	15	8	23	2.56
arm	12	9	21	2.33
shoulder	14	4	18	2.00
abdomen	11	0	11	1.22
neck	2	6	8	0.89
eye	5	0	5	0.56
elbow	4	0	4	0.44
face	3	1	4	0.44
hip	2	1	3	0.33
ribs	1	2	3	0.33
thumb	3	0	3	0.30
clavicle		1	1	0.11
jaw				0.00
throat				0.00
Not specified	377	371	748	
Total	**991**	**657**	**1648**	**99.97**

Table A17.4. *Lameness recorded in the Haslar and Plymouth Musters (n= 258).*

Element	Haslar	Plymouth	Total	% of lameness of known location (n= 140)
arm	13	25	38	27.14
hand	10	18	28	20.00
leg	9	13	22	15.71
foot	8	4	12	8.57
knee	5	7	12	8.57
loins	1	6	7	5.00
ankle	3	3	6	4.29
thigh	3	3	6	4.29
finger	1	3	4	2.86
thumb		2	2	1.43
face	1		1	0.71
hip	1		1	0.71
side	1		1	0.71
shoulder				0.00
Not specified	58	60	118	
Total	**114**	**144**	**258**	**100.00**

Appendix 18. Injuries and disabilities recorded in Greenwich Entry Papers

This table summarises the injuries cited in 801 entries in the Greenwich Entry Books (collated from Wilcox 2011).

Body part	Wounded	'Lost'/ Amputated	Broken'/ Fractured	Total
L leg	82	16		98
R leg	68	21	4	93
Leg unsided	3	0	1	4
	153	**37**	**5**	**195**
L eye	15	14	29	58
R eye	19	19	38	76
Eye unsided	2	2	4	8
	36	**35**	**71**	**142**
L arm	41	13	1	55
R arm	49	13	1	63
Arm unsided	1	0		1
	91	**26**	**2**	**119**
L hand	39	8		47
R hand	48	13		61
Hand unsided	4	1		5
	91	**22**		**113**
L ankle	2	1		3
R ankle	3			3
	5	**1**		**6**
L thigh	18	0	1	19
R thigh	15	0	1	16
Thigh unsided	8		3	11
	41	**0**	**5**	**46**
L side	29			29
R side	23			23
	52			**52**
L shoulder	8			8
R shoulder	8		1	9
Shoulder unsided	6			6
	22		**1**	**23**
L ribs	0			0
R ribs	1		1	2
Ribs unsided	16		4	20
	17		**5**	**22**
L knee	9			9
R knee	16			16
Knee unsided	2			2
	27			**27**
L hip	2			2
R hip	1			1
	3			**3**

Body part	Wounded	'Lost'/ Amputated	Broken'/ Fractured	Total
L foot	9	0		9
R foot	8	0		8
Foot unsided	1	0		1
	18	**0**		**18**
L elbow				0
R elbow	1			1
	1			**1**
L clavicle	0		0	0
R clavicle	0		0	0
Clavicle unsided	2		2	4
	2		**2**	**4**
Neck	6			6
Jaw	1			1
Head	47		4	51
Face	6			6
	60		**4**	**64**
Breast	14			14
Belly	5			5
Back	23			23
	42			**42**
Total injuries cited	**1240**	**226**	**190**	**877**

Miscellaneous injuries	N= 46
wounded	11
'too right feat'	1
testicles	1
teeth	2
back side	1
'spitting of blood'	1
'broke'	3
broken stomach	1
browsed	1
fall	1
dropsy	1
dumb	1
loins	10
body	6
limbs	1
lame	1
lost the use of his limbs	1
lost the use of his right side	1
lost the use of left arm	1

Appendix 19. Osteological evidence of medical interventions

Site code	Skeleton	Affected element	Healed/ unhealed	Comments
Haslar Hospital				
HAS09	217	R tibia and fibula	unhealed	
HAS09	217	L humerus (distal elements)	unhealed	articulated distal arm in grave backfill (medical waste)
HAS09	219	R femur (distal elements)	unhealed	articulated distal leg in grave backfill (medical waste)
Greenwich Hospital				
KWK99	3045	R femur	osteomyelitis still active	extreme osteomyelitis and bony remodelling
KWK99	3086	L femur	healed	healed
KWK99	3061	R tibia and fibula	healed	marked demineralisation of stump
KWK99	3261	L femur	healed	healed
KWK99	6089	L hand	healed	noted by absence of hand- no cutmarks noted
NMR	295B	R tibia	healed	Well healed stump, dense- ? weight-bearing
Plymouth Hospital				
EA6102	520	R femur	unhealed	active periostitis (multiple elements- possible syphilis); OA L knee- possibly due to increased weight-bearing
EA6102	547	R femur	healed	Large bony outgrowth on stump; periostitis
EA6102	571.1	R humerus	healing	shoulder joint damage
EA6102	633	R femur	unhealed	no associated infection; possible penetrating wound to iliac blade
EA6102	662	R femur (distal element)	unhealed	articulated amputated leg placed in gravefill (medical waste); butterfly fracture to fibula; necrosis ad fracture to tibia- possible gunshot injury
EA6102	713	L femur	unhealed	no associated infection; fine cut marks also present
EA6102	624	L tibia and fibula	healing	healing stump with associated periostitis; adolescent 11-13 y
EA6102	802	femur	unhealed	disarticulated femur found in grave backfill (charnel or medical waste)
EA6102	914	L tibia and fibula (distal element)	unhealed	articulated leg found in backfill of grave (medical waste); possible sharp force trauma with necrosis of tibial shaft
EA6102	875	L femur	unhealed	amputated limb buried with sk- died on table; unhealed
EA6102	823	R femur	unhealed	
EA6102	DA912	R femur (distal element)	unhealed	disarticulated element
EA6102	DA04	R femur (distal element)	unhealed	disarticulated element
EA6102	DA02	R femur (prox)	unhealed	disarticulated element
EA6102	DA01	R humerus	healing (infected)	profuse periostitis; retraction of periosteum- necrosis of stump; adolescent 14-16 y
Craniotomies				
HAS08	103	saucer craniotomy	perimortem	
HAS08	104	saucer craniotomy	perimortem	
KWK99	3105	saucer craniotomy	perimortem	
KWK99	3106	saucer craniotomy	perimortem	
KWK99	3119	saucer craniotomy	perimortem	
KWK99	3159	saucer craniotomy	perimortem	
EA6102	519	saucer craniotomy	perimortem	
EA6102	520	saucer craniotomy	perimortem	

Cutmarks (probable autopsy)				
EA6102	633	L ilium	perimortem	Cutmarks; penetrating trauma to R ilum, R femoral amputation
EA6103	581	L sternum, L ribs, R scapula cutmarks; decapitation	perimortem	Possible failed radical forequarter amputation of arm & shoulder & then autopsy
EA6102	713	decapitation	perimortem	
HAS09	220	Sawn clavicles	perimortem	Autopsy to open chest, no pathology noted
Dental treatment				
EA6102	551	dental filling		molar filled by black metal (possibly silver or lead amalgam)

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Appendix 20. Bibliography

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