The role of microvascular free tissue transfer for foot and ankle defects: Results and outcome.

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Abstract:

Introduction: The foot and ankle defects include large primary defect following trauma, infection with osteomyelitis and oncologic resection with soft tissue loss. The primary goal of lower limb reconstruction is to prevent amputation and give a durable coverage of defects. Therefore, microvascular free tissue transfer is a useful and an effective method for foot and ankle reconstruction. **Materials and method:** In the current study, we performed a prospective analysis of patients who underwent lower limb reconstruction at our medical institution during the period of January 2018 to October 2018. In our study we reconstructed defects of dorsum of feet and ankle using radial forearm free flap, latissimus dorsi free flap, anterolateral thigh free flap. These were performed patients age ranging between 20 to 55yrs. All the patients were followed for 6 months. **Results: there were** 15 patients, 13 males and 2 females, with age ranging between 20 to 55years; we reconstructed defects of dorsum of foot and ankle defects with free flap. Overall survival of flap rate was 93.3% (14/15) **Conclusion:** Free flap is an ideal option for foot and ankle defects especially in patient with large defects to salvage the limb. It is a better option in case of sole and dorsum of foot defects.

Keywords: - Foot and ankle defects, Free tissue transfer, Microvascular.

Introduction:

The foot and ankle defects include large primary defect following trauma, infection with osteomyelitis and oncologic resection with soft tissue loss. The primary goal of foot and ankle reconstruction is to prevent amputation and give a durable coverage for the defects. This would allow the patient to resume their daily life, ambulate and go back to work. Foot and ankle reconstruction many a times poses a challenge to the surgeon. Among the methods for reconstructing defects of foot and ankle, there are direct closure, skin grafting and local flaps including the muscle flap, cross leg flap and free flap.[1]

Sometimes when the defects are large, direct closure is not possible. Skin grafting has the disadvantages of less durable coverage, more chances of recurrence, prolonged splintage and cosmetically less appealing. When dealing with larger defects local flaps gives less satisfactory results due to anatomic variations of the area, lack of suitable flap limiting the mobility, exposure of vital structures while elevating the flap

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(such as tendons, vessels), paucity of tissue. The cross-leg flap causes inconvenience to the patient especially elderly patients, due to prolonged immobilization and restricts mobility. Cross leg flap is a multi-stage procedure. Therefore, microvascular free tissue transfer is a useful and an effective method for the reconstruction of foot and ankle defects.

The advantages of free flap are that defects can be covered with identical tissue, flap has a good vascularity, cosmetically satisfactory, usually no second stage procedure needed, useful in large defects, it provides a durable cover.

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]

Materials and Methods:

In the current study, we performed a prospective analysis of patients who underwent foot and ankle reconstruction at our medical institution during the period of January 2018 to October 2018. In our study we reconstructed defects of dorsum of foot and ankle using radial forearm free flap, latissimus dorsi free flap, anterolateral thigh free flap. These were performed patients age ranging between 20 to 55yrs. All the 15 patients were followed up for 6 months.

Patients medical history, demographic details, site of defect, co-morbidities like diabetes, hypertension, peripheral vascular disease, history of smoking and tobacco chewing, were documented. In all the patients arterial doppler of lower limb was performed to evaluate the status of vessels.

In our study, we analyzed the factors that might affect the survival of free flap, which includes age, sex of the patient, smoking, tobacco chewing, diabetes mellitus, hypertension, anastomosis in the zone of trauma.

Results:

Demographic characteristics: In our study, 15 patients underwent free flap for reconstruction of foot and ankle defect, comprising of 2 females and 13 males. Mean age of these patients were, ranging between 20 – 55 years old. Of these 2 patients were diabetic, 1 patient diabetic and hypertensive, 1 patient was a chronic smoker.

Causes of defects: In our study, cause of foot and ankle defect was road traffic accident in 12 patients, and 3 patients were solely diabetic patient with diabetic foot.

Sites of defects: the site of defect was dorsum of foot in 13patients and heel in 2 patients.

