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Original Article

Reconstruction of Bone Defects with Non-vascularized Fibular Graft

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Abstract

Background: The most common problems involving the bone and soft tissues are bony defects caused due to fractures, infections, and tumors. These defects can be due to various causes such as post-traumatic bone loss, post-infective bone loss, and defect resulting due to excision of tumors.

Aim: The aim is to study the outcome of reconstructing the bony defects due to removal of benign tumors with non-vascularized fibular graft.

Methods: This is the prospective study conducted to determine the outcome of reconstruction of bony defects in benign tumors using non-vascularized fibular graft pre-operative workup was done to exclude metastatic tumors. Clinical and radiological review was done at periodical interval for all our patients.

Result: Functional outcome was analyzed according to Mankin *et al.* criteria such as excellent - 18 cases, good - 5 cases, fair - 5 cases, and failed - 7 cases.

Conclusions: Our overall experiences with non-vascularized fibular graft for reconstructing bony defects are encouraging; however, we are aware that this is a short-term study and would require further evaluation and more inputs.

Key words: Benign tumors, Non-vascularized fibular graft, Segmental bony defects

INTRODUCTION

Defects in long bones pose a great challenge to orthopedic surgeon. These can arise in long bones due to malignancy, high-energy trauma, and atrophic non-unions. If untreated, these can lead to unacceptable shortening and may render extremity unfit for use. Autograft, allograft, prosthetic replacement, or allograft-prosthetic composite are established methods for reconstructions.[1,2] Among the autograft and allograft reconstructions,[3,4] it can be done either as vascularized or non-vascularized graft. The advantage of using vascularized graft[5] is rapid biological incorporation, good growth potential, and the ability to thrive in compromised soft tissue. However, these require technical expertise. The long-term follow-up of non-vascularized fibular graft also gives good result. Hence, we made an attempt to study the outcome of reconstructing the bony defects due to removal of benign tumors with non-vascularized fibular graft.

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Aim

The aim is to study the outcome of reconstructing the bony defects due to removal of benign tumors with non-vascularized fibular graft.

METHODS

This is the prospective study conducted in the Department of Orthopedics at Government Royapettah Hospital. A total of 35 cases of various tumorous conditions which satisfy the inclusion criteria were selected. Inclusion criteria are benign tumors, bony defects <10 cm, and tubular bony involvement, after epiphyseal closure. The benign tumors which required anything less than wide resections

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were excluded since that defect was not significant. Among the benign tumors, giant-cell tumor was the most commonly encountered one comprising 49%, which most commonly involves the distal radius. These cases were either aggressive type or late presentation necessitating wide resection. Hence, also in case of aneurysmal bone cyst, we encountered presentation with extensive involvement of the humerus not amenable for curettage or bone grafting. In the case of fibrous dysplasia, one presented with pathological fracture and the other case was a recurrence after an initial treatment of curettage and bone grafting. Thus, in our study, upper limb was involved in 19 cases, and lower limb was involved in 16 cases. Humerus and distal radius put together constitute more than 50% of cases (Table 1).

Pre-operative evaluation done were complete hemogram, serum calcium, serum phosphorus and serum alkaline phosphatase, radiography of appropriate parts, skeletal survey, and histopathological study; computed tomography and magnetic resonance imaging of the lesion and nearby joint were also done. It is that, with these investigations, we identified the exact of the lesion, cortical/articular breach, etc. Based on this, wide resection was planned along with reconstructions.

The patients were selected only if pre-operative imaging had shown that a satisfactory surgical margin could be achieved. Patients with expected defects >10 cm were excluded from the study because vascularized fibular graft in a better option in such condition. All patients were given pre-operative intravenous antibiotics.

Results were based on functional outcome which was analyzed according to Mankin *et al.* criteria.[6]

The follow-up period ranged from 11 months to 7 years. All our patients were analyzed in terms of graft incorporation, oncological evaluation, and functional outcome. Graft incorporation was assessed radiographically.

