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Original Research Article

The role of microvascular tissue transfer in severe limb trauma

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ABSTRACT

Background: Lower extremity reconstruction is an essential part of plastic surgery and focuses on the treatment of wounds. The restoration of an intact covering is the primary surgical requisite following trauma of the lower extremity because deep healing can be no better than the surface covering. Present study will review the field of lower extremity reconstruction focusing on the micro-vascular tissue transfer for severe limb traumatic injuries.
Methods: Patients were fully evaluated and defect was assessed depending on the defect requirement free micro-vascular flap was planned. 20 micro vascular flaps in 18 males and 2 females were used for the wound / defect of lower limbs following trauma.
Results: There were 18 men and 2 women with a mean age of 43.6 years (range, 18-62 years) in the present study. The overall survival of the flaps was 95% (19/20).
Conclusions: The free flap is an effective method of lower-extremity reconstruction. Good outcomes can be achieved with complete debridement and the selection of appropriate recipient vessels and flaps according to the recipient site.

Keywords: Free flaps, Local flaps, Lower extremity reconstruction, Open tibial fractures

INTRODUCTION

The goal of lower extremity reconstruction is the coverage of defects and open wounds of the leg to give patients a healed wound and to let them resume their life, ambulate, and go back to work while preventing amputation. Lower extremity reconstruction is done to reconstruct large primary defect following trauma, infection with osteomyelitis and oncologic resection which in turn can be with or without soft tissue loss. Among the methods for reconstructing defects of the lower extremities, there are direct closure, skin grafting and local flaps including the muscle flap, cross-leg flap, and free flap.[1]

The free flaps are usually the first choice for soft tissue coverage in the limb trauma. Free tissue transfer is a complex procedure that involves removing a piece of tissue with its blood supply (free flap) from a distal part of the body and placing it over a defect, reconnecting the artery and vein to vessels at the recipient site under the microscope.

Micro vascular flap brings better blood supply to poorly vascularized bed and provide skin coverage and padding over bony prominences.

Pollaket al, reported that a better prognosis would be achieved in reconstruction surgery using a free flap even in cases in which the reconstruction could be performed sufficiently using a local flap.[2]

METHODS

In the current study, we performed a retrospective analysis of the medical records of 20 patients who

underwent lower extremity reconstruction at our medical institution during a period ranging from 2013 to 2016.

The mean follow-up period was 3 years. Of these, nine patients had defects over foot and heel, eight patients had defect over leg and three patients had wound over thigh with bone loss of femur in two of these patients. The most common flap used in the present study was anterolateral thigh free flaps in fourteen cases, free fibula flap in two patients, radial artery foreman flap in three patients and latissimus dorsi flap in one patient.

In most of the patients, an angiography of the lower extremities was performed approximately one week before the operation. This was performed for all the patients with diabetes mellitus or hypertension and, in particular, the elderly aged 60 years or older.

Specifically, we reconstructed large defects using anterolateral thigh free flaps as shown in Figure 1.

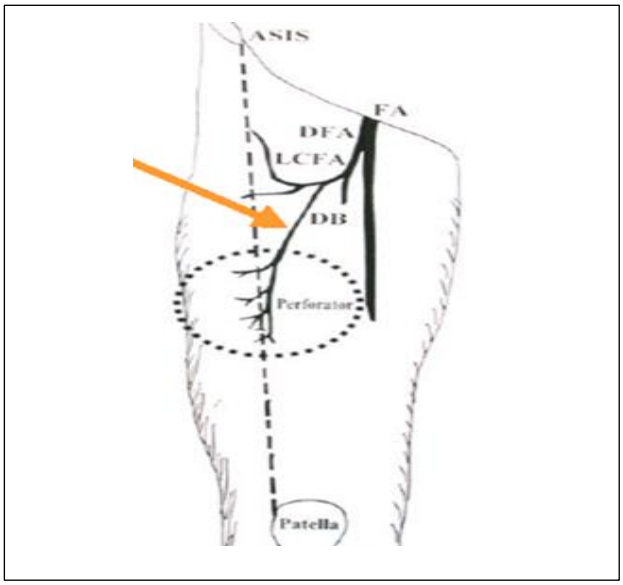

Figure 1: The anterolateral thigh flap.

