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Immediate ipsilateral fibular transfer in a large tibial defect using a ring fixator

A case report

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Abstract. *Massive segmental bony defects in open tibial fractures are generally treated with conventional bone grafting, a free vascularised fibular graft or the ring fixator technique. A vascularised fibular graft may be superior to a conventional bone graft, but it is technically difficult and occasionally impossible. In such circumstances, fibular transfer in conjunction with a ring fixator is an alternative method. This procedure can be accomplished by transferring the osteotomised part of the fibula to the tibia by means of olive wires. The authors have treated a 20-year-old male who presented with a Gustilo type IIIB open tibial fracture. The soft tissue defect was severe, only the tibialis posterior artery was patent and the peroneal artery was partially damaged. A latissimus dorsi flap was performed to cover the soft tissue defect. Since the patent tibialis posterior artery had already been used for the flap, it was difficult to perform a vascularised fibular graft. Moreover, it was technically difficult to accomplish a gradual transport using a ring fixator because the distal tibia was lost. For this reason, the fibular transfer was performed immediately after the ring fixator was applied. Good bony union and fibular hypertrophy were obtained even though these two procedures were undertaken simultaneously.*

Résumé. *Les dommages osseux importants dans les fractures ouvertes du Tibia sont généralement traités par une greffe osseuse conventionelle: on utilise soit une greffe de péroné vascularisée, soit la technique du fixateur (type llizarov). Une greffe de péroné vascularisée peut être meilleure qu'une greffe osseuse conventionnelle, mais c'est une greffe qui est techniquement, difficile et parfois impossible à réaliser. Dans ce cas, le transfert du péroné avec l'utilisation du fixateur externe (type Ilizarov) est une méthode alternative. Cette opération peut être accomplie en transférant la partie ostéotomisée du péroné sur le Tibia au moyen de cables «olives». Récemment, un jeune homme de 20 ans a présenté une fracture ouverte du Tibia de type Gustilo IIIb. Les dommages causés aux tissues étaient sévères. Seule l'artère tibiale postérieure était perméable et l'artère péronéale était partiellement endommagée. Un recouvrement par lambeau de grand dorsal fût réalisé afin de couvrir les tissues endommagés. Le seule artère tibiale postérieure étant déjà utilisé pour le recouvrement, il était difficile de réaliser une greffe de péroné vascularisée. De plus il était techniquement difficile d'accomplir un déplacement graduel en utilisant la fixateur externe (type Ilizarov) car la partie distale du Tiba était perdue. Ainsi, un transfert de péroné fût immédiatement réalisé avoir appliqué le fixateur externe. Une bonne fusion osseuse, ainsi qu'une hypertrophie du péronée ont été obtenues, bien que ces 2 opérations aient été effectuées simultanément.*

Introduction

Conventional bone grafts and free vascularised fibular grafting are methods of treatment of large defects after severe open fractures [2–4, 7, 10, 13]. A vascularised fibular graft is superior to a conventional bone graft [1, 5, 15, 16], but it is technically difficult and occasionally impossible, due to vascular injury [6]. As an alternative to this procedure, the transfer of the

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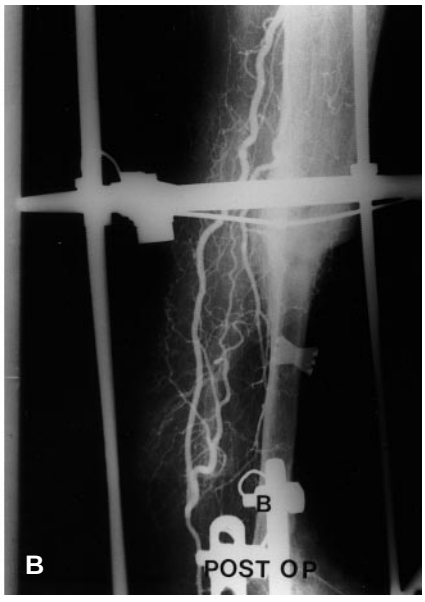