Types of free flap: The selection of flaps for foot and ankle reconstruction was based on several factors such as size of soft tissue defect, location and characteristics of recipient sites. There were 6 patients who underwent foot and ankle defect reconstruction using radial forearm free flap, 7 patients underwent anterolateral thigh flap, 1 patient underwent latissimus dorsi flap.

Image 1: Types of vascular anastomosis.

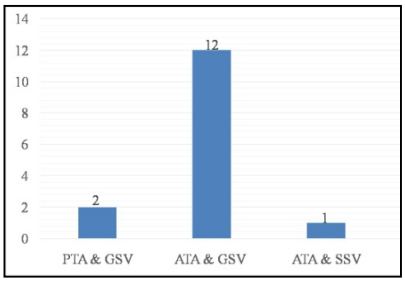


Image 2: Distribution of Types free flaps

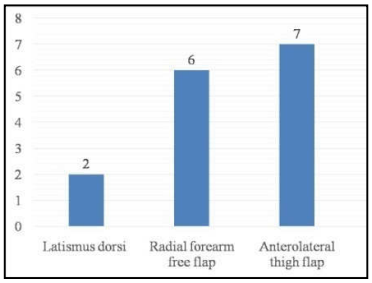
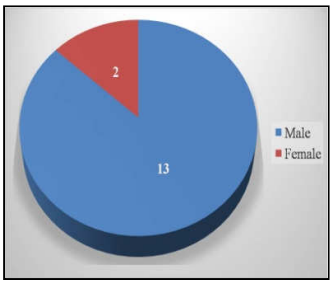


Image 3: Male-female ratio



ATA: Anterior tibial artery, GSV : Great saphenous vein, SSV: Short saphenous vein, PTA: Posterior tibial artery

Size of free flap: the mean size of free flap was 11*17cm.The largest free flap was done with latissimus dorsi for which thoracodorsal artery served as pedicle (25*20cm). The smallest free flap was 6cm*6cm for which radial forearm free flap was done, radial artery served as a pedicle.

Vascular anastomosis: Anterior tibial artery, its venae comitantes and great saphenous vein were used for anastomosis with donor vessels of the free flap in 10 patients. posterior tibial artery, its venae comitantes and great saphenous vein was used in remaining 2 patients. Two venous anastomosis was performed in each patient. the anastomosis that was done was end to end type in 14 patients and end to side in one patient. 4X zeiss loupe was used for magnification during the procedure. Anastomosis was done using 8.0 prolene.

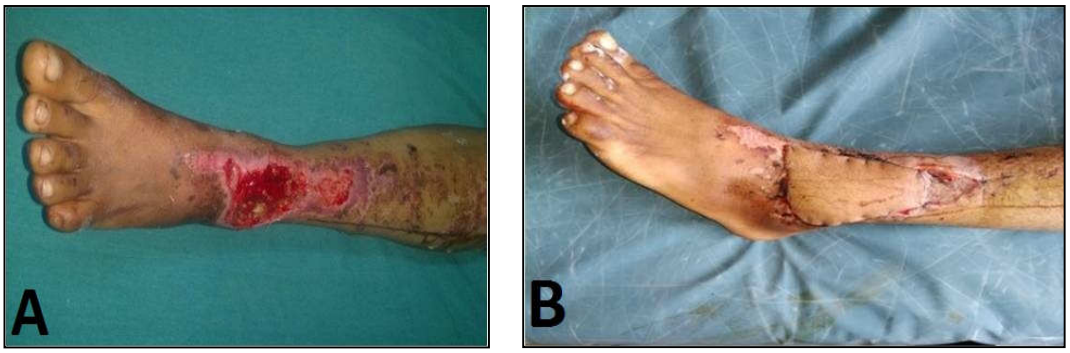
Anticoagulants: Inj. heparin 5000 iu was given intravenously intra-operatively after the anastomosis of artery in all the patients. Post op inj. microspan was given intravenously 20 microdrops/min in 3 patients only.