The anterolateral thigh flap is located between the rectus femoris and vastus lateralis, is a Type B and C flap based on septocutaneous and musculocutaneous perforators of the lateral circumflex femoral branch of the profundal femoris. In 92% cases, main perforator was found in a circle of radius 3cm in the centre of axis line.

RESULTS

There were 18 men and 2 women with a mean age of 43.6 years (range, 17-62 years) in the present study. The overall survival of the flaps was 95% (19/20).

Size of free flap

The mean size of the free flap was 11 cm × 18 cm. The smallest free flap was 5 cm × 6 cm, which was used in a 28-year male who underwent reconstruction of a left heel defect using a medial plantar sensory free flap. The largest one was the flap for which the lateral circumflex femoral artery served as a pedicle of anterolateral thigh flap of size 11cm x 32cm for near total tibial defect following burn injury.

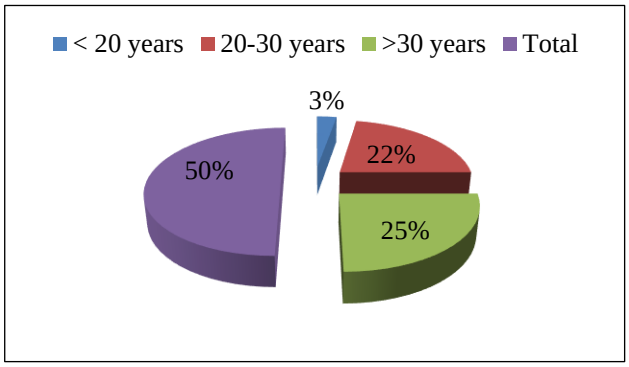

Figure 2: Distribution of cases with respect to age and sex groups.

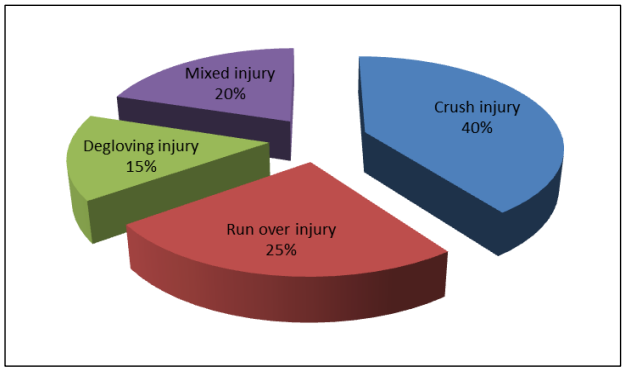

Figure 3: Distribution of cases with respect to type of injury.

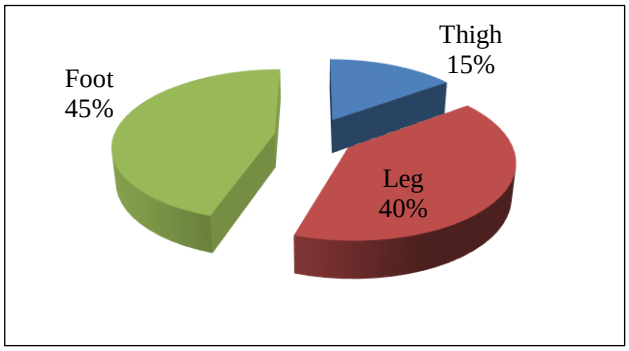

Figure 4: Distribution of cases with respect to the site of the defect/wound.

Vascular anastomosis

In the present study, recipient arteries include the anterior tibial artery in 4 patients, the dorsalis pedis artery in 5 patients, the posterior tibial artery in 9 patients, the superficial femoral artery in 1 patient, and the descending genicular artery in 1 patient (Table 1). With respect to the

methods of arterial anastomosis, there were 11 who received an end-to-end anastomosis and 9 patients who received an end-to-side anastomosis (Table 2).

