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Efficacy of free fibula flap for reconstruction of post traumatic long bone defect: retrospective study of eighteen cases

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ABSTRACT

Background: Complex and segmental bone defects are common after resection of tumors and trauma involving long bones of the extremities. Free fibula flap is commonly practiced for complex oromandibular defects and bone reconstruction after sarcoma and bone tumor excision. But post traumatic bone reconstruction of extremities with free fubula is less commonly practiced and only reserved for long segmental reconstruction or as an alternative to distraction osteogenesis. We are presenting a retrospective analysis of surgical details and outcome of 18 cases with post traumatic long bone defect reconstructed with free fibula osteocutaneous flap.
Methods: 18 patients with post traumatic composite or segmental long bone defect which were reconstructed with free fibula osteocutaneous flap (FFOCF) between 2014 to 2018 are included in this study. Operative details, success rate, bone healing, functional outcome and complications are reviewed retrospectively.
Results: Success rate of flap surgery was 17/18 (94.44%). Bone gap was 6-17 cm and Skin paddle ranged from 10 cm × 8 cm to 15 cm × 10 cm. Bone healing, weight bearing outside cast and return to daily activity period were 8-16 weeks, 10-15 months and 12-18 months respectively. Non-union, malunion and stress fracture were noted in one,one and three patients respectively.
Conclusions: Free fibula flap is a reliable method for reconstruction of post traumatic complex and segmental long bone defects. Quality of bone healing is good enabling resuming to early weight bearing and daily activities and high success rate. Free fibula flap may be procedure of choice for reconstruction of such bony injuries with the microvascular surgical facilities.

Keywords: Free fibula flap, Post traumatic, Long bone defect, Vascularised bone

INTRODUCTION

Complex and segmental bone defects are common after resection of Tumors and Trauma involving the extremities. Free fibula osteocutaneous flap (FFOCF) is being used for composite bone and soft tissue reconstruction of various indications after its first description by Hidalgo in1989.[1-3] Use of free fibula flap for complex bone defect has been popular after increasing trend, expertisation and facilities of micro vascular surgeries.

Spectrum of this flap includes complex oromandibular defect to bone reconstruction after sarcoma and bone tumor excision. But post traumatic bone reconstruction with free fubula is less commonly practiced and only reserved for long segmental reconstruction or as an alternative to distraction osteogenesis.

Free fibula is believed to be superior for bone reconstruction purpose as it provides vascular bone graft and straight tubular bone of maximum length. We are presenting retrospective analysis of surgical details and

outcome of 18 cases with post traumatic long bone defect reconstructed with free fibula osteocutaneous flap.

METHODS

The present study was conducted at Shri Ram Murti Smarak Institute of Medical Sciences, Bareilly, which is a tertiary referral and multispecialty health care providing centre. All the surgeries were done between January 2014 to December 2018 and patients were followed up till July 2019.

Inclusion criteria

All patients with post traumatic composite or segmental long bone defect which were reconstructed with free fibula osteocutaneous flap (FFOCF).

Exclusion criteria

Patients treated with multiple reconstructive procedure and patients lost in follow up before a minimum 6 month follow up period.

Patient related variables are collected from hospital database and subjected to statistical analysis.

Pre-operative assessment

Patients referred from Orthopaedics Department with segmental bone loss or composite (skin and bone) long bone defect were identified. Pre-operative assessment was done including baseline investigations, X-ray of the affected limb and wound culture and sensitivity. Wound bed was prepared with serial debridement to remove all necrotic soft tissue and final bone defect was assessed before surgery. Colour Doppler study and in selected cases CT angiography of the affected limb were done to select recipient vessel. Three cases of secondary bone reconstruction were also included in this study. Bone defects were initially managed with bone cement and spacer in these cases, but the defect persisted due to loss of spacer.

