



Possible case of pressure resorption associated with osteoarthritis in human skeletal remains from ancient China



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ABSTRACT

Osteoarthritis, one of the most common pathological conditions observed in human skeletal remains, is traditionally thought to only affect the structures within the joint capsule. We examined the osteoarthritic distal femora of an individual from Ancient North China, ca. 475–221 BCE. The standard signs of osteoarthritis, marginal lipping and extensive eburnation, were observed in the patellofemoral compartment of the knee joint. In addition however were bilateral pressure-caused fossae on the extra-articular anterior surfaces of the distal femora 10 mm proximal to the large osteophytes at the apex of the patellar surfaces. Anatomy and possible pathogenesis of knee arthritis are explored in order to come to a tentative aetiology of the extra-articular lesions. These lesions are suggested to be a new criterion for identifying severe knee arthritis. The osteological phenomenon is then placed into archaeological context of the Warring States period of ancient China.

1. Introduction

Here we present an osteobiography of a unique individual with severe knee osteoarthritis (OA). This uniqueness stems from the presence of a new phenomenon never before reported in the archaeological/palaeopathological literature: that of extra-articular areas of bone resorption on the anterior distal femur. These are suggested to be new indicators of severe joint disease.

Joint disease, and specifically osteoarthritis, is the most common pathology observed in human skeletal remains from past populations second only to evidence of poor oral health (Waldron, 1995; Wiess and Jurmain, 2007). In modern populations OA is an important public health issue and contributor to chronic disability (Muraki et al., 2011), and must also have been so in the past before the advent of modern medicine.

Changes to the articular surfaces and joint margins are well researched in both the clinical (Anbarasu and Loughran, 2000; Burr and Gallant, 2012; Chu and Andriacchi, 2015; Gomoll et al., 2006; Feldson et al., 2005; Hardcastle et al., 2015; Neogi, 2012; Rogers and Dieppe, 1993; Vincent et al., 2012; Yochum and Rowe, 2014) and palaeopathological literature (Zhang et al., 2017; Eng, 2016; Inoue, et al., 2001; Plomp et al., 2015; Waldron, 1995; Wiess and Jurmain, 2007).

However, although extra-articular sequellae of arthritis have been identified clinically (Monsees and Murphy, 1985; Rose and Cockshutt, 1982; Yochum and Rowe, 2014) to our knowledge these changes have not been described in the palaeopathology literature. Through construction of an osteobiography this paper examines this new phenomenon: bilateral extra-articular osseous morphology of the anterior distal femur in an individual with advanced knee OA from North East China (ca. 475–221 BCE).

2. Materials and methods

The individual in this case study (M364) is one of 289 burials excavated from a rich assemblage of human skeletal remains at Tuchengzi (112°E, 41°N), Inner Mongolia, China (Fig. 1) dating to the Warring States period ca. 475–221 BCE. The site on the Hetao Plain is approximately 40 km south of the modern Inner Mongolian capital Hohhot with the Yinshan Mountains to the north and the Yellow River to the south. Tuchengzi, occupied between the Warring States period (beginning in 475 BCE) and the Liao Dynasty (ending in 1125 CE), was initially established as a semi-agricultural semi-military settlement during Zhao State colonial expansion into modern day Inner Mongolia (Gu, 2010; Woodworth and Du, 2011). Associated burial goods (pottery and

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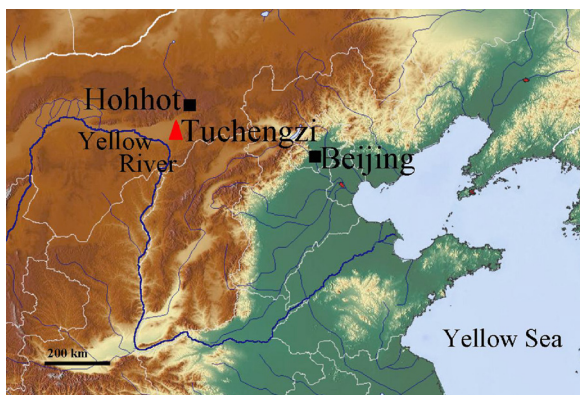


Fig. 1. Location of Tuchengzi on the Hetao Plain of Inner Mongolia, China, relative to the Yellow River, Hohhot, and Beijing.

bronze objects) display stylistic affinities with the Jin and Qin cultures to the south, as well as to northern nomadic groups, highlighting the unique ecological and cultural landscape within which Tuchengzi is located (Gu, 2010).