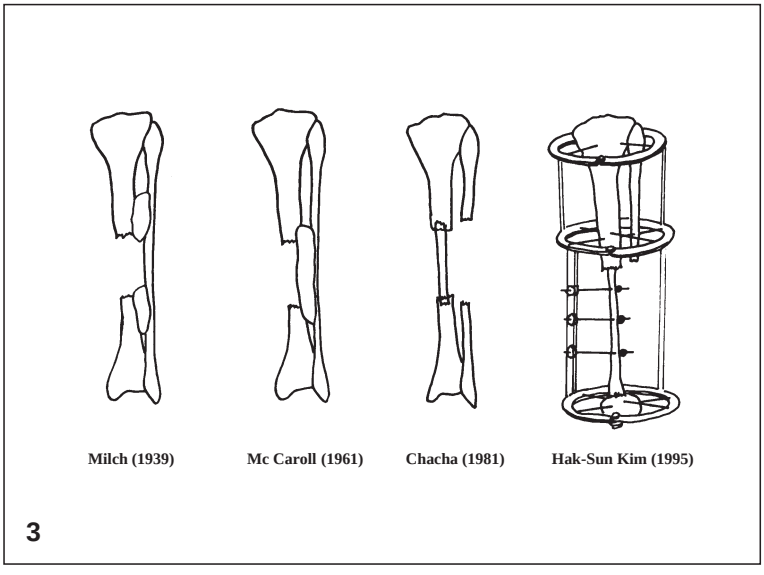

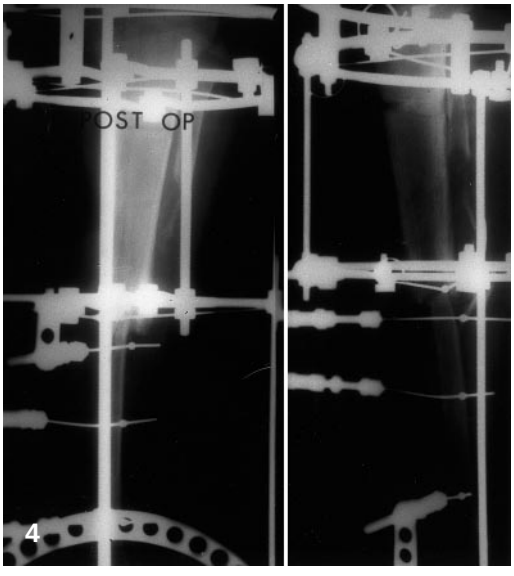

Fig. 1. Radiographs of the right tibia and fibula of a male aged 20 years after a severe open fracture. A defect of nearly 17 cm is present in the tibia

Fig. 2. A Preoperative arteriogram, **B** postoperative arteriogram showing the tibialis posterior artery and the patent perforating branches of the peroneal artery

Fig. 3. Comparison of previously reported methods with the authors' procedure. This figure illustrates the application of traction olive wires to achieve fibular transfer, which was performed acutely

Fig. 4. Postoperative radiograph showing ipsilateral fibular transfer performed with olive stop wires

Fig. 5. A Anteroposterior radiograph at final follow-up, illustrating union and hypertrophy of the fibula. **B** The patient could walk well with aid of a cane

ipsilateral fibula (Fig. 3) into a large defect in the tibia has been reported [2]. Primarily, this technique seeks to achieve a secure synostosis of the fibula to the tibia in its lateral eccentric position. In the presence of a large tibial defect, this leads to asymmetrical loading through the fibula, which is biomechanically unsound and at risk of failure. To improve biomechanical stability, a central vascularised pedicle graft of the ipsilateral fibula has been employed [2, 14]. However, this method also requires the use of a specialised vascular technique. To overcome this disadvantage, we performed an alternative, non-microvascular surgical procedure; this ipsilateral fibular graft (IFG) for the reconstruction of severe tibial and soft tissue defects proved to be successful.

Case report

A male aged 20 years sustained a Gustilo type IIIB open tibial fracture with 10×20 cm soft tissue defect in a motor vehicle accident (Fig. 1). During the emergency operation, the intention was to carry out debridement and fixation, and the proximal tibia and talus were anchored with ring fixators. A femoral angiogram revealed that the tibialis anterior artery was completely disrupted and the distal portion of the peroneal artery was partially injured; the tibialis posterior artery was shown to be patent (Fig. 2A). The state of the leg was considered critical and the prognosis was very uncertain. Below knee amputation was suggested, but the patient refused.

The soft tissue defect was reconstructed by transferring a 10×20 cm latissimus dorsi free flap four weeks after the injury. In the lower zone of the injury an anastomosis was undertaken with the tibial posterior artery. Three months later two rings were added and corticotomy was performed on the proximal tibial diaphysis. Gradual transportation of the osteotomised segment was started ten days later. This procedure failed because the proximal tibial cortex was too weak and was penetrated by olive wires. Bone elongation using ring and connecting wires would have been risky as the connecting wires were on the right oblique and left oblique sides of the tibia, and could have damaged the vascular pedicle of the free flap (Fig. 2B).