Surgery

All the Surgeries were performed by the senior author in a single institute. Flaps were harvested under epidural anaesthesia in lower limb cases and under general anaesthesia or combined spinal and brachial plexus block in upper limb cases under Tourniquet control. Left leg was chosen for flap harvest if it was not the recipient leg or already traumatised. Peroneal perforators were marked with a hand held Doppler. Debridement of the recipient limb done and all necrotic dead bone removed. Bone margins were freshened in segmental loss. Final bone gap and soft tissue loss were measured. Skin paddle and bone length were marked at flap donor limb. A 10 cm × 5 cm flap was taken for vascular monitoring in case of bone only defect. Flap harvesting was started from anterior margin of cutaneous marking. Anterior margin was elevated from peroneal muscle till the perforators were located. Dissection carried out through anterior leg compartment and anterior tibial artery, superficial peroneal nerve was preserved. Osteotomy was done at both end of bone flap. The peroneal artery was identified at lower end of flap, ligated and dissected out from posterior compartment muscle. Dissection was carried till the bifurcation of posterior tibial artey. Now the lateral dissection completed the cutaneous flap elevation. Dissection through deep flexor muscles completed flap elevation. Tourniquet was released, flap was left to be perfused, cutaneous bleeding from flap checked before flap division. Recipient vessels were prepared, bone requirement was measured and osteotomy was done at the margin of fibula for final length adjustment. Double barrel was configured according to availability of bone and need. Bone ends were docked into the recipient bone proximally and distally. Fibula was fixed with cotico cancellous screws or plates at both ends. Vascular pedicle length was adjusted at recipient site, and arterial anastomosis was completed in between vascular clamps. Intravenous bolus 2500 unit heparin administered slowly. Clamps were left in place and venous anastomosis was completed between another pair of vascular clamps. Now venous clamps followed by arterial clamps were removed. Skin Flap inset completed and corrugated drain placed underneath the skin paddle (Figure 1 and 2). Flap donor site was closed primarily or skin grafted. Post-operative slab immobilisation was done for 2 weeks.

Patient was monitored for flap viability 3 hourly for first 24 hours and 6 hourly for next 48 hours and then 12 hourly up to first post-operative week. Flap donor site dressing changed and drain removed on 5thpost operative day. Patients were discharged after first post-operative week and called for follow up.

Follow up

Patients were followed up twice a week for one month and twice a month for 6 months and as and when required.

Patients were assessed for bone healing with bi planar X ray and union at bone docking site, cortical thickness, alignment bone width noted (Figure 3). External fixator was removed after complete bone healing. In lower extremity cases greater trochanter to toe cast applied subsequently and patient was allowed weight bearing. Plaster cast removed after 4 months and physiotherapy started with patient walking on support for 3-4 months. Time to return to activity, donor site healing and complications were also noted.

Data analysis

Patient related variables are collected from hospital database, tabulated and statistical analysis was done with SPSS software. Friquency distribution with percentage, mean, standard deviation (SD) and standard error of mean (SEM) are calculated whenever required.

