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Current Problem Case

Reconstruction of a Large Tibial Defect with a Free Vascularized Fibular Graft

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Summary. A successful reconstruction of a large tibial defect with a free vascularized fibular graft is presented. The fibular graft demonstrated a significant hypertrophy 2 years postoperatively.

Zusammenfassung. Die erfolgreiche Rekonstruktion eines ausgedehnten Tibiadefektes mit einem freien, vaskularisierten Fibulaspan wird vorgestellt. Der Fibulaspan zeigte 2 Jahre nach der Operation eine eindeutige Hypertrophie.

Recent advances in microsurgery now have made free vascularized bone graft a clinical reality. This paper reports a successful reconstruction of a large tibial defect with a vascularized fibular graft.

Case Report

A 28-year-old male sustained a compound fracture of his right tibia and fibula, as a result of a motorcycle accident on July 19, 1978. The wound was cleansed and closed elsewhere. As the wound became infected, he was transferred to our hospital in September 1978.

Examination, two months after injury, revealed purulent discharge and scarred, attenuated skin over the anterior aspect of the tibia. Roentgenogram showed double fracture of the right tibia and fibula.

On September 20, sequestrectomy was performed. At the operation, all sequestra including the dead, grossly contaminated central fragment of the tibia, and other necrotic tissues were removed. The resultant defect in his tibia measured 11 cm (Fig. 1). Sequestrectomy was followed by closed irrigation which continued for fourteen days. Drainage subsided and the wound healed.

Because of the size of the defect in his tibia, the results of the conventional methods of bone grafting appeared to be unpredictable because of a slow healing process. Possibility of free vascularized fibular graft was then considered. A preoperative angiogram revealed the patent peroneal artery as well as the obstructed anterior and posterior tibial arteries in the right leg. The opposite leg maintained the normal arterial supply to the fibula.

Operation

A free vascularized bone graft was performed on January 24, 1979 (Fig. 2). Under general anesthesia, the patient was placed in the supine position, and pneumatic tourniquets were employed to assure non-bleeding operative fields. The vessels were identified and isolated at the recipient site. Because the peroneal artery appeared to be the dominant vessel in the recipient leg, the anterior tibial vessels were selected as the recipient vessels. The anterior tibial compartment of the right leg was explored. With some difficulty, the anterior tibial artery and its venae comitantes were exposed which demonstrated suitable flow. The two ends of the tibia were debrided and prepared to receive the fibular graft.

A Henry approach was utilized to expose the donor fibula. The attachment of the soleus to the fibula was divided parallel

Fig. 1. Radiograph showing the 11 cm defect in the tibia

to the fibula, and the peroneal and posterior tibial vessels were identified. The peroneal vessels were preserved carefully along with their branches supplying blood to the fibula. Dissection was continued distally and posteriorly while preserving a 1-cm-thick muscle cuff circumferentially around the fibula, thereby preserving the nutrient artery and periosteal vessels. This

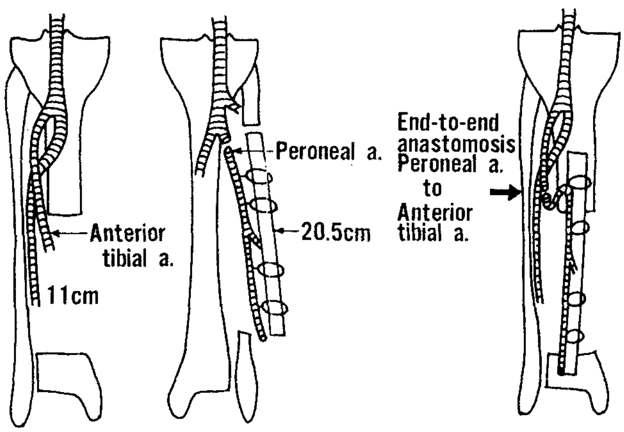


Fig. 2a–c. Diagram of the free vascularized fibular transfer: **a** 11 cm bone defect in the right tibia; **b** 20.5 cm segment of the fibula isolated on its vascular pedicle consisting of the peroneal artery and its venae comitantes; **c** fibular graft in place with end-to-end anastomoses of the peroneal artery and its accompanying vein to the corresponding anterior tibial vessels

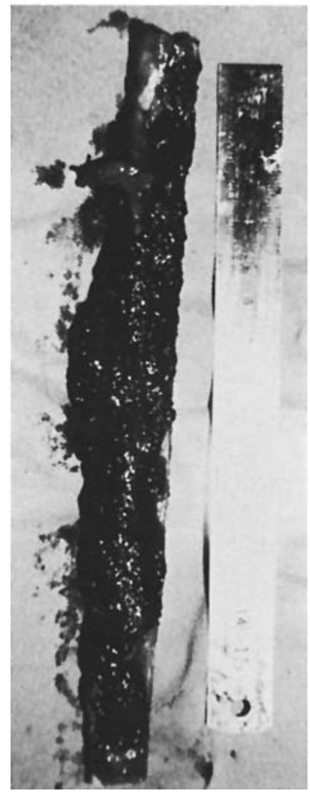
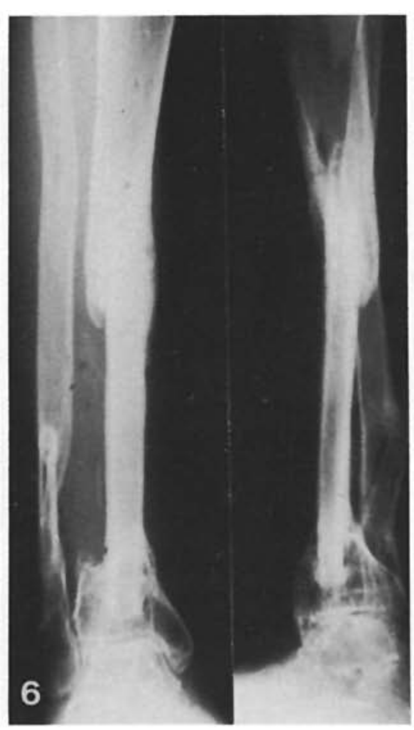