The fibula was exposed through a 4 cm longitudinal incision on the proximal defect of the tibia and a 3 cm incision over the lateral part of the ankle joint. It was divided proximally and distally, and at each osteotomised site 2–3 mm was trimmed to facilitate mobiliation of the graft. Preparation for the docking sites was made so that both ends of the fibula could be packed by reaming 5 mm in depth of the tibial medullary canal and the talus. Immediate fibular transfer was performed using olive wires in the operating room. After the osteotomised fibula had been moved toward the distal tibia and talus, the fibula was further adjusted manually and placed in the prepared intramedullary canal of the tibia and in the talus. It was fixed to the tibia and talus with olive wires, and care was taken not to injure the nutrient vessel of the flap (Fig. 4). A cancellous bone graft was packed around both sides of the graft.

An arteriogram 10 months after the operation showed excellent circulation in the transferred fibula and patent perforating branches of the peroneal artery (Fib. 2B, arrow). Good bony union and fibular hypertrophy had been obtained even though fibular transfer had been undertaken as an emergency measure. Sensation in the sole of the affected foot was preserved and medication for pain was not required. The length of the affected leg was 2 cm shorter than that of healthy leg. The patient was walking with a brace 19 months after the initial fracture and 16 months after the operation. The total cost of the multiple procedures was five times that of an amputation alone. Despite the satisfactory outcome, the patient transferred from his occupation as a mechanic to a secretarial post (Fig. 5A, B).

Discussion

Primary amputation [8] is advisable when the distal limb is not viable, but when the circulation in the toes remains brisk and sensation is preserved in the sole of the foot, it is difficult to recommend this procedure. Conventional bone grafting is useful for short defects (<6 cm) in a well vascularised, non-infected bone. However, defects larger than 8 cm may exceed the available supply of cancellous bone [7]. In a large defect, conventional bone grafting poses risks of nonunion and infection; in these circumstances further operations may be necessary [1,12]. In order to avoid these complications, a vascularised fibular graft has been used extensively for reconstruction [1, 3, 5, 9, 11, 13–15, 17]. If only one vessel remains uninjured vasularised fibular transfer is difficult and ipsilateral fibular transfer may be the safest method of limb salvage. In our patient, as the only patent artery had already been used, repeated microvascular surgery presented technical difficulties.

Chen and Yan [3] noted that up to 10×20 cm of skin may be harvested with the fibula. However, transfer of a large skin island creates a significant donor defect, and staged reconstruction has been suggested [6]. It is for this reason that we opted for staged reconstruction in our patient.

Transfer of the ipsilateral fibula has been reported by several authors [11, 14]. The majority of these techniques seek to obtain a secure synostosis of the fibula to the tibia in its eccentric position. This leads to uneven loading through the fibula, which is biomechanically unsound and stands a risk of failure.

The use of the IFG with an intact blood supply through its perforating branches provies a large living graft. Kim et al. [11] reported that IFG had the same advantages as a free vascularised fibular graft. With angiography, we have shown good evidence of the viability of such a graft (Fig. 2B).

Chacha et al. [2] reported excellent results in 10 cases (19%) and Kirn et al. [11] in 2 cases (100%). Nevertheless, the microvascular technique which was used is a highly specialised technique involving harvesting of the ipsilateral fibula, and it is not readily available even in major centres. The disadvantage of Chacha's method is the high degree of specialisation which is required. The objective of our approach was similar to that of Shapiro but differed in two respects. Firstly, no exposure of the vascular pedicle was involved and secondly, transposition of the fibula was achieved with the use of olive wires. We believe that our method is easier than Shapiro's because the vascular pedicle is not exposed.

Ebraheim et al. [4] reported that fibular transfer may be carried out by using the Ilizarov method with

olive wires. Traction on the olive wires and subsequent fibular transport is achieved by turning the nuts 1 mm per day. In our patient it was technically difficult to accomplish gradual transport using a ring fixator because the distal tibia was lost. For this reason, the fibular transfer was performed immediately after a fibular osteotomy. Although we have presented only one case, and the salvaged limb was scarred and ugly, we consider that this procedure can be used as an alternative method of management of difficult tibial fractures. The patient considered that this approach was preferable to amputation although the procedure was very costly.

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