

Research Article

Comparison between Free Anterolateral Thigh Flap and Free Medial Sural Artery Perforator Flap in Reconstruction of Post Traumatic Soft Tissue Defects of Dorsum of the Foot

Abo Elhassan WS^{1*}, Abulezz TA¹, Ali AE² and Elsayed GY¹

¹Department of Plastic and Reconstructive Surgery, Faculty of Medicine, Sohag University, Sohag, Egypt
²Hand and Reconstructive Microsurgery Unit, Assiut University Hospital, Assiut, Egypt

*Corresponding author: Waleed S Abo Elhassan, Department of Plastic and Reconstructive Surgery, Faculty of Medicine, Sohag University Sohag, Egypt

Received: August 06, 2021; Accepted: August 19, 2021; Published: August 26, 2021

Abstract

Background: The objective of this study was to compare the pliability, the function, aesthetic outcome, complications and patient satisfaction between free anterolateral thigh flap and free medial sural artery perforator flap in reconstruction of post traumatic soft tissue defects of dorsum of the foot.

Method: The study was conducted on forty patients with post traumatic soft tissue defects of the dorsum of the foot between August 2018 and August 2019. Patients were divided randomly into two groups. In group1 (20 patients), the defects were reconstructed with free anterolateral thigh perforator flap. In group 2 (20 patients), reconstruction was done by free medial sural artery perforator flap.

Result: In group 1 (ALT flap), Complete flap survival was achieved in 100% of cases. Thirteen patients required secondary debulking procedures and scar revisions.

In group 2 (MSAP Flap), Complete flap survival was achieved in 85% with one flap totally lost and two flaps had distal necrosis. One patient needed scar revision and another patient needed flap advancement.

Conclusion: MSAP flap is superior to ALT flap. It has many advantages: it is thin, pliable, fitted to normal footwear, less hairy and there is no need for secondary procedures in most cases.

Keywords: Medial sural artery perforator flap; Reconstruction of soft tissue defect of dorsum of the foot; Anterolateral thigh flap

Introduction

The foot is an important part of the body which maintains the standing posture and gives a stable relationship between the body and the ground during walking. Foot function is affected by multiple pathological processes that may result from many etiologies, but it is mostly due to trauma. Despite the high advances in reconstructive options for foot defects such as, fasciocutaneous, myocutaneous and perforator flaps, foot reconstruction is still complexing and challenging. The microsurgery development results in great numbers of reconstructive options. Free flaps offer a variety of coverage of variable sizes and multi-structural defects of the foot [1].

Anterolateral Thigh flap (ALT flap) is now a common method for soft-tissue coverage due to a large skin island with minimal donor-site morbidity, long vascular pedicle with sufficient diameter for micro-anastomosis. The flap can be thinned up to 3 to 6 mm but when we need bulk, we can take it as myocutaneous flap to provide adequate contour for various defects and complicated needs [2].

Medial Sural Artery Perforator flap (MSAP) has limited donor site morbidity with suitable thickness for shallow foot defects, with long pedicle that can be anastomosed away of the trauma zone,

with no need to sacrifice major vessels of the leg, the donor and the recipient sites are in the same operation field which can be managed by one microsurgical team for the entire flap harvest and inset [3].

Previous studies discussed the use of medial sural artery perforator flap in reconstruction of head and neck, upper and lower extremity. In this series we compared the using of ALT flap and MSAP flap in reconstruction of dorsal foot soft tissue defects.

Patients and Methods

The study was observational study conducted on forty patients with post traumatic soft tissue defects of the dorsum of the foot between August 2018 and August 2019. Patients were allocated sequentially into two groups. In group1 (20 patients), the defects were reconstructed with free anterolateral thigh perforator flap. In group 2 (20 patients), reconstruction was done by free medial sural artery perforator flap.

The two groups were compared according to age, sex, flap size, defect size, number of perforators, and type of anastomosis, recipient vessels, donor site closure, complications, patient satisfaction and need for secondary debulking procedures.



