Management of postinfection defects in long bones with a vascularized fibular bone graft

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Received 2 October 2012
Accepted 2 January 2012

The Egyptian Orthopedic Association 2013, 48:289–294

Background
Management of chronic osteomyelitis is a difficult task, complicated by problems including combined bone and soft-tissue loss, bacterial colonization, fibrotic local tissue, and local factors detrimental to wound healing. Vascularized bone grafts, by definition, are placed with their vascularity intact and are thus immediately viable.

Objective
The aim of this study was to review the clinical and radiographic results of a vascularized fibular graft (VFG) in the management of defects in upper and lower limbs with chronic osteomyelitis.

Patients and methods
Six patients with chronic osteomyelitis (two tibiae, two ulnae, one femur, and one radius) underwent radical debridement, followed by reconstruction using a VFG, and were evaluated for radiographic and clinical success using standard anteroposterior and lateral radiographs. Four men and two women were included and their average age at surgery was 38.8 years (range 30–50 years). Union, solid hypertrophy, range of motion, grip strength, failure of anastomosis, and recurrence of infection were evaluated at the final follow-up.

Results
Radiological assessment indicated union in all cases after an average period of 10.6 weeks in upper limb cases and 18 weeks in lower limb cases. Solid hypertrophy and weight bearing were allowed for lower limb cases after an average period of 12 months. No failure of the graft or recurrence of infection was encountered in this study.

Conclusion
VFG for the reconstruction of long bone defects following radical debridement in cases of chronic osteomyelitis effectively achieves union and eradicates infection.

Keywords:
long bone defect, postinfecion, vascularised bone graft, vascularised fibula

Egypt Orthop J 48:289–294

1110-1148

Introduction

Vascularized bone grafts (VBGs), by definition, are placed with their vascularity intact, and are thus immediately viable. As a result, VBGs obviate the need for incorporation by creeping substitution and may instead incorporate into the adjacent host bone through primary (or secondary) bone healing. This process allows for the mechanical strength and structural integrity of the vascularized graft to be preserved, which may confer greater strength and more immediate stability to the recipient site [1]. Osteomyelitis is difficult to treat as infection is characterized by progressive inflammatory destruction and new apposition of bone [2]. Treatment for chronic osteomyelitis of long bones presents one of the most difficult challenges for the reconstructive surgeon [3]. The mainstay of treatment for chronic osteomyelitis is surgery. Until recently, however, the disease was particularly frustrating for the patient and the surgeon because of its persistence despite multiple surgical interventions and prolonged antibiotic regimes [4]. Management of chronic osteomyelitis is a difficult task, complicated by problems including combined bone and soft-tissue loss, bacterial colonization, fibrotic local tissue, and local factors detrimental to wound healing [5]. Adequate treatment of the disease process requires radical debridement of all involved tissue, including soft-tissue scarring, and bone resection until only clearly viable tissue remains [6]. Resolving chronic osteomyelitis is problematic primarily because of three issues: inadequate debridement caused by concerns about preservation of structural integrity, difficulties related to soft-tissue reconstruction in wound management, dead-space coverage, and bone-defect reconstruction, especially when the defects are greater than 6 cm [7].

Microsurgical advances have established the concept of free distant transfer of VBGs using immediate anastomosis of the nutrient vessels [8]. The VBGs retain their intrinsic blood supply, and viability is preserved, so that healing occurs by simple fracture union rather than creeping substitution after bone transfer [9]. Therefore, bone union and graft hypertrophy may be hastened and the viable cortical structure can lead to better mechanical support [10].

Patients and methods

Between 2007 and 2011, six patients with chronic osteomyelitis of long bones were treated with radical debridement and reconstruction with a vascularized fibular graft (VFG) in the orthopedic department, Benha University, and El Helal Hospital. The mean age of the patients was 38.8 years (range 30–50 years), four men and two women. The affected bones were two tibiae, two ulnae, one femur, and one radius. The average bone loss after debridement was 13 cm. The average follow-up period was 24.3 months (range 16–36 months).

