



## **Skeletal Palaeopathology as illustrated by Sudeck's Dystrophy in a post-trauma foot from the Middle Ages**

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### **Abstract**

As a branch of pathology, palaeopathology searches in human or animal remains for marks of diseases, which occurred in ancient times. We present a foot from the Middle Ages showing changes caused by Sudeck's dystrophy, presumably due to a fracture of the talus. In addition to its historical interest, this observation underlines the opportunities provided by osteoarticular palaeopathology alongside today's pathology.



## **Introduction**

As defined by the pioneer Ruffer [16], palaeopathology is “the science of the diseases which can be demonstrated in human and animal remains of ancient times “. Mainly concerned with the osteoarticular field, this particular branch of pathology should extrapolate from morphological data to today’s nosography. This will be discussed in the light of a case from the Middle Ages whose bone alterations could be attributed to post- trauma Sudeck’s dystrophy [20] .Given a post-mortem diagnosis , we adopted an historical denomination to avoid those usually provided, essentially related with physiopathological, clinical and radiological approaches: respectively , Sympathetic Reflex Dystrophy, Algodystrophy, Transient Osteoporosis [1].

## **Material and Methods**

The case concerns a skeleton with the anthropological characteristics of a male who died between 40 and 70 years of age and had been buried in a Swiss cloister (13th - 14th century - T 96-Romainmotier, Canton de Vaud). The bones available were well preserved and essentially composed of thoracic and lumbar vertebrae, sternum, pelvic girdle and limbs , but not phalanxes . After a macroscopically study of the whole to exclude any osteoarticular systemic disease ,the only territories of interest to pathology were the lower left limb, particularly the foot: tarsus and metatarsus. These bones , as well as tibia , fibula and femur , were macroscopically and radiographically compared with those of the corresponding right limb , with binocular magnifying glass examination of sawn slices.

## **Results**

The left foot showed a dislocation of the tarsal bones. Neither ankylosis nor osteoarthritis eburnation was observed in tibio- tarsal or inter-tarsal situation. As compared with the controlateral bones, the main alterations observed concerned the calcaneus, talus, cuboid and metatarsal bones.



The calcaneus was reduced in size. Its sustentaculum tali was distorted and remodelled, as were the articular surfaces facing the talus and the cuboid. Regarding the lateral aspect, the very thin cortex was unequally broken or disconnected from an underlying spongiosa demonstrated by two sharply distinct changes, i.e. a wall made of thin bone plates linked together by bridges and partly connected to the corticalis or, posterior, as a network of thin trabeculae (Fig 1). The area of the pseudo-cystic “neutral triangle” limited by stress lines from the tibia via the talus [9] could be recognized (Fig 2 A). Moreover, right below the sustentaculum tali, it was flanked by a newly -formed wall of dense smooth bony plaques directly up against a normal medial cortex (Fig 2 B).

In the collapsed talus the mark of an old fracture separated two distinct remodelled areas of the spongiosa. The one under the middle facet (i.e. sustaining overload) presented a particular kind of remodelling with (arrow) a dystrophic cyst similar, per se, to those observed in osteoarthritis (Fig 3). The cuboid bone showed trabeculae thickening indicating the evolution of a previously active remodelling process (Fig 4). In the metatarsal bones, the first had a thin and papyrus -like cortex, generally disconnected from rare and thin trabeculae (Fig 5). The others, when compared with their right homologues, presented a thin cortex (Fig 6). This left foot dystrophy had an impact on the lower limb. On the left side, in addition to articular erosion of both malleoli ascribable to the talus fracture, the tibia and fibula were shortened as compared with the right side (by 15 and 22 mm respectively), and their robustness index (i.e. the length / circumference ratio) appeared reduced, particularly in the fibula. Macroscopic and radiologic the tibial and fibular transversal slices appeared homogenous. On the right side, the predominance of insertion hyperostosis of the tibial popliteal line and of the femoral linea aspera, i.e. “activity indicators” [7], were the mark of compensatory muscular traction.

## **Discussion**

The case is centred on a post-trauma bone dystrophy of the left foot similar to that reported in Sudeck’s first reports [20]. Some changes of the corresponding leg appear to be due to



“disuse atrophy “which is expressed by the contralateral predominance of activity indicators and by a reduced robustness index attributable to a lack of periosteal muscle activity [15, 21]. In fact the macroscopic appearance and the x-rays of tibial and fibular cross slices do not demonstrate the cortex “spongy atrophy” which might show a Sudeck’s dystrophy in association with that of the foot [10].