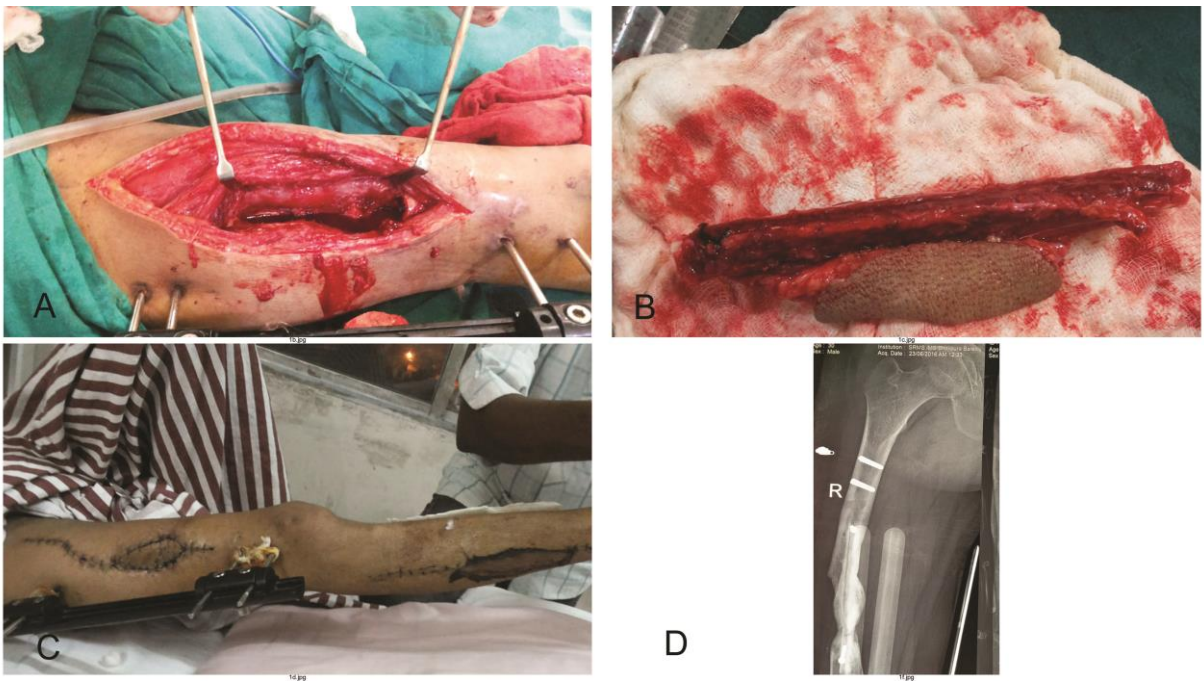

Figure 1: Free fibula flap for reconstruction of segmental defect of femur, (A) segmental femur defect, (B) harvested osteocutaneous fibula flap, (C) lap inset and donor site coverage demonstated in same limb. Skin paddle is used for flap monitoring purpose as well as to close receipient site without tension and (D) post-operative X-ray showing significant bone hypertrophy at flap receipient site.

Figure 2: Free fibula flap for tibial defect, (A) tibia bone segment and soft tissue loss of right leg treated with skin grafting; (B) free fibula osteocutaneous flap being harvested from left lower limb; (C) harvested flap (D) flap inset.