Two venous anastomoses were performed in each patient.

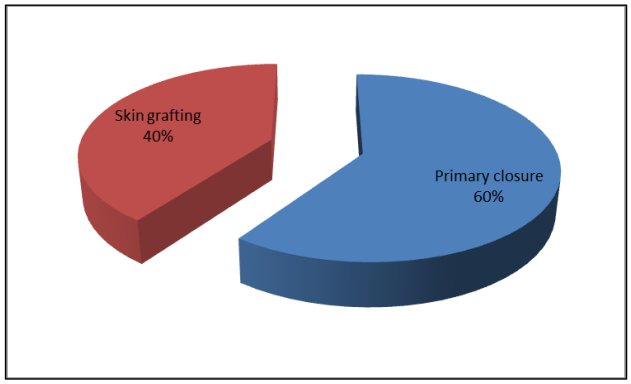

Figure 5: Distribution of cases with respect to donor site morbidity.

Table 1: Types of the artery.

No. of patients	Recipient artery
4	Anterior tibial artery
9	Posterior tibial artery
5	Dorsalispedis artery
1	Superficial femoral artery
1	Descending genicular artery

Table 2: Types of the anastomosis.

No of patients	Type of arterial anastomosis
11	End to end
9	End to side

Case 1

In a patient presented with wound at plantar surface reconstruction was done with an anterolateral thigh flap.

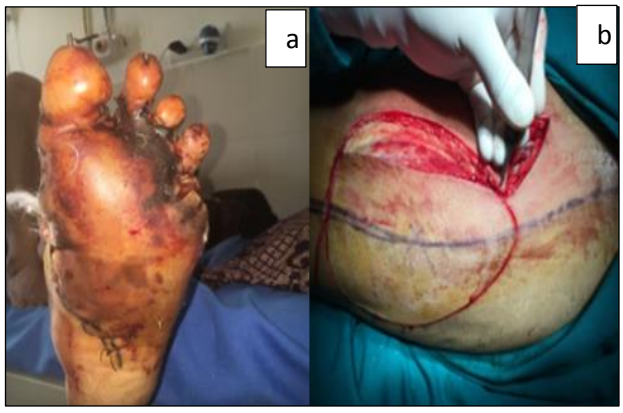

Figure 6: a) degloved injury left sole of foot and; b) ALT flap harvest.

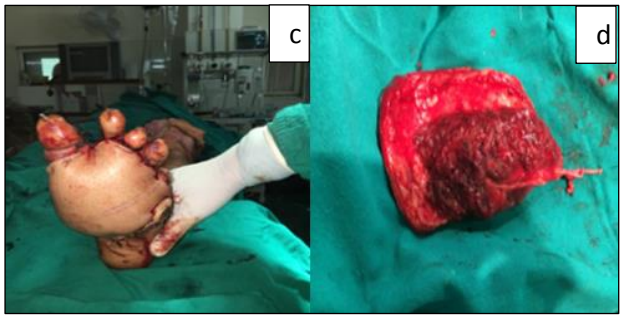

Figure 6: c) Flap inserted into sole defect; d) ALT flap with vascular pedicle.

Figure 6: e) Months followed-up.

Case 2

In a patient presented with wound at foot and was salvaged with ALT free flap.

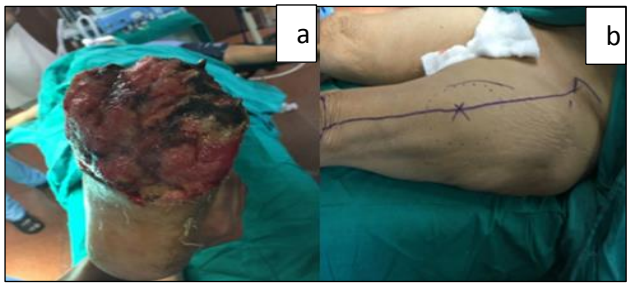

Figure 7: a) Cruse injury left foot; b) ALT flap marking.

