ANTHROPOLOGICAL SCIENCE
Vol. 121(3), 149–159, 2013

Leprosy in individuals unearthed near the Ermida de Santo André and Leprosarium of Beja, Portugal

Nathalie ANTUNES-FERREIRA[1,2], Vítor M.J. MATOS[2]*, Ana Luísa SANTOS[2,3]

[1]*Instituto Superior de Ciências da Saúde Egas Moniz, Caparica, Portugal*
[2]*Research Centre for Anthropology and Health (CIAS), University of Coimbra, Coimbra, Portugal*
[3]*Department of Life Sciences, University of Coimbra, Coimbra, Portugal*

Received 28 March 2013; accepted 2 July 2013

Abstract Documentary sources refer to leprosy patients in the Portuguese territory since the first century AD, and in the Middle Ages around 70 leprosaria were established. However, prior to 2003 this historical evidence had not been confirmed by archeological findings. The excavation performed in monitoring the rehabilitation done by the Polis program in the area of the Ermida de Santo André (hermitage of Saint Andrew) allowed the exhumation of seven human skeletons, and commingled bones from at least three individuals, in the vicinity of the Beja leprosarium. The objective of this study is to present the paleopathological lesions relevant to the discussion of the differential diagnosis of leprosy. Macroscopic observation of the bones and scrutiny of lesions according to the paleopathological literature allowed the identification of a probable case of leprosy in an adult male, showing rhinomaxillary changes and concentric remodeling of hand and foot bones, and four possible cases (two young adults and two adults, all probably males), with a set of lesions in facial bones and skeletal extremities. The poor preservation of the bones precluded further confirmation of this diagnosis. According to historical data, the leprosaria functioned between the 14th and 16th centuries AD. The exact chronology of these findings was not determined either during the excavation or by radiocarbon dating because the bones presented poor collagen levels. In Portugal as a whole there are few osteological evidences of leprosy, and thus this study adds new information about this chronic infectious disease.

Key words: Hansen's disease, leprosy, paleopathology, rhinomaxillary changes, destructive diaphyseal remodeling

Introduction

Leprosy has been present in Europe since at least the 4th–3rd centuries BC (Mariotti et al., 2005; Roberts and Manchester, 2005). For the following centuries the paleopathological and/or written records of this disease are rare. However, it is known that in the 5th century AD the first hospital for leprosy patients was established (Carvalho, 1932; Mira, 1947; Dueñas et al., 1973). The archeological excavation of medieval cemeteries associated with leprosaria has revealed an increased number of skeletons with lesions compatible with leprosy—for example, the cases of St. James and St. Mary Magdalene hospitals at Chichester (Magilton et al., 2008) and St. Mary Magdalene at Winchester (Roffey and Tucker, 2012), both in England, and St. Jørgen's at Naestved (Møller-Christensen, 1952, 1953a, b; Andersen, 1969; Bennike, 1991, 2002) and St. Jørgen's at Odense (Arentoft, 1999; Boldsen, 2001; Matos, 2009; Matos and Santos, 2013) in Denmark.

In Portugal the first written references to leprosy date from the 1st century AD and during the Middle Ages around 70 small leprosaria were founded in the country (Carvalho, 1932). According to this author, this disease was rare until the 17th century. The first paleopathological evidence of this chronic infection was found in 2003 during the excavation conducted along with the rehabilitation of the area surrounding the Ermida de Santo André (hermitage of Saint Andrew), in Beja, by the Polis programme (Antunes-Ferreira and Rodrigues, 2003).

The Ermida de Santo André in Beja dates from the 15th century AD (Viana, 1943; Espanca, 1992; Borrela, 1995; Goes, 1998) but according to written sources it may have been built in the 12th century AD (Cardoso, 1751; Viana, 1943; Borrela, 1995). Documentary research revealed the existence of a leprosarium (*gafaria*) in the surroundings of this hermitage (Espanca, 1992; Goes, 1998). However, its chronology was not fully established. Carvalho (1932) quoted a will dated from 1377 made in favor of the poor and leprosy victims from the Albergaria de Santa Anna which seems to correspond to the Beja leprosarium. Mestre (1991) stated that the leprosarium of Saint Anne was extinct in the 15th century and their belongings were incorporated in the hospital of Our Lady of Mercy (Nossa Senhora da Piedade) built in the 15th/16th centuries. This hospital is also called Mercy hospital (Hospital da Misericórdia) (Carvalho, 1932;

* Correspondence to: Vítor M.J. Matos, Research Centre for Anthropology and Health (CIAS), Department of Life Sciences, University of Coimbra, Apartado 3046, Coimbra P 3001-401, Portugal.
E-mail: vmatos@antrop.uc.pt

Published online 14 September 2013
in J-STAGE (www.jstage.jst.go.jp) DOI: 10.1537/ase.130702

Mestre, 1991) and in 1932 it still preserved the old archives of the *gafaria* (Carvalho, 1932). The name of the patron of the leprosarium is not the same in the publications consulted, since Goes (1998) used the designation St. Lazarus leprosarium, reporting its activity at least between 1509 (Goes, 1998) and around the end of the 16th century (Espanca, 1992; Goes, 1998). This discrepancy might be related to the administrative change that happened after its incorporation in the Mercy hospital. Further references to this place were found in early 20th-century reports that the houses and other ruins from the leprosarium were demolished in 1939 and the hermitage was renovated under the supervision of the municipality and heritage office (DGEMN, Direcção-Geral dos Edifícios e Monumentos Nacionais) (Borrela, 1998; Borrela and Campaniço, 2004).

This site, along with the cemetery identified in 2009 in the 'Leprosarium Valley' in Lagos, dated to between the 15th and 17th centuries (Ferreira et al., 2013) are, so far, the only two archeological evidences of past leprosaria cemeteries in this country.

The aim of the current paper is to report the pathological lesions with relevance to the differential diagnosis of leprosy in individuals exhumed from the cemetery near the Ermida de Santo André.

Materials and Methods

In 2003, during the Polis rehabilitation program in Beja, the surroundings of the Ermida de Santo André were excavated by the archeology enterprise Crivarque, Lda, having as anthropologist one of the authors (N.A.F.). In the fieldwork seven surveys were opened in the vicinity of the hermitage (five were located about 20 m north, one next to the north wall of the hermitage and one 5 m south), totaling an area of 42.56 m^2.

