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Original Article

Results of non-vascularised fibular grafting in gap non-union of long bones in paediatric age group

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ABSTRACT

Background: Bone defect has always been a challenge to treat for the orthopaedic surgeon. Fibular grafting is a popular method for bridging the gap in bone defects created by tumour excision, trauma or bone loss as sequelae to infection. Fibula is a popular substitute for this method because of its easy accessibility and minimal donor site morbidity. The present study is aimed at finding the results in paediatric population.

Material and methods: 20 patients with bone defect (19 as a result of chronic osteomyelitis and one as a result of excision of a tumour) were included in the current study. The age of the patients ranged from one year to 12 years. The fibular graft was applied after freshening of bone end and fixed with K wire or plating and cancellous bone graft was also applied at both ends. The limb was immobilized in plaster till union of fibula at both ends. **Results:** The average gap was 8 cm (range 6–12 cm). Out of the twenty cases nine involved the humerus, seven in the tibia, two in radius and one each in femur and ulna. Union was achieved at both ends in 80% of the patients after the first surgery. Three out of six patients with K wire as fixation device failed and one out of fourteen patients with plate as fixation device ended in non-union. Union was achieved in these patients after revision surgery. One patient had stress fracture at distal end of the plate after weight bearing. Union occurred in this patient after plaster immobilization. Range of motion at distal and proximal joint was comparable to normal side. Superficial infection was seen in two patients and they responded to antibiotics.

Conclusion: Non-vascularised fibular grafting is a good option for bone defects in paediatric population provide adequate fixation and immobilization has been done.

Level of evidence: Level IV (Therapeutic).

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1. Introduction

Bone defect has always been a challenge to treat for the orthopaedic surgeon. Fibular grafting is a popular method for

bridging the gap in bone defects created by tumour excision, trauma or bone loss as a sequelae to infection.^{1–4} Fibula is a popular substitute for this method because of its easy accessibility and minimal donor site morbidity.⁵ Various other

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options are also available using the principles of bone transport to bridge the gap. Both ilizarov and monorail system have been used for bone transport.^{6–8} Both these procedures are technically difficult, cumbersome and have poor patient compliance. Fibular grafting has been used in all age groups. Our study is aimed at finding the results of non-vascularised fibular grafting in the paediatric age group. Fibular grafting has the advantage of being a much simpler procedure and avoids the use of costly implants making it a more feasible and practical solution for bone defects in developing countries and small centres.

2. Material and methods

20 patients with bone defect (19 as a result of chronic osteomyelitis and one as a result of excision of a tumour) were included in the retrospective study. A written informed consent was obtained from each patient.

The age of the patients ranged from 1 year to 12 years. Infection had settled at the time of surgery in patients with chronic osteomyelitis. **This was confirmed by pre operative inflammatory markers ESR and CRP which were not elevated in any patient. There was no clinical and radiological signs of infection.** 13 patients were male and seven were female.

The average gap after freshening of both ends of the defect was 8 cm (range 6–12 cm). Out of the 20 cases nine involved the humerus, seven in the tibia, two in radius and one each in femur and ulna. The surgical technique in all these cases included freshening of the bone ends. Intra-operatively tissue was collected and sent for culture. Mid segment of Fibula was harvested from the leg under tourniquet using the posterolateral approach. For tibial defects the contralateral leg was used as donor. The fibular graft was 1 cm longer than the bone gap. This bone was then fixed at the site of the defect with the help of either intramedullary K wire or using plates and screws. Six cases were fixed with intramedullary K wire and the remaining were fixed with plating. In one of the cases external fixator was also used for stabilization of the graft along with intramedullary K wire. Cancellous bone grafting from iliac crest was also done at both proximal and distal end of the fibular graft to facilitate union. Postoperatively the limb was immobilized in plaster slab in form of U slab, above elbow and above knee slab. The patient with femoral gap non-union was kept in hip spica till the union occurred.

All patients were given prophylactic antibiotics. Pre-operative antibiotic was given intravenously in all patients. Postoperatively oral antibiotics were given.

Patients were followed at three, six, twelve weeks, six month, nine months and twelve months post operatively. Later follow up was done at 6 monthly intervals. Follow up included radiographic evaluation and documentation of any complication.

3. Results

20 patients with bone defect were included in the current study. 13 patients were male and seven were females. Out of the 20 patients 19 had a gap non-union as a sequelae to

chronic osteomyelitis. In one case the bony defect developed as a result of excision of a benign bone tumour (aneurismal bone cyst). The average follow was 38 months with a range of 24–72 months. The average bone gap was 8 cm (range 6–12 cm).

Two patients required soft tissue stretching before the definite surgery to restore the limb length. Soft tissue stretching was done with the help of external fixator. Intra-operative tissue culture were negative in all patients.

