Brief communication

Pediatric chronic osteomyelitis in the outskirts of Al-Ushbuna (Carnide, Lisboa, Portugal)

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ABSTRACT

The skeletal remains of seven individuals (five non-adults and two adults) were recovered during an archeological intervention in the township of Carnide (Lisbon, Portugal). Funerary archaeology strongly suggests that the sample is from the Medieval Islamic period (8th – 12th centuries AD). This report presents a case of chronic osteomyelitis in a non-adult individual. The diagnostic is substantiated by the presence of pathognomonic signs of osteomyelitis, including the presence of cloacae and a sequestrum in the left tibia. The bone infection is discussed in the context of inadequate socioeconomic conditions. This case from a relatively unfamiliar chronology and cultural context supplements the uncommon paleopathological descriptions of osteomyelitis in non-adults from historical populations.

1. Introduction

The history of osteomyelitis is ancient. The oldest evidence of an osteomyelitic infection was identified in the vertebral column of a Permian reptile (Moodie, 1923). Osteomyelitis of the scapula was recognized in the Shanidar 1 Neanderthal (Trinkaus and Zimmerman, 1982) and an association between bone infection and fracture was already suggested in the Hippocratic corpus. Notwithstanding, hematogenous osteomyelitis was described much later, in 1773, by W. Bromfield (Klenerman, 2007). Osteomyelitis was a major health problem before antibiotics, with mortality rates up to 30% (Gilmour, 1962). After the introduction of penicillin mortality dropped to less than 1% (Dormans and Drummond, 1994).

Osteomyelitis is an inflammatory process of bone and bone marrow, usually caused by an infectious microorganism (Lew and Waldvogel, 2004; Macnicol and Watts, 2005), The major causative agent is Staphylococcus aureus, but other pathogens may be implicated, including Streptococcus spp., Haemophilus influenza type B, Kingella kingae, Salmonella spp., Pseudomonas aeruginosa, fungi (e.g., Aspergillus spp., Blastomyces dermatitidis), and multicellular parasites (Dormans and Drummond, 1994; Lew and Waldvogel, 2004; Stone et al., 2016). Osteomyelitic infections can be restricted to a single area of the bone or affect several regions, e.g., the marrow, cortex, periosteum and soft tissues (Lew and Waldvogel, 2004; Macnicol and Watts, 2005).

The modern clinical classification of osteomyelitis is usually done by patient age (neonatal, childhood, adult), etiological agent, route of infection (exogenous or hematogenous) or clinical progress (Dormans and Drummond, 1994). Exogenous osteomyelitis results from local spread of a contiguous infected source (e.g., cellulitis), and trauma, including bone surgery/prosthetic replacement. It can also be secondary to vascular insufficiency, especially in patients with diabetes (Lew and Waldvogel, 2004). Hematogenous osteomyelitis is characterized by bacterial seeding from the endosteal blood supply; it is common in prepubertal children and older individuals (Harik and Smeltzer, 2010; Lew and Waldvogel, 2004). Clinical presentation can be acute, subacute or chronic (Macnicol and Watts, 2005). Acute osteomyelitis progresses for days or weeks, and typically occurs in the metaphysis of long bones, in most cases as a single focus in the femur or tibia (Dormans and Drummond, 1994). Chronic osteomyelitis is defined — rather subjectively — when it develops for months or even years, being typified by low intensity inflammation, and the presence of necrotic bone and fistulae (Dormans and Drummond, 1994; Harik and Smeltzer, 2010).

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In the past, osteomyelitis was highly prevalent in children (e.g., Amberg and Ghormley, 1934; Homans, 1912; Nichols, 1904; Wade, 1929; Wakeley, 1932). Curiously, the diagnosis of osteomyelitis in archaeological contexts is relatively uncommon, particularly pediatric osteomyelitis, with few cases reported in the paleopathological literature (Ortner, 2003; Flensborg et al., 2013; Lewis, 2007; Santos and Suby, 2015; Table 1). Accordingly, the purpose of this paper is to present a case of pediatric chronic osteomyelitis in the tibia from an individual recovered in a Medieval Islamic site in the environs of Al-Ush-buna (Portugal).