Donor sitec losure: In our study, in patients who underwent latissimus dorsi free flap, donor site was closed by primary suturing. In patients who underwent radial forearm free flap and anterolateral thigh flap donor site was closed by both primary suturing and split thickness graft.

Case 1:

A 30-year-old male, with history road traffic accident, presented with a left ankle defect, radial forearm free flap was done for this patient. (Image 4)

Image 4 : Case 1 : Left ankle defect treated with radial forearm free flap



(A) Pre-operative **(B)** Post-operative

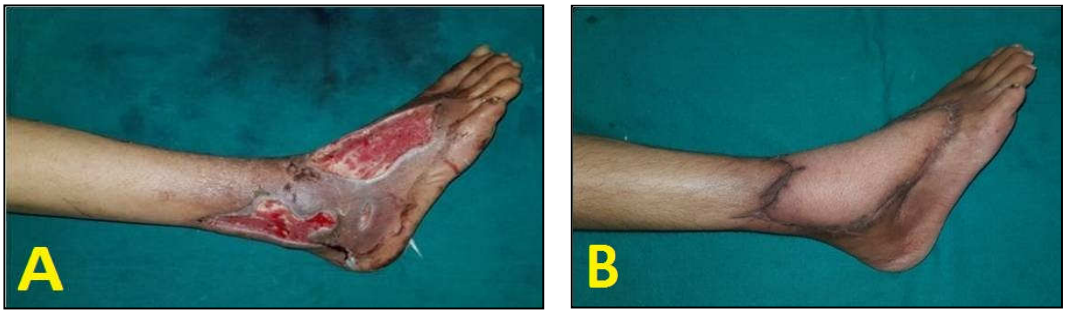
Table 1: Patient summary

Sr. No.	Age/ sex	Defect	Name of flap	Recipient artery/vein	Donor artery/vein	Management of donor
1	30y/m	left ankle defect	radial forearm free flap	ATA GSV venae comitantes	radial artery cephalic vein venae comitantes	split thickness graft + primary closure
2	55y/m	right foot defect	anterolateral thigh free flap	ATA GSV venae comitantes	descending branch of lateral circumflex femoral artery, venae comitantes	primary closure +split thickness graft
3	22y/m	left ankle defect	radial forearm free flap	PTA GSV, venae comitantes	radial artery cephalic vein venae comitantes	split thickness graft + primary closure
4	45y/m	left foot defect	anterolateral thigh free flap	ATA GSV venaecomitantes	descending branch of lateral circumflex femoral artery, venae comitantes	primary closure +split thickness graft
5	22y/m	left foot defect	anterolateral thigh free flap	ATA GSV venae comitantes	descending branch of lateral circumflex femoral artery, venae comitantes	primary closure +split thickness graft
6	55y/f	left foot defect	radial forearm free flap	ATA GSV, venaecomitantes	radial artery cephalic vein venae comitantes	primary closure +split thickness graft
7	53y/m	left foot defect	latissimus dorsi flap	ATA GSV	thoracodorsal artery and vein	primary closure
8	47y/m	right foot and ankle defect	anterolateral thigh free flap	ATA GSV venaecomitantes	descending branch of lateral circumflex femoral artery, venae comitantes	primary closure +split thickness graft
9	50y/m	right foot defect and 4th , 5th toe gangrene	radial forearm free flap	ATA GSV, venae comitantes	radial artery cephalic vein venae comitantes	primary closure +split thickness graft
10	45y/m	right foot defect	anterolateral thigh free flap	ATA GSV venaecomitantes	descending branch of lateral circumflex femoral artery, venae comitantes	primary closure +split thickness graft
11	23y/m	right heel defect	radial forearm free flap	PTA GSV, venaecomitantes	radial artery cephalic vein venae comitantes	primary closure +split thickness graft
12	16y/m	right foot defect	radial forearm free flap	ATA GSV, venaecomitantes	radial artery cephalic vein venae comitantes	primary closure +split thickness graft
13	33y/m	left foot defect	anterolateral thigh free flap	ATA GSV venae comitantes	descending branch of lateral circumflex femoral artery, venae comitantes	primary closure +split thickness graft
14	22y/m	right ankle defect	anterolateral thigh free flap	ATA SSV venaecomitantes	descending branch of lateral circumflex femoral artery, venae comitantes	primary closure +split thickness graft
15	35y/m	right heel defect	latissimus dorsi flap	ATA GSV	thoracodorsal artery, thoracodorsal vein	primary closure

