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Death in the Sun: The bioarchaeology of an early post-Medieval hospital in Gibraltar

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Running title: An early post-medieval hospital in Gibraltar

Word count: 6787

Date of submission: 24th March 2017

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SUMMARY: In 2014, during construction work at the ex-Civil Hospital in Gibraltar, excavations led by the Gibraltar Museum revealed a major, previously unknown burial ground containing more than 200 skeletons. We present the historical, archaeological and radiometric dating evidence from the site alongside the results of initial osteological analyses. The data indicate that the burials pertain to an earlier 16th century Spanish hospice, and therefore stand to offer new insights into the functioning of this early modern hospital and the health and movements of people at a time of incipient globalisation.

INTRODUCTION

Gibraltar, also known as the Rock, located on the Southern coast of the Iberian Peninsula, is a 424 m promontory of Jurassic limestone dominating the eponymous strait. Known since antiquity, Gibraltar has long held a singular place in Western imagination as the nexus between Africa and Europe, the Atlantic and Mediterranean worlds. Its ongoing strategic significance belies its compact size, given that it occupies an area little more than 6.5 km^2, of which 35% is fully uninhabitable. In this small area, over 700 years of urban history jostle, such that one encounters considerable layering of diachronic occupational surfaces. Consequently, it is rare to find relatively intact urban archaeological deposits. Therefore, the discovery in 2014 of over 200 human remains at the site of the ex-Colonial Hospital (closed in 2005), also known as the Old St. Bernard's – since 1963 – or Civil Hospital, during construction of an underground car park was a major discovery.[1] The existence of human remains, particularly dating to the Spanish period (1462-1704), at this location had long been suspected but never conclusively verified.[2]

Hospitals serving civilian, military, and naval needs were established on the site from the 16th century onwards. Given its role as a trade port, military base, and centre of migration, a wide range of infectious diseases were introduced into Gibraltar.[3] The burials at this site provide a unique opportunity to study the impact of trade, war and disease on a changing post-medieval community, and can inform on healthcare at a time when modern medicine first began to develop and burgeoning global human mobility brought novel health challenges.[4]

Since late 2014, an interdisciplinary project involving historians, archaeologists, osteologists and anthropologists has been investigating the nature of these burials, thus maximizing their research potential. Funded by HM Government of Gibraltar, the University of Gibraltar and the University of Cambridge, this research project has started a preliminary study of the human remains, focusing on sex and age profiling, as well as providing a more precise dating of the assemblage. Initial results showed that this was a singular assemblage, being composed of mostly young (aged 15-35 years) men. Also, three chronometric dates positioning the remains within the 15th century, would seem to undermine a material record analysis that suggests rather, a late 16th to 17th century date for the assemblage.[5]

Here then, we assess the contextual history of Gibraltar and the site to thereby reassess the chronology of the remains. Our initial osteological analysis will also set out the basic parameters of the assemblage, focusing on depositional criteria and demographic data gleaned from the bones. We start with a history of Gibraltar, before turning to the site's history and subsequently the archaeological work undertaken at the ex-hospital. This is followed by a section on the extant material culture and chronology of the site, before an in-depth appraisal of the on-going osteological analysis. In conclusion, we reflect on possible interpretations for this assemblage, arguing that the remains pertain to the Spanish period hospital.

HISTORICAL BACKGROUND

The history of Gibraltar is a military one. Its name, derived from the Arabic *Ǧabal Ṭāriq* (Mountain of Ṭāriq), itself evokes the AD 711 conquest of the Iberian Peninsula at the hands

of the Berber military commander Ṭāriq ibn Ziyād. The founding of an actual town at Gibraltar in the 12th century obeyed the same *raison d'être.* By the 14th century, the Castilian conquest of the Iberian Peninsula had finally reached the Strait zone around Gibraltar.[6] The total destruction of Algeciras – the only other deep-sea harbour in the Bay of Gibraltar at the time – in 1379 assured the supremacy of Gibraltar as a port and military outpost in the Western Mediterranean.[7] In 1462, Muslim Gibraltar finally fell, ushering in Castilian (1462-1469), and subsequently Spanish (1469-1704) dominion of the town and its environs.

Initially held by the Dukes of Medina Sidonia, Gibraltar passed directly to the Crown in 1501, being granted a royal warrant and arms by Queen Isabella.[8] As Spain entered its golden age of exploration (1492–1681), expansion and wealth,[9] so too did Gibraltar, serving as the maritime frontier *vis-à-vis* North Africa, while also bridging the Mediterranean and Atlantic Worlds.[10] In much the same manner as post-1704 British Gibraltar, Spanish Gibraltar was a lively place; a garrisoned *entrepôt* that linked this corner of Spain to its colonies and the wider world. This incipient prosperity, combined with its function as an active frontier town, served to attract merchants, soldiers and religious orders. The latter were responsible for the establishment of 19 churches and chapels throughout the Rock.[11] These included evangelising Franciscans, Mercederian hostage negotiators, and hospitaller orders. This last group included the Maltese-headquartered Knights of St. John, and the Spanish order known as San Juan de Dios.

It was the Order of San Juan de Dios that eventually ran the hospital, or hospice, at the site of the later Civil Hospital, the object of this study. The Civil Hospital site was originally the private house of Juan Mateos, a prosperous merchant, who in 1567 turned his home into a hospital for patients with syphilis and other infectious diseases.[12] There is no historical record

of any structure before Juan Mateos' house on the site. By 1591, with Juan Mateos' health failing, the hospital was taken over by the Order of San Juan de Dios – then known as Juan de Dios given that the eponymous founder was not canonised until 1690. This order ran it until 1704, when Gibraltar fell to an Anglo-Dutch force during the Spanish War of Succession (1701-1714). During Juan Mateos' tenure, the hospital was known as *Nuestra Señora de los Desamparados* – Our Lady of the Helpless – under the San Juan de Dios order it was renamed *Nuestra Señora de la Salud* – Our Lady of Health[13] – only gaining the name Hospital of San Juan de Dios following his canonisation. Juan Mateos was buried at the hospital on his death in 1594.[14]

Subsequently, the British authorities used it variously as an Army and Navy hospital, including during the 13th Siege of 1727, until its conversion into the Blue Barracks in 1756. Under Lieutenant Governor George Don, the Civil Hospital was built on the site in 1815, largely respecting the original San Juan de Dios plan of three buildings, aligned north to south, and set around two courtyards (Figure 1). A hospital, in various guises, has then existed on the premises until 2005, the site is now in use as a school.[15]

*** INSERT FIGURE 1 HERE***

ARCHAEOLOGICAL CONTEXT

Located at 40 m above sea level, on the gentler western slope of Gibraltar, the hospital site lay separated from the rest of the town further west during the 16th through to the late 18th century.[16] Built on a natural terrace, the hospital would have enjoyed a deep soil (medium red, sandy silt) matrix, and covered an area of approximately 2,000 m^2, shaped into a rough

rectangle. The Spanish Bravo de Acuña (1627)[17] and the British military garrison (1753)[18] maps both show three main, east to west orientated buildings, aligned in parallel from north to south creating two courtyards in between. Other smaller ancillary buildings enclose the courtyards immediately to the east and west.

The Bravo de Acuña (1627)[19] map shows what was possibly the belfry tower located in the north-eastern corner of the complex, with the main structure – possibly the church or hospital itself – being the central one. What is interesting to note, is that the original hospital was already located away from the general populace, thereby marking the need for separation and isolation of hospitals from the rest of the population. This follows the earlier medieval monastic tradition of locating some hospitals at the periphery of settlements, particularly those for patients with infectious or particularly stigmatised conditions like leprosy.[20] In 1492 a hospital had already been established in the centre of Gibraltar's settlement, but was specifically not for the treatment of infectious conditions such as plague.[21] If constructed at the site of Juan Mateos' house as records suggest, this location may have simply been fortuitous, but it is consistent with historical evidence that the Civil Hospital treated those with contagious diseases.

