International Journal of Paleopathology 24 (2019) 66–78

Contents lists available at ScienceDirect

International Journal of Paleopathology

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

Co-morbidity with hypertrophic osteoarthropathy: A possible Iron Age Sarmatian case from the Volga steppe of Russia

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ARTICLE INFO

Keywords:
Hypertrophic osteoarthropathy
Hypophosphatemic rickets
Tumor induced osteomalacia
Co-morbidity
Paraneoplastic syndromes
Sarmatian

ABSTRACT

Purpose: Hypertrophic osteoarthropathy (HOA) is a condition that can be inherited or acquired. It causes diffuse periosteal new bone formation on the long bones, with a predilection for the appendicular skeleton. When acquired, it is a nonspecific indicator of systemic disease that arises following a primary condition. This paper reviews the palaeopathological literature associated with this rare condition. It also describes the first possible case of co-morbidity associated with hypertrophic osteoarthropathy in an adult skeleton (cal. BC 170 – 1 cal. AD) from the mobile pastoralist Sarmatian culture of the Volga steppes of Russia.
Methods: Macroscopic and radiological examination provide differential diagnoses of the lesions, while clinical and bioarchaeological analyses offer insights into the possible experience of disease and social implications of care among the nomadic populations of Iron Age Russia.
Results: The analysis of Sk. 6524.102 displays lesions that may be due to both hypertrophic osteoarthropathy and osteomalacia. The man was physically impaired and his participation in physically challenging activities would have been limited.
Conclusions: The study stresses that co-morbidity is a key parameter when interpreting disease in past populations, particularly when the diagnosis involves hypertrophic osteoarthropathy.
Significance: This is the first case of hypertrophic osteoarthropathy identified in Eurasian prehistoric populations. The research emphasises the significance of co-morbidity in the past.
Limitations: The diagnosis of co-morbid diseases in human remains is extremely complex and the conditions were identified as most probable by a process of elimination.
Suggestions for further research: Further studies should be dedicated to understanding co-morbidity in the past.

1. Introduction

Hypertrophic osteoarthropathy (HOA) is a relatively rare condition that produces high bone mass and can arise as a paraneoplastic syndrome (Rutherford et al., 2007; Waimann et al., 2011). Paraneoplastic syndromes involve symptoms that manifest systemically in association with various tumours but are not directly related to the physical effects of tumours, rather deriving from hormonal or cytokine secretions from the tumour cells (Delellis and Xia, 2003). In addition to neoplasms, hypertrophic osteoarthropathy has clinically been associated with a range of diseases, including tuberculosis (Horacio et al., 2015), congenital heart disease (Ferreira and Camoes, 2013), myelofibrosis (Kelle et al., 2017), inflammatory bowel disease (Rhee et al., 2014), bronchiectasis and other pulmonary conditions (Nahar et al., 2007). Hypertrophic osteoarthropathy has been sporadically recorded in skeletal remains from across the world, but very few cases of co-morbidity have

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https://doi.org/10.1016/j.ijpp.2018.09.007
Received 26 March 2018; Received in revised form 20 September 2018; Accepted 21 September 2018

Table 1
Summary of the cases of human hypertrophic osteoarthropathy published in the palaeopathological and osteoarchaeological literature in chronological order.

Hypertrophic osteoarthropathy (HOA)