ATA:anterior tibial artery, GSV : great saphenous vein, SSV: short saphenous vein, PTA: posterior tibial artery

Case 2: A 55years old male, a known case of diabetes, developed cellulitis, following which debridement was done. Patient later on developed a right foot defect, ALT free flap was done. (Image 5)

Image 5 : Case 2 : Right foot defect treated with antero-lateral thigh flap



(A) Pre-operative **(B)** Post-operative

Case 3: A 53 years old male presented with a left foot defect following road traffic accident, which was salvaged by latissimus dorsi free flap. (Image 6)

Image 6 : Case 3 : Left foot defect treated with latissimus dorsi flap

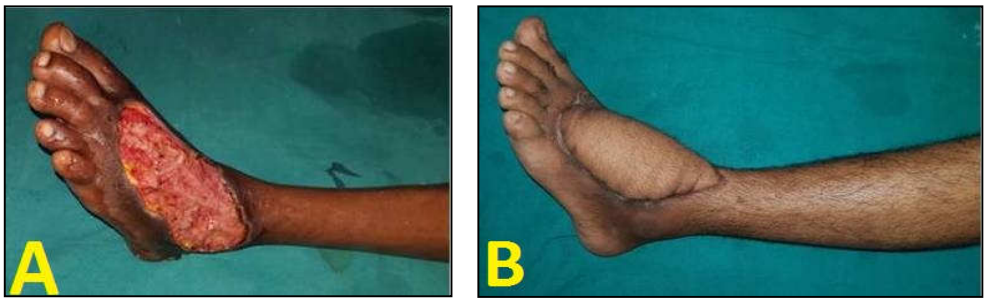
(A) & (B) Pre-operative **(C)** Post-operative after flap, **(D)** After split thickness graft

Case 4: A 22years male patient presented with a left foot defect following road traffic accident, ALT free flap was done.(Image 7)

Case 5: A 23yrs old male with a right heel pad defect, following road traffic accident, radial forearm free flap was done. (Image 8)

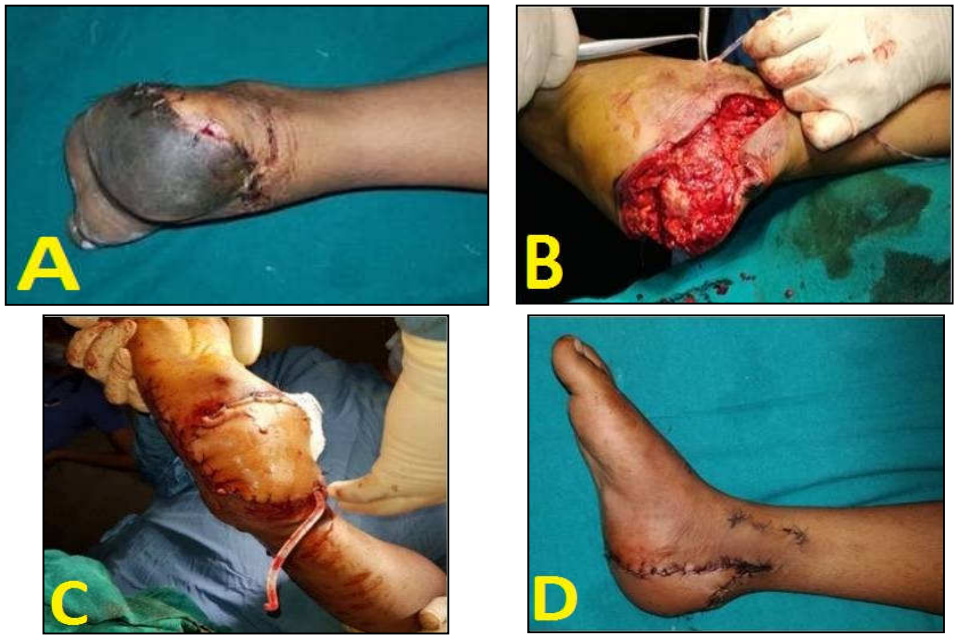
Case 6: A 50yrs old male with right foot 4^{th} and 5^{th} toe gangrene. 4^{th} and 5^{th} toe was amputated and radial forearm free flap was done. (Image 9)

