Acta orthop. Scandinav. *XXXIV*, 357–366, 1964.

From the Clinic for Orthopaedics and Traumatology, University of Helsinki.
(Head: Professor K. E. Kallio.)

NON-TREATED TIBIA DEFECT WITH AN EXCELLENT FUNCTION AND WORKING CAPACITY

By

ARTO SIVULA

The article discusses a tibia defect caused by a fracture resulting from a gunshot wound during the war and never corrected surgically. By the patient's own effort and self-rehabilitation the defect had healed so well despite permanent nonunion that the patient not only walks without any orthopaedic aids but is capable even of surprising performances at work and sports. The case was discovered by coincidence when the patient was hospitalized after a traffic accident.

The patient, a man born on August 20, 1915, was wounded in the war (Jan. 14, 1940) at the age of 24 in the right leg by a machine-gun bullet. The bullet entered the posterior surface of the upper third of the right leg, crushed the tibia and formed a gaping wound in the anterior surface of the leg at the same level. Four days later the wound was explored in hospital and the loose bone fragments were removed. The comminuted tibia fracture was immobilized in a plaster cast. The wound was treated locally through a hole in the plaster but it still required surgery. At three months a fair amount of necrotic bone was removed, after which suppuration soon ended and the wound closed through granulation. The patient's general condition remained good and he moved about on crutches. The plaster cast was finally removed 9½ months after the injury. The fracture was still unstable and the X-ray picture showed a 5 cm. long defect in the upper third of the tibia, but the fibula was intact (Fig. 1). Once the plaster cast had been removed the mobility of the knee was soon restored, but that of the ankle remained largely restricted.

After this stage there appeared difficulties in the further care of the patient. He found it very difficult to adapt himself to the long period of hospitalization and he gradually became so difficult to control that

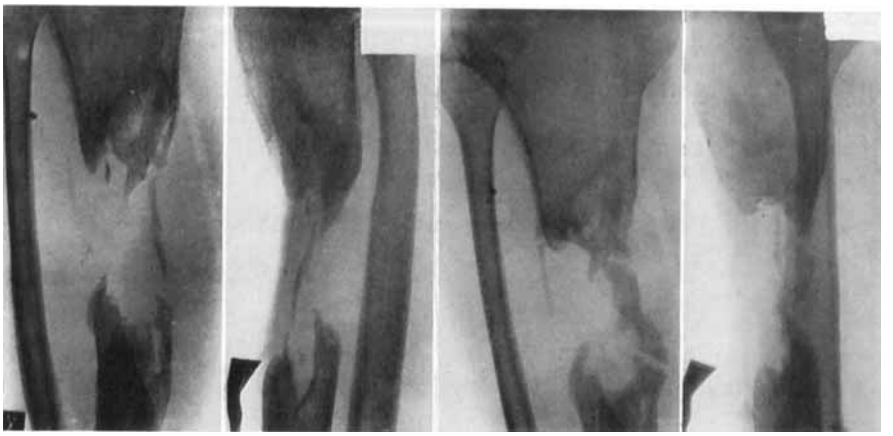

Fig. 1.
Roentgenograms of the earlier phases of the tibia defect. A: A–P and lateral projections 10½ months after the wound (Nov. 28, 1940). B: state 3 years after the wound (Nov. 21, 1942).

Fig. 2.
The present status (May 9, 1962), over 22 years after the wound. The corresponding projections of the healthy limb are shown also. The picture reveals the filling of the defect with the approach of the fractured parts, development of an intermediate fragment and proximal shift of the capitulum fibulae. Attention is also attracted by the marked hypertrophy of the fibula of the injured limb.

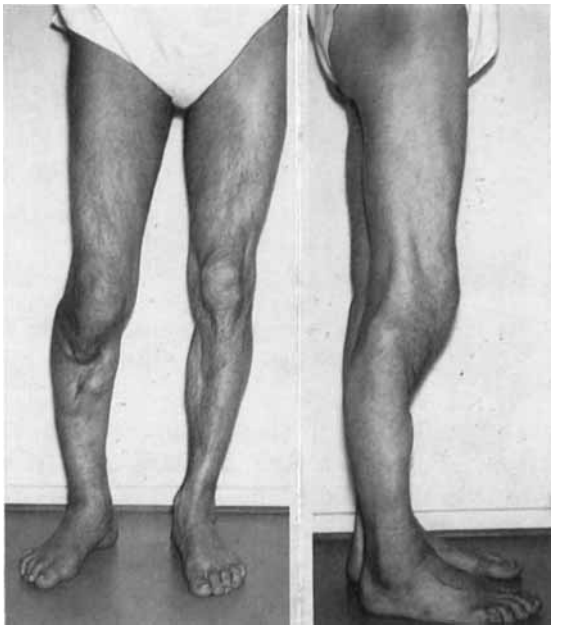

Fig. 3.
Photograph of the patient standing with his weight distributed equally on both lower limbs. The shortening of the right leg is distinct.

