International Journal of Paleopathology xxx (xxxx) xxx–xxx

Contents lists available at ScienceDirect

International Journal of Paleopathology

journal homepage: www.elsevier.com/locate/ijpp

Research article

Extensive periosteal new bone formation in a skeleton from post-Medieval Chichester, England: A probable case of metastatic prostatic carcinoma

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ARTICLE INFO

Keywords:
Differential diagnosis
Post-Medieval England
Neoplasm
Prostate cancer

ABSTRACT

An elderly male skeleton from a site in Chichester, UK, was found with a widespread periosteal reaction, principally affecting the axial skeleton and the pelvis. Radiography showed the presence of sclerosing infiltrates, mainly involving the lumbar vertebrae and pelvis. The differential diagnosis is discussed, reaching the conclusion that hypertrophic osteo-arthopathy (HOA) is the only reasonable alternative condition likely to produce such a widespread periosteal reaction as found here. HOA does not produce secondary deposits in the skeleton, however, and we conclude that his is most likely a case of prostatic carcinoma.

1. Introduction

According to the World Health Organisation (WHO), cancer ranks globally as one of the primary causes of mortality and morbidity, with numbers of new cases expected to rise by as much as 70% over the next two decades (WHO, 2015). This reflects the popular notion that cancer, considering all the various types, is common. It is now well-known that cancer is a disease of great antiquity, with evidence stretching back as far as 1.5 million years (Capasso, 2005). Cancer of the prostate, in particular, is a common condition accounting (in the UK) for approximately 45,000 cases annually, while in the United States it is estimated that there are more than 1.2 million new cases per year (Hage et al., 2000). Its occurrence is strongly positively correlated with age, the incidence being greatest in men aged 75–79 (ca 900 cases/10^5)(Cancer Research UK, 2017). There has been a considerable increase in the number of cases in the last fifty years or so, largely due to the increasing age of the population. The disease is not new, and there is no evidence that the age-specific incidence would be any different to today, although the absolute number of cases would have been much smaller due to a generally lower expectation of life.

The disease shows a great propensity to spread to bone (Soloway et al., 1988), especially the pelvis and lower vertebrae, and generally forms sclerotic lesions within bone although lytic lesions are not unknown (Bubendorf et al., 2000). The lesions are most often confined to the interior of the bone and do not cause any alteration in shape, making diagnosis of this disease difficult in human remains. Cases with sclerosing metastases have been reported in the skeleton (Schultz et al., 2007; Tkocz and Bierring, 1984; Wakely et al., 1995), in cremated remains (Grévin et al., 1997), and in a mummy (Prates et al., 2011). There is a much rarer form of the disease which is characterised by the production of widespread, often spiculated, periosteal new bone (Bloom et al., 1987; Reigman and Stokkel, 2004; Vilar et al., 1979) and it is this type that is most easily recognised in the skeleton (Anderson et al., 1992; Ortner et al., 1991; Waldron, 1997), simply because the lesions are so obvious on direct examination. The periosteal lesions can be reproduced in mice following the injection of prostate cancer cells directly into bone, but their pathogenesis is presently not clear (Henry et al., 2005; McCabe et al., 2008).

Of all the possible neoplastic diseases that can impact the skeleton (breast cancer, lung cancer, plasmacytoma, multiple myeloma, etc.), prostate cancer is one of the most commonly observed in archaeology, with over 15 cases reported throughout the literature (Anderson et al., 1992; Baraybar and Shimada, 1993; de la Rua et al., 1995; Grévin et al., 1997; Klaus, 2017; Lieverse et al., 2014; Luna et al., 2015; Mays et al., 1996; Merczi et al., 2014; Molnár et al., 2009; Prates et al., 2011; Scholtt et al., 2007; Schultz et al., 2007; Tkocz and Bierring, 1984; Wakely et al., 1995; Waldron, 1997; see Ghabili et al., 2016 for a review of the current palaeopathological literature on prostate cancer). We present here a case of a skeleton with wide spread periosteal new bone (or PNB), together with radiological evidence of sclerotic secondary deposits, which we suggest represents a case of prostatic cancer dating to the 18th/19th centuries.

2. Material and methods

2.1. The skeleton

The skeleton under investigation here (designated SK.2788) was

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http://dx.doi.org/10.1016/j.ijpp.2017.07.004
Received 1 February 2017; Received in revised form 10 July 2017; Accepted 19 July 2017