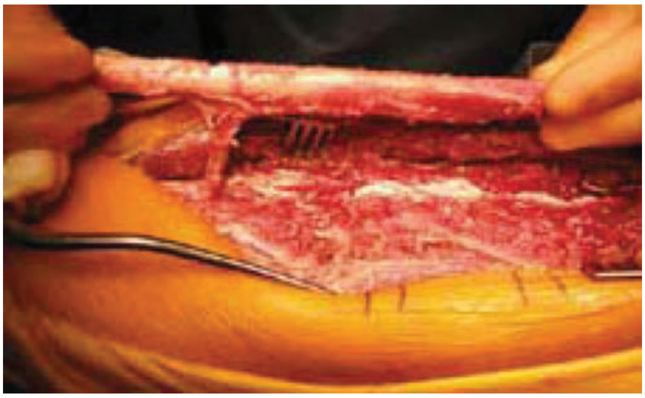
Surgical technique

All cases were done under general anesthesia; the first step was exploration of the site of infection and radical debridement. All nonviable infected hard and soft tissues were removed, leaving only the healthy viable tissues. The second step was reconstruction of the resultant defect by obtaining a fibular graft with its nutrient artery and vein. When the fibula is to be harvested without accompanying skin or soft tissue, a longitudinal incision is made over the lateral aspect of the fibula (Fig. 1). Superficial dissection was performed in the interval between the peroneus longus muscle anteriorly and the soleus posteriorly. The diaphysis of the fibula was circumferentially exposed, with care being taken to preserve the periosteum and periosteal blood supply. This results in the typical 'marbled' appearance to the fibular graft. Circumferential dissection of the fibula was continued anteriorly and posteriorly, reflecting the peroneal and flexor hallucis longus muscles, respectively. The peroneal artery and vein were identified along the posterior aspect of the fibula and carefully protected as the intermuscular septum was divided along the length of the proposed graft. The fibula was osteotomized proximally and distally, with preservation of the peroneal vessels (Fig. 2). Once the recipient site was prepared, the vascular pedicle may be divided and the fibula transferred to the desired location. Following stabilization of the fibula to the recipient site, fixation of the graft was performed using an external fixator for lower limb bones (Ilizarov for the femur and a uniplanar fixator for the tibia). Fixation was performed using an intramedullary rod for the radius and ulna. Microvascular anastomoses were performed, reconstituting both arterial inflow and venous outflow to the fibular graft (Fig. 3). Skin and muscle graft may be obtained with the fibula according to the need.

Figure 1

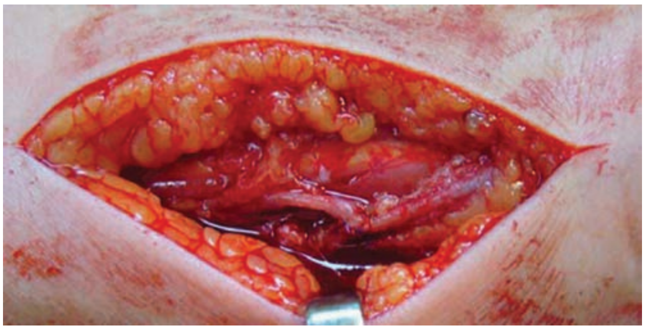
Skin incision, the site of nutrient artery, and the desired length were marked.

Figure 2



Fibula obtained with the peroneal vessels.

Figure 3



Anastomosis between the peroneal artery and the ulnar artery in a case of ulnar reconstruction.