Following the arrival of the British in Gibraltar in 1704, the site was used intermittently as barracks and a hospital. For example, historical documents suggest that deaths from contagious disease during and after the 1727 siege of Gibraltar killed many more of the garrison than the fighting itself by a ratio of around 8 to 1, and that the infection may have been gastroenteritis.[22] By the mid-18th century both courtyards seem to have been further encroached upon by smaller buildings, this is especially so of the northern courtyard. Indeed,

only the western half of the northern courtyard seems to be open by this stage – exactly the area where the human remains where uncovered.[23]

The original British period buildings – at this stage known as the Blue Barracks – suffered considerable damage during the Great Siege of Gibraltar (1779-1783). A new building, the Civil Hospital (1815-1889), was finally constructed in 1815. Again, the original plans followed the three buildings, two courtyards framework indicating that enough of the previous structures remained to follow the same pattern. It is probably therefore, the modernisation of the hospital, and its re-designation as the Colonial Hospital (1889-1963) between 1887 and 1889, that caused the greatest disturbance on the human remains. At this date, a large underground water cistern was built into the eastern half of the North Courtyard. This most likely destroyed up to half of the cemetery, pushing some remains westwards and also partially truncating individuals located in the western half. Further works – new structures in the courtyard, pipes and cabling infrastructure – throughout the 20th century probably disturbed the upper levels of these historical deposits.

In effect, the only remaining, relatively intact area of the original cemetery was part of the western half of the northern courtyard. It was here that archaeological excavations took place between the 9th of April, and the 18th of August, 2014 (Figure 2). The excavated area covered roughly 10.4 m from north to south; and 8.5 m from east to west. Within this excavation area, the site was subdivided into four distinct sectors. A Central Zone was delimited to the east by a cement wall foundation of a 20th century structure and to the west by the 19th century access slope to the hospital. Towards the north, the Northern Zone described the narrow, covered area of passageway connecting the Central Zone to Building H3. The Southern Zone was the extension of the Central Zone, to the south located below the

ramp access continuation that was removed towards the end of the excavation. This zone extended towards the outside edge of Building H5 but stopping at a large 20th century cement plug that interrupted the site's extension to the south. The Eastern Zone is that lying to the east of the cement wall foundation that delimited the Central Zone. The eastern side of this zone was truncated by the 19th century cistern. The upper archaeological levels of the site had been severely impacted by the then ongoing construction works, as had the eastern edge of the same, during removal of the cistern. There was a further small intervention inside the northern building (H3) at the location of a new lift shaft. Disarticulated remains were also recovered from here.

*** INSERT FIGURE 2 HERE***

Within the main *c.* 90 m^2 excavation site were found the partial, and complete, remains of 251 individuals as documented during excavation. Following the truncation of the uppermost levels, the individuals were located from a starting depth of *c.* 38.6 m asl (above sea level) to a maximum depth of *c.* 37 m asl; nevertheless, the main bulk of the remains were arranged between a depth of 37.98 m through to 37 m asl. Some of the burials appear to have been arranged in small groups, of between two to five individuals, which given their close packing with each other indicates they must have been contemporaneously buried (Figure 3), while others appear to have been isolated individual burials. The skeletons were not deposited in a standardised manner although the majority were approximately extended and supine, and orientated either east-west or north-south, with consistent alignment within clusters. This is broadly consistent with Christian burial practices at this time. In contrast, some were placed in an extended position with the limbs neatly arranged, others lay haphazardly with limbs splayed, or even face down (Figure 4). Such anomalous burial positions might be indicative

of rushed or careless burial, with bodies being thrown into open pits, while the face-down position of Individual 188 could be consistent with the 'deviant' burial treatment sometimes afforded to those on the margins of society, such as criminals, whose sometimes unusual burials marked their social status in the early modern (and other) periods.[24] However, we have no evidence to support a specific interpretation in this case.

There were very few grave goods directly associated to individuals, other than the odd shroud pin. A small number of probable coffin nails suggest only the occasional use of coffins and the close packing of some bodies and burials with limbs splayed supports this interpretation. A greatly reduced number of individual graves were identified, although this could also be the effect of the rather homogenising, red silty-sand matrix [U.E. 7] that covered most of the excavated area. This made distinguishing grave-cuts very difficult, although at least five individual graves could be identified. For instance, Individual 103 could be clearly identified because its grave cut into an older deposit [U.E. 16].

*** INSERT FIGURES 3 & 4 HERE ***

This older deposit was important as it was part of a series of walls [U.E.: 12, 35, 46, 56, 66, 76, 85-88], pavement remnants [U.E.: 37, 48, 67, 80], and layers [U.E.: 15, 16, 32, 36, 38, 45, 47, 57, 58, 62, 75, 77-79] pertaining to 14th and 15th century remains. Although the excavation report generically associated these levels to the Arab or Moorish Marīnid period (1271-1374), it is difficult without more detailed study, to conclusively separate Marīnid and Naṣrid (1230/1231-1492) material during this period, especially in the convoluted context of 14th and 15th century Moorish Gibraltar history.[25] Nevertheless, these older deposits clearly delineate an earlier domestic Moorish occupation, located between 37.44 m and 36.63 m asl.

This in turn, begs the question of whether, when the 16th or 17th century Spanish construction was erected, there was any knowledge of these earlier structures. Still, the discovery of extensive Moorish stratigraphic levels at this location serves to highlight the density of the 14th and 15th century town and the fact that construction extended further upslope than the early Spanish historical sources suggested.[26]

The deepest graves cut, removed and redeposited material and finds from some of these 14th and 15th century layers. This happened for instance with the burials of Individuals 103 and 113. Similarly, the topmost levels of the excavation were truncated and contaminated by later 18th-20th century material. In between these two periods the material tends to be much more homogenously late 16th through to 17th century.

CHRONOLOGY AND MATERIAL ANALYSIS

A late 16th through to 17th century date for the remains, and therefore the cemetery would be in keeping with what is known from the historical sources. In this sense, the cemetery would have been linked to the day-to-day functioning of the hospital. To substantiate this, three human bone samples [Individual 162 – Central Zone; Individual 176 – West Zone; Individual 246 – South Zone] where sent for dating to the University of Oxford ORAU laboratory. Unfortunately, the results (Table 1) showed a serious discrepancy with the accepted history for the site.

*** INSERT TABLE 1 HERE***

The uncalibrated radiocarbon ages are extremely consistent with each other (OxA-33104: 437 ± 28 BP; OxA-33105: 436 ± 29 BP; OxA-33304: 422 ± 24 BP). Due to a plateau in the relevant part of the calibration curve, the calibrated dates at the 95.4% probability level (OxCal v4.2.4;[27] r:5 IntCal13 atmospheric curve[28]) fall either within the 15th century (between approximately cal AD 1420 and cal AD 1490, >92% probability), or within the first decade of the 16th century (<3% probability: Table 1, Figure 5). This indicates a 15th century date is overwhelmingly more likely, and the associated ranges straddle the final period of Moorish Gibraltar (ending in 1462) and Moorish Spain (ending in 1492), and the subsequent Castilian and Spanish hegemony.[29] The implication is that we might be looking at a late Arab, or early Christian cemetery.