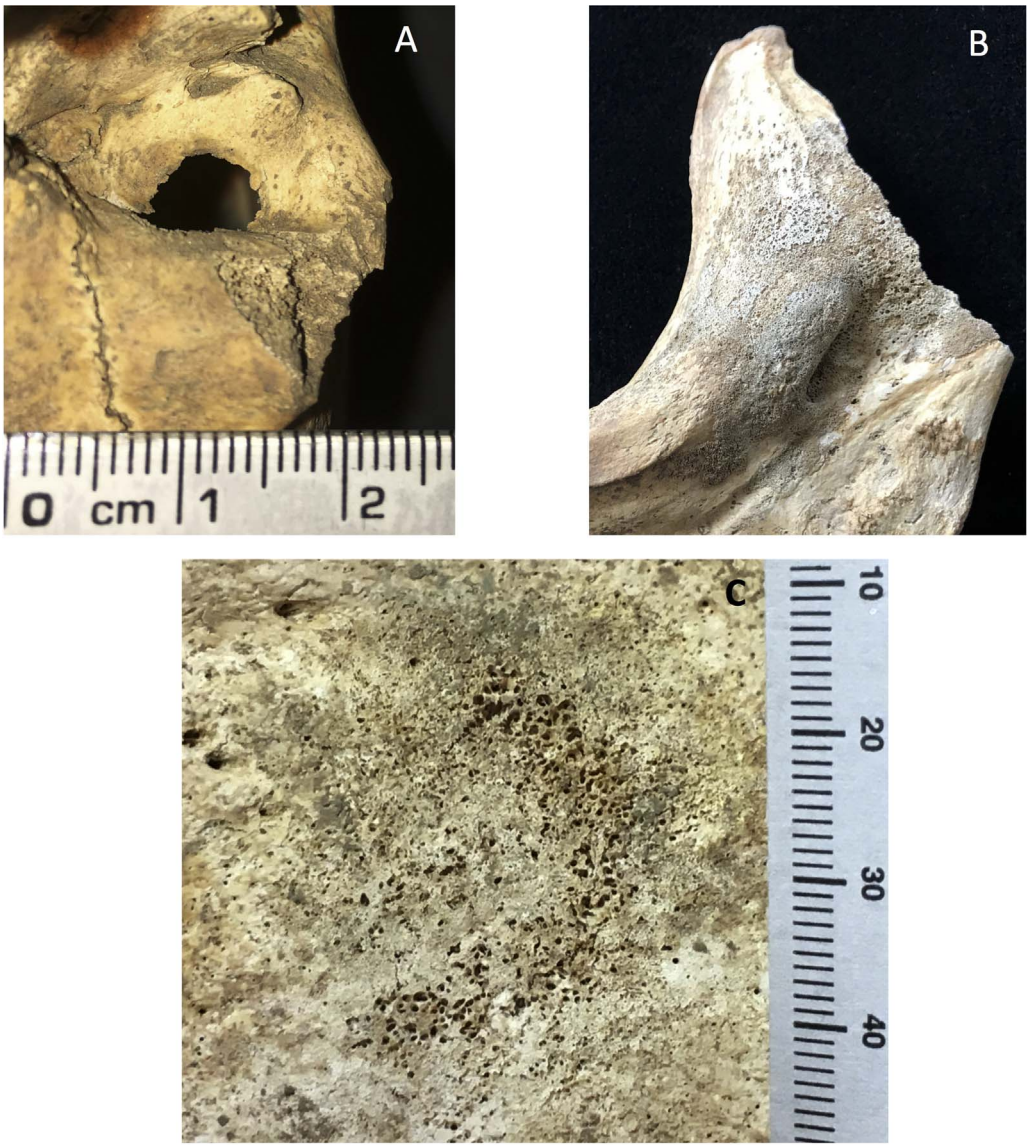

Fig. 1. Blastic and lytic lesions observed in the skull. A) Penetrative defect through the left temporal bone (within the mandibular fossa); B) Plaques of periosteal new bone along the internal surface of the right mandible, with an observed expansion and alteration of the internal trabecular bone; C) Lytic, non-penetrative lesion along the internal surface of the vault, on the frontal bone.

uncovered as part of an archaeological rescue excavation of the disused cemetery St Michaels Litten in Chichester, England. Interred in a coffin, SK.2788 dates to the latter part of the cemetery's occupation (the 18th and 19th centuries).

A biological profile of the remains was performed by the authors using standard anthroposcopic and metric methods (Buikstra and Ubelaker, 1994). Due to the somewhat fragmentary nature of the remains (especially in the pelvic region) and the extensive amount of post-mortem taphonomic modification, sex estimation was based primarily on the metric assessment of the femoral head (Bass, 1995), and age assessment was based on the marked degree of tooth wear (Brothwell, 1981) and the small portion of the auricular surface present (Lovejoy et al., 1985). Considering these factors, it was concluded that the skeleton was likely male and of an advanced age [over 50 years]. Furthermore, the individual was robust, with marked muscle attachments across all bones; this high level of bone forming across the skeleton may account for the very pronounced degree of pathological changes observed (refer to Section 3).

2.2. Methods

The primary evaluative framework for understanding the nature of the observed pathological changes was comprehensive macroscopic analysis of the entire skeleton coupled with radiographic imaging of specific skeletal elements known to be of diagnostic value in cases of possible neoplastic disease. Following descriptive analysis, a thorough differential diagnosis was undertaken, from which a presumptive diagnosis was made. No further exploratory methods were attempted, such as CT or basic histology (see De Boer et al., 2013), as there would be no grounds for comparison with the known clinical features. However, new approaches, such as proteomics (Schlott et al., 2007; current review on the state of molecular palaeopathology see Nerlich, 2017) are proving extremely promising and will likely expand our knowledge of cancer in the past, with more and better diagnoses.

3. Results

3.1. Description of the skeleton and the bony lesions

3.1.1. Preservation and general appearance

The skeleton is largely complete, although fragmentary in places. Only a few of the vertebrae have survived, the pelvis is highly fragmented and fragile, and the ribs are in poor condition. Those elements that are present are in good condition, with sound external cortical bone, where not affected by disease. The cranium and mandible are in fair condition, with some fragmentation and post-mortem damage. All