Tuchengzi was excavated through ten field seasons between 1997 and 2005. Although more than 2000 burials were identified, only 289 adult burials were excavated. Of those excavated 64 skeletons from the Warring States period were available for study.

The human remains were examined macroscopically for evidence of oral disease, non-specific indicators of stress and anomalies of the articular surfaces (Hardy, 2015). Age and sex were estimated following methods articulated in the Standards Book (Buikstra and Ubelaker, 1994). Previous analysis (Hardy, 2015) indicates that individual M364 is an older adult male with poor overall oral health, exhibiting 5 alveolar abscesses, 2 caries and 2 teeth lost antemortem, consistent with other older adults in the sample. His stature is estimated at $163.95\text{cm} \pm 3.80$ (Trotter, 1970) or $160.55\text{cm} \pm 5$ (Shao, 1985), approximately 2.51 cm–4.28 cm shorter than the estimated average stature at Tuchengzi ($166.46\text{cm} \pm 3.80$ (Trotter, 1970) or $164.83\text{cm} \pm 5$ (Shao, 1985; Hardy, 2015)).

Although a small number of individuals from the Warring States period displaying skeletal pathology were identified, individual M364 is unique in displaying extreme joint disease on all joints available for analysis. The skeletal elements of M364 (Fig. 2) were examined macroscopically and photographed using digital SLRs: a Nikon D40 and a Canon Eos Rebel T2i (by the first two authors, respectively). Lesion location was recorded within the skeleton and within each skeletal element. Lesions were characterized by surface morphology as exhibiting bone addition, bone resorption or both, healed or unhealed. Identification of OA followed the criteria set out in Waldron (2009)¹.

3. Results

All articular facets of M364 available for examination exhibited articular changes of osteoarthritis. Because of the extent of the articular and extra-articular morphology detailed examination of the knee is described here. The articular facets of M364 revealed extensive changes to the joints with new bone formation (Fig. 3) and marginal lipping (Fig. 4). Regions of eburnation on both patellar surfaces are grooved, and particularly deep on the right femur (Fig. 5). Of greatest importance to this paper are the bilateral bony defects in the cortical surface of each femur 10 mm proximal to the proximal-most extent of

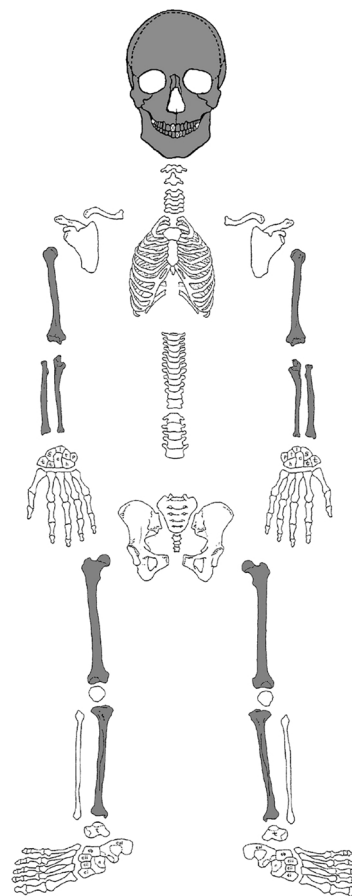


Fig. 2. Skeletal elements of M364 available for examination.



Fig. 3. Posterior view of left distal femoral condyles showing new bone formation (arrow). Scale bar = 10 mm.

the knee joint capsule (Fig. 5). The defects are roughly circular, 10 mm in diameter, and 3 mm deep. Each depression is smooth surfaced and aligns with grooves of eburnation on the articular surface and an area of joint margin without lipping (Fig. 5). Unfortunately the patellae were not available for analysis.

4. Discussion

The most notable feature in the skeletal remains of individual M364 is extensive bilateral severe arthritis of the knee. The contours of the knee joint articular surfaces of the distal femora have been modified through both bone formation as small nodules on the articular surfaces

¹ In skeletal remains arthritis is recognized if any of the two following are present: changes in joint surface contour, size, and shape, subchondral cyst development, marginal osteophyte formation, eburnation. Osteoarthritis is also diagnosed if eburnation alone is present (Waldron, 2009).

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