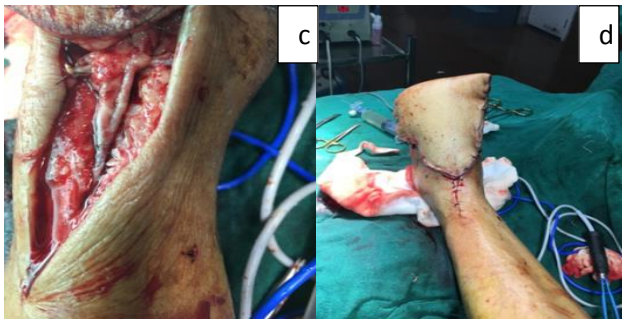

Figure 7: c) Anastomosis; d) complete in setting of flap.

Case 3

In a patient presented with wound at heel and ALT free flap was done for heel reconstruction.

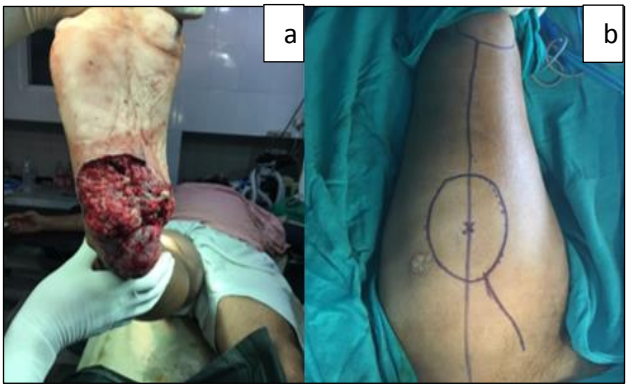

Figure 8: a) Right heel loss; b) ALT flap marking.

Figure 8: c) Follow-up at one year.

Case 4

In a patient presented with heel injury was salvaged with ALT free flap.

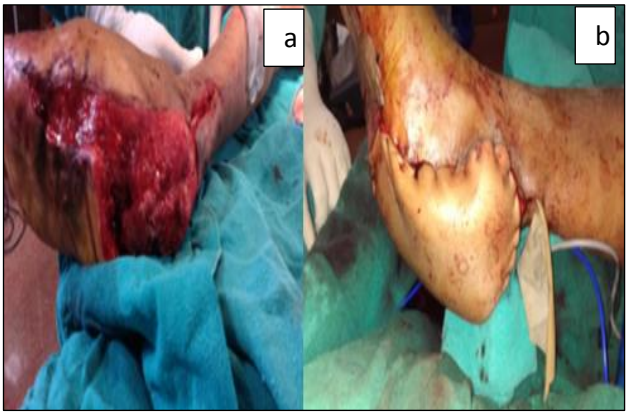

Figure 9: a) Crush injury right foot with heel loss b) ALT flap coverage.

Case 5

In a patient presented with dorsum foot injury was salvaged with ALT free flap.

Figure 10: a) ALT flap; b) Crush injury partial foot amputation.

Figure 10: c) One month follow up of same patient

Case 6

In a patient with de-gloving injury at dorsum and plantar surface of right foot, reconstruction was done using anterior lateral flap.

Figure 11: (a and b) Crush injury right foot covered with ALT flap for sole and SSG over dorsal surface of foot.

Figure 11: c) Follow up at 2 years.

Case 7

Patient presented with severe injury at foot with non-healing wound at dorsum foot and fracture.

Figure 12a: Debridement was done.

Figure 12b: ALT flap was used for soft tissue defect.

Case 8

Dorsum foot injury was salvaged with ALT free flap.

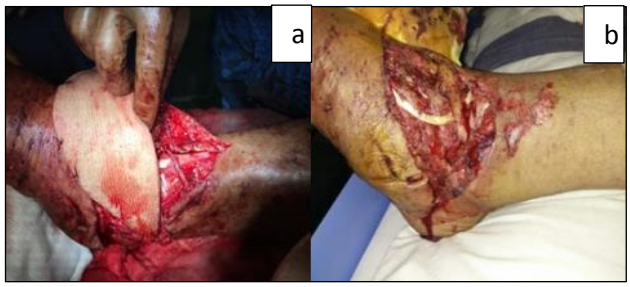

Figure 13: (a and b) Crush injury right foot with ALT flap in situ showing anastomotic site.