RESULTS

The patients selected were aged between 15 and 52 years. The average age of our study group is 28 years. Out of 35 cases, 12 were female and 23 were male. 17 cases of osteoclastoma, 9 cases of aneurysmal bone cyst, 7 cases of fibrous dysplasia, and 2 cases of chondromyxoid fibroma were done (Table 2).

To decrease the time of surgery and to avoid contamination, we had two operation teams: One for tumor resection and another for graft harvesting. Under anesthesia, without using tourniquet, incision was made such that it includes the biopsy scar. The tumor was resected en bloc with wide margin. The margin of clearance ranged from 2.5 to 5 cm. At most care was taken to avoid contamination to nearby tissues. The resected segment was measured, to plan the length of the graft to be harvested. Graft harvested through posterolateral approach (Henry approach) skin incised depending on the requirement. If proximal third of fibula is to be resected, identified and protected the common peroneal nerve along the posteromedial aspect of the biceps tendon in the proximal part of the wound. The fascial plane between soleus muscle and peroneus longus muscle is located, and the dissection is deepened to reach the fibula. Subperiosteal stripping was started distally and progressed proximally to protect the anterior tibial vessel that passes between the neck of fibula and the tibia. The fibula was resected according to the length of the bony defect. After resection was completed, the bicep femoris tendon and fibular collateral ligament were sutured to the adjacent soft tissues.

As per the above technique, the proximal fibula was harvested in 11 cases (distal radius reconstruction), and shaft of the fibula was harvested in rest of the cases. After bony reconstruction, the soft tissue reconstruction was done to enhance union rigid fixation with plate and screws or with lag screw if a step cut osteotomy was performed or with Kirschner wire (Figures 1-3).

All our patients received 5 days of post-operative intravenous antibiotics. Sutures were removed 10-12 days after surgery and sent home with plaster cast. This was maintained usually for 6-8 weeks. Then, the extremities were taken out passive movements only. In case of lower limb, partial weight bearing was allowed after 12 weeks, and in case of upper limb, gentle mobilization was started after 6 weeks. All our patients were reviewed clinically and radiologically at regular interval of 1 month up to 6 months. After 6 months, they were followed up at 2-month interval till union or incorporation.

Our results were as follows:

Excellent	18 cases
Good	5 cases
Fair	5 cases
Failed	7 cases

In our study, the graft united in 28 out of 35 patients between 4 to 12 months. Average time for graft incorporation was 7.2 months. 6 months in case of wrist and 8-12 months in case of other bones. In the remaining seven cases, the graft did not incorporate due to various reasons that are discussed in later of this text giving a poor result.

Table 1: Distribution of site of reconstruction

Site of reconstruction	No. of patients
Humerus	11
Distal part of radius	11
Supracondylar region of femur	7
Tibial plateau	2
Distal part of tibia	2
Shaft of tibia	1
Meta tarsal	1

Table 2: Distribution of diagnosis

Diagnosis	No. of cases		
	Male	Female	Total
Fibrous dysplasia	7	-	7
Aneurysmal bone cyst	4	5	9
Osteoclastoma	10	7	17
Chondromyxoid fibroma	2	-	2

Out of 35 tumor cases, 34 remained free from disease till date and one patient was operated for recurrences of giant-cell tumor. In our study, we had few post-operative complications. One case of stitch abscess and one case of early post-operative infection treated appropriately. One case of recurrence was encountered with distal radius giant-cell tumors for which excision and centralization of the ulna were done. We had three cases of persistent infection which resulted in necrosis of the graft and failure. Regarding donor-site morbidity, one patient had transient peroneal nerve palsy which recovered on physiotherapy and splinting. Another patient had permanent peroneal nerve palsy planned for tendon transfer.

DISCUSSION

The goal of treatment is to cure the patient while preserving as much function, anatomical, and quality of life as possible. Thus, every effort should be made to totally eradicate the primary lesion during the initial surgical treatment itself. Thus, *en bloc* resection is strongly recommended for aggressive/recurrent benign lesions and for some of the low-grade malignant tumor. Reconstruction is necessary after adequate resection of tumor to preserve the function and alignment. Many reconstructive options are available after resection.