*** INSERT FIGURE 5 HERE***

Nevertheless, even given the homogeneity between the three dates (which adds confidence that they are correct), there are potential problems with them. Firstly, there is a tendency towards high $\delta^{15}N$ isotope levels in the samples (range 10.7-13.5‰: Table 1), perhaps indicating a heightened consumption of marine products.[30] A marine diet in this context would not be untoward considering the fact that Gibraltar was an important deep-sea port, and that the hospital was originally set-up for sick sailors.[31] A high marine diet has been linked to a reservoir effect on C^{14} dates in which an offset towards an older date is likely (see [32] for examples of the marine reservoir effect on dating of human bones). Yet, we should note that the $\delta^{13}C$ in these samples was not particularly enriched, casting some doubt on the maritime diet hypothesis. Further isotope research is being undertaken to address this issue. Given that there is a small kink in the radiocarbon calibration curve in the very early 17th century, dates from the first decade of the 17th century are indistinguishable from those of the

early-mid 15th century in radiocarbon terms. Therefore, it is possible (although of far lower probability) that the true dates are 16th century and no marine reservoir effect need be invoked.

Secondly, and perhaps fundamentally, there is an inconsistency between these dates, the historical sources, and the extant archaeological material culture. An initial report on the archaeological material culture recovered from the site,[33] sets the site within a well-defined typological context. The typological parameters divided the material into five distinct time segments within recognised periods: Roman Period (218 BC – AD 400); Late Islamic Period (1333-1462); Late Medieval – Early Modern transition (*c.* 1490-1520); Early Modern Period (1550-1650); and British Period (1830-1870).

Of the five periods represented above, the first – Roman Period (218 BC – AD 400) – is present in a small number of scattered finds including some *terra sigilata* fragments, a Roman coin, and even some Carthaginian ceramics. The latter is not surprising, given that the large and important Cartho-Roman city of Carteia was located scant kilometres to the northwest of Gibraltar.[34] While it is not unheard of to find material from this period in Gibraltar,[35] the type of wares found seem to tantalisingly suggest a possible Roman domestic context at, or near the site. Invariably the finds from this period are found mixed with that from the later Islamic Period. Indeed, from a strictly historical perspective, the first documented settlement at Gibraltar is Islamic and dates to AD 1160.

The late Islamic Period (1333-1462) material is directly associated to the Moorish structures uncovered at the site, and also occurs within the re-depositional contexts of the lowest lying graves where these have disturbed earlier levels, with the material being reinterred within the

grave-cut. None of it occurs as primary deposits associated to the human remains and the lack of anything suggesting Muslim burial customs on the graves themselves – burial on the right side rather than supine, and facing Mecca, as observed in Muslim period burial grounds in southern Spain [36] – supports a post-Muslim period date for the burials themselves. Again, the material is of a domestic nature and comes from the Naṣrid potteries of Malaga, with some material from Granada, and nearby Marīnid Ceuta. A ceramic study of the assemblage is unequivocal in stating that the material is 14th and 15th century, Marīnid and then increasingly Naṣrid (Marīnid influence in the Iberian Peninsula declines dramatically after 1374).[37] There is no evidence of 13th century ceramic.

The Late Medieval – Early Modern transition (*c.* 1490-1520) material culture is of a reduced and scattered nature – although a complete vessel has been uncovered. It was found as a secondary deposit in association with some of the graves. There is no contextual evidence linking it to the earlier Islamic structures, and the assemblage is of domestic wares of a Sevillian origin. It should be noted that this style has a long history of use that extends to the 17th century, so it is not surprising to find it in an archaeological context replete with late 16th and 17th century material.

The human remains are in close association with the Spanish Early Modern Period (1550-1650) material. This is the most diverse, and largest material assemblage of all the periods considered. The characteristics of the ceramic are such, for instance Seville blue on white ware and gunmetal ware, that a late 16th and early 17th century date can be strongly posited for the assemblage. At least two of these ceramics have Christian symbols on them – a hospitaller cross and the *JHS* Christogram – and some of the ceramic also has a clear medical function, such as pharmacy jars and marble mortars. There were also imported ceramics from

Italy, Portugal, Germany and China. Aside from the previously described Roman coin, there are a number of 16th century Spanish *maravedis*. Moreover, the material associated to the three directly dated individuals [Individuals 162; 176; 246] belongs to this period. A fragmented animal bone cross was also found. All this reinforces the belief that these C^{14} dates have been somehow offset, thereby reflecting an older date.

The final, British Period (1830-1870) is stratigraphically located above the human remains in intrusive features, as well as within a test-pit carried out inside Building H3 for a lift-shaft. All this material is clearly of a later date and it unrelated to the graves themselves. Indeed, the British material is not even from the earlier part of this occupation (1704-1815), suggesting that occupation of the site during this period was perhaps not very substantial.

In conclusion, the C^{14} dates by themselves may not be entirely unreliable, but the material culture analysis argue strongly for a late 16th and early 17th century date for the cemetery. This correlates very well with the historical sources, which set the founding of the hospital to 1567. Furthermore, the lack of late 17th century material would seem to indicate that the cemetery, or at least this area of it, had already been decommissioned before the Order of San Juan de Dios was exiled from Gibraltar in 1704. New C^{14} dates are expected in 2018, and included will be animal samples (sheep/goat) that will act as a control to measure the possibility of a marine reservoir offset effect on the human bones. Alongside, we will be undertaking a detailed isotope analysis on the bones of 33 individuals to determine what percentage, if any, of the people interred here were consuming marine resources on a regular basis.

OSTEOLOGICAL ANALYSIS

Together with local volunteers, we have begun the huge task of cleaning the human remains and documenting the age at death and sex of the skeletons, taking bone measurements, and assessing evidence of pathology. Combined with the contextual data, the results already offer preliminary evidence as to why and when these individuals were buried here. Multiple lines of evidence will be needed to fully answer these questions and elucidate whether the burials are from the Spanish hospital or later British Military activity, but the initial results concerning demography, trauma and pathology will be considered here. Work is in progress on ancient DNA and light stable isotopes analyses, which will shed light on the geographic origin and diet of the individuals. Ultimately, the skeletal evidence will offer novel insight into the nature of the site and those treated there, which can complement and augment information from historical records.

Preliminary osteological analyses have been completed on 147 of the individuals identified by the excavators, although poor preservation and later disturbance of the burials has been a significant limiting factor. Completeness of each individual was estimated as being <25%, 25-50%, 50-75% or 75-100% of skeletal elements present. Figure 6 demonstrates that 40.1% of individuals were less than 25% complete.

*** INSERT FIGURE 6 HERE***

In terms of demography, a cemetery associated with a hospital treating sailors or the military might be expected to contain predominantly young adult males. Sex was estimated for adult individuals using sexually dimorphic features of the pelvis and skull.[38] For older adolescents (estimated age at death 15 years or greater) sex was estimated from pelvic morphology only

because cranial features tend to develop later.[39] Sex estimation for younger individuals was not attempted and they are listed as 'indeterminate'. Age at death was estimated from epiphyseal fusion stage in individuals whose growth was incomplete, using reference ages from Scheuer and Black,[40] and dental development and eruption following Buikstra and Ubelaker.[41] For those in whom growth was complete (all epiphyses other than medial epicondyle of the clavicle fused), age was estimated using degenerative changes to the pelvic auricular surface[42] and pubic symphysis[43] following Buikstra and Ubelaker.[44] Where the pelvis was insufficiently preserved, sternal rib end changes[45] were used. Following common practice, individuals were then assigned to broad age categories. 'Infant/juvenile' if estimated age at death was below 12 years, 'Adolescent' if estimated age at death was over 12-19 years but bone epiphyses remained unfused indicating growth was incomplete, and for adults into young (20-35 years), middle (35-50 years) and old (50+ years) categories.[46] Where age could not be estimated more narrowly but the individual was clearly skeletally mature, remains were assigned to a general 'adult' category.

