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Corresponding Author: Dr. Valentina Giuffra, PhD

Corresponding Author's Institution: University of Pisa

First Author: Valentina Giuffra, PhD

Order of Authors: Valentina Giuffra, PhD; Angelica Vitiello; Sara Giusiani; Davide Caramella, MD; Gino Fornaciari, MD

Abstract: Archaeological excavations carried out at the castle of Monte di Croce near Florence brought to light a small cemetery complex belonging to the castle church, dated back to the 11th-12th centuries. A privileged stone tomb contained the skeletal remains of a male aged 35-45 years with an evident pathology of the right tibia. The bone appears massively enlarged in correspondence of the proximal metaphysis and of the upper half of the diaphysis as a result of a severe chronic periostitis. At transversal section complete obliteration of the medullary cavity by new spongy bone, with some large cavitations, is evident. The residual completely remodeled primitive tibial shaft is still recognizable. This finding and the strong sclerotic reaction with some central cavitations allowed us to rule out any form of bone tumor and to suggest a chronic inflammatory disease. The morphological and radiological picture and the tibial localization suggest a diagnosis of chronic sclerosing osteomyelitis of Garré, a rare form of chronic osteomyelitis characterized by small or by no suppuration, and by an intense periosteal reaction.

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Dear Editor,

we revised the manuscript, according to the referees' comments.

Here in bold type a detailed list of the changes and the rebuttal against each point. In the manuscript the changes are highlighted in yellow.

I have reviewed your manuscript, which I now attach as a WORD document. Ihave made numerous minor editorial changes, primarily copy-editing. I have afew questions inserted in the text.

Reply: we accepted all editorial changes and we answered all questions inserted in the text.

What this fine paper lacks, however, is an introduction. If you will pleasego to the advice for authors on the IJPP web site, you will see that CaseStudies need to be justified in terms of the special nature of the disease, therigor of the differential diagnosis, or other circumstances. Therefore, yourneed to discuss more specifically how "rare" the condition is in the literatureon paleopathology. If reference to these cases (or if none exist, that shouldbe noted as a rationale for the Case Study), is your differential diagnosismore extensive and convincing (which I suspect is the case). Also, how doesthis (or does it) condition enlighten us about the community in which this individual lived?

Reply:a new introduction was written.

Best regards

Valentina Giuffra

Division of Paleopathology, Department of Translational Research on New Technologies in Medicine and Surgery

University of Pisa

Via Roma 57 - 56126 Pisa - Italy

Tel. 050.992894; Fax 050.992706

A possiblecase of Garre'ssclerosing osteomyelitis from Medieval Tuscany (11th-12th centuries)

Giuffra Valentina[1,2*], Vitiello Angelica[1], Giusiani Sara[1], Caramella Davide[3], Fornaciari Gino[1,2]

[1] Division of Paleopathology, Department of Translational Research on New Technologies in Medicine and Surgery, University of Pisa, Via Roma 57, Pisa, Italy. E-mail: v.giuffra@med.unipi.it, angelicavit@tiscali.it, sara.giusiani@gmail.com, gino.fornaciari@med.unipi.it

[2]Center for Anthropological, Paleopathological and Historical Studies of the Sardinian and Mediterranean Populations, Department of Biomedical Sciences, University of Sassari, Viale San Pietro 43/B, Sassari

[3]Division of Diagnostic and Interventional Radiology, Department of Translational Research on New Technologies in Medicine and Surgery, University of Pisa, Via Roma 57, Pisa, Italy. E-mail: davide.caramella@med.unipi.it

[*]Corresponding author. Tel.: 0039 050 992894; fax: 0039 050 992706. E-mail addresses: v.giuffra@med.unipi.it (V. Giuffra)

Abstract

Archaeological excavations carried out atthe castle of Monte di Crocenear Florence brought to light a smallcemetery complexbelonging to thecastle church, dated back to the 11th-12th centuries. An elitestonetombcontained the skeletal remains ofa male aged 35-45 years withan evidentpathologyof the right tibia. The proximal metaphysisand the upper halfof the diaphysis appear massively enlargedas a result of severe chronicperiostitis. Atransverse section illustrates complete obliterationof the medullary cavitybynewspongy bone, with some largecavitations.Theprimary, butcompletelyremodeled tibialshaftis still recognizable.This finding and the strong sclerotic reactionwith somecentralcavitations rules out any form of bone tumor and suggestsa chronic inflammatory disease. Themorphological and radiologicalpicture and the tibial localization suggestadiagnosis of chronic sclerosingosteomyelitis ofGarré, a rare form ofchronic osteomyelitis characterized byan intenseperiosteal reaction with little or nosuppuration.

