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Research Article

Tuberculosis in the non-adults from Romano-British Poundbury Camp, Dorset, England

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ABSTRACT

The prevalence of tuberculosis and pulmonary disease in 165 non-adults (under 17 years) from Romano-British Poundbury Camp (1st–3rd centuries AD) is examined. Previous studies have reported eleven individuals with tuberculosis in England during the Roman period, but none are of children. Ten (6.1%) non-adults between the ages of 3 and 15 years were identified that presented lesions suggestive of a pulmonary infection, with seven (4.2%) likely to have been suffering from tuberculosis. Pathological changes included spinal lytic lesions, active new bone on the visceral aspects of the ribs, widespread periostitis on the long bones, dactylitis, and osteomyelitis of the mandible and scapula. The nature of skeletal tuberculosis in children and various differential diagnoses are discussed. The results from this study increase our knowledge of tuberculosis in the UK, and suggest that the disease was much more prevalent in Romano-British society than has been previously reported.

1. Introduction

Tuberculosis (TB) is a chronic infectious disease caused by *Mycobacterium tuberculosis*. It can affect the lungs (pulmonary TB), lymph nodes (tuberculous adenitis), skin (scrofula), intestines (gastrointestinal TB) and in fewer cases, the bones and joints (Resnick and Kransdorf, 2005). Our knowledge of tuberculosis in past populations from Britain is limited, with around 136 skeletons identified in the published literature with varying degrees of certainty (Brickley et al., 2006; Gray Jones and Walker, 2007; Lee and Boylston, 2008; Mays, 2007; Miles et al., 2008; Roberts and Buikstra, 2003: 134–6; Waldron, 2007). The earliest example is from the Iron Age (9th BC–1st AD) (Mays and Taylor, 2003), and eleven date to the Romano-British period (Roberts and Buikstra, 2003: 134–6). All of these cases are from England. To date, no definitive cases of child tuberculosis have been reported in Roman Britain. The paucity of TB in non-adult skeletons in general has been attributed to poor skeletal preservation, segregated burial, or death before skeletal changes can manifest (Roberts and Buikstra, 2003: 50). This paper describes lesions indicative of tuberculosis in the non-adults (children defined as skeletons under 17 years of age) from the Romano-British cemetery of Poundbury Camp in Dorset. The site has one of the largest samples of Romano-British non-adults, and represents children who lived and died in a small civitas capital between the 3rd and 4th centuries AD. In order to understand the nature of the lesions and to eliminate other possible diagnoses, it is important to understand how skeletal tuberculosis manifests and differs in adults and children.

1.1. Childhood tuberculosis

There are three types of tuberculosis in humans; primary, secondary and miliary TB. Primary TB from a site of initial inoculation is the most common form in children (Leung et al., 1992), with secondary TB, resulting from a reactivation of a latent infection, usually occurring in adults and adolescents (Maraise et al., 2004). Miliary TB results from the extension of primary caseating lesions into pulmonary vessels leading to the haematogenous or lymphatic spread of infection to the lungs and distant sites. This widespread dissemination of the infection is a frequent complication in children (Shingadia and Novelli, 2003). Today nearly 30 million people suffer from tuberculosis, and between 1 and 3% develop skeletal lesions (Rankin and Tuli, 2010). A survey carried out between 1983 and 1993 in South Africa and the US showed that 46% of the new cases of TB were in children aged 0–15 years, with most (36.5%) aged between 0 and 5 years. The vast majority of these cases (98% in South Africa and 82.5% in the US) were pulmonary TB (van Rie et al., 1999). Miliary TB and meningitis can occur 1–3 months after exposure to the bacillus, with spinal and joint changes evident after 1–3 years in those under 5 years of age (Wallgren, 1948). Haematogenous spread to the gastrointestinal tract is uncommon especially in children, as it requires a greater period of time for lesions to manifest, and is often difficult to diagnose (Boukthir et al., 2004; Shingadia and Novelli, 2003). When it occurs it is usually the result

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Table 1
Likely cases of child tuberculosis reported in UK sites (England).

Period	Location	Age (years)	Area affected	Reference
Early medieval	Ailcy Hill, Ripon, North Yorkshire	14–15	Pott's disease	Langston (1996)
Early medieval	Oxford mass grave, Oxfordshire	Adolescent	Lytic lesion thoracic vertebrae, visceral rib lesions, widespread periostitis, dactylitis of metatarsals and metacarpals	Falys (pers. comm.)
Early medieval	Raunds Furnells, Northamptonshire	10.5–14.5	New bone on lumbar and sacral vertebrae, lytic lesion on ilium	Lewis (2002)
Later medieval	Abingdon Abbey, Oxfordshire	12–14	Pott's disease (T4–L2)	Ortner and Bush (1993)
Later medieval	Blackfriars Friary, Suffolk	11	Lytic lesions of the spine	Mays (1991)
Later medieval	Fishergate House, York, North Yorkshire	12–14	Pott's disease, visceral rib lesions	Holst (2003)
Later medieval	St James and Mary Magdalene, Chichester, Sussex	12–15	Pott's disease, lytic rib lesions	Lewis (2008)
Later medieval	Jewbury, York, North Yorkshire	15–20	Pott's disease, widespread postcranial new bone	Brothwell and Browne (1994)
Later medieval	Jewbury, York, North Yorkshire	15–20	Pott's disease	Brothwell and Browne (1994)
Later medieval	St Peter and Paul, Taunton, Somerset	4–5	Lytic spinal lesions, visceral rib lesions	Dawson (2008)
Post-medieval	Christ Church Spitalfields, London	0.6–2.5	Pott's disease, endocranial lesions	Molleson and Cox (1993) Lewis (2002)
Post-medieval	Christ Church Spitalfields, London	0.6–2.5	Pott's disease, lytic lesions on distal femur and proximal tibia (knee)	Lewis (2002)
Post-medieval	St Martin's Church, Birmingham, West Midlands	'Adolescent'	Pott's disease	Brickley et al. (2006)
Post-medieval	St Martin's Church, Birmingham, West Midlands	'Child'	Pott's disease, lytic lesions and new bone formation on innominates, scapula, ribs and skull	Brickley et al. (2006)
Total		14		