Human remains were found in survey number 6, located near the north wall of the hermitage. This area was originally 4 m × 3 m but was later extended to 5.8 m × 3.2 m (18.56 m^2) due to the presence of ten graves. However, only seven were excavated because the remaining three (sk 2, 9, and 10) were outside the working area. This excavation also exposed a pavement (built of small blocks of granite, quartzite and quartz) placed directly over one of the burials; a small wall, partially destroyed, built in brick and close to grave number 7, which possibly was from one of the houses destroyed in the early 20th century; and a drainage pipe placed by the DGEMN which also affected the burials. In short, skeleton 1 did not include the skull, cervical vertebrae, and scapulae; in skeleton 3 the right humerus was absent; skeleton 4 is the only one which is quite complete; skeleton 5 preserved only the skull, humeri, and the upper part of the trunk; skeleton 6 did not preserve the lower left limb bones and the right tibia, fibula, and foot bones; skeleton 7 did not preserve the distal portion of both femurs or any of the remaining lower limb bones; and skeleton 8 did not have the skull.

The graves did not show any delimitation structure with the four older ones having an oval shape built into the rock while the three more recent ones were placed over the previous. All the individuals were inhumed in dorsal decubitus position, with a NE–SW orientation, aligned with the hermitage wall, suggestive of Christian burials. Their upper limbs, when discernible, were placed along the body ($n = 1$), above the abdominal region ($n = 2$), or above the pelvis ($n = 3$). Beside the individuals in articulation, over the right lower limb of skeleton 3 were placed commingled bones from at least three individuals, two adults and one non-adult. Despite all efforts it was not possible to match these bones with the primary inhumations. However, this possibility cannot be completely discarded due to post-mortem fragmentation.

The doubts about the chronology of the leprosarium of Beja were not solved by the excavation because the stratigraphy points to a medieval/modern occupation. Thus, a bone sample from skeleton 3 was sent to the radiocarbon unit of Oxford University but the analysis "failed due to very low yield."

In the laboratory, the human remains were observed macroscopically, through a naked eye observation using an artificial light and, whenever necessary, a 10× magnifier lens. Sex and age at death were estimated according to standard methods (Ferembach et al., 1980; Buikstra and Ubelaker, 1994; Bruzek, 2002).

The paleopathological analysis followed the generic recommendations detailed in standard textbooks (Buikstra and Ubelaker, 1994; Aufderheide and Rodríguez-Martín, 1998; Ortner, 2003). Additionally, the identification of the specific bone lesions commonly considered relevant for the discussion of a leprosy diagnosis on dry skeletal material was based on the following: (1) rhinomaxillary changes were identified according to the original descriptions for facies leprosa made by Møller-Christensen (1953b, 1961, 1967) and also using the later modifications brought by the rhinomaxillary syndrome concept proposed by Andersen and Manchester (1992); (2) bone changes of the hands and feet were researched following Møller-Christensen (1961), Andersen (1969), Andersen and Manchester (1988), Andersen and colleagues (1992, 1994), Rothschild and Rothschild (2001), Ortner (2003, 2008a, b) and Rothschild and Behnam (2005); (3) periosteal reactions on long bone diaphyses were identified following Buikstra and Ubelaker (1994) and Ortner (2003) but also attending to the considerations made by Hackett (1976), Lewis et al. (1995), Matos and Santos (2006) and Weston (2008) regarding new bone formation classification, recording, and interpretation.

The differential diagnosis of the recorded lesions, solely or combined, and whether these are indicative, or not, of leprosy was discussed considering the works by Møller-Christensen (1967), Andersen and Manchester (1992), Ortner (2003, 2008a, b), Waldron (2009) and Matos (2009).

Results

Ten skeletons were identified in the area excavated. Of the seven exhumed, three were adolescent/young adults and four adults, probably males (Table 1). Three (sk 2, 9, and 10) were not excavated, remaining in situ, and the observation of pathological lesions was not possible during the fieldwork. The pathological observation of the exhumed individuals will be presented by anatomical region.

Table 1. Summary of the main findings for the seven individuals exhumed near the Ermida de Santo André

Skeleton no.	Sex	Age at death	Rhinomaxillary changes	Hand changes	Foot changes	Tibia and fíbula (new bone formation)	Other bone changes	Leprosy diagnosis
1	M?	15–20	no skull	unilateral (left)	bilateral	bilateral (both)	no	Possible
3	M?	Adult	present	no lesions	no lesions	bilateral (both)	apical cyst	Possible
4	M	Adult	present	bilateral	bilateral and symmetrical	bilateral (both)	cribra orbitalia (right); porosity external to the trochlear notch lateral margin	Probable
5	M?	Adult	poorly preserved	no bones	no bones	left fíbula (tibiae and right fibula not preserved)	new bone formation at the left supraorbital margin; scattered cranial pitting	No
6	M	20–25	present	no lesions	no bones	no bones	cribra femoralis	Possible
7	F?	Adolescent/ young adult	poorly preserved	poorly preserved	no bones	poorly preserved	cribra femoralis	No
8	M?	Adult	no skull	bilateral	right (unique foot preserved)	bilateral (both)	proliferative changes at linea aspera of right femur	Possible