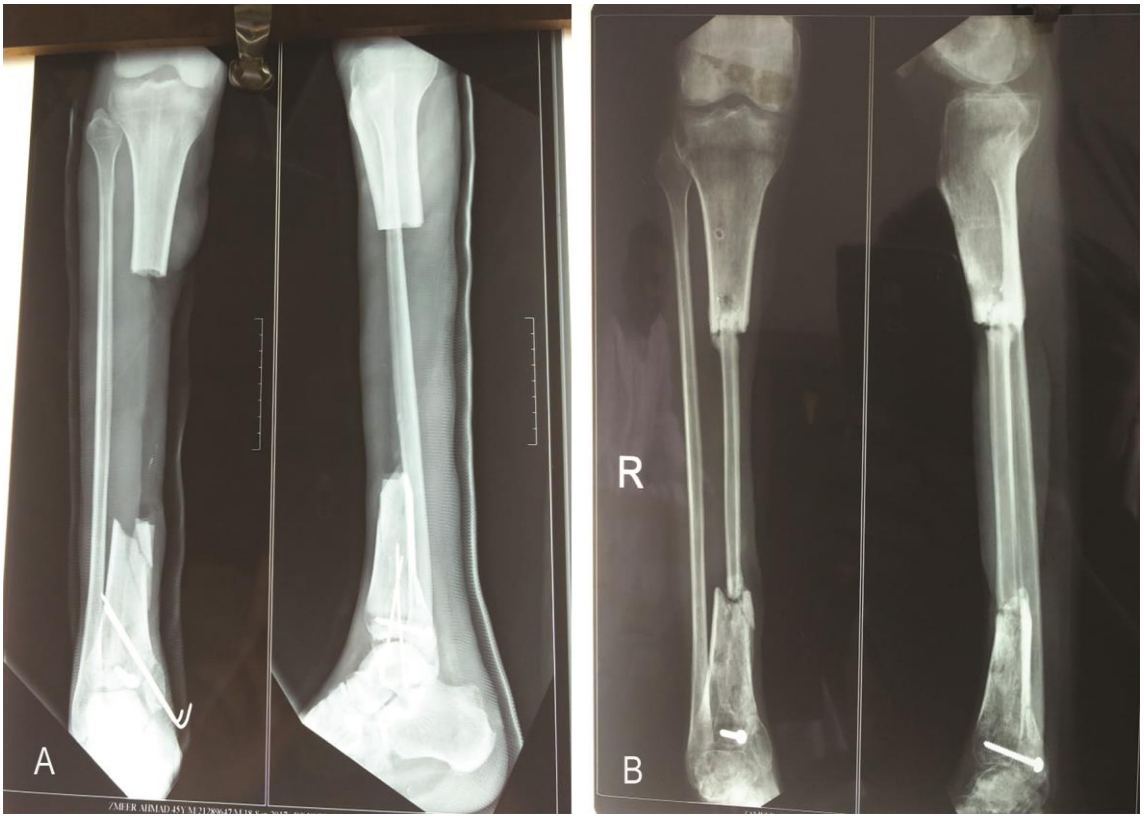

Figure 3: Pre-operative and post-operative X-ray of the limb shown in Figure 2.

RESULTS

Demography

17 male and 1 female patients were included in our study. Age of the patient ranged from 25 to 50 years. Fifteen patients presented with primary segmental bone defect after trauma. Three patients were referred from orthopaedics unit after previously treated with spacer to bridge the bone gap and subsequent spacer loss. Upper limb with humerus was involved in two cases. Lower limb was involved in 16 cases where femur and tibia were the involved in 2 and 14 cases respectively. Composite bone defect was seen in 12 cases and only segmental bone loss was noted in 6 cases. Length of bone segment loss were ranged from 8 to 17 cm (Mean-10.56, SD-2.70, SEM 0.64).

Outcome of flap surgery

All the surgeries were done between 1 to 3 months after injury. Length of harvested fibula was 18-20 cm and bone was divided according to requirement.

In 12 cases skin paddle was used to cover anastomoses and defect and in 6 cases used for monitoring purpose only. Skin paddle ranged from 10 cm × 8 cm to 15 cm × 10 cm (mean 13.22 cm × 8.22 cm). 5 cm perforator included in 3 cases and 10 cm perforator included in 15 cases. Bone was double barrelled in two cases. Bone gap was 6-17 cm (mean-10.56, SD-2.71, SEM-0.64).

Table 1: Surgical details of flap surgery.

Parameters		Value
Bone Defect	Humerus	2
	Tibia	14
	Femur	2
Bone Gap		Mean-10.56; SD-2.70; SEM 0.64
Skin Paddle	Width	Mean-8.22 SD-1.80; SEM-0.42
	Length	Mean-13.22 SD-3.1; SEM-0.73
Arterial Anastomosis	BA	2
	LCFA	2
	ATA	9
	PTA	5
Venous Anastomosis	Vein-VC 16, Superficial vein	2
	VC	13
	Superficial and VC (dual)	3

BA: brachial artery; BV: basilic vein; LCFA: lateral circumflex femoral artery; ATA: anterior tibial artery; PTA: posterior tibial artery; VC: vanae comitantes.

Brachial artery (end to side) and vanae commitantes (end to end) anastomoses were done in both upper limb cases. Anterior tibial artery and posterior tibial artery used as receipient artery in 9 and 5 cases respectively in case of

tibia. In both cases involving femur, arterial anastomoses were done in descending branch of lateral circumflex femoral artery (LCFA). Second venous anastomoses using great saphenous vein along with venae comitantes was done in 3 cases. Pedicle length was adequate in all and Interpositional vein grafts was not required in any cases. Bone fixation was done with plate and cotico cancellous screws and docking of both ends done in all cases. Operative details are summarised in Table 1.

