

Original research article

Functional evaluation following free fibula transfer for upper limb long bone segmental defects: A retrospective analysis

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Abstract

In the present study, out of 11 cases that underwent free fibula flap for the period 2005 to 2016, 8 were humeral defects and 3 were forearm defects. In 7 of these cases the reconstruction of the skin and bone was done as a primary procedure and in 4 cases the reconstruction was secondary. The final outcome was evaluated using Tang criteria, Mayo elbow performance score and abbreviated UEFI (Upper Extremity Functional Index). Based on a study of Tang suggested a criteria to assess success based on long term functional outcome and radiological union. In our study, Functional outcome is excellent in 5, good in 3, Fair in 1, poor in 2 patients. The results of reconstruction with VFG for upper limb long bone defects in terms of patient satisfaction in accomplishing activities of daily living are encouraging.

Keywords: Free fibula flap, VFG, Tang 'criteria, Mayo elbow performance score

Introduction

Segmental bone defects of the upper limb cause lack of stability, limb length discrepancy, adjacent joint instability, and inability to use the hand for prehension.

While addressing defect in upper limb, surgeon has to consider important parameters like length of bone defect, condition of soft tissue bed in terms of infection, vascularity, adequacy of soft tissue cover, function in affected limb, available pedicles at recipient site etc. These open long bone injuries always require multidisciplinary management to reconstruct the composite defects of bone and soft-tissue [1,5].

Staged procedures can be used to first provide skin and soft tissue cover in the form of pedicle flaps and restoration of skeletal continuity can be done in the second stage using non vascularized cortico-cancellous bone grafts, good skeletal fixation and the possibility of the use of Ilizarov to ensure skeletal union need to be considered [7,10].

Single stage procedure which can transfer bone with a skin component as a free flap is ideal, this not only ensures primary bone union but also decreases the time for rehabilitation.

Amongst various vascularized bone transfers available the free fibula transfer is the most preferred one. It has proven a valuable tool in managing defects > 6 cms with poor bed with an impressive success rate. The vascularised free fibula has been expanded to an osteocutaneous flap by including a cutaneous flap on the lateral part of the lower leg by Taylor *et al.* [10] facilitating one-stage reconstruction of bone and soft-tissue defects. Indications for vascularised bone transfer in the upper limb are traumatic bone defects, post-tumour resection defects, bony non-union, failed conventional bone graft, bridging congenital defects, pseudo arthrosis of the ulna, radial club hand and management of osteomyelitis etc., . In a study conducted by Scott *et al.* [8] 20 patients who received free fibula for upper limb long bone defects were satisfied with their quality of living.

Functional recovery for upper extremity segmental defects treated with the vascularized- fibular osteo cutaneous grafts has been short of ideal. While no studies have directly compared upper extremity function following vascularized-fibular transfer with amputation or prosthesis, it is safe to say that the majority of patients will prefer preservation of their native limb, albeit with some level of impaired function.

The functionality of the reconstructed limb in activities of daily living is being evaluated in this present study.

Aims and Objectives

1. To assess success rate of the microvascular transfer and its attendant complications, if any.
2. To analyse number of secondary procedures required to achieve optimal result.

- Functional evaluation of limb using the Tang criteria, Mayo elbow performance index and abbreviated UEFI (Upper Extremity Functional Index).

Materials and Methods

A retrospective analysis of the functional outcome following free fibula transfer in upper limb long bone defects following trauma, tumour resection, post traumatic non-union, osteomyelitis,etc. was done. Isolated segmental defects of the ulna were excluded

Out of 11 cases who underwent free fibula flap for the period 2005 to 2016, 8 were humeral defects and 3 were forearm defects. In 7 of these cases the reconstruction of the skin and bone was done as a primary procedure and in 4 cases the reconstruction was secondary.

The case sheets and outpatient records of the patient were obtained to document the clinical findings and operative and post-operative details; patients were called up for follow up assessment using the criteria mentioned below. The final outcome was evaluated using Tang criteria, Mayo elbow performance score and abbreviated UEFI (Upper Extremity Functional Index)

Table 1: Tang criteria

	Tang Criteria	
	Clinical	Radiological
Excellent	Ability to carry out normal work	Healing within 6 months, without any reintervention
Good	Ability to carry out ADL with no difficulty related to reconstructed part	Healing within one year with no intervention
Fair	Limited ability to perform ADL sometimes with difficulty	Healing after one year or reintervened
Poor	Inability to perform ADL	Nonunion after repeated surgeries

*ADL activities of daily living

Table 2: Mayo Elbow Performance Score

Function	Points	Definition	Points
Pain	45	None	45
		Mild	30
		Moderate	15
		Severe	0
Motion	20	Arc > 100	20
		Arc 50-100	15
		Arc < 50	5
Stability	10	Stable	10
		Moderate Instability	5
		Gross Instability	0
Function	25	Comb hair	5
		Feed	5
		Hygiene	5
		Wear Shirt	5
		Wear Shoes	5

Total Score = 100

Excellent result = >90, Good result = 75-89, Fair result = 60-74, Poor result = <60

aUEFI

The final outcome measurement was done by adopting the abbreviated upper extremity functional index (aUEFI). The original UEFI considers the patient's ability to perform activities of daily life (ADL).20 different activities are considered and the rating as experienced by patient is recorded. The total best score is 80, higher scores correlate with a better outcome.

In this study we have abbreviated the original functional index to make it more patient friendly (as the patients in this study have come from various educational backgrounds) by taking ten of the twenty criteria and calculating for a maximum score of 40 only. The patient is asked to tell the degree of difficulty or ease in performing the activities mentioned below.