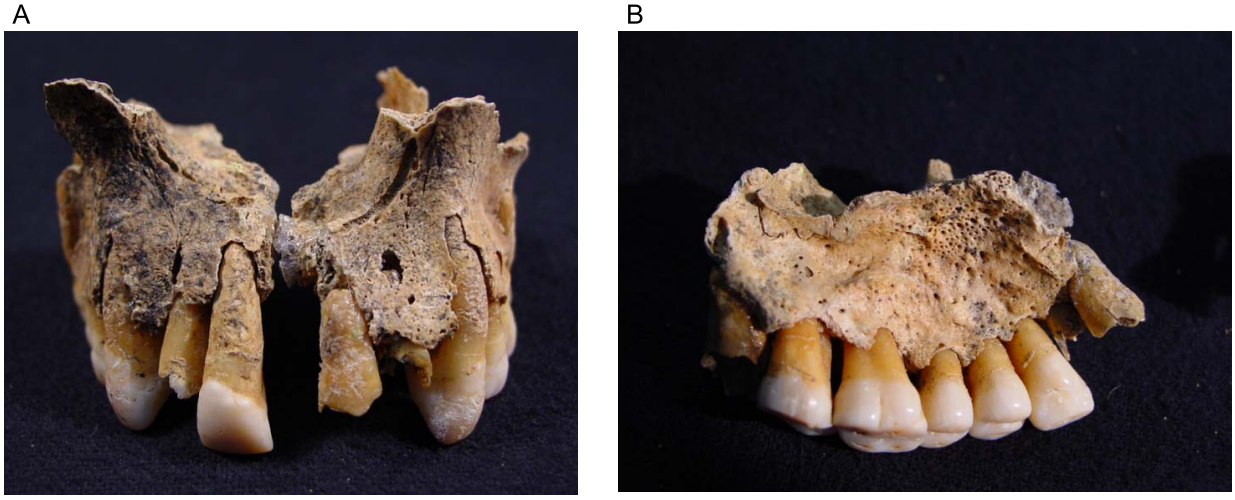

Figure 1. Maxilla of skeleton 4. (A) Anterior view of the piriform aperture presenting destructive pathological remodeling affecting the lower margins. (B) Inferior view of the incomplete left half of the palate showing abnormal pitting on the anterior region.

Rhinomaxillary changes

Rhinomaxillary bone changes were observed in three individuals (sk 3, 4, and 6), i.e. all the skeletons with this area preserved. The most conspicuous lesions were noticed in skeleton 4, showing pathological remodeling of the piriform margins (Figure 1A) and abnormal pitting on both anterior halves of the palate encompassing the incisive canal (Figure 1B). Both the anterior nasal spine and the posterior region of the palatine process were destroyed post mortem and thus not observable. In skeleton 6 only a small area from the right maxilla was preserved, showing new bone formation at the nasal floor, or nasal surface, of the palatine process. Additionally, this fragment shows that both anterior nasal spine and piriform margins were intact, i.e, without pathological changes (Figure 2). Skeleton 3 preserved a small fragment of the middle region of the palatine process, showing "inflammatory" changes, consisting of pitting and new bone formation in both nasal floor (Figure 3) and palate.

Despite the presence of nasal and palatal changes in these three individuals, the six classic signs of the rhinomaxillary syndrome (RMS) were not simultaneously present in the same individual. This could be either due to post-mortem destruction or because RMS changes are not always concomitant (as skeleton 6 demonstrates).

Postcranial changes

Concerning the lower limb bones, bilateral new bone formation on tibiae and fibulae was observed in skeletons 1, 3, 4, and 8 (Table 1). The most common lesions and location are exemplified in Figure 4. In skeleton 5, the two fragments of the left fibula recovered presented periosteal reaction while the right was not recovered. Skeleton 6 did not preserve these bones and skeleton 7 was poorly preserved, precluding the observation of bone surface; however, the neck of the femurs shows porosity also called cribra femoralis.

The most notorious lesions were found on skeleton 8, which presented bilateral and symmetrical extensive new

Figure 2. Superior view of the right maxilla from skeleton 6 where new bone formation and pitting are noticeable on the nasal surface of the palatine process. The sharp edge (arrow) of the inferior margin of the piriform aperture denotes the absence of destructive pathological remodeling.

Figure 3. Superior view of the nasal surface of the palatine process of skeleton 3 presenting evidence of pitting and abnormal proliferative bone along the right side of the median palatine suture.

bone formation on both tibiae and fibulae (Figure 5).

In the hand and foot bones, lesions were found in only three individuals (sk 1, 4, and 8). Interestingly, these changes affected simultaneously the hand and foot bones of the skeletons. Skeleton 4 showed the most striking postcranial lesions, all presenting bilateral distribution. In the hands, concentric diaphyseal destructive remodeling and acro-osteolysis was noticed in six left (Figure 6A) and one right phalange. The second right metacarpal showed evidence of acro-osteolysis and knife-edge diaphyseal remodeling (Figure 6B). As shown in Figure 7, similar pathological phenomena were recorded bilaterally and symmetrically on the second–fifth metatarsals. Additionally, the fifth left metatarsal presented an oval osteolytic lesion located at the

Figure 4. Medial and lateral views (left and right figures, respectively) of the left tibia from skeleton 3 showing mild new bone formation. This type of bone change and its location on the tibia were the most commonly observed.

Figure 5. Right (medial view) and left (lateral view) fibulae from skeleton 8 showing extensive new bone formation.