While sex could not be estimated for 68 individuals (46.26% of the total) largely due to poor preservation, 87.3% of sexed individuals were male or probably male, and just 12.8% were female or probably female (difference from expected equal numbers of males and females highly significant by $\chi^2_{df=1}$, $p<0.001$). In terms of age, 28.6% of individuals could not be aged more precisely than determining that they were adult. Of the remainder who could be aged more precisely, 21.0% were adolescents and 51.49% were young adults, while just 4.8% were older adults. Aside from a few isolated fragments, there is little evidence of infants, children or younger adolescents (Figure 7). The MNI for infants and children is 2 (one partial infant radius, 1 child based on 2 permanent incisors with roots ¾ formed, indicating an age around 5-6 years at death) based on isolated bone fragments found in other burials.

*** INSERT FIGURE 7 HERE***

Remembering that pathology and other frequencies quoted here are preliminary and should be interpreted cautiously given the incompleteness and poor preservation of the remains, our observations suggest the occupants of the cemetery pursued active lifestyles, indicated by strong muscle insertions such as cortical defects of the rhomboid fossa (attachment of the costo-clavicular ligament) on the clavicle and frequent vertebral Schmorl's nodes (affecting 12.9% of individuals: Fig. 8a-b).[47] Schmorl's nodes are depressions on the superior or inferior surfaces of the vertebral bodies resulting from herniation of the intervertebral disc during life most likely resulting from heavy loading of the spine.[48] As 12 of the 19 individuals with Schmorl's nodes are young adults and one is an adolescent, and of the 6 individuals with cortical defects of the rhomboid fossa, one is an adolescent and three are young adults, this indicates that the frequency of these lesions is not merely a function of age.

Ante-mortem trauma included well-healed fractures recorded for eleven individuals (7.5% of the total) affecting ribs, metacarpals, the skull and tarsals; two examples of major soft tissue injuries to the lower limbs; and one example of healed blade injuries to the head. Such injuries are consistent with patterns found at other sites of this period and likely relate to common everyday activities and accidents.[49] If the burials had been from the 18th century British military activity on the site, we would have expected evidence of interpersonal violence. We did not find evidence of peri-mortem trauma that would imply siege victims.

*** INSERT FIGURE 8 HERE***

There is also evidence of activities expected at a hospital including amputations (n = 2: both lack evidence of healing and therefore did not survive more than hours/days) and possible autopsy[50] (Fig. 8c-f), as well as infections of the long bones, ribs and/or cranial vault (26 individuals affected, or 17.7% of the sample). There are two putative cases of syphilis, but no confident diagnoses can be made. Relatively complete skeletons would be required for a firm diagnosis, while these cases represent a skull with a caries-sicca-type erosive lesion on the frontal (parietal), but which lacks postcrania, and a tibia with severe periostitis similar to classic syphilitic 'sabre shin', although again the rest of the skeleton is missing.[51] While the number of potential syphilis cases might appear small if the hospital did function to treat the 'French disease' among sailors, skeletal manifestations of syphilis only occur late in the disease process (10 years or more after initial infection) and may affect only between 1 and 20% of cases.[52]

The possible autopsy case has a large rectangular section of the frontal bone removed from the skull. This rectangle has been sawn on all four sides, although the horizontal saw mark at the top of the picture (Fig. 8c) does not fully penetrate the skull, perhaps as the rectangle of bone to be removed broke away along the line of the suture. In two places the saw was repositioned before the cut fully penetrated the bone. There is also evidence of three holes along those saw marks possibly to assist with the removal of the cut bone, and several areas of fine knife marks on the rectangle of frontal bone and the parietals posterior to the saw cut. These knife marks are likely associated with the anatomist or surgeon retracting the scalp prior to cutting the bone (Fig. 8c). The location and nature of the cuts is not consistent with known surgical procedures or standard autopsy procedures.[53] However, other cases of non-standard cranial cuts have been reported[54] and as such a restricted autopsy or dissection are possible explanations[55].

Stature is a sensitive indicator of past health and growth,[56] and was estimated from long bone lengths using the equations for US whites developed by Trotter and Gleser[57] to ensure comparability with published data. The final stature estimate for each individual was obtained by averaging all of the estimates available for that individual. Mean stature for 31 males (including probable males) was 170.3 cm and for seven females (or probable females) was 158.4 cm. This is at the upper end of the range for three medieval populations from the Iberian peninsula,[58] which ranged from 166.8-171.2 cm for males and 153.5-160.7 cm for females, and slightly shorter than the mean for a small sample from the medieval Islamic cemetery at Écija, near Seville (males: 172.6 cm; females = 160.7 cm).[59] Male stature is also similar to that recorded for British military recruits in the early 18th century (168 cm).[60] Therefore, stature estimates do not suggest that the occupants of this burial ground stood out in terms of stature compared with contemporaneous samples.

DISCUSSION

The combined archaeological, osteological and historical analyses completed to date are already elucidating the origins of the burials found at the site of the Old St. Bernard's Hospital in Gibraltar in 2014. While there are clearly outstanding issues surrounding the radiocarbon dates, material culture analyses give a strong indication that we are dealing with the burial ground of the Spanish hospital. Osteological analyses also provide evidence consistent with this interpretation, and begin to shed light on the nature and purpose of the hospital.

The high proportion of adolescent or young adult males from this site departs from a typical mortality profile for non-industrial agricultural populations, where higher infant and older

adult mortality and a more equal sex ratio would be expected.[61] While the paucity of infant and juvenile remains at the site might be attributed to poorer preservation of more delicate non-adult bones or due to their burial in shallower graves which were more prone to later disturbance,[62] the presence of isolated elements amongst other burials suggests these remains were recoverable from the site, and the high numbers of adolescent/young adult males remain unusual.

The pattern is consistent with the site being the burial ground of the Spanish hospital, which historical evidence indicates was established to treat mariners in particular.[63] Comparative data from southern Spain are lacking, but studies of medieval and early modern hospices and/or hospital burial grounds linked to religious institutions in the UK (excluding leprosaria) indicate that while some burial grounds contained a more balanced sex ratio (e.g. St John's, Cambridge; St Giles', Brough; St Bartholomew, Bristol), others (e.g. St Nicholas' Hospital, Lewes; St Leonard's, Newark) show a similarly strong predominance of males (Barber, et al., 2010, Gilchrist and Sloane, 2005a, Cessford, 2015, Gilchrist and Sloane, 2005b). This variation may relate to the purpose of the hospitals/hospices, with some established as single sex institutions and others treating a wider segment of the population (Knowles and Hadcock, 1971).

The age distribution of British medieval hospital and hospice cemeteries appears to have been similarly variable, with some containing mainly older adults (e.g. St Bartholomew, Bristol), others lacking non-adults and having a high proportion of young adults (e.g. St Leonard's, Newark), and others a broader range of ages (e.g. St John's, Cambridge; St Nicholas, Lewes).[64] Interestingly at the John of Jerusalem Knights Hospitaller priory in Clerkenwell (Juan Mateos' hospital was run by an analogous order in the late 16th-17th centuries), out of

the nine adults, five were classed as young (16-25 years at death) and seven were male, although the presence of three individuals aged under 15 years[65] departs from the pattern at the Gibraltar hospital.

