INTRODUCTION

Gap non-union is one of the most perplexing problems facing the orthopedic surgeon today due to the advancements in trauma and tumor diagnosis and management. Gap non-unions may be caused either by trauma, tumor excision or bone loss due to osteomyelitis. Fibular bone graft with metallic implant stabilization is one of the definitive management in gap non-unions.1-3 The other effective method is Ilizarov ring fixator or monorail systems, using the principle of distraction osteogenesis.4-6 But compared to fibular grafting, fixators have morbidity associated with them, need expertise for application and also have low patient compliance. Fibula is the preferred site of non-vascularized bone graft due to its easy accessibility to surgical resection and minimal donor site complications.7 Fibular grafting therefore due to the above mentioned advantages is the better technique in developing countries where the necessary infrastructure and skill may not always be available and patient compliance to follow up is poor. The aim of study is to evaluate functional outcome of non-vascularized fibular graft in gap non-union.

METHODS

We conducted a retrospective study in Grant Medical College and Sir JJ group of hospitals Mumbai from August 2016 to May 2019 which included 11 patients of gap non-unions. The age of the patients ranged between...
13 to 80 years (mean=34.9 years). Of the 11 patients 5 (45%) were male and 6 (55%) females. The average bone gap was 7 cm (4-13 cm). The technique involved thorough debridement and clearance of fibrotic tissue and crushed devitalized bone or tumor to create a gap. The fibular graft was harvested from the mid shaft region under tourniquet using the standard posterolateral approach. For tibial and fibular defects, the contralateral leg was used as a donor site. The graft was fixed at the site of gap using plate and screws in 7 (64%) patients, Tens nail in 3 patients and monorail system (LRS) in one patient (Figures 1 and 2). Cancellous bone graft taken from the iliac crest was applied at both ends of the fibular graft to aid in union.

Postoperatively limb was immobilized for variable period’s minimum being 6 weeks in appropriate slab or cast. All patients were given Intravenous antibiotics in perioperative period and continued post operatively for 48 hours to 7 days depending on surgical site condition. Post 48 hours patients were shifted on oral antibiotics for 5 days. Follow up was conducted at 1 ½ months, 3 months, 6 months, 9 months, and 12 months and later at 6 monthly intervals till the time of submission of this article. Follow up focused on identifying complications and conducting serial radiographs to assess union. In doubtful cases, a metal artifact reduction system-computed tomography scan was done to assess union.

The statistical analysis was done by using SPSS-20.

RESULTS

Out of the 11 patients included in the study, 5 (45%) were males and 6 (55%) were females (Figure 3). Of the 11 patients with gap nonunion, 6 (55%) involved the femur, 1 tibia, 1 fibula, 1 humerus, 1 radius and 1 ulna (Figure 4). Of the 11 gap non unions 7 (64%) were due to trauma, 2 were due to tumor excision, 2 were due to osteomyelitis (Figure 5).

Figure 1: (A) A 25 year female presented with a chronic slowly growing swelling of the left forearm which on further investigations was found to be fibrous dysplasia of the ulna; (B) patient underwent complete resection of the tumor with non-vascularized fibular graft interposition with fixation with TENS nail (immediate post-op radiograph); (C) a 24 week follow up shows complete integration of the graft with union at both ends.

Figure 2: (A) 24 year female presented to us with bone loss in the radius due to osteomyelitis developed in a case of plating for radius and ulna where in the radius plate got infected and was removed along with infected bone and exfixator was done; (B) after confirming the non infective nature of the tissue by various blood parameters and local bone biopsy, we operated the patient with local debridement followed by non-vascularised fibular bone graft and fixed it with a tens nail (immediate post-op); (C) 24 weeks follow-up radiograph reveals complete union at both ends.

Figure 3: Sex distribution.

Figure 4: Distribution according to bone involved.

