FEMORAL BOWING DEFORMITY: POSSIBLE AETIOLOGIES IN A 14TH-19TH CENTURY SKELETON FROM CONSTÂNCIA (PORTUGAL)

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Introduction

Bowing or deformity of the long bones corresponds to an abnormal deviation from its longitudinal axis. This alteration may assume the form of a gentle arc, or of a more conspicuous angulation. Bone bowing is a dynamic phenomenon overlapped by distinct factors, such as, the intrinsic properties of bone, the biomechanical stresses exerted and its remodelling capacity[1].

Morphologically, long bones show a mild degree of bowing - physiological bowing, that usually resolves itself during normal growth and development[1,2,3]. Pathological bowing may appear as an accentuation of the normal long bone curvature, as a localized curvature, or a distinct angulation[1]. Several congenital, traumatic or metabolic conditions can be pointed out as possible aetiologies[3].

The necropolis

Constância is a small village in the centre of Portugal, and located between two important Portuguese rivers, the Tejo and the Zêzere

- Archaeological excavation: ancient necropolis of Constância
- Total sample: 151 skeletons (105 adults and 46 subadults)
- Chronology: 14th-19th centuries[4,5]

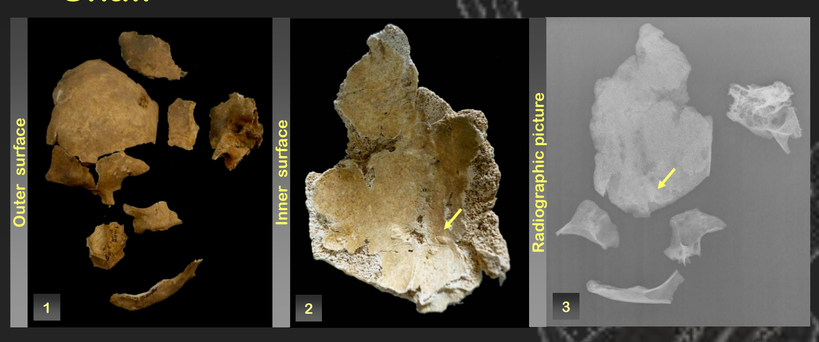
Sk.31: biological and funerary profile

Old Female (>50 years old)[6]
Post mortem damage of the axial skeleton and pelvis

- Shallow grave without evidence of coffin use
- Extended supine with flexed arms and straight legs
- Aligned on a West-East axis

Paleopathological description

Skull

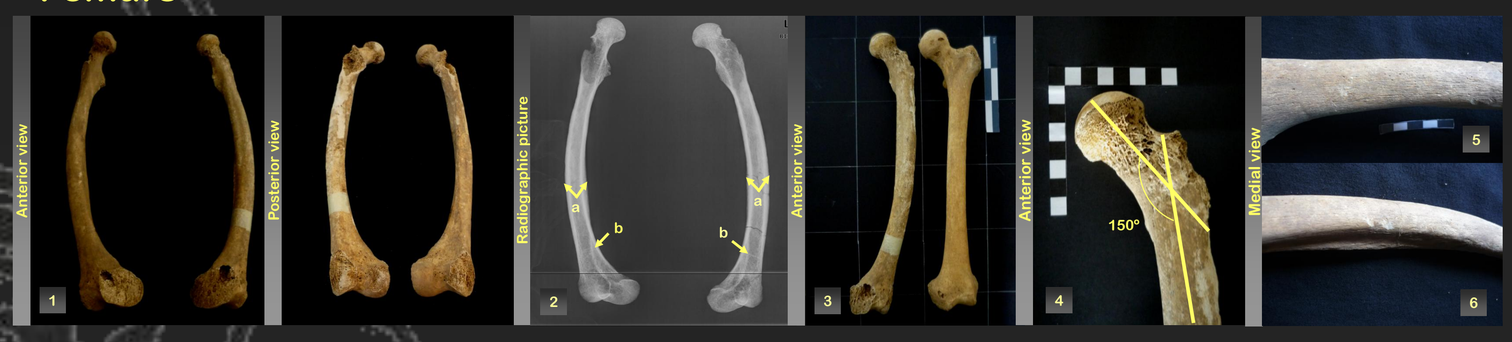


1. Highly fragmented

2. Presence of small nodes in the inner portion of the frontal bone –*hyperostosis frontalis interna* (HFI)[7,8,9]

3.Increased radiopacity in the affected area

Femurs



1. Bilateral femoral bowing: anterolateral curvature

2. a. Cortical thickness in the femoral shaft, more pronounced in the convex face; b. Bilateral Harris lines[8]