The predominance of older adolescent/young adult remains would again be consistent with an institution serving mariners, who would have been almost exclusively male and would have often begun their working lives as young boys or teenagers. While parallels for mariners' hospitals are rare, evidence from slightly later Royal Navy hospital burial grounds (17th-18th century) at Haslar, Gosport, and Stonehouse, Plymouth[66] demonstrates a similar predominance of older teenage and young adult men, as do skeletons from the wreck of the 16th century English warship the *Mary Rose*,[67] burials of presumed crew from one of Columbus' voyages to the Americas,[68] and 18th century Dutch whalers.[69] This demographic profile would also of course be consistent with 18th century British Military use of the site, but such an interpretation would contradict the material evidence.

As the evidence strongly suggests the burials pertain to the Spanish hospital, future analyses of the collection stand to afford us important new insights into the nature and function of this particular hospital, data which the limited historical information does not afford. The similarity or otherwise of this institution to other contemporary hospitals and hospices will be of interest given its reported specialist role in treating sailors and chronic infections. Furthermore, the hospital dates to the 'Age of Discovery', which represents the dawn of the early modern period. This was a time of increasing mobility and trade as far afield as the Americas and the Far East. These new, far-flung, and for the first time truly global, contacts also led to the exchange of diseases across the globe and outbreaks of typhus, yellow fever and cholera in Europe.[70] Gibraltar's strategic location for European trade routes and

navigation mean this assemblage will offer new insights into the movements, lifestyle and health of people involved in this trade at a formative time for the modern world.

Some clusters of burials must have been made at the same time, or at least within a short period of one another while the grave trench was still open, given their close packing and lack of intercutting. Such multiple burials are often associated with disease outbreaks or catastrophic events,[71] and evidence of a lack of care in some burials, similarly supports the idea that some burials were made hastily. Further analysis of the size of these clusters and their relationship to each other and to other burials will help to discern their possible origin and nature. While they may relate to more well-known disease outbreaks, such as various incidences of plague in the late medieval and early modern period, they may equally pertain to outbreaks of other more common infections within a group of people living in close quarter whose health was already precarious. Analyses of ancient pathogen DNA might hold the key to interpreting some of these burials.[72]

CONCLUSION

The skeletal remains of over 200 individuals uncovered in 2014 in the northern courtyard of the Old St Bernard's Hospital or Civil Hospital, Gibraltar, most likely date to between 1567 and 1704, based on initial analysis of the archaeological contexts and finds. Indeed, the archaeological material analysis would seem to curtail these dates further to the late 16th and early 17th century. The burials would therefore pertain to the period following the initial founding of the hospital in 1567 by Juan Mateos and its subsequent management by the hospitaller order of San Juan de Dios from the late 16th to early 18th century, when Gibraltar

was under Spanish jurisdiction. Despite relatively poor skeletal preservation and extensive disturbance of the burials by later activity on the site, preliminary osteological analyses indicate a predominance of older teenage and young adult males, which would be consistent with historical evidence that the hospital was established to treat sick mariners.

There remain further analyses to complete on the skeletal remains, and the existing radiocarbon dates are currently at odds with the material culture evidence. Ongoing work to obtain additional radiocarbon dates and investigate the possibility of marine diet effects on the dates from human bone will help to resolve the chronology of the burials. Further macroscopic skeletal analyses, as well as the results of ongoing light stable isotope and ancient DNA analyses will assist in clarifying the origin of the burials, and their significance for understanding the hospital and its role within a local context, as well as the impacts of expanding trade networks and international on mobility, health and disease at the origins of a global world.

ACKNOWLEDGEMENTS

This work was supported by grants from the McDonald Institute for Archaeological Research, University of Cambridge; Her Majesty's Government of Gibraltar, Ministry of Sports, Culture, Heritage, and Youth [MSCHY]; and the University of Gibraltar. We are grateful to Minister Steven Linares and Mr. George Victory of the MSCHY for lending their commitment to the project. We thank Gibraltar Museum support staff and volunteers for their hard work: Sioned Cox; Brielle Gafan, Kasmeen Khaira, Nuhaila Mkerref, Justin Martinez, Marie Mosquera, Jake O’Donohoe, Gwynneth Bennet and Angela Pomeroy. For advice, thank you to Dr Jay T Stock, Dr Tamsin O'Connell, Dr Emma Lightfoot, Dr Toomas Kivisild, Dr Jenna Dittmar and Freddi Scheib, Department of Archaeology and

Anthropology, University of Cambridge; Dr Linus Girdland Flink of Liverpool John Moores University, and Dr Johannes Krause and Marcel Keller of the Max Planck Institute, Jena, Germany.

NOTES

[1] Mata, Cobos & Ramírez León 2015.

[2] Benady 1994.

[3] Sawchuk 2001; Andrews 1958; Constantine 2009; Benady 1994; Sawchuk & Burke 1998.

[4] Benady 1994.

[5] Reinoso del Río & Gutierrez López 2016.

[6] Lane *et al.* 2014.

[7] del Castillo 2012.

[8] Jackson 1987; López de Ayala 1782.

[9] Kamen 2014.

[10] Sáez Rodríguez 2006.

[11] Hernández del Portillo 2008 [1610-1622].

[12] Benady 1994.

[13] Hernández del Portillo 2008 [1610-1622].

[14] Benady 1994.

[15] Benady 1994.

[16] British Military Garrison - Gibraltar 1753.

[17] Bravo de Acuña 1627.

[18] British Military Garrison - Gibraltar 1753.

[19] Bravo de Acuña 1627.

[20] Metzler 2012.

[21] Benady 1994.

[22] Edwards 1830; James 1771; Hennen 1830.

[23] British Military Garrison - Gibraltar 1753.

[24] Tarlow 2015

[25] Lane *et al.* 2014.

[26] Hernández del Portillo 2008 [1610-1622].

[27] Ramsey 2009.

[28] Reimer *et al.* 2013.

[29] Kamen 2014; Harvey 1992.

[30] Oxford Radiocarbon Accelerator Unit, pers. comm. 01/03/2016

[31] Hernández del Portillo 2008 [1610-1622].

[32] Ascough, Cook & Dugmore 2005; Ascough *et al.* 2012; Bayliss *et al.* 2004.

[33] Reinoso del Río & Gutierrez López 2016.

[34] Romero de Torres 1909.

[35] Giles Guzmán *et al.* 2010; Finlayson *et al.* 1996; Finlayson *et al.* 1997; Finlayson *et al.* 2000.

[36] Zakrzewski 2011; Insoll 1999.

[37] Reinoso del Río and Gutierrez López 2016

[38] Buikstra & Ubelaker 1994.

[39] Lewis, Shapland, & Watts 2016; Shapland & Lewis 2013.

[40] Scheuer & Black 2000.

[41] Buikstra & Ubelaker 1994.

[42] Lovejoy *et al.* 1985.

[43] Todd 1920; Todd 1921; Brooks and Suchey 1990.

[44] Buikstra & Ubelaker 1994.

[45] Burns 1999; Işcan, Loth & Wright 1984; Işcan, Loth & Wright 1984; Işcan & Loth 1986.

[46] O'Connell 2004.

[47] Capasso, Kennedy & Wilczak 1999; Mann & Hunt 2013.

[48] Capasso, Kennedy & Wilczak 1999; Kyere et al. 2012; Mann & Hunt 2013.

[49] Roberts and Cox 2003 and references therein.

[50] J. Dittmar, pers. comm. 2015

[51] Aufderheide & Rodríguez-Martín 1998; Ornter 2003

[52] Resnick & Niwayama 1995; Ortner 2003; Aufderheide & Rodríguez-Martín 1998.

[53] Furgusson 1845; Thomas, 1873; Harris, 1887; Cattell, 1903.