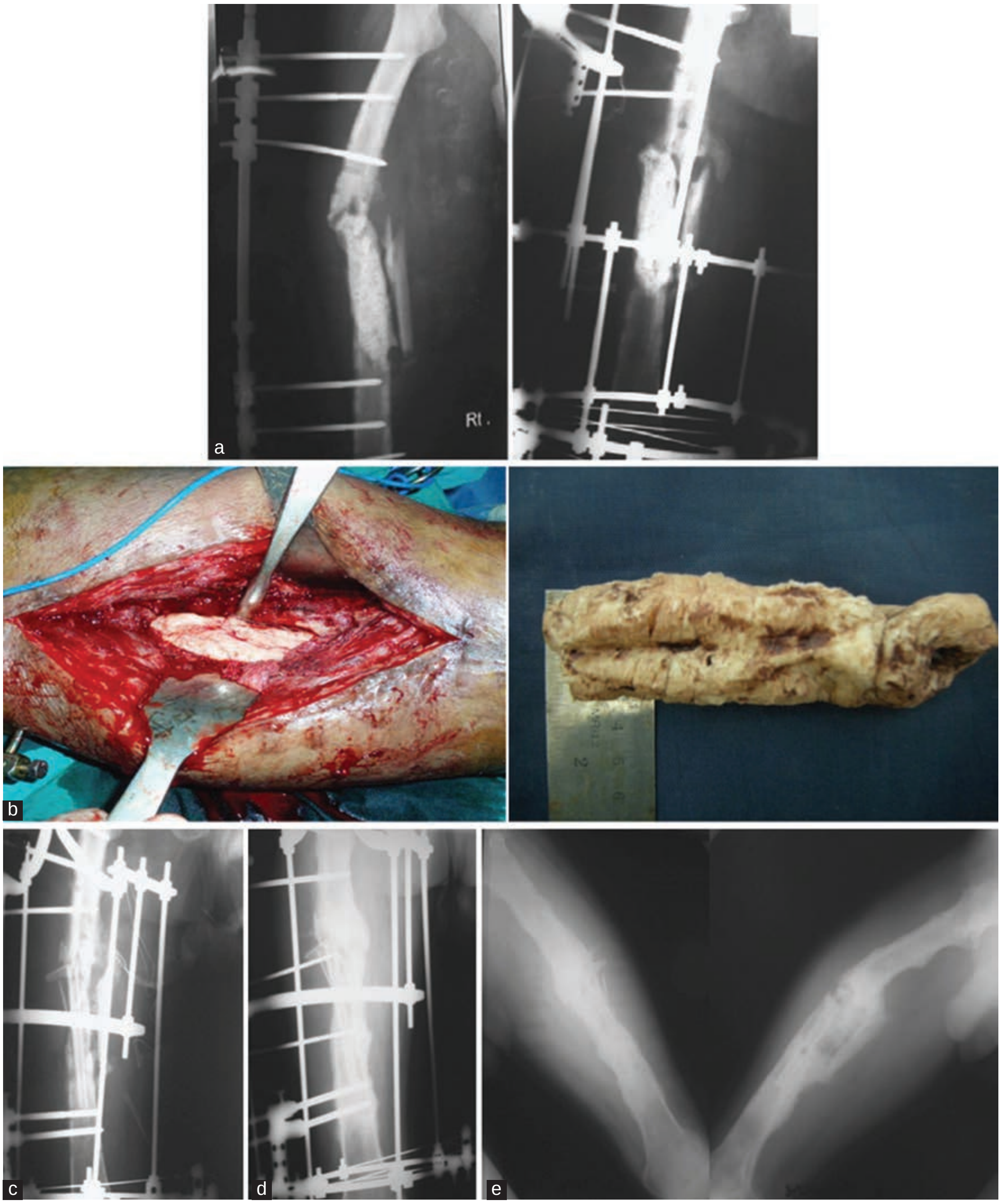
Postoperatively, the patients were evaluated every 2 weeks clinically and radiologically for signs of union and recurrence of infection. When union was achieved, range of motion (ROM) exercises of the nearby joints were started without weight bearing in lower limb cases until solid hypertrophy of the fibula occurred, and then the fixator was removed and weight bearing was started.

Union was achieved in all cases without need for another operation as debridement was radical so, debridement done until viable bleeding bone reached. Thus, debridement was performed until viable bleeding bone was reached. When fibula was harvested, the periosteal envelope was longer than the fibular graft by 3 cm on each side and the periosteum in the recipient site was repaired; this enhanced healing at both ends of the graft (Figs 4 and 5).

Figure 4

A 40-year-old female patient with an infected plate ulna. (a) Infected nonunion ulna with plate fixation. (b) After debridement and plate removal. (c) Second debridement and maintance of length with bone cement and intramedullary rod. (d) Reconstruction with vascularized fibular graft and intramedullary fixation. (e) Reconstruction with vascularized fibular graft. (f) Union of the proximal and distal end. (g) After full union and removal of wires.

Figure 5



A 50-year-old male patient with an infected nonunion femur. (a) Infected nonunion femur, removal of an external fixator, and application of an Ilizarov fixator with correction of angulation. (b) Debridement and removal of necrotic nonviable bone. (c) Reconstruction of bone defect with a vascularized bone graft. (d) Full union of the gap defect. (e) Complete union with removal of the fixator.