he had to be discharged. According to the plan of treatment, the intention was to perform an excision of the cicatrix, provide a brace and, finally, to perform a bone graft. The patient was re-admitted to hospital a few times but due to bad behaviour the plan of treatment could not be fulfilled at all. Gradually all attempts at treatment were abandoned and the patient did not even get a brace; he remained on his crutches. For several years he led a restless life, consuming quantities of alcohol. His lack of social responsibility finally brought him into contact with the law. The patient's hospital record of April 13, 1944, in prison, contains the following entry: "General condition good. Walks on crutches. The wound is closed. Normal mobility of the knee, mobility of the ankle improved, 130–80°." Surgery and bone graft were proposed but the patient was not interested.

In 1945 the patient married and moved to the countryside. He gradually began to calm down. He occupied himself at home, but accepted no work proper for years. He still moved on the two crutches but began gradually to lean on the injured limb. This was very painful at first, but the tenderness decreased gradually as the exercise advanced. Bicycle

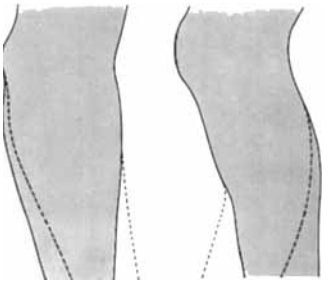

Fig. 4.
The drawing shows the extreme positions of movement in the pseudarthrosis in the A–P and lateral directions.

riding seemed to strengthen the limb particularly, and for exercise the patient rode distances of several tens of kilometres. He used crutches for walking up to 1949 when, by chance, he once noticed that he could do very well without them. This increased his enthusiasm for exercise. The patient began to walk with a stick and work in the fields, and gradually also began to undertake heavy forest work. After strenuous exercise or work the injured leg became painful from knee to ankle, but a sauna and massage always relieved the pain. The patient has never had a permanent or persistent ache. He has never taken pain-killing drugs; from 1950 he steadily reduced his consumption of alcohol until in 1953 he abstained completely. With heavy work, his condition improved fast. He achieved such skills in forest work that he won the logging championship of his commune in 1951 after a very strenuous 5-day competition. In 1951 the patient began to walk without a stick even. In 1953 a brace was made for him, but it felt heavy and clumsy and he never wore it.

The patient had also started skiing for exercise and made such good progress that he began to take part in skiing races in 1953. He skied in some twenty events a year up to 1960, including the 15 and 30 km. cross country and once the 50 km. He took part in general competitions with normal men and did not do badly at all. His beautiful cupboard contains a large number of prizes to testify to the success of his enthusiasm for skiing.

The patient's present social standing is good. He works as a janitor, doing all the jobs involved himself.

Subjective symptoms.—The patient is happy with his present condition. The fact that the site of fracture is unstable does not worry him —he is used to it and has adopted the right gait. Ordinary walking

Fig. 5.
Photographs showing the patient's gait. A: Right lower limb at the end of the swinging phase, before weight was placed on it. B: The right lower limb in the supporting phase of the gait, with the patient's whole weight on the right lower limb. The marked bending of the pseudarthrotic site and the prominence of the region of the proximal end of the fibula during the leaning are clearly visible.

causes no pain at all. If he has to move about more than usual he feels some pain, especially at the proximal tibiofibular joint. Sometimes the tibial pseudarthrosis also gives some pain after stress. No pain has occurred in the knee or ankle.

Present condition.—In 1962, 22 years after the wound, the patient is 47 years old, his general condition is good, body-build well-proportioned, muscles strong. He is 171 cm. tall and weighs 67 kg. Local symptoms: a varus and recurvatum deformity can be seen at the border of the top and middle third of the right leg. Abnormal mobility to 25° in the sagittal plane and just over 10° in the frontal plane is also observed (Fig. 4). At this height in the posterior surface of the calf there is a small round scar marking the point of entry of the bullet. The anterior surface of the leg shows a cicatricial area of 3 × 10 cm. The muscles of the right lower limb are not atrophied, but it is 3 cm. shorter than the fellow limb. The right knee shows the full extent of movement. The

Fig. 6.
The pseudarthrotic site when the patient's weight is borne on the right leg. The bend, and the prominence of the fibular head are distinct when compared with X-ray pictures taken without loading (Fig. 2).

right ankle shows full plantar flexion, but dorsal flexion is restricted by 10°. The inversion and eversion of the right ankle are complete. The foot and toes are normal. Peripheral pulses are felt, normal and symmetrical in the limbs. No signs of nerve lesion can be found.