Date	Chrono-culture, site	Age (yrs)	Sex	Lesions of the axial skeleton	Lesions of the appendicular skeleton	Interpretation	Author(s)
7300-6210 BC*	Pre-Pottery Neolithic C period, Atlit-Yam, Israel	1	n/d	Endocranial lesions	Extensive shell of PNBF** in a long bone	HOA associated with tuberculosis (aDNA)	Hershkovitz et al., 2008
		~ 25	F	n/d	Slight PNBF in the distal diaphysis of the preserved tibia	Tuberculosis (aDNA) with possible HOA	
4780 - 4715 BC	Late Neolithic, Hódmezővásárhely - Gorzsa, Humgary	19-20	M	Cribra orbitalia, cribra cranii, slight PNBF in the mandible, active PNBF in the ribs, lytic lesions on a rib and vertebrae	Widespread and symmetrical diffuse active PNBF in the upper and lower limbs and the foot bones, lytic lesions in phalanges	Pulmonary HOA associated with tuberculosis (aDNA)	Masson et al., 2013
~ 950 BC*	Antiquity, Island of El Hierro,the Canary Archipelago	Adult	M?	n/d	Rough proliferative PNBF in the ulnae, radius, and tibiae, with preservation of the trabecular structure	HOA	González-Reimers et al., 2015
2nd–3rd c.	Meroitic cemetery of Berber, Sudan	25-35	M	Dental enamel hypoplasia, caries, periapical lesions. Lamellar and woven bone in five ribs	Extensive and symmetrical PNBF (mostly lamellar) in the scapulae, distal halves of the humeri, radii, ulnae, hip bones, femora, tibiae, fibulae, metacarpals and metatarsals. Osteoarthritis	Secondary HOA	Binder and Saad, 2017
2000 BC – AD 100	Formative period, Ticoman, Mexico	Young adult	M	No change	Digital clubbing. PNBF in the radii, ulnae, femora, tibiae, fibulae and metatarsal bones	HOA	Martinez-Lavin et al., 1994
AD 300 - 900	Classic Maya, Jaina Island, Mexico	Young adult	F	No change	Thickening of the tibiae and fibulae with a 'tree bark' appearance. PNBF was milder on the femora, radii and ulnae		
AD 500 - 700	Merovingian, Les Rues des Vignes, France	Young adult	n/d	n/d	Active PNBF in the long bones and iliac bones	HOA	Blondiaux et al., 1992
6th - early 8th c.	Merovingian, Lauchheim, Germany	35–50	M	Ankylosis of lumbar vertebrae	Healed and active PNBF in the long bones, the clavicles, scapulae and pelvis.	Secondary HOA	Flohr et al., 2018
~ AD 1000	Huari culture, El Ingenio, Peru	32	F	n/d	Extensive multi-layered PNBF in a femur	Primary HOA	Allison et al., 1976
9-13th c.	Medieval, Zalavár, Hungary	22-32	M	Dental enamel hypoplasia, unusual severe periodontal disease	PNBF and osteolysis of the left coxal bone. Widespread bilateral and symmetrical PNBF in the tibiae and fibulae, the calcanei and the metatarsals	Treponematosis, leprosy, TB, or HOA as a secondary syndrome	Christensen et al., 2013
10th-16th c.	Medieval, Wharram Percy, England	30-40	M	PNBF in the ribs	Symmetrical woven and remodelled bone in the scapulae, distal halves of the humeri, left ribs, radii, ulnae, metacarpals, femora, tibiae, fibulae, calcanei, metatarsals. Dense PNBF at the entheses	Pulmonary HOA associated with tuberculosis (aDNA)	Mays and Taylor, 2002
		> 50	M	PNBF in the ribs	Symmetrical woven and remodelled bone in the distal radii, ilia bones, femora, tibiae, left fibula. Dense PNBF at the entheses	Pulmonary HOA possibly secondary to non-tuberculous respiratory infection (aDNA)	
Medieval	Czarna Wielka, Poland	40-50	M	Dental abscesses	PNBF in the ulnae, tibiae, fibulae and metacarpals	Secondary HOA	Gladykowska-Rzeczycka and Prejzner, 2015
AD 1904 -1936	Coimbra Skeletal Identified Collection, Portugal	26 individuals (7–87)	M and F	No change	Bilateral and unilateral localised/ diffuse PNBF especially in the radii, ulnae, tibiae and fibulae and less frequently the scapulae and foot bones	HOA associated with tuberculosis, pulmonary non-TB and extra pulmonary non-TB	Assis et al., 2011
AD 1961	IPAZ 6649, autopsy 1259	58	F	n/d	Symmetrical and dense PNBF affected the tibiae, fibulae, radii, ulnae and metatarsals	Pulmonary HOA	Ortner, 2003
AD 1970	Cemitério dos Remédios, Portugal	73	M	Active PNBF in the ribs	Irregular and dense PNBF in the left femur, tibia, fibula and foot. Fusion of the left fibula- tibia. Dense PNBF at the entheses. Right lower limbs less affected	HOA	Anselmo et al., 2016

* Date was converted to BC.
** PNBF: Periosteal new bone formation.