Re exploration was required for vein thrombosis and flap congestion in one case but flap could not be salvaged. Bone distraction was done as secondary procedure in this case and is thus excluded from further outcome analysis.

Follow up

All the patients are followed up till a minimum period of 6 months and ranging from 6 months to 5 years.

Complete bone union was noted between 8 to 16 weeks (mean 10.67, SD 3.9, SEM 1.00). Non-union or malunion at one end of bone graft were noted in 2 cases which were treated with debridement and non-vascularised corticocancellous bone graft from iliac crest.

Stress fracture was seen 3 in cases and managed with re immobilisation in protective cast till bone reunited. Patients were mobilised completely without support between 10 to 15 months (mean 11.13, SD 1.46, SEM 0.38) and resumed to daily activities between 12 to 18 months (mean 14.24, SD 4.24, SEM 1.03). Findings are summarised in Table 2.

Table 2: Operative outcome (bone healing time, weight bearing period, return to daily activity period and complications.

Parameters		Value
Bone healing time (weeks)		Mean-10.67 SD-3.90 SEM-1.08
Weight bearing period (months)		Mean-11.13 SD-1.46 SEM-0.38
Return to daily activities (months)		Mean-14.24 SD-4.24 SEM-1.03
Complications	Flap failure	1
	Stress fracture	3
	Non union	1
	Malunion	1

Donor site healing was satisfactory in all cases. Donor site was closed primarily in 6 cases and grafted with split thickness skin graft in 12 cases. Graft take and healing was complete with in three weeks in all cases. Morbidity or complication like peroneal nerve injury, graft loss, tendon exposure ware not seen in any case.

DISCUSSION

Composite bone defect and bone segment loss poses surgical challenge to reconstructive surgery team involving both orthopaedic and plastic surgeon. Aetiologies of segmental defect are congenital bone defect, post traumatic, post oncologic resection, osteomyelitis, tuberculosis of bone, avascular necrosis etc.[4-7]

Different options for bone reconstruction use either autogenous tissue, allo bonegraft or alloplastic materials.[5] Among autogenous tissues non vascularised or vascularised bone grafts, distraction osteogenesis are the most popular mode to bridge a segmental defect. While non-vascularised bones are used for small defect (<6 cm), vascularised bone graft or distraction osteogenesis are popularly used to bridge longer bone gap. Iliac crest, fibula, olecranon, femoral condyle, ribs are described source of bone graft and among them Iliac crest and fibula are most popular.

Ilizarov method or bone transport involving principle of distraction osteogenesis (DO) commonly practiced method to bridge bone gap that cannot be covered by non-vascularised bone graft. This method is most effective for medium length bone gap (up to 6-8 cm). But Role of distraction osteogenesis or Ilizarov method for bone defect more than 8 cm is questionable and reported to be prone for recurrent fracture. There are also report of neurovascular injury, bone and pin tract infection and limb loss subsequent to Ilizarv method. It has longer healing time and weight bearing time relative to vascularised bone graft.[4,8]

Bio membrane formation following use of bone cement or spacer followed by staged non vascularised bone graft (masquelet technique) have been reported for longer bone defect but utility or superiority over Vascularised bone graft is not clearly established.[9]

Vascularised fibular bone graft thus is thus most useful method to bridge longer bone defect presently. It may be harvested as pedicled flap from the same limb to bridge adjacent Tibial defect or may be used as free flap for all type of bone defect. Several advantages of vascularised fibula makes it most popular reconstructive modality for composite defect presently such as: provide soft tissue along with vascularised bone for composite reconstruction, high success rate due to comprehensive flap harvest, reliable perforator based skin paddle, long pedicle, less anatomical variation.[2] Minimum donor site morbidity.[3] Fibula provides long tubular bone of maximum length without affecting weight bearing of the donor limb.

