RESEARCH ARTICLE

Functional outcomes of lower limb reconstruction using vascularised fibula following oncological resection

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Abstract

Objectives: To assess the functional outcomes of patients undergoing lower limb reconstruction with vascularised fibula following tumour resection in a tertiary care setting.

Method: The single-centre, retrospective, observational study was conducted at the Shifa International Hospital, Islamabad, Pakistan, and comprised data from January 1, 2017, to December 31, 2022, of patients who underwent lower limb reconstruction with vascularised fibula following oncological resection. Functional outcome was assessed using Musculoskeletal Tumour Society score. Data was analysed using SPSS 26.

Results: Of the 31 patients with mean age 18.2±9.9 years, 18(58%) were females and 13(42%) were males. Mean follow-up time was 3.8 ± 3.4 years. Mean length of bony defect was 15.3 ± 5.1cm. Mean length of fibular graft harvested was 20.0+5.9cm. The mean Musculoskeletal Tumour Society score was 26.7± 2.8. Mean score was higher in foot defects recreated with single barrel fibula 29.3 ± 1.0 compared to tibial defects 27.2 ± 3.3. Minor wound-related complications were encountered in 5(16.1%) patients.

Conclusion: Vascularised fibula was found to be an ideal option for the reconstruction of post-oncological treatment defects in the lower limb.

Keywords: Lower extremity, Fibula, Free tissue flaps, Limb salvage, Autografts. (JPMA 75: 66 2025)

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Introduction

In this era of optimising functional outcomes in patients undergoing lower limb osseous tumour resection, the struggle to find the ideal reconstructive option for limb salvage continues. Amputation, though an easy and cost-effective alternative, tends to cause significant morbidity.[1] With advancements in adjuvant and neoadjuvant therapies, the long-term survival of patients undergoing oncological procedures has increased.[2,3] Hence, the role of reconstructive surgery for limb salvage is becoming more popular.[1,4] The reconstructive intervention should not increase the disease recurrence risk compared to what it would have been with an amputation, nor decrease the patient survival or delay the patient's ability to get adjuvant treatments.[1]

Various options exist for the reconstruction of lower limb bony defects following oncological resection. These include the use of biological material (vascularised or nonvascularised autografts/allografts) and endoprosthesis. nonvascularised bone grafts are highly prone to fracture and non-union. They can usually be used for defects <6cm in size.[3,5] Immunocompromised patients are at a high risk of infection, fracture and non-union if nonvascularised bone is used for reconstruction.[6]

Vascularised fibula was first described in 1977 as an option for limb reconstruction and it is increasingly being used now.[7] Vascularised fibula flap is an ideal reconstructive option due to its reliable vascular pedicle, potential to hypertrophy under load-bearing, and long-term mechanical durability.[7] In Pakistan, a part of a third world country, the high cost of endoprosthesis with its associated risk of infection makes vascularised bone grafting a very cost-effective alternative for reconstruction.[8]

The versatility of free fibula allows it to be used in various methods. Reconstruction of lower limb with single-barrel fibula is ideal for small bony defects, especially in children who undergo greater bone hypertrophy compared to adults.[8] Another technique is its usage as a double-barrel flap. The discrepancy in cross-sectional area of donor and recipient bone increases the risk of stress fracture upon exposure to weight-bearing. The technique of moulding the graft into two segments based on a single vascular pedicle can solve this problem. Double-barrel fibula ensures the availability of greater amount of vascularised bone stock. Its limitations are that the defect size should be small (8-10cm) and the pedicle length required should be less. This technique is specifically of importance when dealing with tumours involving long bones of the lower limb, like tibia and femur, since they are exposed to high stress of weight-bearing.[9]

The current study was planned to evaluate the functional

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outcomes of patients undergoing vascularised fibula for lower limb reconstruction following oncological resection.

Materials and Methods

The single centre, retrospective, observational study was conducted at the Shifa International Hospital, Islamabad, Pakistan, and comprised data from January 1, 2017, to December 31, 2023, on patients who underwent lower limb reconstruction with vascularised fibula after oncological resection and patients who underwent immediate or delayed tumour resection and reconstruction. After approval from the institutional ethics review board, data was retrieved using convenience sampling technique. Data of patients suffering from benign lower limb tumours and those with post-traumatic defects, patients undergoing major reconstruction of soft tissue, and patients suffering from metastatic disease was excluded.