2. Case study

2.1. Archeological background

During an archeological monitoring at a construction site in the township of Carnide (Lisbon, Portugal), the skeletal remains of seven

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<thead>
<tr>
<th>Table 1</th>
<th>Pediatric osteomyelitis in the paleopathological literature.</th>
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<tbody>
<tr>
<td>Source</td>
<td>Archeological site</td>
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<tr>
<td>Lax et al. (1982)</td>
<td>Dor, Israel</td>
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<tr>
<td>Canci et al. (1991)</td>
<td>Toppo Daguzzo, Italy</td>
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<tr>
<td>Sheth et al. (1994)</td>
<td>Mexico</td>
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<td>Sheth et al. (1994)</td>
<td>Alaska, USA</td>
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<td>Ubelaker and Pap (1998)</td>
<td>Tapiósele, Hungary</td>
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<td>Baxarias (1999)</td>
<td>Prat de la Riba, Tarragona, Spain</td>
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<td>Ortner (2003)</td>
<td>La Oroya, Peru</td>
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<td>Ortner (2003)</td>
<td>Montgomery County, MD, USA</td>
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<td>Rohmbogner and Lewis (2016)</td>
<td>Trentholme Drive, York, UK</td>
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<th>Table 2</th>
<th>Paleodemographic, funerary and paleopathological data (Palacio de Sant’Ana).</th>
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<tr>
<td>Individual</td>
<td>Age class</td>
</tr>
<tr>
<td>#1</td>
<td>Non-adult</td>
</tr>
<tr>
<td>#2</td>
<td>Non-adult</td>
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<tr>
<td>#3</td>
<td>Non-adult</td>
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<tr>
<td>#4</td>
<td>Non-adult</td>
</tr>
<tr>
<td>#5</td>
<td>Non-adult</td>
</tr>
<tr>
<td>#6</td>
<td>20–29 years</td>
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<tr>
<td>#7</td>
<td>Adult</td>
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LEH: Linear enamel hypoplasia.

Fig. 1. Left and right tibias of individual #1; diaphyseal expansion in the left tibia, with cloacae in the distal region.
the necropols of an al-garya (rural villages around bigger cities) from the Medieval Islamic period (8th – 12th centuries AD) in the outskirts of Lisbon. Lisbon was conquered in 714 CE by the troops of Abde-laziz ibn Musa, and then renamed Al-Usbhana. In 1147 CE, Christian crusaders commanded by Afonso I seized the city and its environs, including Carnide (Santos, 2015). Burial mode and typology is in accordance with Islamic funerary ritual, as archeologically documented in the Al-Andalus (Iberian Peninsula); absence of votive artifacts, shallow and unmarked graves with a SW – NW orientation, which assured a perpendicular alignment with the Qibla (i.e., Mecca), and bodies placed in right lateral decubitus with the face towards Mecca. The focus of this case study is a non-adult that presented osteomyelitis in the left tibia.

Individual #1

Individual #1, an almost complete and well-preserved skeleton, died between 9.0–11.0 years (Maresh, 1970) and 11.0–13.5 years (AlQahtani et al., 2010). The right tibia of this individual displayed an active lesion of periosteal new bone formation, located in the mid-diaphyseal posterior region. In the left tibia, it was observed an anomalous thickening of the distal diaphysis and metaphysis, with the involucrum surrounding an area of devascularized dead bone (sequestrum), and periosteal new bone formation. Diaphyseal expansion attains maximum perimeter in the distal region at 12.9 mm. Maximum circumference at mid-diaphysis is 9.4 mm (as opposed to 7.0 mm in the same area of the right tibia). Three cloacae were identified (Figs. 1–3) in the distal metaphyseal-diaphyseal area. Two of the cloacae, in medial location, perforated the diaphysis. The largest (15.7 × 12.3 mm) exhibited a well remodeled, regular, border. The sequestrum – necrotic bone of irregular morphology – is easily discernible inside the cloaca (Fig. 4).