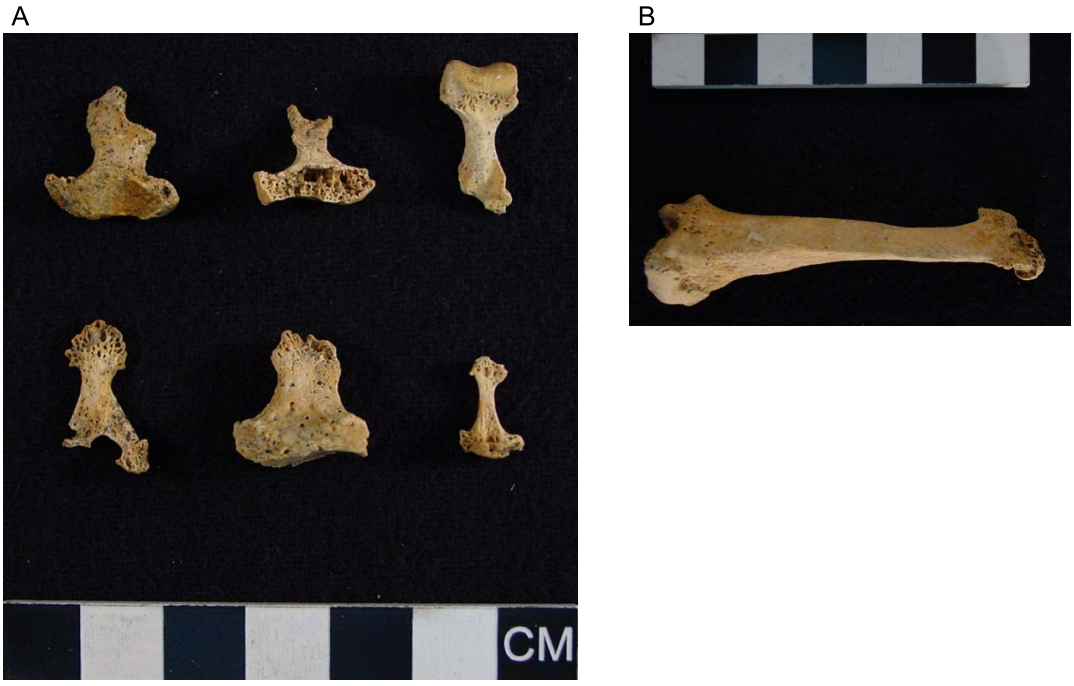

Figure 6. Skeleton 4. (A) Palmar view of the left-hand phalanges presenting concentric diaphyseal destructive remodeling and acro-osteolysis. (B) Dorsal view of the right second metacarpal presenting severe destruction of the distal epiphysis and knife-edge diaphyseal remodeling.

proximal epiphysis probably resulting from secondary infection (Figure 8). Phalanges from both feet (one left and two right) suffered diaphyseal concentric remodeling.

The individual number 8 showed poor preservation of either the upper or lower extremities due to taphonomic constraints. Hand bone lesions were observed bilaterally. Both the fourth left metacarpal and an intermediate right phalange presented acro-osteolysis despite the diaphyseal destructive remodeling being absent. Additionally, a left proximal (?) phalange showed concentric destructive remodeling of the diaphysis and severe degenerative changes on the proximal joint. Concerning the feet it is highlighted that two metatarsals—the fifth right (?) and an unidentified one—presented extensive bone changes and acro-osteolysis. Additionally, the fifth metatarsal showed severe changes of the proximal epiphysis, probably resulting from secondary infection

Figure 7. Medial view of the left and superior view of the right (respectively) metatarsals and foot phalanges of skeleton 4. The second–fifth metatarsals (from right to left in the bottom left figure and the opposite order in the right figure) show bilateral and symmetrical total destruction of the distal ends and knife-edge remodeling of the remaining diaphysis. Concentric diaphyseal destructive remodeling are also visible in the phalanges (one at left and two at right—upper in the figure).

Figure 8. Palmar view of the fifth left metatarsal from skeleton 4 showing an osteolytic focus in the proximal end.

Figure 9. Medial view of the fifth right (?) metatarsal of skeleton 8 displaying acro-osteolysis. Irregular bone surface especially at the proximal epiphysis and possible cloaca resulted from pyogenic osteomyelitis.

(septic arthritis and osteomyelitis), where at least one draining canal (cloaca) is evident (Figure 9).

Skeleton 1 presented unilateral bone changes on the hands since only the left was affected. Ankylosis between an intermediate and distal left phalanx was noticed (Figure 10A). An additional incomplete left phalange presented diaphyseal concentric remodeling. Bilateral foot lesions were observed. Two right metatarsals presented both acro-osteolysis, knife-edge concentric remodeling of the diaphysis, and degenerative changes at the proximal epiphysis (Figure 10B). Acro-osteolysis was further observed in two foot phalanges (one from each side). Additionally, dorsal exostoses were present on the left navicular (Figure 10C).

Discussion

The paleopathological analysis of the skeletons exhumed from the necropolis of the Ermida de Santo André at Beja provides the opportunity to improve our nascent knowledge regarding the presence of leprosy in the Portuguese territory in past times.

The main results obtained from the study of the seven individuals from the St. André church are summarized on Table 1.

Five out of the seven skeletons present lesions for which

Figure 10. Skeleton 1. (A) Dorsal view of ankylosed left hand intermediate and distal phalanges. (B) Dorsal view of two right metatarsals presenting acro-osteolysis, knife-edge diaphyseal remodeling and degenerative changes at the proximal epiphysis. (C) Dorsal view of the left navicular showing dorsal exostosis and porosity.

leprosy could be considered the possible cause. It must be stressed that in the current state of knowledge there are no skeletal lesions that by themselves are pathognomonic, i.e. indicative of the presence of leprosy. In fact, Cook (2002: 82) emphasizes that "'pathognomonic' is rather strong language for a field with many limitations that we must recognize in paleopathology." Differential diagnosis issues are challenging for paleopathologists since many pathological conditions share similar skeletal lesions. This difficulty is obvious in some recent publications (e.g. Phillips and Sivilich, 2006; Brothwell, 2010; Christensen et al., 2013) where leprosy was one of the clinical entities considered when performing differential diagnosis.

The pattern and combination of bony lesions are considered the key and, as Ortner (2008b: 206) notes, "the ability to diagnose leprosy in archaeological human skeletal remains ranges from problematic to highly likely." Møller-Christensen in his pioneering works was aware of the puzzling nature of the paleopathological diagnosis of leprosy as revealed by his writings:

> The degree of certainty of a diagnosis depends of course on the nature of the human remains, and how complete they were. If a cranium displaying facies leprosa was found, it was considered as a possible case of leprosy. If the tibiae and fibulae showed no pathological changes, or had not been preserved, the case was not regarded as being a sufficiently proven one of leprosy. Only when a cranium with facies leprosa was accompanied by tibiae and fibulae showing typical pathological changes, bilaterally and symmetrically, was a more firm diagnosis of the lepromatous type of leprosy made. Fairly certain was only possible when marked changes also occurred in preserved hand and foot bones (Møller-Christensen, 1967: 300).

More recently, the simultaneous presence of rhinomaxillary changes and acro-osteolysis and/or destructive remodeling of the hand and foot bones is considered highly suggestive of leprosy (Ortner, 2008a, b). However, this conservative approach is not always strictly followed and more flexible diagnostic criteria for the diagnosis of leprosy are often applied by researchers. For example, Andersen and Manchester (1992: 122) proposed that "the presence of all components of the rhinomaxillary syndrome is pathognomonic of lepromatous or near-lepromatous leprosy" and Waldron (2009: 101) suggests "operational definitions for leprosy," these comprising "rhinomaxillary syndrome OR concentric loss of bone from phalanges of the feet or neuropathic change in the joints of the feet or ankles." Thus, depending on the criteria adopted for the diagnosis of leprosy

slightly different results, either at individual or population level, may be obtained (Matos, 2009).