Free fibula provides vascularised bone graft and incorporates all osteoinductive, osteoconductive osteoprogenitor element to recipient bone healing.[5] Septocutaneous perforators provides good amount of

reliable soft tissue to fill the soft tissue in composite bone defect. Use of free vascularised fibula was mentioned for a variety of bone defect including Gustilo type III lower limb injury, long segmental defect, non-union, avascular necrosis, joint arthrodesis.[10-13] Though requires skill for microvascular surgery, utility is established as superior result to bridge and align long segment, lower infection and complication rate and faster healing and weight bearing (Figure 3).[8,14-17] Moreover bone reconstruction could be possible as single stage procedure reducing hospital stay and less follow up.[13]

Particular problem is noted with this flap of less cross sectional area of bone. There is possibility of increased chance of stress fracture. This problem could be minimised by use of double barrel bone flap. But this is possible for short segmental defects only. In our study double barrel flap was used in two instances. Otherwise subsequentl substantial bone hypertrophy at receipient site is noted in all cases. This improves weight bearing and mobilisation.

Success rate of free fibula flap reported to vary between 80-100%.[6,17-20] Success rate of our study was 94.44% (17/18). Re exploration rate was 1/18. Average bone gap was 8-17 cm, skin flap ranged from 10 cm × 8 cm to15 cm × 10 cm. Pedicle length and bone length were adequate in all cases.

Incidance of non-union or delayed union found to be 10-20% in previous literatures.[8,15,18,21] Incidence of stress fracture were observed 10 -20% in earlier studies.[17,18] Bone healing time found earlier 3-54 months.[21,22] In our study bone healing was 8-16 weeks. Bone hypertrophy was noted in all patients after a period of 4-6 months (Figure 1D).Weight bearing period outside cast was noted 10-15 months and patients resumed to daily activities after 12-18. Major limb length discripency (>2 cm) was not seen in any cases.

Donor site morbidity reported as weakness of foot, diffuse leg pain, paraesthesia on the dorsum of foot or partial graft loss, but not seen in any of our cases. Thus the efficacy and and utility of the flap in our study were in accordance with the previous studies.

CONCLUSION

So we may conclude free fibula flap is a reliable method for reconstruction of post traumatic complex and segmental long bone defects. Quality of bone healing is good enabling resuming to early weight bearing and daily activities and high success rate. Free Fibula flap may be procedure of choice for reconstruction of such bony injuries with the micro vascular surgical facilities.