Table 3: aUEFI

S. No.	Activites	Extreme difficult y or unable to perform “0”	Quite a bit of difficulty “1”	Moderate difficulty ”2”	A little bit of difficulty “3”	No. difficulty “4”
1	Any of your usual work, housework, or school social activites					
2	Lifting a bag of groceries to waist level					
3	Lifting a bag of groceries to above your head					
4	Grooming your hair					
5	Doing up buttons					
6	Using tools or appliances					
7	Opening doors					
8	Opening a jar					
9	Throwing a ball					
10	Carrying a small suitcase with your affected limb					
	Score (max 40)					

A higher aUEFI score correlates with a better functional outcome

Results

There were 11 patients in all during the period (2005 to 2016).

Sex Distribution

- **Male:** 7.
- **Females:** 4.

Age

- **Range:** 2 years to 31 years.
- **Mean:** 18.2 years.

Location of the skeletal defect

- **Arm:** 8.
- **Forearm:** 3.

Table 4: Cause of the skeletal defect

Cause	No.
Acute trauma	2
Post tumour resection	4
Post traumatic non-union of fracture	3
Osteomyelitis	1
Vascular malformation	1

Table 5: Recipient pedicles used for micro anastomosis

Pedicle	No.
Profundabrachii artery and vena commitantes	5
Brachial artery & cephalic vein	1
Thoracodorsal vessels	1
Transverse cervical artery and external jugular vein	1
Radial artery, vena commitantes and cephalic vein	3

All arterial anastomosis except 1 (using the brachial artery) was done end to end. Venous anastomosis end to end.

1. **Vein:** 6.
2. **Veins:** 5.

2 of the three in the last group needed re-fixation after excision of fibrous callus at the distal bone graft junction, both healed and external splintage could be removed within 15 months of the primary surgery.

1 of the three, a 5-year child with previous osteomyelitis had non-union at both upper and lower ends on account of inadequate bony fixation and is waiting secondary bone grafting.

Table 6: Skeletal shortening

		No shortening	< 2 cms	>2 cms
Acute trauma	2	1		1
Non-union	2	-	1	1
Osteomyelitis	1	-	-	1
Post tumour resection	3	1	1	1

None of the patients had any stress fractures after documentation of skeletal union in the follow up period ranging from 14 months-12 years.

Evaluation of results

Out of 11, 9 patients were available for evaluation. As per tang criteria

Table 7: Evaluation of results

S. No.	Tang Criteria	
	Clinical	Radiological
1.	Fair	Poor
2.	Good	Good
3.	Good	Excellent
4.	Good	Excellent
5.	Excellent	Excellent
6.	Lost to follow up	
7.	Excellent	Excellent
8.	Excellent	Excellent
9.	Lost to follow up	
10.	Excellent	Excellent
11.	Excellent	Excellent

Table 8: According to MAYO score and aUEFI results are

S. No.	MAYO Score	aUEFI
1.	65	28
2.	90	28
3.	95	33
4.	90	27
5.	100	40
6.	Lost to follow up	
7.	95	38
8.	95	38
9.	Lost to follow up	
10.	95	38
11.	80	28

Discussion

When reconstructing these defects, the ultimate objectives are to provide adequate soft tissue protection of vital structures, and to provide optimal functional and aesthetic outcomes. Free tissue transfer should not be selected to cover a limb that has no potential for functional recovery. This requires a sensate hand, mobile joints and a sufficient number of tendons and muscles. The fibular graft is more popular because it is easier to align, has greater strength and can bridge larger gaps ^[12, 16].

Based on a study of 46 free fibula flaps for upper limb defects, Tang suggested criteria to assess success based on long term functional outcome and radiological union. 31 patients were evaluated as per Tang's criteria in the study. Functional outcome is excellent in 13, good in 11, Fair in 5, poor in 2 patients. Radiological outcome was excellent in 22, good in 8 and fair in one.

Mayo elbow performance index has been used to qualitatively analyse functional improvement after reconstructive procedures.

In the present study we have evaluated the functional outcome following free fibula transfer in patients who had segmental defects of long bones of upper limb using TANG criteria, Mayo Elbow Performance index, abbreviated UEFI. 9 out of 11 patients were available for evaluation.

Table 9: According to Tang criteria

	Clinically	Radiologically
Excellent	5	5
Good	3	1
Fair	1	2
Poor	-	1

In the present study, according to Tang’s criteria Functional outcome is excellent in 5, good in 3, Fair in 1, poor in 1 patients. Radiological outcome was excellent in 5, good in 1 and fair in 2 and poor in 1.

Table 10: As per MAYO elbow performance index

>90	Excellent	7
75-89	Good	1
60-74	Fair	1
<60	Poor	-

According to Mayo performance index, Functional outcome is excellent in 7, good in 1, Fair in 1.

Table 11: For abbreviated UEFI

Score	No of Patients
30-40	5
20-30	4

Conclusion

The vascularised free fibula is a viable method for the reconstruction of skeletal defects of more than 6 cm, especially in cases of scarred and avascular recipient sites or in patients with combined bone and soft-tissue defects. The predictability of successful bony union, thus providing skeletal stability following VFG for segmental defects of upper limb long bone defects make it the preferred choice. The results of reconstruction with VFG for upper limb long bone defects in terms of patient satisfaction in accomplishing activities of daily living following evaluation are encouraging. Even though there was limb shortening at follow up it was no functional consequence.

Conflict of Interest: None.

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