Amongst the skeletal material unearthed near the Ermida de Santo André necropolis, only in skeleton 4 can a probable diagnosis of leprosy be established. This individual presents concomitant destructive remodeling in the rhinomaxillary region, metacarpals, metatarsals, and hand and foot phalanges. These lesions were bilateral in both hand and feet, and symmetrical in the feet. It must be stressed that this is the best-preserved skeleton from the sample and, as noted by Pinhasi and Bourbou (2008), the paleopathological diagnosis of leprosy is always conditioned by the skeletal elements available.

The incomplete preservation due to taphonomic constraints of the remaining individuals made the diagnosis of leprosy either impossible, such as in the case of skeletons 5 and 7, or very difficult, namely in skeletons 1, 3, 6, and 8, which are considered possible (but not probable) cases of leprosy since a definitive diagnosis was unattainable. These four individuals can be grouped as follows:

1. Skeletons 1 and 8 do not preserve the skull but present destructive remodeling on hand and foot bones and bilateral new bone formation on tibia and fibula. It is important to emphasize that skeleton 1 exhibited two right metatarsals with a knife-edge diaphysis resulting from the destructive remodeling process (Figure 10). This lesion is considered by Ortner (2008b: 203) as "virtually pathognomonic for leprosy." However, this author recommends that when no evidence of other skeletal disorders exists, conditions such as diabetes, psoriasis, and frostbite cannot be ruled out as its possible cause (Ortner, 2008b). Interestingly, this skeleton also presented two fused left-hand phalanges (Figure 10A), indicating that it may have suffered from claw hand deformity (Andersen and Manchester, 1987; Lee and Manchester, 2008). This condition develops after the peripheral neuropathy often found in leprosy patients (Riordan 1960a, b; Yawalkar, 2002; Ooi and Srinivasan, 2004; Sehgal, 2006; Matos, 2009). The above-mentioned changes presented by skeleton 1 combined with the acro-osteolysis and destructive remodeling of the left foot bones are highly suggestive of the presence of leprosy. However, since cranial bones are absent the more conservative diagnostic approach is preferable and this individual should be considered a possible rather than a probable case of leprosy.

The etiology and pathogenesis of acro-osteolysis and concentric diaphyseal destructive remodeling of the hand and foot tubular bones are not fully understood (Andersen et al., 1992; Jones et al., 2000). These phenomena probably result from the "neurovascular dysfunction consequent upon autonomic neuropathy in leprosy" (Andersen et al., 1992: 214–215). Besides leprosy, other pathological conditions must be considered in the differential diagnosis of these lesions, including neuropathic osteoarthropathy, such as congenital insensitivity to pain (Bar-On et al., 2002), diabetes (Moore et al., 1991; Jones et al., 2000; Rothschild and Rothschild, 2001; Rothschild and Behnam, 2005; Said, 2007; Ortner, 2008a), frostbite (Jones et al., 2000; Golant et al., 2008; Ortner, 2008a), some hereditary syndromes (Ferreira and Domingues, 2012), neurosyphilis (Rothschild and Behnam, 2005), occupational causes (Ferreira and Domingues, 2012), pernicious anemia (Jones et al., 2000; Powell and Cook, 2005), psoriatic arthritis (Rothschild and Behnam, 2005; Mensah et al., 2008; Ortner, 2008a; Ferreira and Domingues, 2012), Raynaud's syndrome (Ferreira and Domingues, 2012), rheumatoid arthritis (Ortner, 2003), scleroderma (Jones et al., 2000; Rothschild and Behnam, 2005; Ferreira and Domingues, 2012), sarcoidosis (Ortner, 2003), syringomyelia (Jones et al., 2000; Powell and Cook, 2005; Roy et al., 2011), systemic sclerosis (Montagna et al., 2002; Astudillo and Arlet-Suau, 2008), and tuberculous arthritis (Ortner, 2003) or dactylitis (Feldmean et al., 1971).

2. Skeletons 3 and 6 present isolated rhinomaxillary lesions without noticeable hand or foot bone changes. Skeleton 3 also presented additional bilateral new bone formation on the lower leg bones, whereas skeleton 6 did not preserve the lower limb bones. These individuals present poor cranial preservation and a clear diagnosis of leprosy cannot be established based on the observed lesions on the fragmentary rhinomaxillary area. Andersen and Manchester (1992) consider that "rhinomaxillary syndrome" is pathognomonic of lepromatous leprosy only when the full spectrum of lesions is present, but this is not the case of either skeleton 3 or 6. Even if this were the case the pathognomonic value of this syndrome is not consensual because this anatomical region may be involved in many other disease processes such as mucocutaneous leishmaniasis (Herwaldt, 1999; Manchester, 1994; Aufderheide and Rodríguez-Martín, 1998; Ortner, 2003; Malekpour and Esfandbod, 2010; Marsteller et al., 2011), neoplasms (Hackett, 1976; Aufderheide and Rodríguez-Martín, 1998; Ortner, 2003; Eggesbø, 2012; Koivunen et al., 2012), rhinoscleroma (Becker et al., 1981; Pontual et al., 2008), rhinosporidiosis (Bonifaz et al., 2011), sarcoidosis (Manchester, 1994; Mrówka-Kata et al., 2010), systemic mycosis (Zargari and Elpern, 2009; Bonifaz et al., 2011), treponematosis (Hackett, 1976; Manchester, 1994; Aufderheide and Rodríguez-Martín, 1998; Cook, 2002; Ortner, 2003; Cook and Powell, 2005, 2012), tuberculosis (lupus vulgaris) (Manchester, 1994; Ortner, 2003, 2008a; Roberts and Buikstra, 2003; Garg et al., 2010), and Wegener's granulomatosis (Chauhan and Cruz, 2007). It must be noted, however, that according to Manchester (1994: 80), in what concerns the interpretation of rhinomaxillary lesions only leprosy, tuberculosis (lupus vulgaris) and treponematosis "are of practical significance in paleopathological differential diagnoses."