Figure 1: A case reconstructed with ALT flap:
A: ALT flap planning view.
B: Dorsal foot defect view.
C: ALT flap 6months postoperative view.
D: ALT donor site 6 months postoperative view.

Seventeen males and 23 females with mean age 14.78 ± 12.154 years. The mean dimension of flap size was $123 \pm 59.9 \text{ cm}^2$. Soft tissue defects were due to trauma in all patients.

Group 1 (free ALT flap group, 20 patients)

Harvesting technique of the ALT flap was the standard technique described by Song et al. 1984 [4].

Eleven females and 9 males with mean age of 11.8 ± 11.4 years. Recipient vessels were anterior tibial vessels in 18 patients and posterior tibial vessels in 2 patients. End to end anastomosis was used in all patients. Primary wound closure was done in 5 patients, split thickness skin graft was used in 15 patients for donor site closure (Figure 1).

Group 2 (free MSAP flap, 20 patients)

Harvesting technique of MSAP flap was the standard technique described by Cavadas, et al 2001 [5].

Twelve females and 8 males with mean age of 17.75 ± 12.40 years. Recipient vessels were anterior tibial vessels in 18 patients and posterior tibial vessels in 2 patients. End to end anastomosis was used in all patients. Primary wound closure was done in 5 patients, and split thickness skin graft was used in 15 patients for donor site closure (Figure 2).

Surgical debridement was done for all cases before reconstruction. Vacuum assisted device was applied for some patients till reconstruction. One surgical team nearly operated all patients.

Statistical Package for Social Science (SPSS) 2019 software program was used for data analysis. Patient satisfaction was measured by asking the patient to rank their satisfaction by one of three grades: poor, fair, or good.

Results

Patient’s demographic data were summarized in Table 1.



Figure 2: A case reconstructed with MSAP flap:
A: MSAP flap planning view.
B: Dorsal foot defect view.
C: MSAP flap 6 months postoperative view.
D: MSAP donor site 6 months postoperative view.

Table 1: Patient demographic data.

	Group 1 ALT	Group 2 MSAP	Total
Number of patients (n)	20	20	40
Age (years)	11.8 ± 11.4	17.75 ± 12.40	14.78 ± 12.15
Sex (%)	11 females, 9 males	12 females, 8 males	23 females, 17 males
Defect size in cm^2 P=0.003	152 ± 62.12	94.65 ± 42.38	123.33 ± 59.9
Flap size in cm^2 P=0.003	155.05 ± 59.29	102.6 ± 42.6	128.83 ± 57.47

Table 2: Showing flap survival, need for secondary procedures and complication.

	Group 1 ALT flap	Group 2 MSAP flap
Flap survival (N), percentage	20 100%	19 95%
Secondary procedures (N), percentage P=0.000	13 65%	2 10%
Complications (N), percentage P=0.000	10 50%	6 30%

Group 1 ALT flap

Flap vascular pedicle length ranged from 8 cm to 15 cm, it was tailored according to flap size and site. Complete flap survival occurred in 20 patients. Numbers of early and late complications occurred. Two cases had flap congestion in day 2 postoperative. Exploration was done, vein re-anastomosis for one flap and hematoma evacuated from the other one. The two flaps were salvaged. Three cases developed infection in the first postoperative week treated conservatively with dressing and parenteral antibiotics.

Late complications reported; four patients had hypertrophic scarring. One patient developed itching and severe hyperpigmentation in the flap. Thirteen patients required secondary debulking procedures and scar revisions. As regard donor site closure, five patients closed primary and 15 patients requires split thickness skin graft. Overall complications rate was (10 of 20 patients) 50%. Patient satisfaction was as follow: 3 patients poor, 8 patients fair and 9 patients good (Table 2).

Group 2 MSAP flap

Complete flap survival was achieved in 85%. One flap totally lost and two flaps with distal necrosis. The totally lost flap occurred due to venous congestion in the third day, re-exploration and venous thrombosis was found. Venous thrombectomy and re-anastomosis were done. Eventually the flap lost. Defect reconstructed with skin graft. Two patients presented with distal end loss, the first flap managed with dressing and healed secondary. The second flap managed with skin graft. Infection occurred in two cases, which was responded well to conservatives.