The diagnosis of the condition is based on macroscopic sequel of cortex and on changes in the spongiosa trabeculae [2] with thinning of the latter (mainly related to an osteoclast activity in a vascularised and oedematous marrow) followed by thickening patterned on the stress lines [3,10,11,17]. The proximity of such opposing changes could be explained by the multifocal incidence of the neurovascular disturbance developed in the condition, a factor which could explain its spotty X-ray images. The association of such physiopathological heterogeneity together with the strains of the foot architecture [19] could today be illustrated by the tarsal and metatarsal involvement which is observed via MRI in active forms of the dystrophy. [4, 5]. In the present case, the cause of the dystrophy seems to be a fracture of the body of the talus, i.e. a condition which today [18] has a fairly grave prognosis.

As a “side effect” of this palaeopathologic study we call attention, inter alia, to four points which might suggest a broader reflection on the problem of bone remodelling.

- Wolf’s laws on functional stresses in bone architecture [3, 23] are illustrated in the present case as the mark of previous dystrophic active remodelling [10, 17].

- A newly-formed bone could be made by the connection of elementary plates developed at the conjunction site of trabeculae (Fig 1), i.e. by an elementary osteogenic process which primarily concerns the three-dimensional architecture of the normal skeleton [3,23] as well as of bone islands (Fig 5).

- In accordance with previous observations on Sudeck’s macerated specimens as well as radiological or histological slides [10,11,17], the “neutral triangle” [9] is not bordered by the bony cyst wall which sometimes occurs in this site [22]. Although both



are related with a local calcaneus stress, this type of bony wall differs from that developed right below the sustentaculum tali in the present case (Fig 2 B).

-Regarding its special macroscopic aspect, the latter is similar to certain dense smooth bony plaques we have observed in the neutral triangle area of elderly people. The nature of such non specific changes might suggest possible further studies.

We do not know of any palaeopathological reports of Sudeck's dystrophy, even under another name. The condition has not been noted in palaeopathological documents whose co-authors were familiar with bone pathology or orthopaedic surgery [ 6,13,14]..However post-fracture bone atrophy has been reported in human skeletal remains [12] and an X-ray trace of a minor equivalent of previous "Sudeck type" dystrophy is suggested by the localized trabecular thickening of a humeral condyle near an old fracture [8].

The lack of documents could be due to post-mortem brittleness of such remains. However, despite the fact that medico-surgical and palaeopathological activities are generally incompatible, it might be desirable for orthopaedic surgeons, rheumatologists, radiologists as well as bone pathologists to be in touch with field researchers when interpreting any observations which have struck their attention in their practice. A suitable methodology might justify an investigation of human remains, providing data that go far further than a collection of curiosities.

Oriented on the past they could be of interest for anthropologists, archaeologists and historians of medicine or of society. Oriented on the present and thus on the future, they could provide medical professions with rather rare documents from pathology collections and be a useful aid in anatomico-radiological correlations in teaching.

Regarding Sudeck's dystrophy, where - fortunately - specimens of macerated bones will probably be rarer in the future, the finding of palaeopathological specimens might help the three-dimensional perception of a concept with broader physiopathological connections.

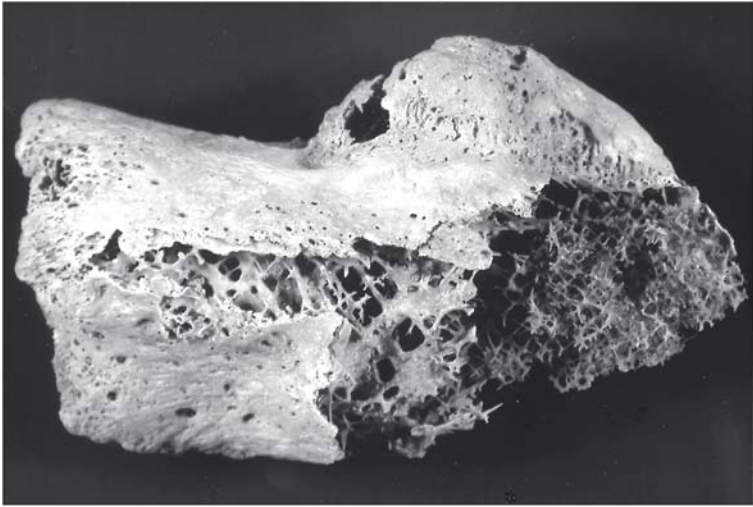
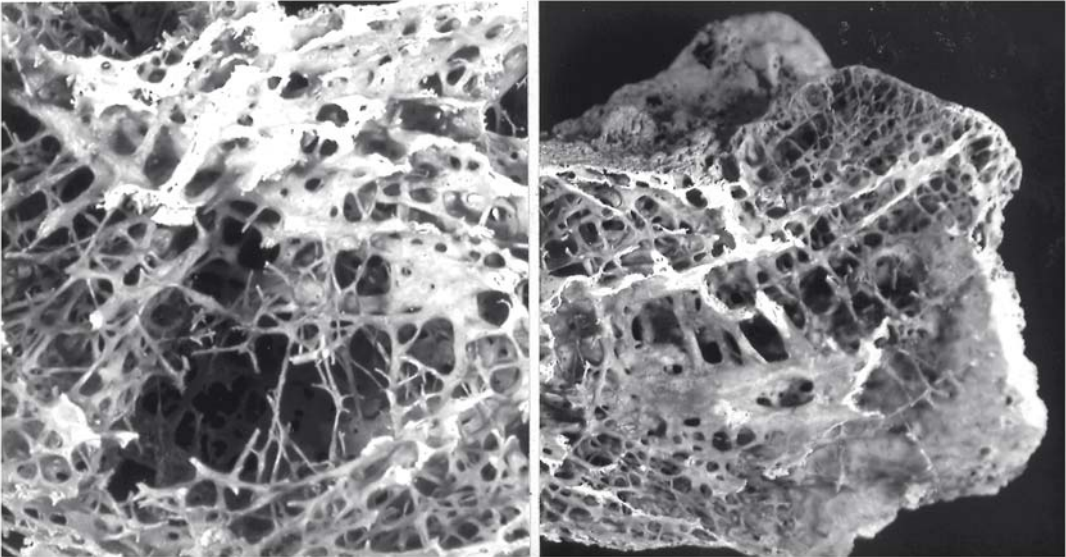