Autograft, allograft, prosthetic replacement, or allograft-prosthetic composite are established methods for reconstruction.[7] Although the use of allograft has shown encouraging results, there are many associated problems. Selection of suitable donors, the method of obtaining and preserving the graft, and the technique of allograft reconstruction deserve particular attention. The surgeon must consider the risks of infection, graft rejection, delayed healing, and function of the concern part. Custom-made prosthetic devices have been used with early success, but problems with late loosening and metal fatigue have not been solved.

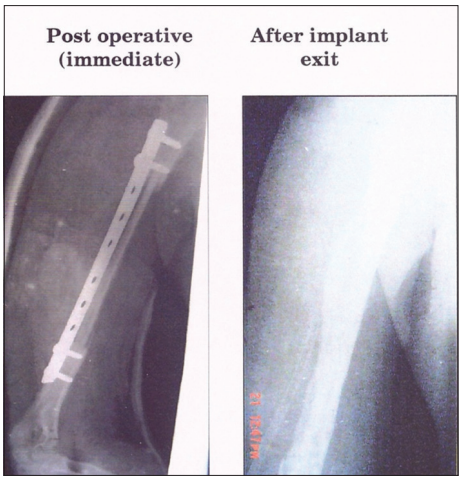

Figure 1: Shaft of humerus with reconstruction with fibula graft and plate

Figure 2: GCT of distal radiu

Figure 3: Shaft of radius with asian DCP

Among the autograft and allograft reconstructions, it can either with non-vascularized or vascularized graft. Vascularized fibular autograft is technically more demanding with the use of microsurgical techniques. Non-vascularized fibular graft incorporation as an autograft is more rapid and predictable than an allograft.[4,8] Moreover, it is easily accessible without significant donor-site morbidity.[3,9] It is also a biological solution, and the most of orthopedic surgeons can perform this surgery in an average setup.[10,11] They are associated with relatively low rate of complication, and they survive for a longer duration, whereas metal implants are difficult to design and have shortcut life span.

In our study, non-vascularized fibular graft was used for reconstructing defects in humerus, distal femur, metatarsal shaft, and proximal tibia that araised due to resection of tumors conditions. We had 35 cases of benign tumors which were resected and reconstructed with non-vascularized fibular strut graft.

Out of 35 cases, 11 cases were giant-cell tumors involving the distal radius which was reconstructed with the proximal fibula giving excellent results because of their structural similarity except one case of recurrence.[12,13]

In another 9 cases, the defects were near large joints (distal femur and proximal tibia). In these cases, the fibular graft was augmented either with bone cement or bone grafting. Even though we could clear the disease and achieve anatomical alignment, there was some impairment of joint movements. Thus, the functional outcome was good-to-fair in cases of large joint involvement.

In case of distal tibia giant-cell tumor after resection, the reconstruction was done by arthrodesis of tibia and calcaneum with fibular graft augmented with Kuntscher nail. Here, the functional outcome was fair because the patient developed calcaneus deformity.

We could eliminate the tumors in 34 out of 35 cases (97.14%); one case of giant-cell tumor recurred. This case was further treated by excision and centralization of ulna.

In all these cases of failure, the graft did not incorporate probably due to inadequate fixation even after 1½ years, which was subsequently managed by bone grafting and replating.

In our study, 65% (23 of 35) had stable, painless extremity, and resumed active use of the involved extremity without protective device after 1 year. The fair results in 5 patients were because of painful extremity and they required assistive devices; four patients with distal femur reconstruction had knee stiffness and flexion deformity. The other patient with distal tibia reconstruction had calcaneus deformity. The seven patients with failure were due to infection, non-union, and recurrence. In summary, considering the problems for which the reconstruction was done 23 out of 35 patients (18 excellent and 5 good) had satisfactory results.

CONCLUSION

The bony defects arising out of wide resection of the benign tumor can be successfully reconstructed with fibular graft-giving good functional outcome. However, these bony defects can be successfully managed with fibular reconstruction when they present early to the surgeon. Our overall experiences with non-vascularized fibular graft for reconstruction bony defects are encouraging; however, we are aware this is a short-term study and would require further evaluation and more inputs.

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