The patients were followed up for a mean period of 56 weeks (24 to 80 weeks). The average bone gap was 7 cm (4-13 cm). 64% of the patients achieved bone union after the first procedure. One of these, a case of radius shaft osteomyelitis managed with excision and fibular bone grafting with tens nail, developed a superficial infection...
at the surgical incision site which was managed with five days of intravenous antibiotics followed by oral antibiotics. Patient had an uneventful course with bony union achieved at 24 weeks. Of the remaining 4 patients, one patient a case of femur shaft gap non-union managed with fibular strut graft with distal femur plating in an operated case of bipolar hemi-arthroplasty, the patient had a stress fracture at the tip of the bipolar prosthesis at 54 weeks follow-up due to weight bearing which further complicated the union process resulting in non-union till present follow up at 74 weeks. Another patient a case of femur shaft gap non-union operated with fibular strut graft with angle blade plating showed signs of graft resorption from site at around 50 weeks follow up. This was managed with multiple sittings of bone marrow aspiration and injection over the fibular graft followed by one sitting of tricortical bone graft, harvested from the iliac crest, at the resorption site. This patient achieved union at 18 weeks following the second grafting surgery. In a similar case of resorption following being operated for a similar fracture, was still found to be in non-union at present follow up of 80 weeks and is now planned for bone marrow aspiration and injection followed by bone grafting. In the latest case of tibia shaft gap non-union due to trauma, fibular bone grafting with monorail system or limb reconstruction system (LRS) was attempted with a patient. Present follow up of 16 weeks still not showing any signs of union, but this patient needs subsequent follow ups to assess the same.

**Figure 5: Cause of gap nonunion.**

The average limb shortening was 2 cm with a range of 0.5 cm to 3.5 cm. Range of motion in both the proximal and distal joint was full and free in both the proximal and distal joints in 9 out of 11 patients while the remaining 2 patients presented with a painful and stiff joint. This was corrected with extensive physiotherapy and the patient gained functional range of motion. The donor site wound healed with no complication as a rule in all patients further reinforcing the fact that fibular graft harvesting is a comparatively safe and effective procedure.

**DISCUSSION**

Non-vascularised fibular grafting has been used to treat bone defect for a long time. Removal of fibula did not cause any complication in the donor leg. Non-vascularised fibular grafting is a simple procedure. The procedure is relatively easy and has much better patient compliance when compared to other methods of treating bone defect like bone lengthening procedures using ilizarov.

Free non-vascularised fibular grafting has been used in post-traumatic bone defects. Swamy et al in their study including 20 patients, from the pediatric age group, reported a union rate of 80% following first surgery and in the remaining 4 patients union was achieved after the second procedure of bone grafting. Patwardhan et al in their series of 26 pediatric patients of gap non-union, reported union in 24 patients (92%) with 2 patients undergoing delayed union requiring secondary procedures. They concluded that the procedure was simple, not requiring any special skill with a very low complication rate. Lenze et al concluded that the procedure was a valuable procedure in defects less than 12 cm in length with an excellent union rate with minimum complications.

El-Sayed et al in a study of 12 patients with post traumatic bone defects, reported union in 11 cases (union rate of 92%) in an average period of 4 months. They used plate and screws for upper limb defects and external fixators for tibia with cortico-cancellous bone graft along the entire length of fibular graft to augment graft uptake. Morsi et al (union in 6 out of 7, 86%), Steinelechner et al (union in 7 out of 8, 88%) and Lawal et al (union in 8 out of 10, 80%) all reported excellent results in their respective studies on non-vascularised fibular grafting concluding separately that it is a comparatively simple procedure with excellent results. Al Zahrani et al in his study on 27 patients with varied etiologies leading to bone gap concluded that non vascularised fibular graft is a safe an effective procedure to treat gap non-union with a union rate of 92%, stress fractures occurring in 26% with no significant graft hypertrophy. As compared to all the above studies, we report similar outcomes in non-vascularized fibula grafting in gap non-unions secondary to trauma, osteomyelitis and tumor. Limitations of study are small sample size.

**CONCLUSION**

From our results mentioned above we conclude that non vascularized fibular bone grafting is a simple and effective treatment option which does not require any special skill, has a very low complication rate and has very high patient compliance.

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