Article type: Case study

Key words: chronicperiostitis, tibia, 11th-12th centuries

1.Introduction

Reports on sclerosingosteomyelitis of Garré, a chronic form of osteomyelitis characterized by an intense periosteal reaction with little or no suppuration, are absent in the paleopathological literature. To the best of our knowledge, only one paper mentions a tibia from Poland affected by this condition, but the diagnosis is not supported by a detailed description and no differential diagnosis was made (Prejzner and Gladykowska-Rzeczycka, 1997).

This paper presents a possible case ofsclerosingosteomyelitis of Garré,observed in the tibia of an individual from the Medieval church cemetery of Monte di Croce, in Tuscany.The purpose of this work is to describe in detail the case and evaluate the results of the imaging study; differential diagnoses, evaluating other possible conditions that can produce features similar to those seen in the tibia from Monte di Croce, such as some forms of bone tumors, syphilis and Paget's disease, are also discussed.

2.Materials and Methods

2.1 Archaeological and Historical Context

The archaeological site ofMonte di Croceis located on a hill near the small town of Pontassieve (Florence)and is occupied by the ruins of a Medieval castle and of a church.The castle of Monte di Croce represented an importantstrongholdof the power of the CountsGuidi, as it controlledthe commercial trafficof northern Tuscanyin opposition tothe nascent*comune* of Florence.It is well established that the castle washeld by alocalaristocratic family, theGaliga, strict allied ofthe Guidi(Cortese, 2005; Cortese, 2007). The army ofFlorencebesieged Monte di Crocein 1143and, after various vicissitudes, the castle was destroyedin 1154 (Repetti, 1839).

Alittle churchinside the castlewasusedas a privatechapel. The building can be identified as the Church of Saints Miniato and Romolo, already attested at the end of the 11th century. The religious building (13m x6.50 m) is reduced to the foundation levelsand consists in a single roomwithapse.

The church was enlarged in the 12th century reaching the dimensions of 21.5m x10m, but the works were never completed to the destruction of the castle (Francovich et al., 2003).

Excavationsof the church of Saints Miniato and Romolo,conductedin 2001-2002by the Departmentof Archaeology andArt History of the UniversityofSiena, allowed full explorationof the smallcemetery complexof thecastle, dated back to the 11th-12th centuries (Francovich et al., 2003).The importanceof the cemeteryof Montedi CroceCastle derives from the factthatit is a private cemetery, probably reserved to the burial of thebailiffs and *fideles*of the castle's lords;paleonutritional analyses revealed in fact that the alimentation of this human group was based on vegetables and was poor in animal proteins, suggesting that the individuals buried in the cemetery did not belong to the aristocratic élite (Fornaciari et al., 2012).A total of71 individuals, including 35subadultsand 36adults, were brought to light. Thiscemetery areaincludedtwelvestone burialscoffinsand manysimple fossa burials(Fornaciariet al., 2003).

Alithictomb (n. 59), leaning against thesouth wall and made of square stones worked on the surface, was found amongthe gravessurroundingthechurch. The position and the unusual elaboration lead to suppose that this was an elite tomb. Itcontained the remains ofan adult individual still in connection (n. 16), whoshowedan evidentpathologyof the right tibia(fig. 1).

2.2 Skeletal Methods

Sex determination was performed on the basis of the morphologic features of the skull and pelvis (Ferembachet al., 1977-79; BuikstraandUbelaker, 1994). Age at death was estimatedfrom the examination ofpubic symphysis morphology (Brooks and Suchey, 1990), dental wear (Lovejoy, 1985) and sternal rib end modification (Loth andIscan, 1989). The stature was established by the formulas of Trotter and Gleser (1977).

