

# THE ASSUMPTION OF THE SUPPORTIVE FUNCTION BY THE FIBULA AS A CONSEQUENCE OF ACQUIRED UNTREATED TIBIAL PSEUDARTHROSIS

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**The authors present a case of acquired, untreated pseudarthrosis of the tibia which resulted in adaptation to the weight-bearing function by the fibula. The case described shows the adaptation abilities of the bone tissue which, when subjected to unusual loading, undergoes the necessary reconstruction.**

**Key words :** tibial pseudarthrosis, supportive function of fibula.

**Mots clés :** pseudarthrose du tibia, fonction de support par le péroné.

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## INTRODUCTION

The skeleton of a human adult consists of 206 bones, the function of which is transmission of the forces occurring during the movement of the body. Some of them have a supportive function, and their shape, structure, and biochemical composition of the spongy and compact parts are the results of static and dynamic pressures present both in the bone itself and in the musculotendinous system attached to it (1, 2, 4, 5). The fibula is one of the long bones of the leg, but in contrast of the tibia, it does not have a supportive function. The literature has not presented any cases, to date, of adaptation of supportive and weight-bearing function by the fibula in an adult with acquired chronic tibial pseudarthrosis.

## CASE REPORT

A 59-year -old male patient presented purulent infection of the soft tissues of his right leg at the

age of 7 years. Inadequate treatment resulted in the spread of the pathological process to the tibia. Seven months later the patient was admitted to the hospital because of persistent purulent discharge from the fistulas and curvature of the bone axis at the site of the pathologically altered bone. Xray revealed a fracture of the affected bone. The patient underwent two operations. The infection focus was incised, debrided and drained. Antibiotic therapy was instituted, and the extremity was immobilized in a plaster cast for four months. The treatment resulted in remission of inflammation and formation of pseudarthrosis of the tibia with dislocated bone fragments. For the next twelve years the patient remained asymptomatic with full weight bearing on his right leg. In the years 1970 to 1979 he was hospitalized twice because of recurrence of bone infection at the site of the fracture. The atrophic tibial pseudarthrosis with complete translation of the bone fragments was then noted. Simultaneously with the pseudarthrosis formation in the tibia, the fibula underwent a remarkable reconstruction. Its diameter doubled, and it took over all supportive function of the right leg. The

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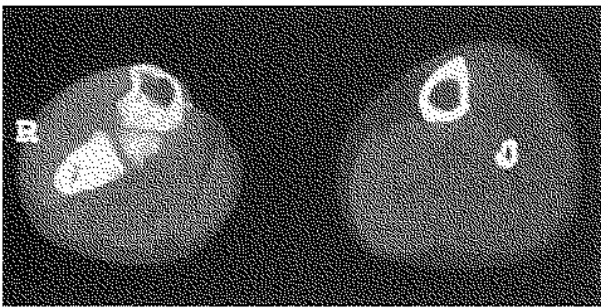
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*Fig. 1.* — Roentgenogram of the leg.



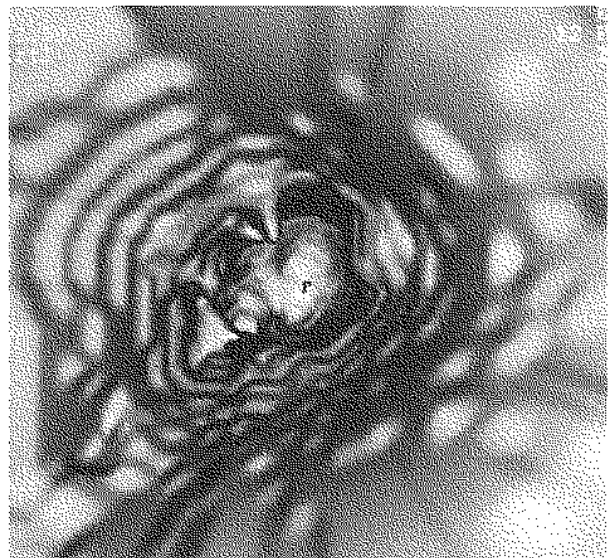
*Fig. 2.* — Transverse cross-section of the leg on CT-scan.

patient underwent a second operation. After incision, debridement and drainage of the infection site, antibiotic therapy was instituted, which resulted in an uneventful recovery. In view of persistent structural changes in the bones of the right leg, a major surgical procedure was not undertaken to treat the pseudarthrosis. The current xray picture of the right leg in the lateral projection is presented in fig. 1. Using a spiral CT-scan, transverse sections

of both legs were obtained showing remodeling of the compact and spongy part of the right fibula and the presence of the tibial pseudarthrosis (fig. 2). The xray picture of the obliteration of the marrow cavity in the proximal portion of the right tibia was obtained by means of virtual reconstruction with the spiral CT (“virtual endoscopy”) (fig. 3). Apart from this, a three-dimensional computer (3-D) picture of both legs was obtained (fig. 4). Presently, the patient does not report any serious complaints concerning his right leg. He walks normally with full weight-bearing on his right leg, despite the shortened tibia, with compensatory deformation of the lumbar spine and pelvis. The mobility of the right knee and ankle has remained normal. Despite his weight of 97 kg the patient is able to stand on his deformed right leg (fig. 5).