Function.—The patient wears no brace and walks without a stick. He limps slightly but can conceal most of the limp by using an easy and elastic gait. The patient can negotiate stairs well, too. When leaning on the right lower limb the pseudarthrosis shows the notable swing illustrated in Fig. 5.

X-ray finding.—The study of the roentgenograms reveals how the original tibia defect has filled, how it has been possible to achieve the state of weight-bearing and how the leg has shortened by 3 cm. despite an intact fibula. So the following points attract attention:

1) The right tibia has a pseudarthrosis at the margin between the top and middle third where the main fragments are joined by a separate fragment to fill the tibia defect (Fig. 2). The intermediate fragment has developed from those small pieces of bone seen in the primary pictures (Fig. 1).

2) The fibula is heavily hypertrophied. The medullar cavity has remained equal in size throughout to that of the left fibula, while the

Fig. 7.
Oblique projection showing the arthrotic changes that had developed in the upper tibiofibular joint: osteophytes on the edges of the joint surfaces of both the tibia and the fibula. The abnormally proximal position of the whole joint is also visible. It is surprising that no arthrotic changes are demonstrable in the knee joint or the talocrural joint.

corticalis is greatly thickened and shows increased density. In the lateral projection especially the thickening of the fibula is distinct. Measured from the roentgenograms, the thickness of the right fibula at the thickest point is 28 mm. and that of the left 19 mm. The medullar cavities at this level are 10 mm. wide, and thus the aggregate thickness of the corticalis is 18 mm. on the right and 9 mm. on the left. The thickening of the fibula is greatest on the ventral surface, but even in the other parts the corticalis of the right fibula is practically throughout twice as thick as that of the left (Fig. 2).

3) The right leg is shortened by 3 cm. although the fibula is intact. This is possible because of the shift of the capitulum fibulae about 2 cm. in the proximal direction at the proximal tibiofibular joint and the lateral arching of the fibular shaft. This shortening of the leg has been a very important factor in the filling of the defect.

4) The right knee joint and the talocrural joint show no secondary arthrosis, while the margins of the surfaces of the proximal tibiofibular joint show distinct marginal osteophytes (Fig. 7).

5) Exposures taken with the patient leaning on the right lower limb

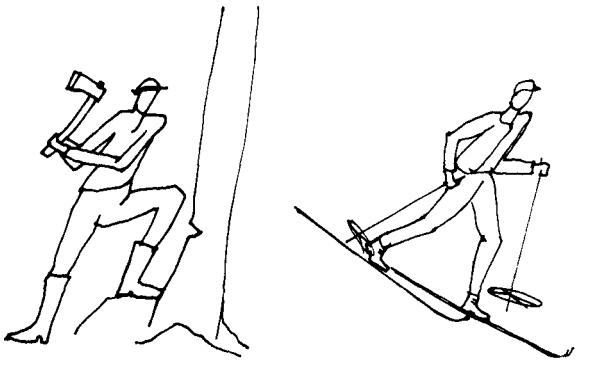

Fig. 8.
In sharp contrast to the anatomical changes are the patient's remarkable performances at work and sports achieved in general competition with healthy persons.

show marked bending in the tibial pseudarthrosis. The capitulum fibulae shows a distinct rise proximally under loading, its highest point becoming visible above the level of the tibial joint surface, while in exposures taken without loading it is below the articular slit (Fig. 6).

COMMENT

The subject involved in this case is an exceptional man with a strong will; his own attitude and activity have played a decisive role in his vicissitudes. But there are also points of general interest associated with the case. The primary treatment of the injury was quite routine. It obviously helped that so much tissue capable of producing viable bone remained in the area between the fragments that it could form an intermediate fragment to provide an important increase in stability. The subsequent progress depended entirely on the patient's own initiative. A remarkable self-rehabilitation took place which had a surprising outcome.