Fig. 1



A

Fig. 2

B

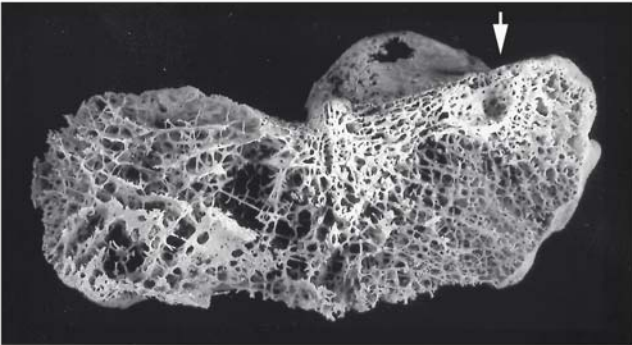


Fig. 3



**Fig.1**

*Left calcaneus ,.supero-lateral aspect (x 2 ).Thinned cortex ,unequally broken away from the spongiosa. Remodeling of the latter, either as thin trabeculae in the posterior third. or as a wall made of connected plates.*

**Fig 2.**

*Left calcaneus . A) paramedian sagittal slice at the site of the neutral triangle (x 3) , central thin trabeculae and surrounding remodelled spongiosa - B) (x 2,5 ) dense smooth bony plaques right below the sustentaculum tali and directly up against the postero-medial cortex.*

**Fig 3.**

*Left talus, paramedian sagittal slice (x 1,5 ).Collapse with the mark of an old fracture separating two distinct remodelled spongiosa areas,in the posterior of which an arrow indicates a dystrophic cyst..*

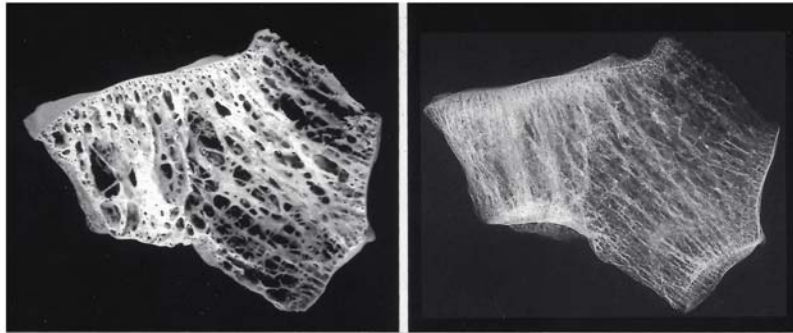


Fig.4

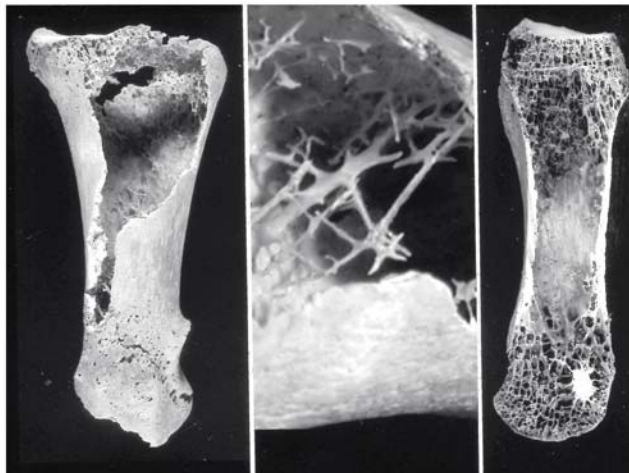


Fig. 5



Fig. 6

**Fig 4**

*Left cuboid bone, medial slice , macroscopical and radiological views (x 2 ) .Unequal thickening of spongiose trabeculae .*