[54] Kausmally 2012, 2015.

[55] J. Dittmar, pers. comm. 2015, 2017.

[56] Tanner 1987; Komlos 1994.

[57] Trotter & Gleser 1952; Trotter & Gleser 1958; Trotter 1970; Trotter & Gleser 1977.

[58] Lalueza-Fox 1998.

[59] Pomeroy 2006.

[60] Komlos & Cinnirella 2007.

[61] Chamberlain 2006.

[62] Bello *et al.* 2006.

[63] Hernández del Portillo 2008 [1610-1622].

[64] Barber *et al.* 2010; Gilchrist & Sloane 2005a; Gilchrist & Sloane 2005b, Cessford 2015.

[65] Gilchrist & Sloane 2005, Gilchrist & Sloane 2005.

[66] Sinott 2013, Shortland *et al.* 2008; Oxford Archaeology 2005.

[67] Stirland 2005.

[68] Tiesler *et al.* 2016.

[69] Maat 2004.

[70] Nguyen-Hieu *et al.* 2010; Benady 1994; Harper *et al.* 2011.

[71] DeWitte 2014, McCullagh & McCormick 1991; Antoine 2008.

[72] Nguyen-Hieu *et al.* 2010; Papagrigorakis *et al.* 2006; Drancourt *et al.* 1998.

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The archive and finds are deposited with the Gibraltar Museum, 18-20 Bomb House Lane, PO Box 939, Gibraltar

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LIST OF FIGURE CAPTIONS

FIG 1

Above, Luis Bravo de Acuña's map of Gibraltar (1627), showing the location of the hospital founded by Juan Mateos on the hillside above the town (enlargement). Below, *Particular Survey of Gibraltar* from 1753, showing the double courtyard layout, respected by later buildings.

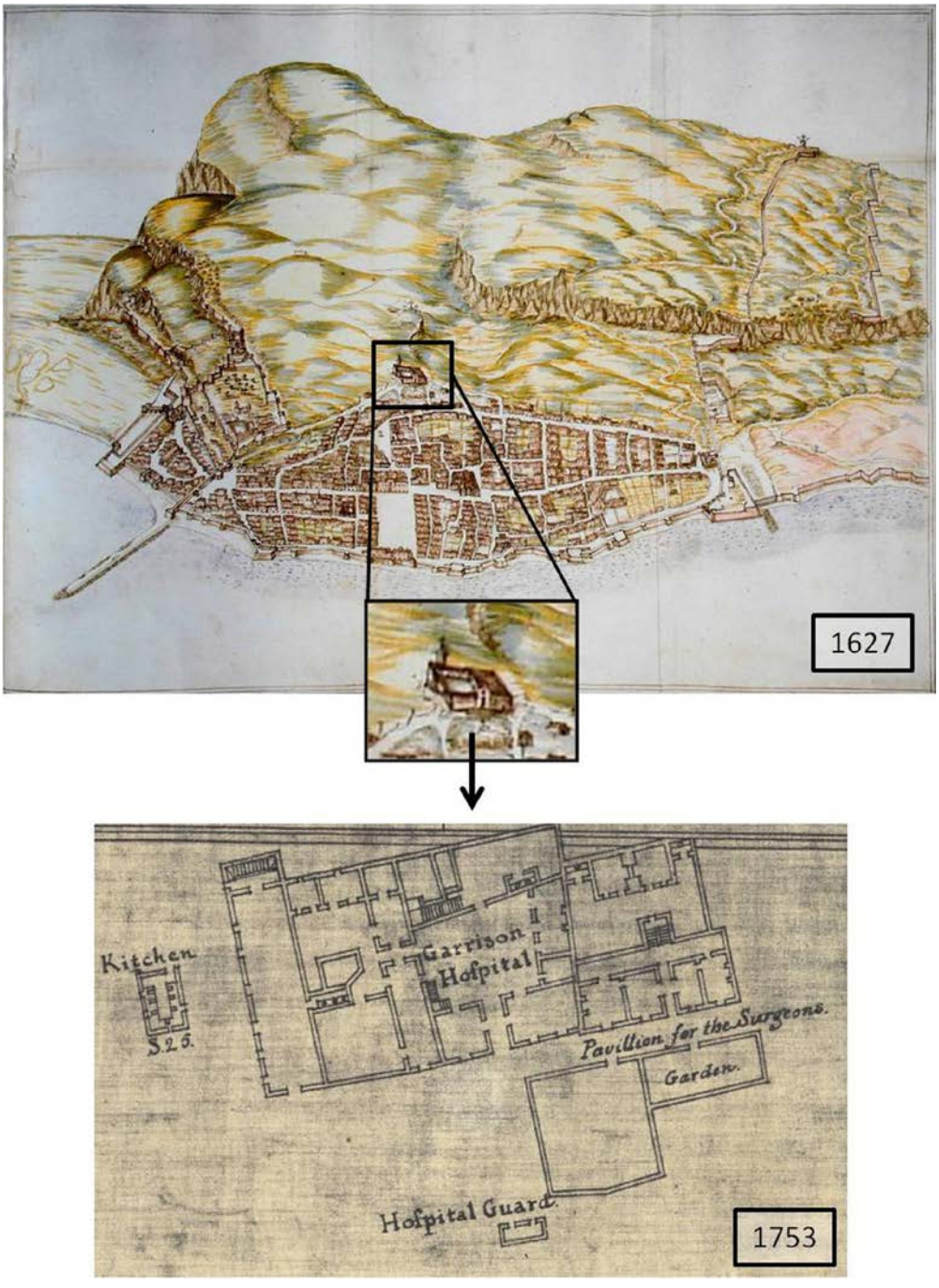


FIG 2

Plan of excavations in the north courtyard of the Old St Bernard's Hospital site in 2014. Site referenced using UTM coordinates.