Image 7 : Case 4 : Left foot defect treated with ALT flap



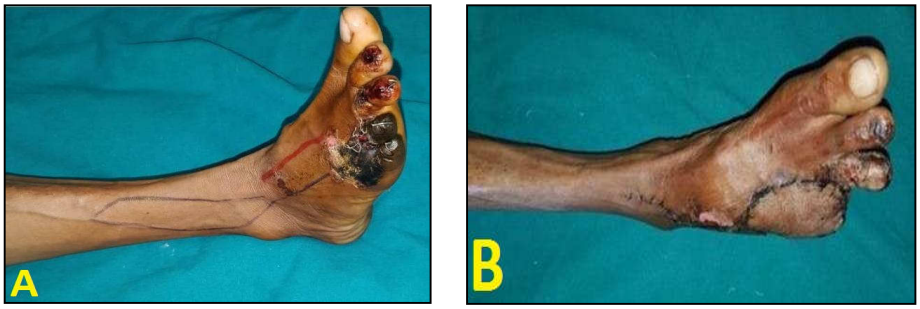
(A) Pre-operative **(B)** Post-operative

Image 8 : Case 5 : Right heel gangrene treated with radial forearm flap



(A) Pre-operative **(B)** Intra-operative after debridement **(C)** Immediate Post-operative **(D)** After 3 months

Image 9 : Case 6 : Right 4th & 5th toe gangrene treated with radial forearm free flap



(A) Pre-operative **(B)** Post-operative

Case 7: A 55yrs old male, known case of diabetes presented with cellulitis of left foot, debridement was done, left foot defect was salvaged with anterolateral thigh flap. (Image 10)

Case 8: A 35yrs old male, presented with a right heel defect following road traffic accident, limb was salvaged with latissimus dorsi free flap (Image 11)

Image 10 : Case 7 : Right foot cellulitis treated with anterolateral thigh flap

(A) Pre-operative **(B)** Post-operative

Image 11: Case 8: Right heel defect treated with latissimus dorsi flap

(A) Pre-operative **(B)** Immediate post-operative **(C)** After split thickness graft

Case 9: A 45yrs old male, presented with a left ankle defect following road traffic accident, limb was salvaged with anterolateral thigh free flap. (Image 12)

Image 12: Case 9: Left ankle defect treated with antero-lateral thigh flap

(A) Pre-operative **(B)** Post-operative

Discussion:

The primary goal of foot and ankle reconstruction is to provide a stable and durable soft tissue cover, which helps in maintaining the function. Foot and ankle defects, especially the distal 1/3rd pose a challenge to the reconstructive surgeon.Due to thin non-expendable soft tissues and predisposition for massive oedema even small defects in foot and ankle can become problematic.

Skin graft, Local flaps, musculocutaneous flaps, cross leg flap, free flap are the options for lower extremity reconstruction. In reconstruction of foot and ankle, surgeon

should consider risk of infection, surrounding tissue when zone of injury is extensive, and the size of defect.

Skin grafts are one of the options for lower limb defects coverage; however it is a less durable cover, cosmetically less appealing, with chances of recurrence (ulceration).

One of the disadvantages of local perforator flap is that when they are raised within the zone of injury, may leave part of the flap with a potentially impaired perfusion.[3] local flaps have a limited role in large defects.