The smaller cloaca (4.4 × 3.5 mm) is located above the larger (distance of 6.5 mm). Both orifices are part of a single canal that contains the sequestrum. Macroscopical analysis of the skeleton and plain radiographies of both tibiae showed no evidence of trauma. All the recovered individuals were recovered, including five non-adults (Table 2). Age at death of the non-adults was estimated through skeletal and dental development (AlQahtani et al., 2010; Maresh, 1970). They were buried in
mandibular teeth presented at least one linear enamel hypoplasia (LEH). No other pathologies were observed in this individual. Other individuals in the sample presented non-specific indicators of stress, including cribra orbitalia and porotic hyperostosis (see Table 2).

3. Discussion

The presence of cloaca and sequestra with periosteal new bone formation are pathognomonic of chronic osteomyelitis (Ortner, 2003; Santos and Suby, 2015; Sheth et al., 1994). The cloaca is an opening in a involucrum that enables drainage of purulent and necrotic matter from the dead bone (Macnicol and Watts, 2005). The case described represents, according to the Penny (2004) anatomical classification, a “typical” type I osteomyelitis, with a well-defined sequestrum and involucrum. The tibia and femur are the skeletal elements more often involved (Dormans and Drummond, 1994; Lew and Waldvogel, 2004) and, in the majority of cases, the lesion is solitary although it can be multifocal, especially in neonates (Yeo and Ramachandran, 2014). In the few paleopathological cases of pediatric chronic osteomyelitis, the involvement of different bones seems to be the rule, with a slight preponderance of the tibia (see Table 1). A study of pediatric acute hematogenous osteomyelitis in the Coimbra Identified Skeletal Collection (and the Coimbra University Hospital records) suggests that the lower limb bones were the most affected in pre-antibiotic populations (Santos and Suby, 2015; see also Amberg and Ghormley, 1934; Homans, 1912; Nichols, 1904).

There are no signs of trauma in the studied juvenile, but an exogenous origin of osteomyelitis cannot be definitely discarded. A diagnosis of hematogenous osteomyelitis is more plausible. Pediatric hematogenous osteomyelitis commonly involves the long bones of the leg, with a single focus, and presents a bimodal distribution, usually affecting infants with less than two years and preadolescents between eight and twelve years (Stone et al., 2016; Yeo and Ramachandran, 2014). It is more common in individuals with compromised immunity, chronic disease, concomitant infectious diseases (parasites, Mycobacteria), anemia, malnutrition and substandard sanitary conditions (Macnicol and Watts, 2005; Spiegel and Penny, 2005). The profile of the studied individual is consistent with these demographic and socioeconomic characteristics. The child was buried in the funerary ground of a small al-gorya — Carnde — in the outskirts of Al-Ushuna. The periphery of Lisbon was characterized by an agrarian subsistence model (Santos, 2015). Bioarchaeological data pertaining this small sample point to faulty socioeconomic conditions — most of the studied non-adult individuals experienced physiological systemic stress. Also, the observed differences between dental and skeletal development suggest a lower than average environmental quality (Cardoso, 2007).

The complications associated with non-adult chronic osteomyelitis include the suppression of the growth plate with skeletal deformity, pathological fractures, avascular necrosis, cachexia, septicemia, and death (Macnicol and Watts, 2005; Tudisco et al., 1991). It was not possible to ascertain the cause of death of the studied preadolescent; notwithstanding, the diagnosis of osteomyelitis, as the presence of LEH, discrepancy in skeletal and dental maturation, and age at death, are suggestive of overall frailty. In other paleopathological examples (e.g., Baxarias, 1999; Cenci et al., 1991) the association of osteomyelitis with other skeletal markers of stress is interpreted in a global context of sanitary and nutritional deficits. Medical knowledge in the Medieval Islamic world was prolific (Lawrence, 2009) but in this case there are no signs of therapeutic intervention of any type (see, e.g., Binder et al., 2016; Mitchell, 1999; Toyne, 2015).

Osteomyelitis in the past was very common, especially in prepubescent children. Notwithstanding, most paleopathological cases were observed in adults, with only a few cases affecting non-adults. Frequently, pediatric osteomyelitis does not produce pathognomonic lesions; as such, the identification of osteomyelitis in past populations, especially in non-adults, is intricate (Ortner, 2003; Santos and Suby, 2015). This case from a Medieval Islamic site in the Al-Andalus, a relatively unfamiliar chronology, geography and cultural context, complements the limited case histories of osteomyelitis in non-adults from past populations.

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References