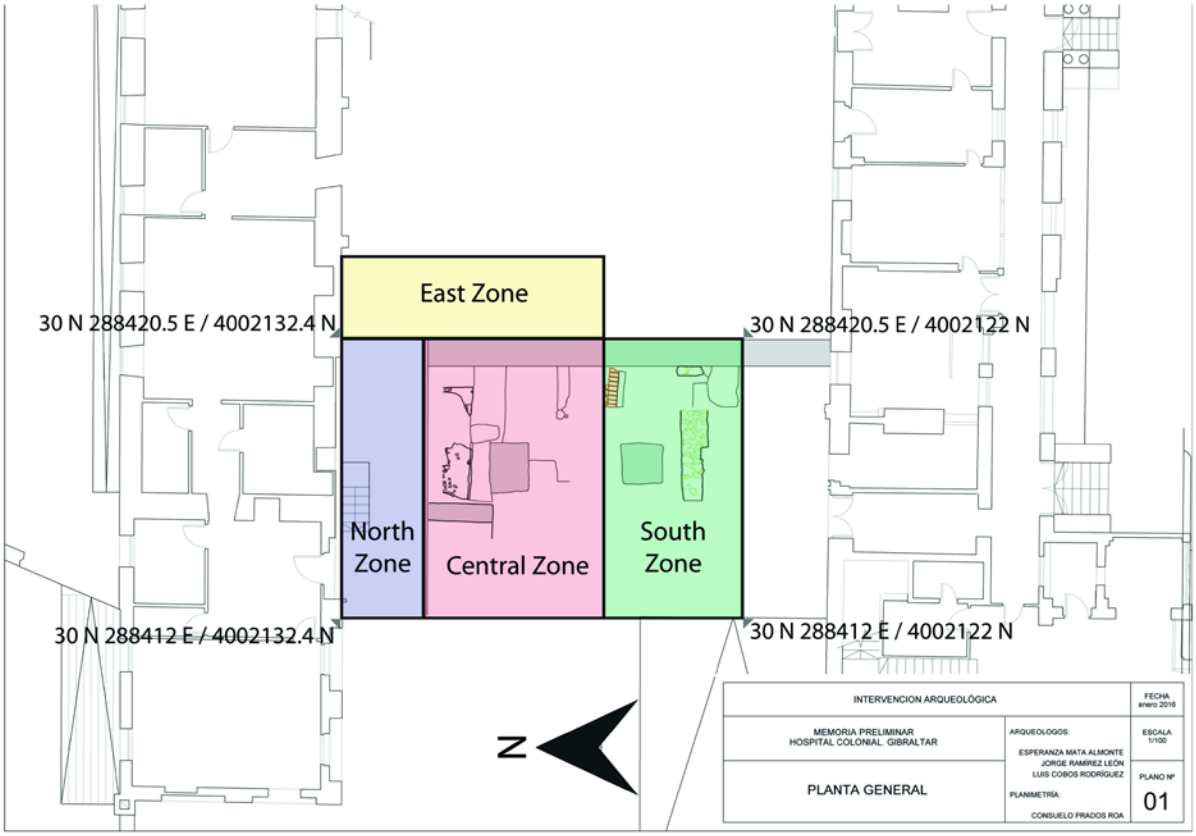


FIG 3

Partial view of the excavations, demonstrating an area of close-packed burials.

FIG 4

Examples of burial positions of Individuals 166 (above), 191 (below) and 188 (right), demonstrating unconventional body positioning.

FIG 5

Plot of radiocarbon dates for 3 human bone samples from the Old St Bernard's Hospital site, Gibraltar, calibrated using OxCal v4.2.4 Bronk Ramsey (2013); r:5 IntCal13 atmospheric curve (Reimer, et al., 2013). Black bars represent confidence intervals at 3σ and 2σ associated with each date.

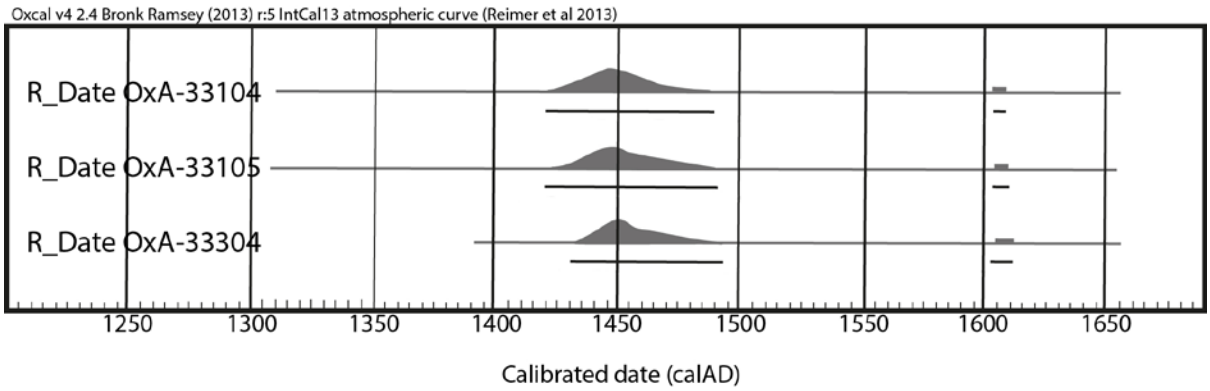


FIG 6

Preservation of 147 human burials analysed to date from the Old St Bernard's Hospital, Gibraltar.

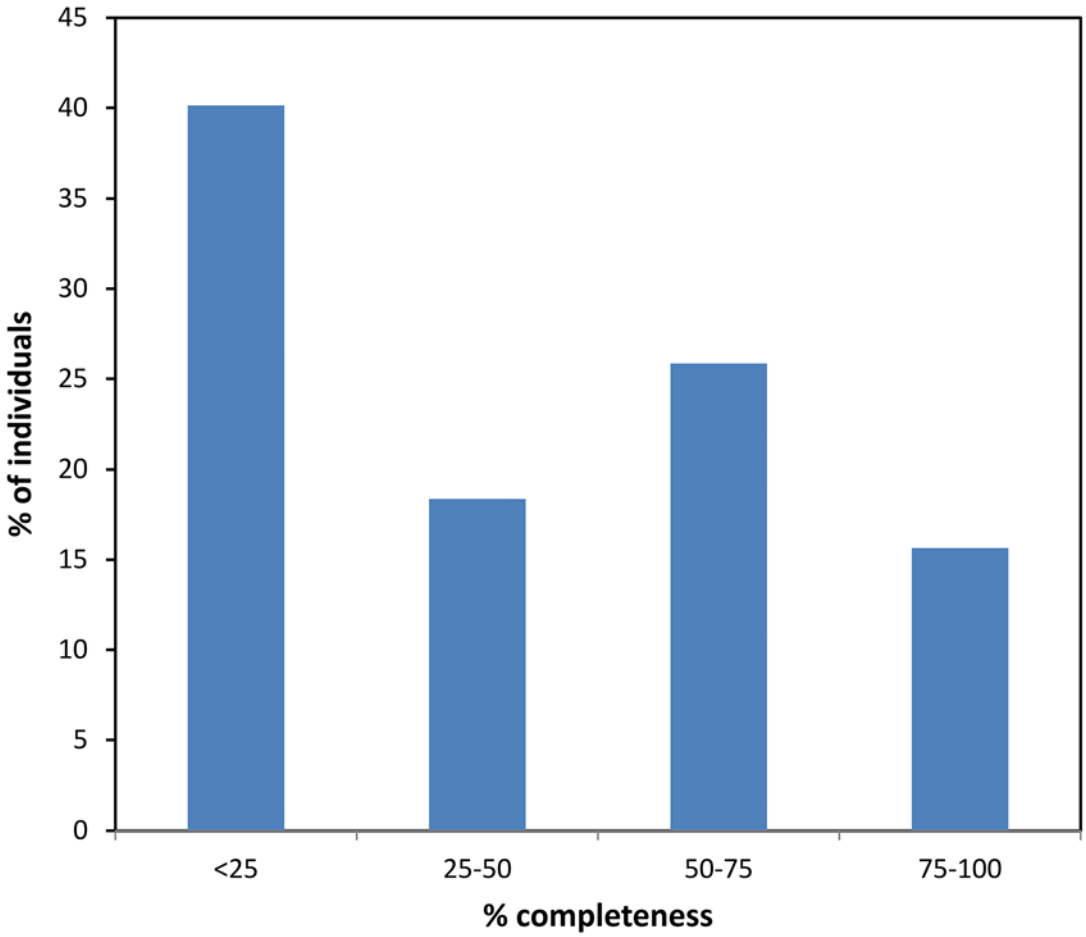


FIG 7

Sex and age at death distribution of the sample, showing a strong predominance of young adult males and probably males (?M). 'Adult' refers to individuals who were identifiably adult at death, but for whom conventional methods (auricular surface, pubic symphysis and rib end morphology) could not be applied due to poor preservation.