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REFERENCES

1. Tideman H. Fibula free flap: A new method of mandible reconstruction. Int J Oral Maxillofacial Surg. 1990;19(1):61.
2. Wolff KD, Ervens J, Herzog K, Hoffmeister B. Experience with the osteocutaneous fibula flap: an analysis of 24 consecutive reconstructions of composite mandibular defects. J Cranio-Maxillofacial Surg. 1996;24(6):330–8.
3. Lin PY, Lin KC, Jeng SF. Oromandibular reconstruction: The history, operative options and strategies, and our experience. ISRN Surg. 2011;8:24-5.
4. Malizos KN, Nunley JA, Goldner RD, Urbaniak JR, Harrelson JM. Free vascularized fibula in traumatic long bone defects and in limb salvaging following tumor resection: comparative study. Microsurgery. 1993;14(6):368-74.
5. Wee C, Ruter D, Schulz S, Sisk G, West J, Tintle S, Valerio I. Reconstruction of extremity long bone defects with vascularized fibula bone grafts. Plast Aesthet Res. 2019;6:12.
6. Chen CM, Disa JJ, Lee H-Y, Mehrara BJ, Hu QY, Nathan S, et al. Reconstruction of Extremity Long Bone Defects after Sarcoma Resection with Vascularized Fibula Flaps: A 10-Year Review. Plast Reconstruc Surg. 2007;119(3):915–24.
7. Zhang, J, He WS, Wang C, Yan YG, Ouyang ZH, Xue J, et al. Application of vascularized fibular graft for reconstruction and stabilization of multilevel cervical tuberculosis. Medicine. 2018;97(3):e9382.
8. Song HR, Kale A, Park HB, Koo KH, Chae DJ, Oh CW, et al. Comparison of internal bone transport and vascularized fibular grafting for femoral bone defects. J Orthop Trauma. 2003;17(3):203-11.
9. Wong TM, Lau TW, Li X, Fang C, Yeung K, Leung F. Masquelet Technique for Treatment of Posttraumatic Bone Defect. Scientific World J. 2014:7:103-2.
10. Bumbasirevic M, Stevanovic M, Bumbasirevic V, Lesic A, Atkinson HDE. Free vascularised fibular grafts in orthopaedics. Int Orthopaed. 2014;38(6):1277–82.
11. Zaretski A, Amir A, Meller I, Leshem D, Kollender Y, Barnea Y, et al. Free fibula long bone reconstruction in orthopedic oncology: a surgical algorithm for reconstructive options. Plast Reconstr Surg. 2004;113(7):1989-2000.
12. Del Pino GJ, Del Valle EB, Grana GL, Villanova JF. Free Vascularized Fibular Grafts Have a High Union Rate in Atrophic Nonunions. Clin Orthopaed Rel Res. 2004;419:38–45.
13. Zhen P, Hu YY, Luo ZJ, Liu XY, Lu H, Li XS. One-Stage Treatment and Reconstruction of Gustilo Type III Open Tibial Shaft Fractures With a Vascularized Fibular Osteoseptocutaneous Flap Graft. J Orthop Trauma. 2010;24:745-51.
14. Panagiotis K, Christos T, Stamatis K, Nikolaos D. A Simple Treatment for a 15-cm Tibia Bone Defect: A

Case Report of an Ipsilateral Vascularized Fibula Transfer. J Orthopaed Trauma. 2007;21(3):215-18.
15. Zhen P, Liu XY, Lu H, Li XS. Fixation and reconstruction of severe tibial shaft fractures with vascularized fibular grafting. Arch Orthop Trauma Surg. 2011;131:93-9.
16. Malizos KN, Nunley JA, Goldner RD, Urbaniak JR, Harrelson JM. Free vascularized fibula in traumatic long bone defects and in limb salvaging following tumor resection: comparative study. Microsurgery. 1993;14:368-74.
17. Yazar S, Lin CH, Wei FC. One-Stage Reconstruction of Composite Bone and Soft-Tissue Defects in Traumatic Lower Extremities. Plast Reconstr Surg. 2004;114(6):1457-66.
18. Singh P, Kalra G, Goel P. Reconstruction of post-traumatic long bone defect with vascularised free fibula: A series of 28 cases. Indian J Plast Surg. 2013;46(3):543.
19. Wei FC, El-Gammal TA, Lin CH, Ueng WN. Free fibula osteoseptocutaneous graft for reconstruction of segmental femoral shaft defects. J Trauma. 1997;43(5):784-92.
20. Minami A, Kasashima T, Iwasaki N, Kato H, Kaneda K. Vascularised fibular grafts. An experience of 102 patients. J Bone Joint Surg Br. 2000;82(7):1022-5.
21. González del Pino J, Bartolomé del Valle E, Graña GL, Villanova JF. Free vascularized fibular grafts have a high union rate in atrophic nonunions. Clin Orthop Relat Res. 2004;(419):38-45.
22. Petersen MM, Dorrit Hovgaard, Elberg JJ. Rechnitzer C, Soren Daugaard, AidaMuhic. Vascularized Fibula Grafts for Reconstruction of Bone Defects after Resection of Bone Sarcomas. Sarcoma. 2010;2010:524721.

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