Local flaps and distally based flaps are an option for lower limb defects, but these flaps may have the risk of flap necrosis. If the adjacent area is involved in the zone of injury, there may be injury to their muscle and vascular pedicle. If the defect is large, local flap may not suffice. Local flap can leave a significant cosmetic defect relating to the donor site, which may be difficult camouflage[4.]

Cross leg flap is another alternative for reconstruction of lower third leg defects but the main disadvantage of prolong immobility of leg for three weeks in uncomfortable position and prolonged hospital stay.

The skin is thin and devoid of subcutaneous adipose tissue in the dorsum of foot. The patients cannot only wear shoes but also have a cosmetically satisfactory results if a thin flap is elevated.

Since O'Brien *et al.* [5] first used a free groin flap to reconstruct a foot defect in 1973; free flaps have been widely used to reconstruct the sole of the foot. After the free latissimus dorsi procedure was described by Baudet *et al.* [6], in 1976, many authors used this and other myocutaneous flaps to repair wide foot defects. Because of the excessive thickness of those flaps, the use of the free latissimus dorsi muscle-plus-skin graft was advocated. [7] Later in the 1980s, the use of fasciocutaneous flaps was strongly suggested as a standard for foot reconstruction. [8]

The latissimus dorsi flap can be harvested as a pure muscle flap or as a myocutaneous flap, based on the thoracodorsal artery. Its advantages are large dimensions flaps can be harvested, easy dissection, long pedicle and large diameter of the vessels. Its main disadvantages are thickness of the flap and sacrificing of a major muscle[6].

The radial forearm flap is harvested as a pure cutaneous flap based on the radial artery. Its advantages are easy dissection, long pedicle with large diameter vessels, reinnervation through cutaneous nerves and the possibility to include a bone[9]. The free radial forearm flap was a useful adjunct for one shallow and small soft tissue defect in our study. It was selected for its thin component that did not interfere with the postoperative function and footwear, however, its donor site morbidity and cosmetically not appealing was the main patient complaint.

Our study showed the success rate of free flap was 93.3%(14/15). In the study by Min Jo Kong et al[10], success rate was 96.2%. Percival et al,[11] it was 85% while it was 90% in the study by Small and Mollan[12]. In our study there was only one flap failure, which is comparable to other studies.

Some of the possible complications and drawbacks observed after undergoing reconstruction of the foot and ankle using free tissue transfer was donor site morbidity, lengthy operative times, bulky contour, and recipient vessel trauma.

Free flap is best alternative for foot and ankle reconstruction. The field of reconstructive surgery has taken a significant leap forward with the introduction of free flap. This is made possible with the development of knowledge in vascular anatomy and cutaneous circulation. It is ideal for reconstruction of small to medium sized defect in distal leg and ankle. With good cosmetic, excellent color and thickness match. However, relative contraindications of free flap include electrical burns, single vessel limb, delayed referral and in patient after bone tumor resection that had radiotherapy.

To ensure success for every free-tissue transfer to the foot and ankle defects, in our study we developed a comprehensive approach that includes patient selection, flap selection, selection of donor vessel, selection of recipient vessels, flap dissection, flap preparation, microvascular anastomosis, flap inset, immediate postoperative care, and further follow-up care . Every single step in this comprehensive approach is critical to the success for free-tissue transfer to the foot and ankle in contrast to some beliefs that only microvascular anastomosis is important. If each step in this comprehensive approach is not properly conducted, failure of free-tissue transfer to the foot and ankle is likely to happen.

Conclusion:

Free flap is an ideal option for foot and ankle defects especially in patient with large defects. It is a better option in case of sole and dorsum of foot defects. The versatility and vascularity of free tissue transfer have made them an indispensable tool in lower limb reconstruction. The salvage of the severely traumatized lower extremity requires sound judgment on the part of the surgeon, and the patient must be made aware of the length of time involved in the complete reconstruction.

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