Figure 13: c) Post op of the patient after flap in setting.

Case 9

Open comminuted fracture of the right tibia with large soft tissue defect which exposed wound, ALT was taken to fill the defect.

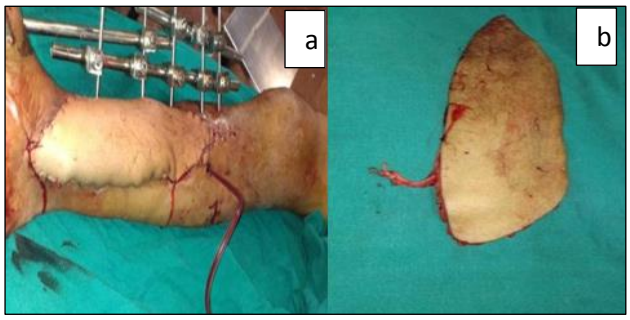

Figure 14: a) ALT flap for right tibial defect; b) ALT flap with distal pedicle.

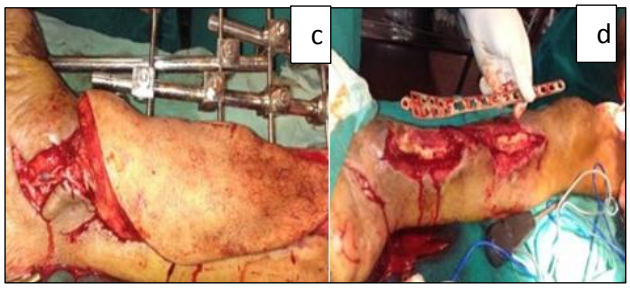

Figure 14: c) Flap in setting pf ALT flap showing vascular anastomosis; d) Debridement with removal of exposed implant.

Figure 14: e) Follow up at 3 weeks.

Case 10

Fibular osseous free flap was taken to fill the 10-cm femoral bone defect and plating was done.

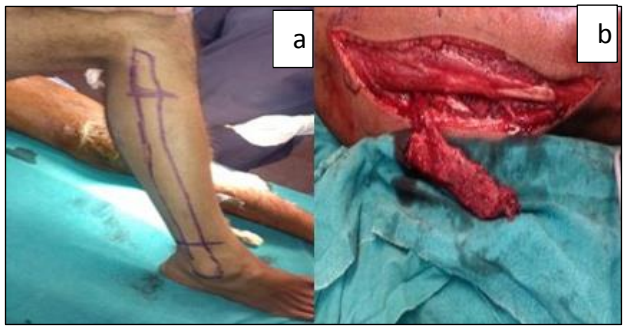

Figure 15: a) Free fibula flap marking; b) Free fibular flap harvest with intact pedicle.

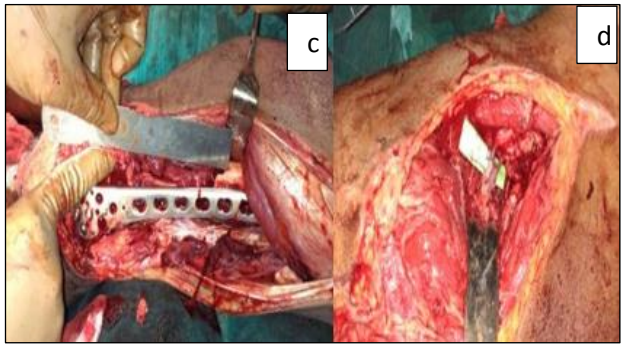

Figure 15: c) Fmuur defect measurement after application of plate; d) vascular anastomosis at recipient site.

Case 11

ALT free flap was used to fill soft tissue defect at dorsum of foot.