Final Comments

In an area of 18.56 m^2 excavated near the Ermida de Santo André and also documented as the location of Beja leprosarium seven skeletons were unearthed, plus at least three individuals in commingled bones. Three more skeletons were identified but remained in the soil. From this assemblage one adult male presents lesions compatible with a probable case of leprosy while in four others (two young adults and two adults, all probably males) the poor bone preservation only allows the recording of possible cases.

Unfortunately neither the excavation nor the attempted radiocarbon dating of one skeleton allowed the determination of an exact chronology of these individuals. Nevertheless,

these findings reinforce the information from documentary sources that place the Beja leprosarium to have been active at least between the 14th and 16th centuries AD, in the area surrounding the Ermida de Santo André. Due to the importance of this site to the history of leprosy in the country, further excavation in this area would be beneficial.

Acknowledgments

Thanks are due to the Biblioteca Municipal de Beja, Santa Casa da Misericórdia de Beja, Florival Baiôa Monteiro, Leonel Borrela, Crivarque, Lda., António Monge Soares and Philip Allsworth-Jones.

Grant sponsorship: FCT doctoral grant with reference SFRH/BD/70158/2010 (N.A.F.) and FCT post-doctoral grant with reference SFRH/ BPD/70466/2010 (V.M.J.M.).

References

Andersen J. (1969) Studies in the mediaeval diagnosis of leprosy in Denmark: an osteological, historical, and clinical study. Danish Medical Bulletin, 16: 1–142.

Andersen J.G. and Manchester K. (1987) Grooving of the proximal phalanx in leprosy: a palaeopathological and radiological study. Journal of Archaeological Science, 14: 77–82.

Andersen J.G. and Manchester K. (1988) Dorsal tarsal exostosis in leprosy: a palaeopathological and radiological study. Journal of Archaeological Science, 15: 51–56.

Andersen J. and Manchester K. (1992) The rhinomaxillary syndrome in leprosy: a clinical, radiological and palaeopathological study. International Journal of Osteoarchaeology, 2: 121–129.

Andersen J., Manchester K., and Ali R. (1992) Diaphyseal remodelling in leprosy: a radiological and paleopathological study. International Journal of Osteoarchaeology, 2: 211–219.

Andersen J., Manchester K., and Roberts C. (1994) Septic bone changes in leprosy: a clinical, radiological and palaeopathological review. International Journal of Osteoarchaeology, 4: 21–30.

Antunes-Ferreira N. and Rodrigues A.F. (2003) Intervenção arqueológica no largo da ermida de Santo André (Beja). Al-Madan, 12: 193.

Arentoft E. (1999) De spedalskes hospital: udgravning af Sankt Jørgensgården I Odense. Udgivet af Odense Bys Museer, Odense.

Astudillo L. and Arlet-Suau E. (2008) Images in clinical medicine: systemic sclerosis and acral osteolysis. New England Journal of Medicine, 358: 2812.

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

Bar-On E., Weigl D., Parvari R., Katz K., Weitz R., and Steinberg T. (2002) Congenital insensitivity to pain: orthopaedic manifestations. Journal of Bone and Joint Surgery. British volume, 84: 252–257.

Becker T.S., Shum T.K., Waller T.S., Meyer P.R., Segall H.D., Gardner F.C., Whitaker C.W., Simpson W.R., Teal J.S., and Hawkins D.R. (1981) Radiological aspects of rhinoscleroma. Radiology, 141: 433–438.

Bennike P. (1991) Epidemiological aspects of paleopathology in Denmark: past, present, and future studies. In: Ortner D. and Aufderheide A. (eds.), Human Paleopathology: Current Syntheses and Future Options. Smithsonian Institution Press, A symposium held at the international Congress of Anthropological and Ethnological Sciences, Zagreb, Yugoslavia, 24–31 July 1988. Washington and London, pp. 140–144.

Bennike P. (2002) Vilhelm Møller-Christensen: his work and legacy. In: Roberts C., Lewis M., and Manchester K. (eds.), The Past and Present of Leprosy. Archaeological, Historical, Palaeopathological and Clinical Approaches. Archaeopress—BAR International Series 1054, Oxford, pp. 135–144.

Boldsen J.L. (2001) Epidemiological approach to the paleopathological diagnosis of leprosy. American Journal of Physical Anthropology, 115: 380–387.

Bonifaz A., Vázquez-González D., and Perusquía-Ortiz A.M. (2011) Endemic systemic mycoses: coccidioidomycosis, histoplasmosis, paracoccidioidomycosis and blastomycosis. JDDG: Journal der Deutschen Dermatologischen Gesellschaft, 9: 705–715.

Borrela L. (1995) Ermida de Santo André. Diário do Alentejo, 691.

Borrela L. (1998) A gafaria de S. Lázaro. Diário do Alentejo, 826: 23.

Borrela L. and Campaniço I. (2004) A Ermida de Santo André e a Gafaria de S. Lázaro. Agenda cultural da Câmara Municipal de Beja, 30: 3–5.

Brothwell D. (2010) On problems of differential diagnosis in palaeopathology, as illustrated by a case from prehistoric Indiana. International Journal of Osteoarchaeology, 20: 621–622.

Bruzek J. (2002) A method for visual determination of sex, using the human hip bone. American Journal of Physical Anthropology, 117: 157–168.

Buikstra J. and Ubelaker D. (1994) Standards for data collection from human skeletal remains. Proceedings of a seminar at the Field Museum of Natural History. Arkansas Archeological Survey Research Series No. 44, Fayetteville, AS.

Cardoso L. (1751) Dicionário geográfico ou noticia historica de todas as cidades, villas, lugares, e aldeas, rios, ribeiras, e serras dos Reynos de Portugal, e Algarve, com todas as cousas raras, que nelles se encontraõ, assim antigas, como modernas. Regia Officina Sylviana e da Academia Real, Lisboa.

Carvalho A.S. (1932) História da lepra em Portugal. Oficinas Gráficas da Sociedade de Papelaria, Porto.

Chauhan S. and Cruz S. (2007) Saddle nose deformity. New England Journal of Medicine, 356: 2720.

Christensen T., Martínez-Lavín M., and Pineda C. (2013) Periostitis and osteolysis in a medieval skeleton from South-West Hungary: (Leprosy, treponematosis, tuberculosis or hypertrophic osteoarthropathy) A diagnostic challenge! International Journal of Osteoarchaeology, 23: 69–82.