Fig. 3. The composite fibular graft, ready to be placed



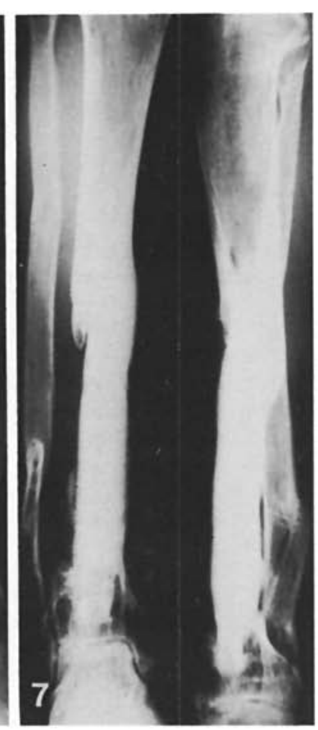


Fig. 4. Radiographs at 3 months post-op.

Fig. 5. Angiogram showing a patent anastomosis *(arrow)* at 15 months post-op.

Fig. 6. Radiographs at 21 months post-op. when the patient felt dull pain in the right shin

Fig. 7. Radiographs showing significant hypertrophy of the graft at 24 months post-op.

muscle cuff consisted of the soleus proximally, flexor hallucis longus medially and peronei laterally. The dissection was then extended arteriorly and the anterior aspect of the fibula was isolated, protecting the anterior tibial vessels and deep peroneal nerve. A 20.5 cm segment of the fibula was transected at the predetermined levels with a Gigli saw. The distal ends of the peroneal artery and venae comitantes were ligated and divided. The interosseous membrane was divided and the composite fibular graft was isolated entirely on its vascular pedicle. The peroneal vessels were sectioned at their bifurcation from the posterior tibial vessels and the composite fibular graft was transferred to the recipient leg (Fig. 3).

The proximal end of the fibular graft was placed into the slot in the proximal tibial segment and the distal end of the graft was doweled into the medulla of the distal tibial segment: 3 transfixing screws were used for immobilization.

Microvascular anastomoses of the donor peroneal artery and its accompanying vein were performed to the corresponding anterior tibial vessels of the recipient leg, with interrupted 9-0 nylon sutures. Upon completion of the anastomoses, there was brisk arterial bleeding from the muscle sleeve with a satisfactory venous return along venae comitantes. Direct closure of the wounds was easily achieved for both the donor and recipient limbs. The right limb was immobilized with a cast above the knee.

Progress

The postoperative course was uneventful. An angiogram 7 weeks postoperatively revealed a patent anastomosis with re-establishment of the peroneal vascular tree of the graft. At 3 months, the leg was placed in a patellar-bearing brace and gradual partial weight-bearing was allowed (Fig. 4). At 11 months, a sound clinical and radiological union of the graft was evident—allowing full weight-bearing on the graft. In April 1980, the transfixing screws were removed. An angiogram at this time revealed a patent anastomosis (Fig. 5). At 21 months, the patient felt dull pain in the right shin. The clinical features suggested a stress fracture of the fibular graft but an X-ray examination indicated no apparent fracture line (Fig. 6). The pain subsided spontaneously within six weeks. At 24 months, X-ray examination revealed a significant hypertrophy over the entire graft reaching to almost twice its original thickness (Fig. 7). At present, the patient has no disability in either leg. Residual shortening of the affected tibia measures 2 cm.

Discussion

The difficulty of bridging large bone defects in compound wounds is well known to all who practice bone surgery. The conventional methods available to bridge a large bony defect in the tibia can be summarized as follows.

1. Autogenous cortical bone grafts (hemicylindrical grafts, fibular grafts, etc.).
2. Transference of the fibula.
3. Tibiofibular fusion.

In autogenous bone grafts, the majority of osteocytes undergo necrotic changes, requiring the eventual replacement of the dead bone by creeping substitution. It is believed that autogenous cortical bone grafts are incorporated very slowly, and that spontaneous fractures are commonly defeating the purpose of grafts with large defects. When the tibiofibular fusion is established by method 2 or 3, a single fibula is subject to stress and strain and may easily fracture. This leads to an extended period of external support. For our patient, our logical reaction was to perform a living bone graft with microvascular anastomoses. Since the nutrient blood supply is preserved by microvascular anastomoses, osteocytes in the graft continue to survive, permitting simple fracture healing at the graft-recipient bone juncture. It is commonly accepted that a living bone graft accelerates the bone union and minimizes the period of immobilization.

Transfer of free living bone was initiated by McCullough and Fredrickson [1] and Östrup and Fredrickson [2], who successfully transferred living rib bone grafts to the mandible of dogs. The first clinically successful free vascularized bone graft was achieved by Taylor et al. [3] in 1975, utilizing a fibular segment from the opposite leg to reconstruct a large tibial defect.

With our case under discussion, the vascularity of the fibular graft was confirmed by the postoperative angiogram and the postoperative course was nearly identical with the one reported by Taylor et al. [4]: at 11 months, solid bony union was established and at 2 years the free vascularized fibular graft showed a significant hypertrophy.

However, care must be taken in following this technique with regard to certain aspects. This procedure is not recommended unless a satisfactory recipient artery is confirmed to provide a normal blood flow to the bone graft. It is a lengthy operation ($6^3/_4$ h in this case) and patency of the anastomoses cannot be assessed for a possible revision in the immediate postoperative phase.

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