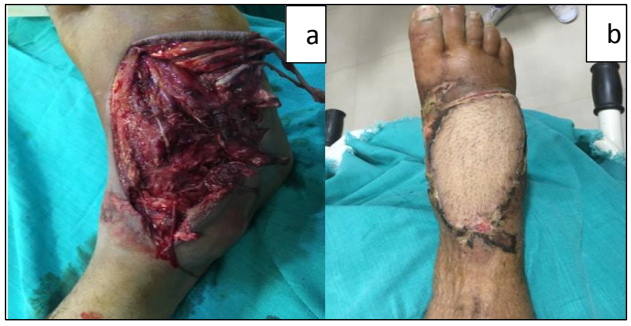

Figure 16: a) Crush injury right foot; b) Free ALT flap for wound coverage done at 22 weeks follow-up.

Complications

There were 2 cases of vascular complications, out of which one flap survived after intervention. There were 3 cases of minor complications of seroma and partial flap necrosis and infection.

DISCUSSION

The management of lower leg trauma with significant tissue loss has improved significantly with the advent of free tissue transfer. Godina demonstrated that free flap transfer within 72 hours produced significantly less flap failures, less post-operative infections, shorter bone-healing time, shorter hospital stay and fewer operative procedures.[3]

Naique et al, demonstrated that there is an increased incidence of complication rates and revision surgery in patients with grade III b open tibial shaft fractures who are not initially treated at a specialist centre.[4]

The free flap is an effective method of lower-extremity reconstruction. Good outcomes can be achieved with complete debridement and the selection of appropriate recipient vessels and flaps according to the recipient site.

The selection of appropriate recipient vessels is an essential element for achieving successful treatment outcomes in the reconstruction of lower extremity defects using free flap.[5]

According to study by Erdmann experience of pedicled fasciocutaneous flaps in lower limb trauma. Over a five-year period, they used distally-based, islanded fasciocutaneous flaps to reconstruct open tibial fractures to cover the distal one-third of the leg, ankle, heel or foot in 61 patients, with 25 fractures graded as Gustilo IIIB. The overall complication rate was 7.6%, but in the present study overall complication rate was 5%.

In a series of 100 consecutive local fasciocutaneous flaps, which included 67 to the lower extremity, Hallock reported that 15% required further surgical intervention, with the majority in lower limb wounds.[7] But in the present study 10% cases required further surgical intervention.

In recent years, however, it has been reported not only that there is no significant difference in surgical outcomes between the muscle flap and the fasciocutaneous flap, but also that there is no need to sacrifice muscle tissue at donor sites.[8]

The selection of appropriate recipient vessels is an essential element for achieving successful treatment outcomes in the reconstruction of lower extremity defects using free flap.[9]

The anterior tibial artery is more vulnerable to damage compared with the posterior tibial artery. It has therefore been reported that the posterior tibial artery would be more appropriate as a recipient vessel.[10-12] If there were damages to the arteries at recipient sites, however, we

dissected their proximal part and anastomosed it to the arteries with normal perfusion. In two patients with arterial insufficiency, the dorsalis pedis artery served as the recipient vessel, for which an end-to-end anastomosis was performed.

Godina reported that end-to-side anastomosis showed superior results compared with end-to-end anastomosis.[13] Afterwards, however, several authors have reported that there was no significant difference in flap survival between end to-side anastomosis and end-to-end anastomosis.[14,15]

In two patients with venous thrombosis, the thrombosis occurred at the sites of anastomosis to the great saphenous vein. It has been reported that superficial veins are more vulnerable to damage compared with deep veins because of the anatomical location. In particular, a poor prognosis of the great saphenous vein has been documented.[11]

In addition, it has also been reported that there is no significant difference in treatment outcomes between end-to-side anastomosis and end-to-end anastomosis. This was also seen in venous anastomosis.[14,15]

CONCLUSION

The free flap is an effective method of lower-extremity reconstruction. Good outcomes can be achieved with complete debridement and the selection of appropriate recipient vessels and flaps according to the recipient site. It requires micro-surgical training and patience and monitoring of flap to achieve desirable result.

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Conflict of interest: None declared
Ethical approval: The study was approved by the institutional ethics committee

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