Paleopathological study included both macroscopic and radiological examination.For conventional X-rays a FCR Velocity by Fujifilm computed radiography equipment was used, with the following parameters: 10-12 mAs with 54-60 keV, DFF 110 cm. Computed Tomography (CT) was carried out

with a CT scanner Toshiba Aquilion 16, 100 kVp, 100 mA, rotation time 0,5 s, slice thickness 3 mm, DFOV 49,4x35,9 cm.

3.Results

The skeletal remains of individualn.16 belong to an adult male aged 35-45 years. The stature isabout 177 cm.

The right tibia appears affected by a severe pathology. The bone is not completely preserved: the medial condyle with the underlying spongy bone and the distal epiphysis are missing. Post-mortem damage removed the cortical portion of the bone that included the medial central diaphysis, involving an area of ca 90 x 40 mm and exposing the underlying spongy bone; in addition, the bone is broken transversally, 25 mm under the nutrient foramen.

Thetibia appears to be greatly enlarged in correspondence to the proximal metaphysisandthe upper halfof the diaphysis(fig. 2).Diameters at midshaft and at the nutrient foramen of the right tibia are significantly larger than those of the left unaffected tibia (table 1).

	Right tibia (mm)	Left tibia (mm)
Maximum diameter at midshaft	50	29
Transversal diameter at midshaft	44	23
Maximum diameter at the nutrient foramen	53	32
Transverse diameter at the nutrient foramen	51	25

Table 1Diameters of the right and left tibia

The posterior and lateral surface of the proximal metaphysis appears altered by periostitic reaction consisting in plaques of new bone formation, porosities and bone spicules, irregularly disposed; the medial surface of the proximal metaphysis appears less irregular,with porosities and absence of bone spicules. Atransverse section of the bone, due topost-mortem breakage,shows athickened

cortexandtotal scleroticobliterationof the medullary cavitybynewspongy bone; a sub-cortical largecavitation is present in correspondence of the superior-lateral portion of the bone.Theposterior portion of the earlier, normaltibial shaft, completelyremodeled, is recognizable (fig. 3).

Radiological examination showed heterogeneous sclerosis along the proximal to mid diaphysis, with bone expansion; new bonelevels are disposed parallel to the diaphysis. The cortical compact bone appears to be locally thickened. The complete obliteration of the medullary cavity with endostealnew bone formation is confirmed, along with cavitations and osteolytic phenomena. The original diaphysis is reabsorbed but stillrecognizable. Bone sequestra, including drainage channels (*cloacae*) are absent(fig. 4).

The CT sections, at different levels, better defined partial (figs. 5a and 5b) and total obliteration (fig. 5c) of the medullary canal; local circumferential cortical thickening and bone lacunae were present. The residual original diaphysis, visible as cortical bonesurrounded by abundant new spongy bone, is recognizable.

No bone lesions or traumatic injurieswere observed in the left tibia. The other portions of the cranial and post-cranial skeleton presented no additional evidence of pathology, including trauma.

4.Discussion and conclusions

Themacroscopicand radiological features of the left tibia from Monte di Croce (Tomb 59, Skeleton 16) include a fusiform enlargement of the diaphysiscaused by strong periosteal reaction, obliteration of the medullary cavity and absence of sequestra and fistulisation.In differential diagnosis several diseases need to be considered, in particular bonetumors, includingosteoblastoma, Ewing sarcoma and low grade osteogenicsarcoma, as well as other entities, such as syphilis, Paget's disease and osteomyelitis.

An osteoblastomais considered abenigntumor, but locally aggressive. The tumoraffects malesmore than females, in a ratio of 2:1, and the age of occurrence is between 10 and 25 years. The most common site of occurrence is the posterior portion of the column, but this tumor can also involve

the long bones, in particular the femur and tibia in the medullary cavity and diaphysis, whereasepiphysealinvolvementis rare.The tumor contains a central area usually larger than 2 cm and a sclerotic reaction circumscribing the lesion (Atesok et al., 2011). In our casethe ageisabove average, there are internal cavitations, and the involved segment is larger than in osteoblastoma.