Cook D.C. (2002) Rhinomaxillary syndrome in the absence of leprosy: an exercise in differential diagnosis. In: Roberts C., Lewis M., and Manchester K. (eds.), The Past and Present of Leprosy. Archaeological, Historical, Palaeopathological and Clinical Approaches. Archaeopress—BAR International Series 1054, Oxford, pp. 81–88.

Cook D.C. and Powell M.L. (2005) Piecing the puzzle together: North American treponematosis in overview. In: Powell M.L. and Cook D.C. (eds.), The Myth of Syphilis: The Natural History of Treponematosis in North America. University Press of Florida, Gainesville, FL, pp. 442–479.

Cook D.C. and Powell M.L. (2012) Treponematosis: past, present, and future. In: Grauer A.L. (ed.), A Companion to Paleopathology. Wiley-Blackwell, Chichester, pp. 472–491.

Dueñas F.C., Miquel R., and Inclan S. (1973) Historia de la lepra en España. Madrid, Gráficas Hergon.

Eggesbø H.B. (2012) Imaging of sinonasal tumours. Cancer imaging: the official publication of the International Cancer Imaging Society, 12: 136–152.

Espanca T. (1992) Inventário artístico de Portugal: Distrito de Beja. Academia Nacional de Belas-Artes, Lisboa.

Feldmean F., Auerbach R., and Johnston A. (1971) Tuberculous dactylitis in the adult. American Journal of Roentgenology, 112: 460–479.

Ferembach D., Schwidetzky I., and Stloukal M. (1980) Recommendations for age and sex diagnosis of skeletons. Journal of Human Evolution, 9: 517–550.

Ferreira I.R. and Domingues V.S. (2012) Acro-osteolysis. The Lancet, 380: 916.
Ferreira M.T., Neves M.J., and Wasterlain S. (2013) Lagos leprosarium (Portugal): evidences of disease. Journal of Archaeological Science, 40: 2298–2307.
Garg A., Wadhera R., Gulati S.P., and Singh J. (2010) Lupus vulgaris of external nose with septal perforation—a rarity in antibiotic era. Indian Journal of Tuberculosis, 57: 157–159.
Goes M.L.C. (1998) Beja: XX séculos de História de uma cidade. Câmara Municipal de Beja, Beja.
Golant A., Nord R.M., Paksima N., and Posner M.A. (2008) Cold exposure injuries to the extremities. Journal of the American College of Orthopaedic Surgeons, 16: 704–715.
Hackett C.J. (1976) Diagnostic criteria of syphilis, yaws and trepanarid (treponematosis) and some other diseases in dry bone (for use in osteo-archaeology). Springer-Verlag, Berlin.
Herwaldt B.L. (1999) Leishmaniasis. The Lancet, 354: 1191–1199.
Jones E.A., Manaster B.J., May D.A., and Disler D.G. (2000) Neuropathic osteoarthropathy: diagnostic dilemmas and differential diagnosis. Radiographics, 20: 279–293.
Koivunen P., Makitie A.A., Back L., Pukkila M., Laranne J., Kinnunen I., Aitasalo K., and Grenman R. (2012) A national series of 244 sinonasal cancers in Finland in 1990–2004. European Archives of Oto-Rhino-Laryngology, 269: 615–621.
Lee F. and Manchester K. (2008) Leprosy: a review of the evidence in the Chichester sample. In: Magilton J., Lee F., and Boylston A. (eds.), 'Lepers Outside the Gate': Excavations at the Cemetery of the Hospital of St. James and St. Mary Magdalene, Chichester, 1986–1987 and 1993. Council for British Archaeology, Chichester excavations 10. CBA Research Report 158. York, pp. 208–217.
Lewis M., Roberts C., and Manchester K. (1995) Inflammatory bone changes in leprous skeletons from the medieval hospital of St. James and St. Mary Magdalene, Chichester, England. International Journal of Leprosy, 63: 77–85.
Magilton J., Lee F., and Boylston A. (eds.) (2008), 'Lepers Outside the Gate': Excavations at the Cemetery of the Hospital of St. James and St. Mary Magdalene, Chichester, 1986–1987 and 1993. Council for British Archaeology, Chichester excavations 10. CBA Research Report 158, York.
Malekpour M. and Esfandbod M. (2010) Cutaneous leishmaniasis. New England Journal of Medicine, 362: e15.
Manchester K. (1994) Rhinomaxillary lesions in syphilis: differential diagnosis. In: Dutour O., Pálfi G., Bérato J., and Brun J-P. (eds.), L'Origine de la Syphilis en Europe: avant ou aprés 1493? Editions Errance—Centre Archéologique du Var, Paris, pp. 79–80.
Mariotti V., Dutour O., Belcastro M.G., Facchini F., and Brasili, P. (2005) Probable early presence of leprosy in Europe in a Celtic skeleton of the 4th–3rd century BC (Casalecchio di Reno, Bologna, Italy). International Journal of Osteoarchaeology, 15: 311–325.
Marsteller S.J., Torres-Rouff C., and Knudson K.J. (2011) Pre-Columbian Andean sickness ideology and the social experience of leishmaniasis: a contextualized analysis of bioarchaeological and paleopathological data from San Pedro de Atacama, Chile. International Journal of Paleopathology, 1: 24–34.
Matos V. (2009) O diagnóstico retrospectivo da lepra: complementaridade clínica e paleopatológica no arquivo médico do Hospital-Colónia Rovisco Pais (Século XX, Tocha, Portugal) e na colecção de esqueletos da leprosaria medieval de St. Jørgen's (Odense, Dinamarca). Ph.D. thesis, University of Coimbra, Coimbra.
Matos V. and Santos A.L. (2006) On the trail of pulmonary tuberculosis based on rib lesions: results from the Human Identified Skeletal Collection from the Museu Bocage (Lisbon, Portugal). American Journal of Physical Anthropology, 130: 190–200.
Matos V. and Santos A.L. (2013) Leprogenic odontodysplasia: new evidence from the St. Jørgen's medieval leprosarium cemetery (Odense, Denmark). Anthropological Science, 121: 43–47.
Mensah K.A., Schwarz E.M., and Ritchlin C.T. (2008) Altered bone remodeling in psoriatic arthritis. Current Rheumatology Reports, 10: 311–317.
Mestre J.F. (1991) Beja olhares sobre a cidade. Edição da Câmara Municipal de Beja, Beja.
Mira F. (1947) História da medicina portuguesa. Lisboa: Imprensa Nacional de Publicidade.
Møller-Christensen V. (1952) Case of leprosy from the Middle ages of Denmark. Acta Medica Scandinavica, 142: 101–108.
Møller-Christensen V. (1953a) Location and excavation of the first Danish leper Graveyard from the Middle Ages—St. Jørgen's Farm, Naestved. Bulletin of the History of Medicine, 27: 112–123.
Møller-Christensen V. (1953b) Ten lepers from Næstved in Denmark: a study of skeletons from a Medieval Danish leper hospital. Danish Science Press, Medical Monographs, no. 2. Copenhagen.
Møller-Christensen V. (1961) Bone Changes in Leprosy. Munksgaard, Copenhagen.
Møller-Christensen V. (1967) Evidence of leprosy in earlier peoples. In: Brothwell D.R. and Sandison A.T. (eds.), Diseases in Antiquity: A Survey of Diseases, Injuries and Surgery of Early Population. Charles C. Thomas, Springfield, IL, pp. 295–306.
Montagna G.L., Baruffo A., Tirri R., Buono G., and Valentini G. (2002) Foot involvement in systemic sclerosis: a longitudinal study of 100 patients. Seminars in Arthritis and Rheumatism, 31: 248–255.
Moore T.E., Yuh W.T.C., Kathol M.H., EI-Khoury G.Y., and Corson J.D. (1991) Abnormalities of the foot in patients with diabetes mellitus: findings on MR imaging. American Journal of Roentgenology, 157: 813–816.
Mrówka-Kata K., Kata D., Lange D., Namysłowski G., Czecior E., and Banert K. (2010) Sarcoidosis and its otolaryngological implications. European Archives of Oto-Rhino-Laryngology, 267: 1507–1514.
Ooi W.W. and Srinivasan J. (2004) Leprosy and the peripheral nervous system: basic and clinical aspects. Muscle & Nerve, 30: 393–409.
Ortner D. (2003) Identification of pathological conditions in human skeletal remains. Academic Press, New York.
Ortner D.J. (2008a) Differential diagnosis of skeletal lesions in infectious diseases. In: Pinhasi R. and Mays S. (eds.), Advances in Human Palaeopathology. John Wiley, Chichester, pp. 57–76.
Ortner D.J. (2008b) Skeletal manifestations of leprosy. In: Magilton J., Lee F., and Boylston A. (eds.), 'Lepers Outside the Gate': Excavations at the Cemetery of the Hospital of St. James and St. Mary Magdalene, Chichester, 1986–1987 and 1993. Council for British Archaeology, Chichester excavations 10. CBA Research Report 158. York, pp. 198–207.
Phillips S.M. and Sivilich M. (2006) Cleft palate: a case study of disability and survival in prehistoric North America. International Journal of Osteoarchaeology, 16: 528–535.
Pinhasi R. and Bourbou C. (2008) How representative are human skeletal assemblages for population analysis? In: Pinhasi R. and Mays S. (eds.), Advances in Human Palaeopathology. John Wiley, Chichester, pp. 31–44.
Pontual L.d., Ovetchkine P., Rodriguez D., Grant A., Puel A., Bustamante J., Plancoulaine S., Yona L., Lienhart P.-Y., Dehesdin D., Huerre M., Tournebize R., Sansonetti P., Abel L., and Casanova J.L. (2008) Rhinoscleroma: a French national retrospective study of epidemiological and clinical features. Clinical Infectious Diseases, 47: 1396–1402.
Powell M.L. and Cook D.C. (2005) Treponematosis: inquiries into