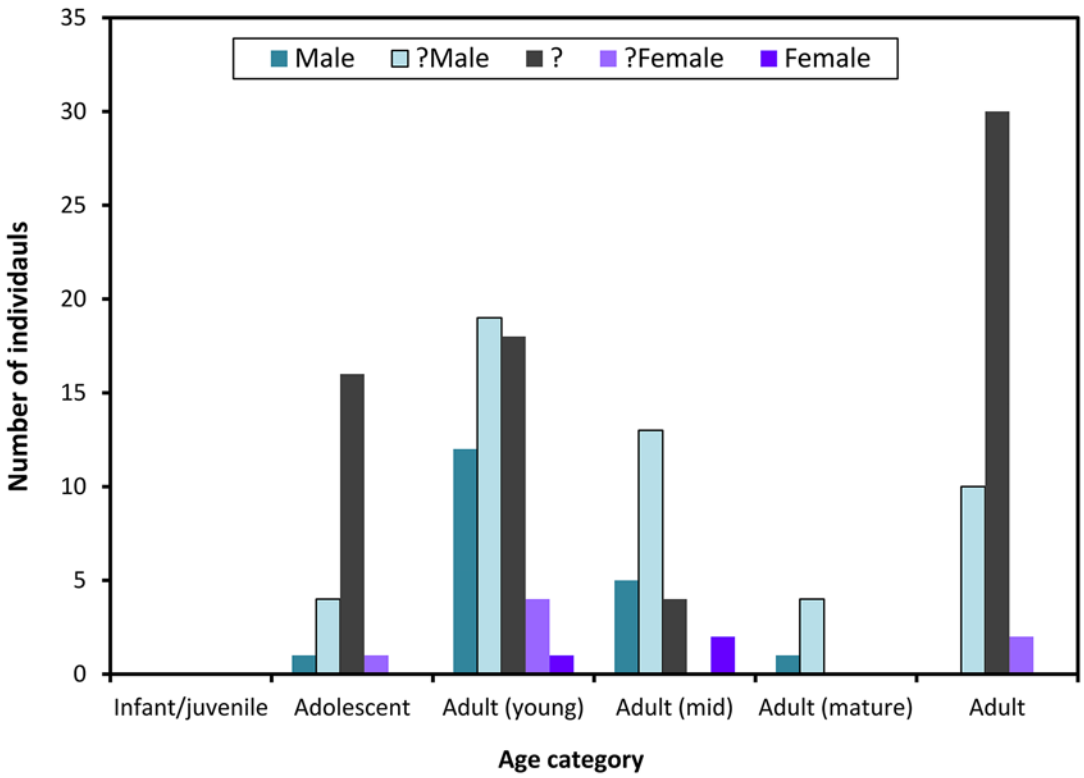
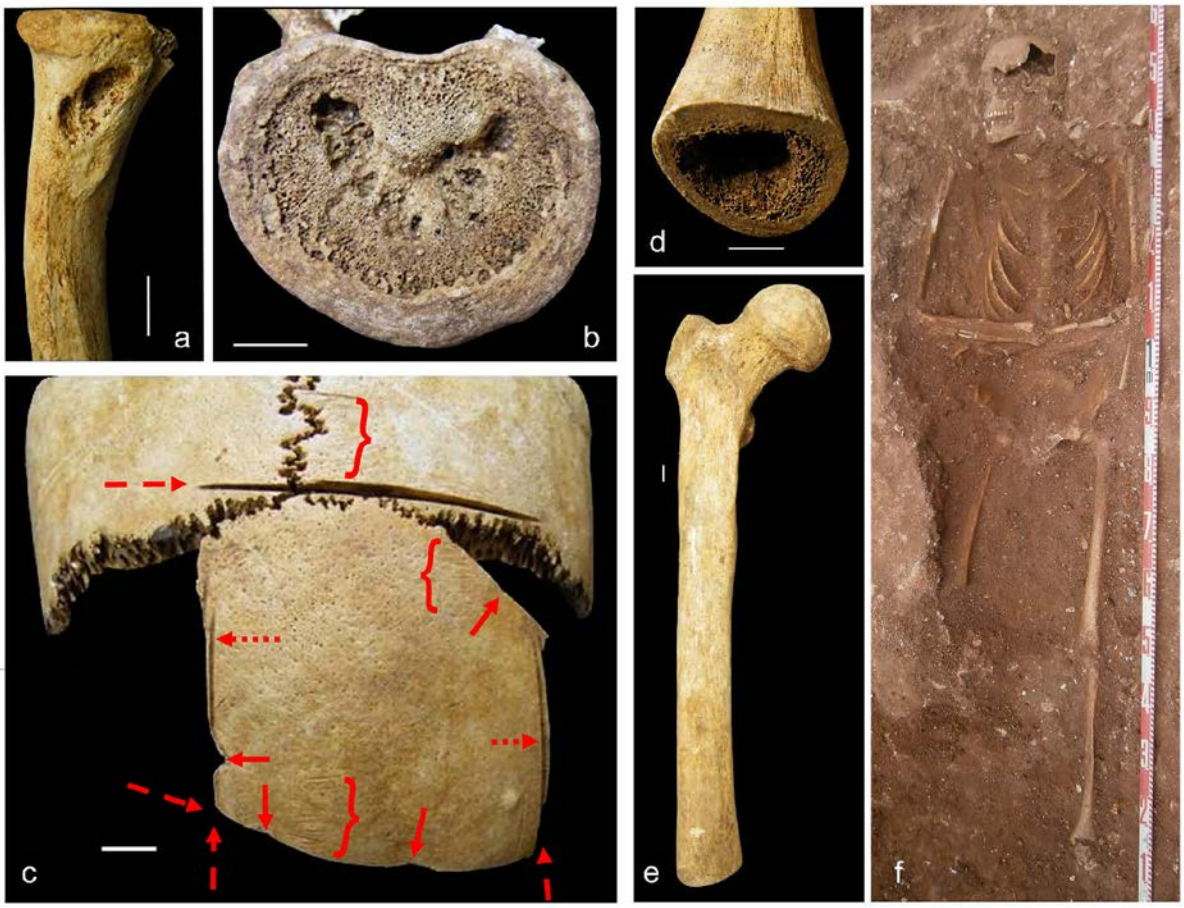


FIG 8

Evidence of active lives (a-b), possible autopsy (c) and surgery (d-f). (a) Marked rhomboid fossa of the right clavicle (Individual 232) and (b) large Schmorl's node on the inferior side of a lumbar vertebra (Individual 230). (c) Possible autopsy: Individual 17 with fine knife marks (enclosed by brackets), sawing (dashed arrows indicate saw lines) including partial cuts where the saw has been repositioned (dotted arrows) and possibly chiselling/drilling (solid arrows). (d-f) Mid-thigh level amputation of the right leg in Individual 252 shown (d) at the level of the cut (posterior is up), (e) the whole remaining part of the right femur (anterior view) of Individual 252 and (f) Individual 252 in situ. Scale bar = 1cm



TABLES

TABLE 1
Radiocarbon dates for three human bone samples from the Old St Bernard's Hospital site, Gibraltar, calibrated to 95.4% probability using OxCal v4.2.4 Bronk Ramsey (2013); r:5 IntCal13 atmospheric curve (Reimer, et al., 2013).

Lab Reference	**Description**	**Individual**	**$\delta^{13}C$**	**$\delta^{15}N$**	**Uncalibrated radiocarbon age (years BP ± 1σ)**	**Calibrated date range at 95.4% overall probability**	
						Range (cal AD)	**Probability (%)**
OxA-33104	Left Femur (*Homo sapiens*)	162	-17.58	10.7	437 ± 28	1420-1489	94.5
						1604-1608	0.9
OxA-33105	Left Tibia (*Homo sapiens*)	176	-18.27	11.9	436 ± 29	1420-1491	93.8
						1603-1610	1.6
OxA-33305	Rib (*Homo sapiens*)	246	-19.92	13.5	422 ± 24	1430-1493	92.7
						1602-1611	2.7