Ewing sarcoma is a malignant tumor of bone rarely occurring in patients older than 30 years. The tumorcan arise in any bone and the femur and tibia are the most commonly affectedlong bones (DorfmanandCerniak, 1998).Ewing sarcoma is highly aggressive, and it causes extensive destruction of the cancellous and cortical bone. Radiological examination reveals a permeative lytic lesion with periosteal reaction, frequently of the "onion-skin" type. In our case the age at onset, the absence of extensive destruction and the presence of the original diaphysis do not support the diagnosis of Ewing sarcoma.

Low-grade centralosteosarcoma is a rare form of intramedullary osteosarcoma, whose average age of occurrence is 30 years. The most involved bones are the femur and tibia and the lesion originates in the metaphyseal tract, sometimes extending to the diaphysis (Kashima et al., 2013).Radiographically, both lytic andosteoblastic phenomenacoexist in the mixed form (Andresen et al., 2004). However, the structure of thescleroticlesion visible bothincompact andspongy bone, combined with preservation of tracts of theoriginaldiaphysis, allow the exclusion ofthis tumor.

As for other entities, bone involvement is common in tertiary syphilis and the most affected bones are the skull and the tibiae.The lesions on the tibiae correspond to a non-gommatousosteomyelitis, including bone enlargement withnarrowing of the medullar cavity; there mayalso be an anterior bowing, as in"saber shin" tibia (Aufderheideand Rodriguez-Martin, 1998). However, in lueticosteomyelitis the lesions are commonly bilateral (Ortner, 2003); in our case the diagnosis of tertiary syphilis shouldtherefore be ruled out.

Paget's disease of bone is a metabolic skeletal disease, characterized by excessive resorption followed by excessive formation of bone, with abnormal bone remodeling. Involvement is usually polyostotic and asymmetric, and the most affected bones are the pelvis, spine, skull, femur, and

tibia.Mixed lytic and sclerotic changes are typicalat X-ray examination (Griz et al., 2014).The deformities in the tibia mainly consist in a markedexpansion of bone and anterior bowing (Lee et al., 2004). In the tibia from Monte di Croce (Tomb 59, Burial 16), the absence of bowing deformity and atypical sclerotic and lytic lesions ("mosaic" aspect)exclude Paget's disease.

Osteomyelitis isan inflammatory processcaused bypyogenicgerms, such as staphylococcus, streptococcusandpneumococcus,that can affectallskeletal segments (Resnick andNiwayama, 1989).The infection produces a local ischemia and subsequent necrosis of the bone segment, forming a sequestrum. The periosteum is stimulated to produce new bone in order to enclose the affected portion, forming an involucrum, that can be perforated by cloacae (Aufderheide and Rodriguez-Martin, 1998).

Amorphological picturesimilar to our case could represent an acute osteomyelitis become chronic.Chronic sclerosingosteomyelitis ofGarré isa rare form ofchronic osteomyelitis first described by Carl Alois Philipp Garré in 1893; other names arechronic osteomyelitis with proliferative periostitis, chronic sclerosing osteomyelitis, ossifying periostitis or non-suppurative chronic sclerosing osteomyelitis(Moraes et al., 2014).This condition affects young children and adults, predilecting the male sex (Vannet et al., 2014). Themandible is the mostcommonlyaffectedbone, but the disease can also affect the metaphyseal region of the long bones (Belli et al., 2002); among the long bones, the tibia is the most preferred localization (Vannet et al., 2014).

Clinically, the onset of the condition is characterised by local pain and reaction in the affected bone, whereas the symptomatology may persist for several months and in some cases even for years, with an episodic non-progressive course and low mortality. During the acute phase the symptoms include pain, heat, redness, tumor growth and deformity. The affected bone generally maintains its function, and most patients appear to be healthy during the interval between episodic exacerbations, (Bernard-Bonnin et al., 1987; Moraes et al., 2014). The radiographic changes consist in general sclerosis, which canproduce obliterationof the medullary canal, widening of the cortex and possible

cystic changes. There is no evidence of abscesses and sequestra (Nikomarov et al., 2014; Vannet et al., 2014).