the nature of a protean disease. In: Powell M.L. and Cook D.C. (eds.), The Myth of Syphilis: The Natural History of Treponematosis in North America. University Press of Florida, Gainesville, FL, pp. 9–62.

Riordan D.C. (1960a) The hand in leprosy: a seven-year clinical study. Part I. General aspects of leprosy. Journal of Bone and Joint Surgery. American volume, 42-A: 661–682.

Riordan D.C. (1960b) The hand in leprosy: a seven-year clinical study. Part II. Orthopaedics aspects of leprosy. Journal of Bone and Joint Surgery. American volume, 42-A: 683–690.

Roberts C. and Manchester K. (2005) The Archaeology of Disease. Sutton Publishing. London.

Roberts C.A. and Buikstra J.E. (2003) The Bioarchaeology of Tuberculosis: A Global View on a Reemerging Disease. University Press of Florida, Gainesville, FL.

Roffey S. and Tucker K. (2012) A contextual study of the medieval hospital and cemetery of St. Mary Magdalen, Winchester, England. International Journal of Paleopathology, 2: 170–180.

Rothschild B.M. and Behnam S. (2005) The often overlooked digital tuft: clues to diagnosis and pathophysiology of neuropathic disease and spondyloarthropathy. Annals of the Rheumatic Diseases, 64: 286–290.

Rothschild B.M. and Rothschild C. (2001) Skeletal manifestations of leprosy: analysis of 137 patients from different clinical settings in the Pre- and Postmodern treatment eras. Journal of Clinical Rheumatology, 7: 228–237.

Roy A.K., Slimack N.P., and Ganju A. (2011) Idiopathic syringomyelia: retrospective case series, comprehensive review, and update on management. Neurosurgical Focus, 31: e15.

Said G. (2007) Diabetic neuropathy: a review. Nature Clinical Practice Neurology, 3: 331–340.

Sehgal A. (2006) Leprosy. Chelsea House Publishers, Philadelphia.

Viana A. (1943) Beja. Edição da Câmara Municipal de Beja, Beja.

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

Weston D.A. (2008) Investigating the specificity of periosteal reactions in pathology museum specimens. American Journal of Physical Anthropology, 137: 48–59.

Yawalkar S. (2002) Leprosy for medical practitioners and paramedical workers. Novartis Foundation for Sustainable Development, Basle, Switzerland.

Zargari O. and Elpern D.J. (2009) Granulomatous diseases of the nose. International Journal of Dermatology, 48: 1275–1282.