**Fig.5**

*Left 1. metacarpal bone with atrophy of cortex and spongiosa. Macroscopic view (x 1,5) and detail (x 10) compared to a slice of the normal right homologue bone (with a distal bone island).*

**Fig.6**

*Left 5. metacarpal bone with thinning of cortex and spongiose atrophy as seen in the proximal epiphysis (x 1,5 ). Compared to the normal right homologue bone (with a periosteal splinter).*





## References

1. Alvarez-Lario B, Aretxabala-Alcibar I, Alegre-Lopez J, Alonso-Valdivielso JL (2001) Acceptance of the different denominations for reflex sympathetic dystrophy. *Ann Rheum Dis* 60:77-79.
2. Bickerstaff DR, Charlesworth D, Kanis JA (1993) Changes in cortical and trabecular bone in algodystrophy. *Brit J Rheumatol* 32: 46- 51.
3. Bullough PG (1997) Bullough and Vigorita's Orthopaedic Pathology . Mosby-Wolfe, London.
4. Calvo E, Alvarez L, Fernandez-Yruegas D, Vallejo C (1997) Transient osteoporosis of the foot. Bone marrow oedema in 4 cases studied with MRI. *Acta Orthop Scand* 68: 577-580.
5. Darbois H, Boyer B, Dubayle P et al (1999) Séméiologie I R M de l'algodystrophie du pied. *J Radiol* 80:849-854..
6. Dastugue J, Gervais V (1992) Paléopathologie du squelette humain . Société nouvelle d'éditions Boubée, Paris.
7. Dutour O (1986) Enthesopathies ( lesions of muscular insertions ) as indicators of the activities of Neolithics Saharian populations. *Am J Phys Anthropology* 71:221-224.
8. Glencross B, Stuart-Macadam P (2001) Radiographic clues to fractures of distal humerus in archaeological remains. *Int J Osteoarchaeol* 11:298-310.
9. Harty M (1973) Anatomic considerations in injuries of the calcaneus. *Orthop Clin North Am* 4: 179-183.
10. Lagier R (1994) Algodystrophy - Reflex sympathetic dystrophy. Sandoz Medical Publications. Basle.
11. Lagier R, Van Linthoudt D (1978) Dystrophie de Sudeck de l'arrière pied. Confrontation anatomo-radiologique. *Ann Radiol* 21: 539-544 .
12. Merbs CF (1989) Trauma in: Reconstruction of life from the skeleton eds: MY Iscan and KAR Kennedy, pp 161-190. Alan B Liss Inc. New York.
13. Ortner DJ, Putshar WGJ (1985) Identification of pathological conditions in human skeletal remains. Smithsonian Institution Press , Washington.



14. Pales L ( 1930) Paléopathologie et pathologie comparative. Masson & Cie. Paris.
15. Resnick D, Niwayama G (1988) Osteoporosis in Diagnosis of bone and joint disorders eds.D Resnick and G Niwayama. WB Saunders, Baltimore.
16. Ruffer MA (1913) Studies in Palaeopathology. Arthritis deformans and spondylitis in ancient Egypt. J Pathol Bacteriol 18: 149-162.
17. Rutishauser E, Vernet A, Mazabraud A (1956) L'ostéoporose post-traumatique. Etude histopathologique. Acta Orthop Belg Suppl i :123-148.
18. Sneppen O, Bach Christensen S, Krogsoe O, Lorentzen J (1977) Fracture of the body of the talus. Acta Chir Scand 48 : 317-324.
19. Steindler A (1964) Kinesiology of the human body. Charles C. Thomas Publisher. Springfield, Illinois.
20. Sudeck P (1901) Über die akute ( reflectorische ) Knochen atrophie nach Entzündungen und Verletzungen an der Extremitäten und ihre klinischen Erscheinungen. Fortshr Geb Roentgenstrahlen 5:277-293.
21. Uthoff HK, Jaworsky ZFG (1978) Bone loss in response to long-term immobilisation J Bone Joint Surg [Br] 60 :420-429
22. Van Linthoudt D, Lagier R (1978) Calcaneal cysts. A radiological and anatomico-pathological study . Acta Orthop Scand . 49:310-316.
23. Weinmann JP, Sicher H (1955) Bone and Bones. Fundamentals of Bone Biology. CV Mosby Comp. St. Louis.

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