The etiology of thispathologyhas not yet been completely clarified. Itseems to originate from an infection caused by low-virulent, anaerobic bacteria (CollertandIsacson, 1982), but in most cases no bacterial growth can be cultured; therefore, the chronic process may be maintained by a low-grade persistent infection(Vienne andExner, 1997).

In conclusion, in clinical studies chronic sclerosingosteomyelitis ofGarrépresents as a general sclerosis of the involved segmentdue to thesuccession ofperiosteal reactions topersistentinfectiousstimuli,with possible areasof osteolysis. Medullary cavities, sequestra and cloacae are typically absent.In dry bone, this condition is described as characterized by regular fusiform shape of the involved portion, absence of medullary cavity, rough surface and absence of sequestrum and fistulisation (Prejzner and Gladykowska-Rzeczycka, 1997).The morphological and radiologicalfeatures, as well as the tibial localization observed in the case from Monte di Croce(Tomb 59, Burial 16) are most compatible withthe clinical and paleopathological features of chronic sclerosingosteomyelitis ofGarré, thus making this diagnosis the most probable.

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References

Andresen, K.J., Sundaram, M., Unni, K.K., Sim, F.H. 2004. Imaging features of low-grade central osteosarcoma of the long bones and pelvis. Skeletal Radiol. 33, 373-9.

Atesok, K.I., Alman, B.A., Schemitsch, E.H., Peyser, A., Mankin, H. 2011. Osteoid osteoma and osteoblastoma. J. Am. Acad.Orthop. Surg. 19, 678-89.

Aufderheide, A.C., Rodriguez-Martin, C. 1998. The Cambridge Encyclopedia of Human Paleopathology. Cambridge University Press, Cambridge.

Belli, E., Matteini, C., Andreano, T. 2002. Sclerosing osteomyelitis of Garréperiostitisossificans. J. Craniofac. Surg 13, 765-8.

Bernard-Bonnin, A.C., Marton, D., Brochu, P. 1987. Chronic sclerosingosteomyelitis (so-called Garrè's). Review of 12 cases. Arch. Fr. Pediatr. 44(4), 277–82.

Brooks, S.T., Suchey, J.M. 1990. Skeletal age determination based on the os pubis: A comparison of the Acsadi-Nemeskeri and Suchey-Brooks methods. Hum. Evol.5, 227-238.

Buikstra, J., Ubelaker, D. 1994. Standards for Data Collection from Human Skeletal Remains. Arkansas Archaeological Survey Research Series No. 44, Fayetteville.

Collert, S., Isacson, J. 1982. Chronic sclerosing osteomyelitis (Garré). Clin. Orthop. Relat. Res. 164, 136-40.

Cortese, M.E. 2005. Nella sfera dei Guidi: I "da Quona" e altri gruppi familiari aristocratici della BassaValdisieve tra XI e XII secolo,in:Sznura, F. (ed.),Antica possessione con bellicostumi.Aska, Firenze, pp. 157-173.

Cortese, M.E. 2007. Signori, castelli, città. L'aristocrazia del territorio fiorentino tra X e XII secolo. Olschki, Firenze.

Dorfman, H., Cerniak, B. 1998. Ewing sarcoma and related entities. St Louis: Mosby, pp. 607–642.

Ferembach, D., Schwidetzky, I., Stloukal, M. 1977-79. Raccomandazioni per la determinazione dell'età e del sesso sullo scheletro. Rivista di Antropologia 60, 5-51.

Fornaciari, G., Aretini, P., Lubritto, C. 2012. Economie alimentari medievali e postmedievali italiane: i risultati delle analisi isotopiche dirette e i resti umani. VI Congresso Nazionale di Archeologia Medievale. Edizioni all'Insegna del Giglio, Firenze, pp. 693-697.

Fornaciari, G., Giusiani, S., Vitiello, A. 2003. Paleopatologia del cimitero signorile del castello di Monte di Croce (Ia fase, XI secolo). III Congresso Nazionale di Archeologia Medievale. Edizioni all'Insegna del Giglio, Firenze, pp. 292-298.