of a primary infection with *Mycobacterium bovis* (in cattle) from eating infected meat and milk (Sheldon, 1943; Spiro, 1995). *M. bovis* is considered responsible for 20% of bone and joint changes in children (Griffith, 1951). Secondary spread to the stomach may occur due to swallowing of infected sputum from pulmonary tuberculosis (Sharma and Bhatia, 2004). Congenital TB is considered rare, with transmission from the mother to the child occurring via the placenta, or due to the fetus ingesting bacteria through infected amniotic fluid (Hakim and Grossman, 1995; Lorin, 1983).

Skeletal lesions of TB are characterised by minimal bone formation and bone necrosis with marked osteoporosis in the affected limb. Tuberculous granulomata (localised masses of granulation tissue) destroy the joint cartilage and underlying bone, causing necrosis and pus formation, with the end result being fibrous or bony fusion (Shapiro, 2001). In children, the most common manifestations of skeletal TB are spondylitis (spinal lesions), joint involvement and osteomyelitis (Teo and Peh, 2004). It should be noted that much of what we know about the prevalence of TB in children is based on post-1950s data where the natural progression of the disease is hindered by chemotherapy. The expression of the disease in skeletons from the pre-antibiotic era is likely to have been more severe. Marais and colleagues (2004) provide valuable insight into such a group of children (under 15 years) during the 1920s and 1950s. They noted that primary infection with tuberculosis in children less than 2 years typically resulted in miliary TB within 12 months, with joint involvement in those between 1 and 3 years of age. Primary infection between the ages of 2 and 10 years rarely resulted in miliary TB. After 10 years, primary infection led to more adult-type involvement of the spine.

In adults, lytic lesions resulting in collapse of the thoracic and lumbar vertebrae or kyphosis (Pott's disease), and new bone formation on the visceral surface of the ribs are the most commonly reported lesions associated with pulmonary TB in bioarchaeology (Kelley and Micozzi, 1984; Pfeiffer, 1991; Roberts et al., 1998; Santos and Roberts, 2001). In the spine, haematogenous spread leads to lesions on the anterior portion of the vertebrae, where there is greater vascularisation (Antunes, 1992; Smith et al., 1989). In children and young adults, when the disc vascular supply is at its greatest, the infection may start in the disc and extend to the vertebral body (Buikstra, 1976). As segmentary arteries often branch to the adjacent vertebra, spread from one to another is not uncommon, and involvement of the posterior arch may result (Antunes, 1992). Today, 50% of all skeletal TB infections are estimated to involve the spine (Moon, 1997), and in developing countries, spinal TB has been reported in 16% of children under 4 years and 48% under 15 years of age (Antunes, 1992). Involvement of the cervical spine is less common than for the rest of the spine (Moon, 1997; Rajeshwari and Sharma, 1994), but may be present with the absence of any other vertebral involvement (Mathur and Bais, 1997). Children are more susceptible to instability of the spine with vertebral displacement and risk of cord compression that may result in limb paralysis (Moon, 1997).

The diaphyses may become involved through a primary focus of infection in the nutrient canals or through the infected metaphysis (Caffey, 1978). When this occurs, cortical thickening under the inflamed periosteum usually of the femur or tibia, is considered a common radiographic sign of the disease (Hayes, 1961). In children, widespread haemopoietic marrow and vascularisation at the growth plates means that tuberculous lesions of the skeleton are more varied and involvement of the hip, knee, and ankle (especially the calcaneus) is common (Walls and Shingadia, 2004). The haematogenous spread to the joint results in an initial infection in the synovial fluid extending into the epiphysis and metaphysis (Hayes, 1961; Teklali et al., 2003). As skeletons are not routinely radiographed in archaeological samples these early lesions may be easily missed (Lewis, 2007). Tuberculosis of the hip joint is the second most common skeletal manifestation, after tuberculous spondylitis. It is generally agreed to have its onset in childhood, with one study from the 1930s suggesting a peak in children aged 4–6 years (Sorrel and Sorrel-Dejerine, 1932; Ortner, 2003). The ilium may be involved directly through a primary infection of the gastrointestinal tract, or a spread of infection from the spine. In the latter, the infection may perforate the anterior longitudinal ligaments in the spine and spread into the paravertebral muscles, such as the psoas muscle (forming a psoas abscess). From there, infection spreads along the muscle plane to the ilium and the greater trochanter of the femur (Ortner, 2003).

In children, involvement of the short bones of the hand and foot is also possible and is referred to as 'tuberculous dactylitis' or 'spina ventosa', ventosa meaning 'puffed full of air' (Feldman et al.,