Prior to surgical intervention, the patients had undergone baseline investigations and imaging in order to stage the disease. Multidisciplinary Tumour Board meetings were held prior to and after the surgical intervention to ensure that the patient received either neoadjuvant or adjuvant treatment. Surgeries were performed in a single setting involving both orthopaedic and plastic surgery teams. Resection with oncological safe margins was done using intraoperative frozen section, and vascularised fibula was harvested. Based on the size and functional demand of the defect, vascularised fibula with single or double barrel was used for reconstruction as per individual need of each case. Partial weight-bearing was started at 6 weeks, which progressed to full weight-bearing by 3 months.

Functional outcome was assessed using the Musculoskeletal Tumour Society (MSTS) score which evaluated pain, functional status, emotional acceptability, usage of supports, walking and gait.[10] Each component was scored on a scale from 0 = lowest to 5 = highest, with a maximum total score of 30. These scores were obtained at a follow-up period of 1 year postoperatively. Written informed consent had been taken from the patients.

Data was analysed using SPSS 26. Quantitative variables were reported as mean ± standard deviation, while qualitative variables were reported as frequencies and percentages.

Results

Of the 31 patients with mean age 18.2±9.9 years, 18(58%) were females and 13(42%) were males. Overall, 11(35.5%) patients underwent reconstruction with double-barrel fibula having a mean defect size of 15.0±5.2cm. The other 20(64.5%) patients underwent reconstruction with single-barrel fibula (Table 1). Pre-intervention chemotherapy was given to 24(77.4%) patients. Mean length of bony defect was 15.3±5.1cm. Mean length of fibular graft harvested was 20.0±5.9cm.

The mean MSTS score was 26.7±2.8. Mean score was higher in foot defects recreated with single-barrel fibula 29.3±1.0 compared to tibial defects 27.2±3.3 and femoral defects 26.2±2.1.

In the double-barrel group, the mean MSTS score for femoral defect was 25.9±3.7 compared to 26.0±1 for tibial defects. Mean MSTS scores for individual tumour types were: osteosarcoma 26.4±3.2, Ewing sarcoma 26.9±2.7, giant cell tumour 26.7±1.5, angiosarcoma 26.5±0.7, and synovial sarcoma 30±0. Each MSTS domain score was noted separately (Table 2). Further, 3(9.7%) patients died from recurrence and distant metastasis at 17.3 ± 0.5 months after surgery.

The mean follow-up time was 3.8±3.4 years. The free flap survival rate was 100%. All of the vascularized free fibula flaps done by us on these patients had survived. Survival was indicated by regular monitoring of the doppler signals of the pedicle of these flaps. The patients underwent daily hand held doppler monitoring of the pedicle over the first 5 days, followed by weekly monitoring for 6 weeks on outpatient basis. Vascularized free fibula flaps in the patients who died had showed viability of flaps till 6 weeks postoperatively as well.

Minor wound-related complications were encountered in 5(16.1%) patients; recipient site haematoma 2(6.5%), donor site wound dehiscence 2(6.5%) and recipient site dehiscence 1(3.2%). All these patients were managed on an outpatient basis with local wound debridement and wound closure.

Table-1: Demographic characteristics

Characteristic	Sample size(percentages)
Gender	Male 13(41.9%)
	Female 18 (58.1 %)
Site of tumour	Femur 18(58.1%)
	Tibia 9 (29.1%)
	Foot 4(12.9%)
Histological diagnosis	Osteosarcoma 16(51.6%)
	Ewing sarcoma 9(29%)
	Giant cell tumour 3(9.7%)
	Angiosarcoma 2(6.5%)
	Synovial Sarcoma 1(3.2%)
Single Barrel	20(64.5%)
Double Barrel	11(35.5%)

Table-2: Breakdown of Musculoskeletal Tumour Society (MSTS) scores

Component of MSTS	Number of patients (percentages)
Pain	No pain n=21(67.7%)
	Intermediate n=10(32.3%)
Function	No restriction n=20(64.5%)
	Intermediate (score of 4) n=9 (29.0%)
	Recreational restriction n=2 (6.5%)
Emotional	Enthused n=15(48.4%)
	Intermediate (score of 4) n= 14(45.2%)
	Satisfied 2(6.5%)
Supports	None n=19(63.3%)
	Intermediate (score of 4) n= 6(19.4%)
	Brace 3(n=9.7%)
	Intermediate (score of 2) n=3(9.7%)
Walking	Unlimited n=14(45.2%)
	Intermediate n=15(48.4%)
	Inside only n=2(6.5%)
Gait	Normal n=13(41.9%)
	Intermediate (score of 4) n=12(38.7%)
	Minor cosmetic n=4(12.9%)
	Intermediate (score of 2) n=2(6.5%)
Double Barrel	11(35.5%)