Francovich, R., Tronti, C., Causarano, M.A., 2003. Lo scavo della chiesa e del cimitero di Monte di Croce (2001-2002). Una cappella privata tra XI e XII secolo. III Congresso Nazionale di Archeologia Medievale. Edizioni all'Insegna del Giglio, Firenze, pp. 292-298.

Garré, C. 1893. ÜberbesondereFormen und Folgezuständederakuteninfektiösen Osteomyelitis. Beit. Klin. Chir.10, 257-265.

Griz, L., Fontan, D., Mesquita, P., Lazaretti-Castro, M., Borba, V.Z., Borges, J.L., Fontenele, T., Maia, J., Bandeira, F. 2014. Diagnosis and management of Paget's disease of bone. Arq. Bras.Endocrinol.Metabol.58: 587-99.

Kashima, T.G., Gamage, N.G., Dirksen, U., Gibbons, C.L., Ostlere, S.J., Athanasou, N.A. 2013. Localized Ewing sarcoma of the tibia. Clin.Sarcoma Res. 3, 2.

Lee, C.H., Han, S.H., Yoon, B.Y., Lee, Y.W. 2004. Monostotic Paget's disease of the tibia in Korea. Clin.Rheumatol. 23, 381-2

Loth, S.R., Iscan, M.Y. 1989. Morphological assessment of age in the adult: The thoracic region, in: Age Markers in the Human Skeleton.Iscan, M.Y. (ed.).Charles C Thomas Pub, Springfield, pp. 105–135.

Lovejoy, C.O. 1985. Dental wear in the Libben population: its functional pattern and role in the determination of adult skeletal age at death. Am. J. Phys.Anthropol. 68, 47-56.

Moraes, F.B., Vieira Motta, T.M., Assis Severin, A., De Alencar Faria, D., De Oliveira César, F., De SouzaCarniero, S. 2014. Garré'ssclerosing osteomyelitis: case report. Revistabrasileira de ortopedia 49, 401-404.

Nikomarov, D., Zaidman, M., Katzman, A., Keren, Y., Eidelman, M. 2013. New treatment option for sclerosing osteomyelitis of Garré. J. Pediatr. Orthop. B. 22, 577-82.

Ortner, D.J. 2003. Identification of pathological conditions in human skeletal remains. Academic Press, New York.

Prejzner, W., Gladykowska-Rzeczycka, J.J. 1997. An attempt to evaluate the criteria for diagnosing nonspecifica inflammatory diseases observed on ancient skeletons. PrzeglądAntropologiczny 60, 103-109.

Repetti, E. 1839. Dizionario geografico fisico storico della Toscana. Allegrini e Mazzoni: Firenze.

Resnick, D., Niwayama, G. 1989. Osteomyelitis, Septic Arthritis and Soft Tissue Infection: Mechanism and Situations, in:Resnick D (ed.), Bone and Joint Imaging. W. B. Saunders, Philadelphia, pp.728-755.

Trotter, M., Gleser, G.C. 1977. Corrigenda to "Estimation of Stature from Long Limb Bones of American Whites and Negroes"American Journal of Physical Anthropology.Am. J. Phys. Anthropol. 47, 355-356.

Vannet, N.B., Williams, H.L., Healy, B., Morgan-Jones, R.2014. Sclerosing osteomyelitis of Garré: management of femoral pain by intramedullary nailing. BMJ Case Rep.bcr2014206533. doi: 10.1136/bcr-2014-206533.

Vienne, P., Exner, G.U. 1997. Garrésclerosing osteomyelitis. Orthopade 26, 902-907.

Legend to the figures

Figure 1 Tomb 59 with skeleton 16 still in situ: the enlargement of right tibia is evident

Figure 2 Posterior view of both tibiae, withenlargementand fusiform shape of the right one

Figure 3 Section of the right tibia, showing almost complete obliteration of the medullar cavity and residual original diaphysis

Figure 4 Radiographyof the tibiae;heterogeneous sclerosis along proximal to mid shaft of the right tibia with thickening of bone and immature but benign-appearing periosteal new bone formation

Figure 5 Cross-sections of the tibiae at CT: narrowing of the medullary canal by sclerotic new bone, circumferential cortical thickening and areas of osteolysisare evident at the level of the metaphysis (a) and superior third of the diaphysis (b); complete obliteration of the medullary canal is visible at the level of midshaft (c); tracts of the original tibialdiaphysis are well recognizable in all sections