#### DISCUSSION

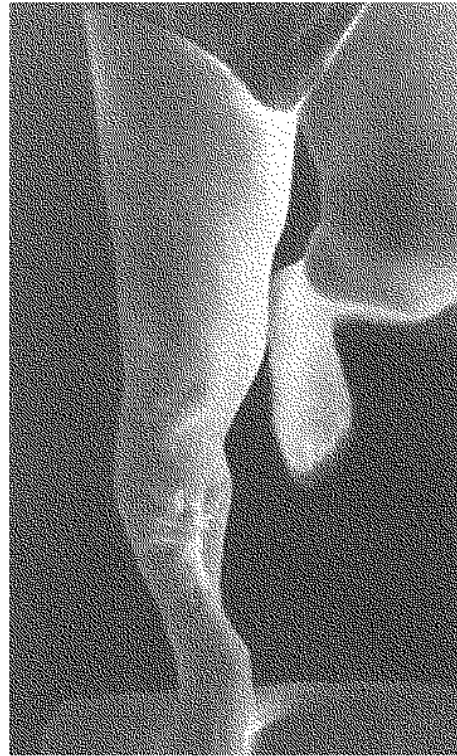
Adaptation abilities of the bony tissue, its changes resulting from the alternating load and final reconstruction or resorption of the bone (according to the “transformation principle”) was first described by Wolff in 1869 (6). At that time



*Fig. 3.* — Obliterated bone marrow cavity of the right tibia. The virtual reconstruction on CT-scan.



*Fig. 4.* — Three-dimensional (3-D) computer reconstruction of the leg.



*Fig. 5.* — Photograph of the patient bearing full-weight on his right leg.

attempts to study these phenomena were presented by Roux. His reports clarified Mayer's theory concerning the arrangement of the trabeculae in the bone cortex in relation to the weight distribution (3, 5, 6). Contemporary theoretical, experimental and clinical studies carried out by Pauwels, Kummer and others have broadened the knowledge of the physiology of bone tissue (1, 2, 4). The cases in which the fibula could fulfill the supportive function mainly concern pathological bone tissue in young adults with neurofibromatosis, or following trauma. However cases of congenital hypoplasia or deficiency of the fibula occur more often. In the case presented, the atypical primary surgical management which was probably caused by difficult social conditions, and no access to specialist treatment, resulted in spontaneous reconstruction of the fibula. The fracture of the tibia with total translation of the bone fragments resulted in the formation of a pseudarthrosis deprived of weight-bearing ability, which led to significant atrophy of

the bone tissue in the fragments of the tibia. The fibula has become arcuate, with its convexity directed postero-laterally; it has become the main supportive element of the leg. In consequence, varus dislocation of the talus ( $10^\circ$ ) developed, affecting the instep. The case reported is unusual because of the exceptional duration of the adaptation processes, which started over 50 years ago. The onset of the changes was at the age of seven years, when the elasticity module of the young bone was very high and loading of the bone much less because of lower body weight. These factors probably explain why the fibula did not fracture, despite the subsequent gradual increase in body weight (1, 2, 4). The fibula, in the sites of action of the greatest loading forces, has become twice as thick in comparison with the left leg. At the same time, the bone cortex has become the thinnest in the regions adjacent to the sites of greatest loading, which confirmed the assumptions of the theory of adaptation (2, 4). The phenomenon described oc-

curred not in a child but in an adult, where the decreased dynamic and static elasticity module would normally lead to fracture of the fibula (1, 2, 4). The use of updated visualizing devices showing the reconstructed bone confirmed the theories of the reconstruction abilities of the bone tissue.

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### SAMENVATTING

*W. HŁADKI, A. URBANIK, P. ORLICKI, R. ANIELSKI, M. GRACA. Aanpassing aan de gewichtdragende functie van de fibula als gevolg van een onbehandelde pseudarthrose van de tibia.*

De auteurs beschrijven een casus van onbehandelde pseudarthrose van de tibia waarbij de fibula zich aanpaste aan de gewichtdragende functie. Dit geval toont duidelijk aan dat botweefsel veranderingen ondergaat wanneer het blootgesteld wordt aan ongewone belasting.

### RÉSUMÉ

*W. HŁADKI, A. URBANIK, P. ORLICKI, R. ANIELSKI, M. GRACA. Reprise de la fonction portante par le péroné dans un cas de pseudarthrose du tibia non traitée.*

Les auteurs présentent le cas d'une pseudarthrose du tibia — non traitée — qui a entraîné la reprise de la fonction portante par le péroné. Ce cas démontre les possibilités d'adaptation du tissu osseux qui, soumis à des contraintes inhabituelles, subit le remodelage nécessaire pour s'y adapter.