Union was achieved at both ends in 80% of the patients after the first surgery. In one patient with gap non-union of humerus the distal end united but the proximal end did not unite. Second surgery in the form of bone grafting was done 7 months after the first surgery. Union occurred in this case after 18 weeks of the second surgery. In two patients the fibular graft resorbed and repeat surgery with fibular grafting and bone grafting at both ends was done. The union occurred at both ends after the second surgery. In another patient with tibial non-union the distal end did not unite. In this patient repeat grafting was done at the distal end. Union occurred after the second surgery.

Three out of the four cases in which union did not occur after the first surgery were fixed with intramedullary K Wire. The fourth case in which failure occurred was fixed with plate. 50% of the patient with intramedullary K wire as fixation device in the preliminary surgery failed. Second surgery was needed in these patients to achieve union. Failure occurred only in one patient out of the fourteen patients with plating being used as fixation device. Average time to union was 22 weeks with a range of 12–32 weeks.

Average shortening in the limb was 2.5 cm with a range of 1–4 cm. Range of motion of the proximal and distal joint was almost full and free at last follow-up. Superficial infection was seen in two patients who responded to oral antibiotics. No complication was seen at the donor site. In one patient with gap non-union of tibia stress fracture occurred at the distal end of the plate after weight bearing. In this case the patient was further immobilized in above knee slab for another 6 weeks after which the fracture united with no further complication (Table 1 Figs. 1–5).

4. 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. El-Sayed et al⁹ reported a study of 12 patients with post-traumatic bone defects. 11 out of the 12 grafts united within an average of 4 months. They concluded that non-vascularised fibular grafting is a simple procedure with good results. El-Sayed et al used plate and screw for upper limb defects and screw with external fixator for tibial defects. In their study the fibular grafts were augmented, along their whole length, by corticocancellous bone graft in

Table 1 – Details and results in 20 patients.

Serial no	Age/sex	Bone involved	Implant used	Time to union (weeks)	Complications	Management
Case 1	5/F	Humerus	K wire	12	None	
Case 2	7/M	Tibia	Plating	20	None	
Case 3	2/F	Humerus	Plating	24	Superficial infection	Antibiotic course
Case 4	9/M	Tibia	Plating	16	None	
Case 5	1/F	Humerus	K wire	20	None	
Case 6	7/M	Humerus	Plating	24	None	
Case 7	10/M	Radius	K wire	22	None	
Case 8	4/M	Humerus	Plating	24	None	
Case 9	4/F	Ulna	Plating	24	None	
Case 10	9/M	Tibia	K wire	44	Non-union at distal end	Bone grafting
Case 11	7/M	Tibia	Plating	32	None	
Case 12	3/M	Femur	Plating	26	None	
Case 13	8/M	Humerus	K wire	52	Non-union at proximal end	Bone grafting
Case 14	8/F	Tibia	Plating	22	Stress fracture	Cast for 6 weeks
Case 15	4/F	Humerus	Plating	66	Resorption of graft	Resurgery
Case 16	3/M	Humerus	Plating	30	None	
Case 17	8/M	Tibia	Plating	20	Superficial infection	Antibiotic course
Case 18	9/F	Radius	K wire	12	None	
Case 19	2/M	Humerus	K wire	60	Resorption of fibular graft	Resurgery
Case 20	7/M	Tibia	Plating	24	None	

tibial defects of adult patients. They had a union rate of 92%. These results are better than our results probably because they did the study in non-infected patients as compared to ours with sequelae of chronic osteomyelitis.

Al-Zahrani¹ et al found good results in 27 patients using of non-vascularised single fibular strut graft, augmented with a corticocancellous bone graft to bridge bone defects. The indications were varied and included infection, fracture with bone loss, non-union, bone tumour, bone cyst and congenital pseudoarthrosis. They achieved primary union in 92%. Stress fracture occurred in 26% and no significant fibular graft hypertrophy occurred. They concluded that the non-vascularised single fibular graft augmented with

corticocancellous bone graft along its whole length, is a simple procedure to bridge bone defects.

Lawal et al¹⁰ succeeded in achieving graft incorporation in eight out of the ten patients they included in three series. The average defect was 6.5 cm. They concluded that free fibular grafting is a good option in bone defects in developing countries.

Omolou et al¹¹ reported good results in two patients with tibial gap treated with non-vascularised fibular graft. Morsi et al¹² succeeded in achieving union in six patients out of seven for tibial gap treated with fibular grafting.

Steinlechner et al¹³ reported excellent results in eight patients with non-vascularised fibular grafting in patients with defects of long bones after sequesterectomy. They followed up

Fig. 1 – (a) This is a 9-year-old boy presenting with gap non-union of tibia of left side as a sequelae to osteomyelitis of tibia. **(b)** Immediate post-operative X-ray after fibular grafting and bone grafting fixed with plating. **(c)** 2-year follow up showing solid union.