Figure 1

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Figure 2

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Figure 3

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Figure 4

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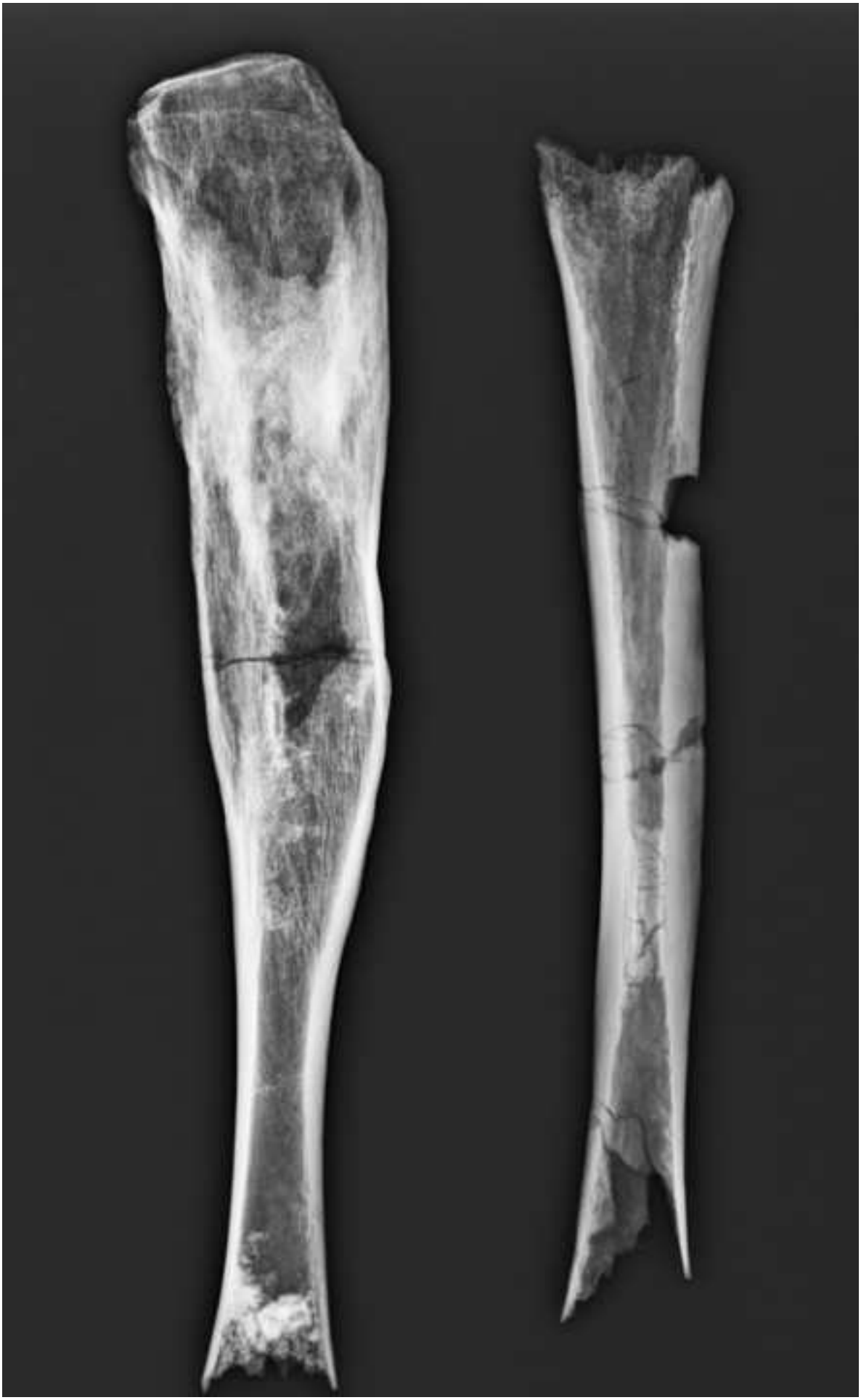

Figure 5

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