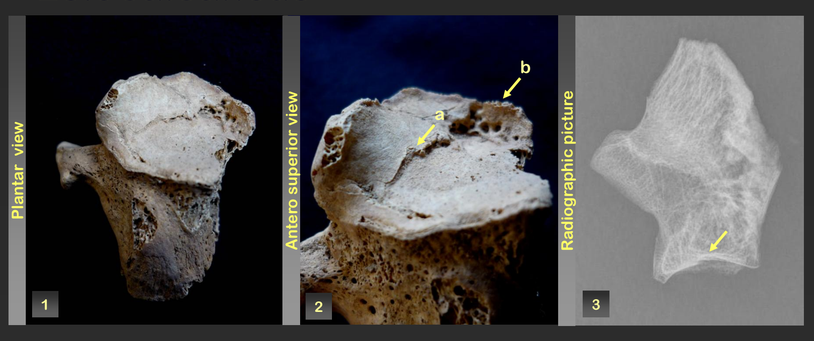
3. Morphological differences between an affected (on the left) and a normal (on the right) femur from a Constância's female skeleton. Increased curvature of the lower third of the affected diaphysis. Normal morphometric values (table 1)

4. Pronounced femoral neck angle: presence of *coxa valga*[10]

5. Periosteal reaction in the lower third of the right femur

6. Hypertrophy at the site of attachment of the linea aspera muscles

Left calcaneus



1. Undisplaced intra-articular calcaneal fracture at the calcaneocuboid joint

2. a: Antero superior compression with healing evidences;
b: Degenerative joint lesions

3. Fracture line. Increased radiopacity

Table 1. Comparative morphometric analysis with Constância's female standards (femur)11

Femur measurements (cm)	Bowed left femur	Constância's female mean values (n=10)
Maximum length	416	418.6
Physiological length	415	414.2
Transverse diameter (middle of the diaphysis)	25	25.56
Sagital diameter (middle of the diaphysis)	27,5	27.68

Discussion

A range of pathological conditions might have cause Sk31 femoral bowing (table 2). Paget's disease and osteoporosis seems unlikely, since none of the most distinctly features are present[7,8,12]. Neurofibromatosis and fibrous dyspalsia are improbable due to its massive bone destruction[8,12]. The absence of long bones fractures and/or limb shortening, rules out a case of osteogenesis imperfecta and bilateral trauma[7]. PBD occurs in children and most commonly affects the forearm. The adult form is rare and the fibula is the most affected bone[2]. Nevertheless, this hypothesis must be considered in the present diagnosis. With the exception of the femoral bowing, all other bony changes due to active rickets are absent. In prolonged rickets, biomechanical forces can produce limb deformities that persist into adulthood - residual rickets[3].

Hypertrophy of the *linea* aspera can be associated with this extensive muscle involvement. The presence of Harris lines may also indicate some degree of physiological stress during growth[8]. However, it is almost impossible to establish a direct relationship between rickets and Harris lines. Even so, *coxa valga*[10], in its acquired form, can be attributed to rickets or osteomalacia. Looser's zones are considered "pathognomonic" of osteomalacia[15]. Due to post mortem damage, none of the specific locations (e.g. scapula body, pubic ramus) were recovered. Forced dorsiflexion is pointed as the main cause of the undisplaced calcaneal fracture. Since only long bone bending deformities are present it is difficult to differentiate between residual rickets and osteomalacia[3]. Consequently, we must consider this two conditions as possible aetiologies.

Table 2. Differential diagnosis for Sk. 31 femoral deformity[2,3,7,8,10,12,13,15].

Metabolic conditions							
Paget's disease	Sk.31	Rickets (R) and Residual rickets (RR)	Sk.31	Osteomalacia	Sk.31	Osteoporosis	Sk.31
Osteoporosis circumscripta (early stages)	No	Craniotabes – thinning of skull bones (R)	No	Buckling of scapular body and pubic ramus	---	Cortical bone thinning	No
"V-shaped" radiolucency	No	Frontal bossing (R)	No	Vertebral body compression: "Codfish vertebra"	No	Cancellous bone rarefaction	No
Cranial vault thickness (later stages)	No	Bending of distal ribs (R)	---	Scoliosis and kyphosis	---	Biconcave or wedged vertebra	No
"Picture-frame" in vertebral body	No	Flaring of the long bones metaphyses (R)	No	Diffuse osteopenia	No	Femoral neck fracture	No
Thickening and lamination of long bone cortex	No	Dorsal curvature of the spine (R)	---	Looser-Milkman zones of radiolucency	No	Long bones bowing	Yes
Long bones bowing	Yes	Long bones bowing (R, RR)	Yes	Long bones bowing (severe cases)	Yes		
Congenital conditions				Traumatic conditions		Miscellaneous conditions	
Neurofibromatosis	Sk.31	Osteogenesis imperfecta	Sk.31	Fracture (F) / Plastic bone deformity (PBD)	Sk.31	Fibrous Dysplasia	Sk.31
Kyphoscoliosis	---	Kyphoscoliosis	---	Bilateral femoral fracture – neck or shaft (F)	No	Long bones bowing/ asymmetry	Yes/No
Lower limbs bowing	Yes	Long bones shortening	No	Long bones bowing (PBD)	Yes	Cortical thinning	No
Long bones asymmetry	No	Long bones bowing	Yes	Posterior Curvature (PBD)	No	Shepherd's crook deformity	No
"Cyst-like" areas	No	Multiple fractures – exuberant callus	No	Cortical thickness/ periosteal deposition (PBD)	Yes	X-ray - "cystic" appearance"	No

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