Table-2: Comparison of data with literature.[9]

Total Patients	Mean follow up time(years)	Mean defect length(cm)	MSTS Score	Complication rate(%)	Study
16	1.0	16.2	25.5		Krieg et al[11]
12	3.2	18.7		50	Rabitsch et al[12]
10	3.1	18.5	26.0	50	Parag et al[13]
24	4.3	15.5	26.1	23	Vinay Kant et a[9]
31	3.8	15.3	26.7	16.1	Our study

Discussion

Oncological resection of lower limb bony tumours creates defects that are challenging to reconstruct. Along with filling the defect, the ideal bone should be sturdy enough to withstand the high stress of load-bearing. Due to the increased life expectancy of tumour patients, the ultimate aim of reconstructive surgeon is limb salvage. [9] Vascularised fibula is an ideal solution for large lower limb segmental bony defects. The functional outcome of lower limb is assessed using MSTS score. The current study showed a mean MSTS score of 26.7, which is comparable to earlier studies (Table 3)[9,11-13] The current MSTS scores were higher than patients undergoing amputations (21.3)[2]. In the current study, for patients who underwent reconstruction with single-barrel fibula, the MSTS score was higher for foot defects (29.3) compared to tibia (27.2) and femur (26.2). This could be due to the small size of defect and flap in the foot, allowing rapid healing and early weight-bearing.

In areas with increased load-bearing, like tibia and femur, vascularised fibula can be used in a double-barrel fashion for reconstruction. This provides a greater bone stock.[5] In the current study, 11 patients underwent double-barrel fibula reconstruction and showed good functional outcomes, with mean MSTS score 26.0 in tibia and 25.9 in femur. The mean MSTS scores were similar for patients with osteosarcoma (26.4) and Ewing sarcoma (26.9). One study showed higher scores for Ewing sarcoma (27.83) compared to osteosarcoma (26.95).[14] The current study used double-barrel fibula for reconstructing defects, and, hence, the size of the defect and post–intervention union was not a limitation for ensuring optimal functional outcomes. The higher MSTS scores for osteosarcoma in the earlier study[14] were attributed to delayed union secondary to chemotherapeutic agents. Since it only used single-barrel fibula or another technique[5] for reconstruction, the earlier study lacked the advantage of the extra strength given by the double-barrel fibula.[14]

Further, the current study reported detailed MSTS scores (Table 2), which could not be compared with literature as no other study was found in this regard.

Majority of the current patients 21(67.7%) were pain-free at 1-year follow up, 20(64.5%) patients could continue daily activities without restriction and 19(63.3%) patients did that without any support (Table 2).

Mean defect size was 15.3cm which was comparable to similar studies reporting mean defect lengths of 14.0cm and 15.5cm.[9,15] Mean femoral defect was 17.9cm and mean tibial defect were 13.9cm. In the current study, the mean defect size for which double-barrel fibula was used was 15.0cm, which was greater than the cutoff (10.8cm) used in another study.[5] Mean length of fibula harvested was 20.0cm, which was greater than the 18.0cm reported by another study.[14]

The mean follow up time in the current study was 3.8 years, which was shorter compared to 7.6 years in an earlier study.[15] This could be due to the fact that the current study reviewed records of a certain period.

The current free flap survival rate was 100% and it was greater than another study (96%) using vascularised fibula (free/pedicled) in combination with an allograft.[9] The overall rate of complication in the current study was 16.1% which was lower than various other studies (Table 3). The rate of infection in the current study was 3(9.7%) which was similar to another study.[16] None of the current patients suffered complications mentioned in literature, including valgus deformity of the donor ankle and common peroneal nerve palsy.[17,18] Valgus deformity was prevented ensuring that distal osteotomies were performed >5cm from the tip of lateral malleolus. One patient who had large segmental femoral defect that was reconstructed with double-barrel fibula underwent ankle screw fixation to prevent valgus deformity of the ankle.

The current study has limitations as it was conducted at a single centre, and had no control group with exposure to different reconstructive options.

Conclusion

Vascularised fibula was found to be an ideal option for the reconstruction of post-oncological defects in the lower limb. Its ability to withstand radiation and to undergo significant hypertrophy over time made it an ideal weight-bearing substitute in tumour defects.\

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SUR: Concept, design, data acquisition and final approval.