The development of the injured limb to tolerate weight-bearing was the result of the joint action of several structural and functional factors. The fibula was hypertrophied to give the leg adequate strength. The proximal shift of the capitulum fibulae, curving of the fibular diaphysis, and the development of the intermediary fragment overcame the continuity break in the tibia. The revived function of the muscles and other soft tissues constituted another natural prerequisite. It is striking that the patient overcame the pain and achieved an almost painless condition. The change to tolerate weight-bearing was a slow process

requiring a great deal of time and effort. But this change helped the patient to adopt a new attitude to life, and his restored self-respect made him again a socially active individual.

The end result is anatomically still quite poor. Complete stability was not achieved because fairly considerable mobility persisted in the pseudarthrosis. The degree of stability that was achieved, however, sufficed to permit a good functional result. The anatomical changes of the proximal tibiofibular joint were accompanied by some secondary arthrosis, but it is surprising that the distal tibiofibular union and the talocrural joint remained completely free from symptoms. It is also surprising that no arthrosis developed in the knee joint.

Rehabilitation alone produced in this case a result that might have been assumed to be impossible without surgery. Successful tibiofibular osteosynthesis might perhaps have given better stability. But the patient is still not interested in surgical treatment. And after all—the purpose of surgery is always only to create the conditions for the achievement of good function.

SUMMARY

A case of war injury is reported in which a gunshot wound gave rise to a tibia defect and pseudarthrosis. The treatment was given up after the primary stage and the patient was left on crutches. However, he began a process of self-rehabilitation by leaning on the injured limb. This had a striking outcome. After 9 years the patient walked with the aid of a stick only and after 11 years he even discarded the stick. The patient became capable of surprising performances at work, including heavy forest work, and he took part in some twenty skiing races a year for many years. The patient was examined 22 years after the injury. It was established that the intact fibula was heavily hypertrophied, the tibia defect was filled by an intermediate fragment and the distance between the main fragments was narrowed by shortening of the leg by a proximal shift of the capitulum fibulae in the proximal tibiofibular joint. There was still considerable mobility in the pseudarthrosis, but the instability had not prevented good function.

RESUME

Il est rapporté un cas de blessure de guerre dans laquelle une plaie due à une balle avait provoqué un défaut du tibia et une pseudarthrose. On avait renoncé à poursuivre un traitement après le stade primaire et

le malade était resté avec des béquilles. Il chercha néanmoins lui-même à procéder à une réadaptation en s'appuyant sur la jambe malade et obtint un résultat étonnant. Au bout de 9 ans le malade marchait avec l'aide d'une canne seulement et au bout de 11 ans, il avait même abandonné la canne. Le malade devint alors en état de fournir des prestations surprenantes de travail, y compris de durs travaux forestiers et il prit part à une vingtaine de courses de ski par an durant de nombreuses années. Le malade fut réexaminé 22 ans après la blessure. Il a été établi que le fémur intact était fortement hypertrophié. La partie manquante du tibia était remplie par un fragment intermédiaire; un rapprochement entre les principaux fragments s'était effectué par le raccourcissement de la jambe grâce à une modification proximale de la tête fémorale dans l'articulation proximale tibio-fémorale. Il y avaint encore une mobilité considérable de la pseudarthrose, mais l'instabilité n'avait pas empêche une bonne fonction.

ZUSAMMENFASSUNG

Ein Fall von Kriegsbeschädigung wird berichtet, in dem eine Schussverletzung einen Tibiadefekt und Pseudarthrose hervorrief. Die Behandlung wurde nach einem ersten Versuche aufgegeben und der Patient wurde den Krücken überlassen. Er begann jedoch mit einem Vorgehen von Selbst-Wiederherstellung indem er die beschädigte Gliedmasse etwas belastete. Dies hatte einen unerwarteten Ausgang. Nach 9 Jahren ging der Patient nur mit einem Stock und nach 11 Jahren konnte er den Stock ganz weglassen. Der Patient vollbrachte erstaunliche Arbeitsleistungen, darunter schwere Waldarbeit, und nahm viele Jahre an ungefähr zwanzig Skiwettläufen jährlich teil. Der Patient wurde 22 Jahre nach der Verwunderung untersucht. Man fandt, dass die intakte Fibula bedeutend hypertrophiert war, der Tibiadefekt war durch ein intermediäres Fragment ausgefüllt und der Abstand zwischen den Hauptfragmenten war durch Verkürzung des Unterschenkels mittels eines proximalen Gleitens des Capitulum fibulæ im proximalen tibiofibularen Gelenk verringert. Eine bedeutende, abnorme Beweglichkeit in der Psuedarthrose war noch immer vorhanden, aber der Mangel an Festigkeit hat eine gute Funktion nicht verhindert.