Evaluation

Patients were evaluated radiologically for union and clinically for anastomosis failure, recurrence of infection, and development of any complication.

Results

All patients achieved radiological union after a period ranging from 12 to 20 weeks. The average time was 18 weeks for lower limb cases and 10.6 weeks for upper limb cases; the average time for all cases was 14.3 weeks (Table 1).

In the femur and tibia, solid hypertrophy and weight bearing were achieved after 12 months. In the radius and ulna, the hand grip achieved 90% of the other side. The ROM of nearby joints reached 93% of the other side. Nonunion, recurrence of infection,

Table 1 Patient data

N	Age (years)	Sex	Affected bone	Bone loss (cm)	Fixation	Time for union (weeks)	Weight bearing for LL/hand grip for UL	ROM of nearby joints	Complications	Follow-up (months)
1	50	Male	Right femur	16	Ilizarov	20	14 months	100% of other side	No	36
2	40	Female	Left ulna	14	Intramedullary rod	12	85% of other side	90% of other side	No	30
3	35	Male	Right radius	10	Intramedullary rod	10	90%	95%	No	26
4	40	Female	Left tibia	15	Uniplanar external fixator	18	12 months	85%	No	20
5	38	Male	Right tibia	12 cm with skin loss	Uniplanar external fixator	16	10 months	100%	Pin-tract infection	18
6	30	Male	Right ulna	11	Intramedullary rod	12	95%	100%	No	16
Mean	38.8	4 males and 2 females	4 right and 2 left 3 UL and 3 LL	13	3 intramedullary rod and 3 external fixator	14.3	12 months/90%	93%	–	24.3

LL, lower limb; ROM, range of motion; UL, upper limb.

and anastomosis failure did not occur in any of the cases and no additional operations were needed. The average follow-up period was 24.3 months (range 16–36 months).

Complication

Pin-tract infection occurred in one case and responded to antibiotic, and did not affect the overall results.

Discussion

The mainstay of treatment for patients who have chronic osteomyelitis is a combination of surgical debridement and systemic antibiotic therapy. Successful treatment for osteomyelitis depends on four essential surgical procedures.

(1) Radical debridement: all contaminated hard and soft tissues are removed until only well-vascularized healthy tissue is encountered.
(2) Obliteration of the resultant dead space.
(3) Bone stabilization.
(4) Bridging of the bone defect [10].

In the present study, six patients with chronic osteomyelitis were treated with removal of radical debridement necrotic infected nonviable tissues and reconstruction of the resultant defect with VFG in five cases and with VFG with skin in one case.

Recurrence of infection did not occur in any case because of wide debridement and closure of the resultant gap with a vascularized graft, which promoted healing and eradication of infection.

Stress fracture did not occur in any case because of the secure fixation of the graft and loading of the graft delayed until secondary hypertrophy occurred in fibula.

Early ROM exercises of the nearby joint aided by secure fixation and good union yielded excellent ROM of nearby joints and almost normal hand grip power in upper limb cases.

Pin-tract infection occurred in one case. This was superficial and resolved with a short period of medical treatment without the need for pin change.

Tu and Yen [11] reported success rates ranging from 80 to 95% in patients who underwent free VBGs for reconstruction of segmental long bone defects in the lower extremity with long segmental bone loss after acute post-traumatic or chronic osteomyelitis, with follow-up of at least 5 years (range 5–14 years; mean 7.5 years). The patients ranged in age from 14 to 69 years (mean 45.3 years). The mean duration from confirmation of infection to microsurgical reconstruction was 5.2 months (range 2 weeks to 6 years). In this study all cases had lower limb long bone defect there was no patients with upper limb bone defect also the graft used were fibular and iliac bone graft.

VFG seems to be a valuable reconstructive technique for the treatment of chronic osteomyelitis. The indication for VFG is a skeletal defect greater than 6 cm in length. Vascularized bone can obliterate dead space, bridge large bone defects, enhance bone healing, resist infection by ensuring blood supply, allow early rehabilitation, and ensure better clinical outcomes in the treatment of long bone osteomyelitis.

Conclusion

VFG for the reconstruction of long bone defects following radical debridement in cases of chronic osteomyelitis effectively leads to union and eradicates infection.

Acknowledgements

Conflicts of interest

There are no conflicts of interest.

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