Fig. 2 – (a) This is a 2-year-old girl presenting with gap non-union of humerus of the right side as a sequelae to osteomyelitis of the humerus. **(b)** Immediate post-operative X-ray after avascular fibular grafting and bone grafting. **(c)** 2-year post-operative X-ray in the same patient showing excellent union.

Fig. 3 – (a) This is a 9-year-old girl with aneurysmal bone cyst of the radius presenting with a swelling of the right forearm for the past 6 months. **(b)** Excision of the tumour was done followed by fibular grafting and bone grafting. **(c)** 3 month post-operative X-ray showing good incorporation of the fibular graft.

seven of the eight patients and all had union at a mean of 10 weeks except one. In this patient union occurred late after second surgery in form of debridement. They used intramedullary K wires as fixation device. As compared to this study the results in our study were significantly poor in patients in which intramedullary K wire was used as the fixation device. The results of our study were comparable to this study in the patients with plating as fixation device. Our study involved only paediatric population and the defect was less than 12 cm in all cases.

The results of fibular grafting fixed with plate were very good with only one case needing a revision surgery. As compared to this patients managed with K wire had significantly higher failure rate with 50% patients needing second surgery. This fact shows the role of stable fixation for achieving union and good results. Thus we would like to conclude that non-vascularised fibular grafting is a good treatment option for gap non-union in paediatric population provided stable fixation has been done.

Fig. 4 – (a) This is a case of gap non-union of the radius as a consequence of osteomyelitis of the radius. **(b)** Fibular grafting was done and fixation was done using K wire. **(c)** 2-year follow up X-ray of the same patient showing good bone formation.

Fig. 5 – (a) This is a case of gap non-union of tibia after osteomyelitis in a 8-year-old girl. This patient was operated with fibular grafting and good union was achieved at 22 weeks. Patient started weight bearing and she developed stress fracture at 8 months. This was managed with above knee cast and fracture united uneventfully. **(b)** X ray showing union after 6 weeks of plaster immobilization in this stress fracture.

Conflicts of interest

No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

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REFERENCES

1. Al-Zahrani S, Harding MG, Kremli M, Khan FA, Ikram A, Takroni T. Free fibular graft still has a place in the treatment of bone defects. *Injury*. 1993;24:551–554.
2. Enneking WF, Eady JL, Burchardt H. Autogenous cortical bone grafts in the reconstruction of segmental skeletal defects. *J Bone Joint Surg Am*. 1980;62-A:1039–1058.
3. Yadav SS. Dual fibular grafting for massive bone gaps in the lower extremity. *J Bone Joint Surg Am*. 1990;72-A:486–494.
4. Tuli SM. Bridging of bone defects by massive bone gaps in tumorous conditions and in osteomyelitis. *Clin Orthop*. 1972;87:60–73.
5. Eh Lee, Goh JC, Helm R, Pho RW. Donor site morbidity following resection of the fibula. *J Bone Joint Surg Br*. 1990;72:129–131.
6. Kocaoglu M, Eralp L, Rashid HU, Sen C, Bilsel K. Reconstruction of segmental bone defects due to chronic osteomyelitis with use of an external fixator and an intramedullary nail. *J Bone Joint Surg Am*. 2006;88:2137–2145.
7. Cattaneo R, Catagni M, Johnson EE. The treatment of infected nonunions and segmental defects of the tibia by the methods of Ilizarov. *Clin Orthop Relat Res*. 1992;280:143–152.
8. de Pablos J, Barrios C, Alfaro C, Canadell J. Large experimental segmental bone defects treated by bone transportation with monolateral external distractors. *Clin Orthop Relat Res*. 1994;298:259–265.
9. El-Sayed M, El-Hadidi M, El Adl Wael. Free non-vascularised fibular graft for treatment of post-traumatic bone defects. *Acta Orthop Belg*. 2007;73:70–76.
10. Lawal YZ, Garba1 ES, Ogirima MO, et al. Use of non-vascularized autologous fibula strut graft in the treatment of segmental bone loss. *Ann Afr Med*. 2011;10(1):25–28.
11. Omolou B, Ogunlade SO, Alonge TO. Limb conservation using non-vascularised fibular grafts. *West Afr J Med*. 2002;21:347–349.
12. Morsi E. Tibial reconstruction using a non-vascularised fibular transfer. *Int Orthop*. 2002;26:377–380.
13. Steinlechner C, Wand M, Kandawire NC. Non-vascularised fibular transfer in the management of defects of long bones after sequestrectomy in children. *J Bone Joint Surg Br*. 2005;87-B:1259–1263.