Late complications reported in one patient who developed hypopigmentation in the flap and donor site after 4 months post-operative. Overall complications rate was (6 of 20 patients) 30%. Two cases required secondary procedures, one patient needed scar revision and the other patient needed flap advancement.

Number of perforators was one in 9 patients, two in 8 patients, three in 2 patients and 5 in one patient. Vascular pedicle length ranged from 8 cm to 14 cm. Donor site closed primary in 5 patients and required skin graft in 15 patients. Patient satisfaction was as follow: 1 patient poor, 3 patients fair and 16 patients good.

Discussion

Reconstruction of soft tissue defects around ankle and feet is a great challenge facing reconstructive surgeons. There was no sufficient subcutaneous tissue and muscles bulk. Trauma produces shallow defects with exposed superficial tendons and bones. Presence of shallow defects and ease of exposure of tendons and bones offered a reconstructive challenge [6,7].

Lower extremities and feet are associated with decreased perfusion in comparison with head and neck and upper limb. Distal peripheral arterial diseases, trauma and limited connections between lower limb vessels exacerbate the conditions and harden the method of reconstruction [6,8].

Although varieties of local, distant and free flap are available, there is no superior method for reconstruction of foot defects [9]. The gold standard option for reconstruction is free flaps which when transferred to defects, they bring well perfused tissue that ensure an infection-free healing for the wounds and fractures [10].

Recently perforator free flaps offered a useful option for lower limb reconstruction [11-16]. Thin, supple, firm skin coverage, rapid return to mobilization, normal foot wear and minimal tolerated donor site morbidity must be achieved for perfect reconstruction [6].

Dorsal foot defects require unique method of reconstruction which is mandatory for proper foot wear [17]. In our study we were concerned with the dorsum of the foot defects after trauma for reconstruction.

In this series anterolateral thigh flap and medial sural artery perforator flap were used for resurfacing dorsal foot defects.

Anterolateral thigh flap was first described by Song et al. 1984; it considered the preliminary type of perforator flaps [4]. In literature, it has been considered an excellent option for head and neck defects reconstruction. However, it was not the first line of choice in lower limb reconstruction [18].

The anatomical region of ALT is a wealthy region; skin, subcutaneous tissue, fascia, muscle, and nerve are available for transfer. In perforator flap we did not raise muscle, however, a small cuff around the perforator may be raised leaving the muscle intact minimizing the donor site morbidity.

Texture and color matching of ALT flap are optimal for lower limb reconstruction in comparison with head and neck region or in case of muscle flaps and graft [8].

In 2010 Derimates et al performed 20 cases with 4 flap loss and one partial loss; they attributed the flap loss to lower limb vessels conditions and not due to perforator dissection problems. In our 20 patients we did not raise muscle or part of it. We had to re-explore 2 flaps in the 2nd postoperative day, but all flaps have survived completely. In harvesting the perforator flaps, we should be very cautious not to injure vascular pedicle during dissection [18].

The ALT flap provides a reasonable long vascular pedicle. The long vascular pedicle was important in post-traumatic foot defects to anastomose the pedicle away from the trauma zone for successful free flap transfer [19]. In our ALT series, the pedicle length ranged from 8 to 15 cm they could be tailored according flap size and site of recipient vessels.

ALT flap thickness is related to body mass index. In obese patient, the flap tends to be bulky which is not suitable for resurfacing of certain area such as dorsal foot. To overcome this problem, a thinning technique was described through which thickness of the flap can be reduced to 2-4 mm in thickness [20]. However, thinning was discouraged by some authors, as it may increase the possibility of flap problems and partial necrosis due to its detrimental effects on flap blood supply [21,22]. ALT flap thinning was not done in our series. Unfortunately, we had 13 patients who requested secondary procedures for debulking and scar revision.

Defect sizes range from 6*12 cm to 12*25 cm so, we had to use skin grafts to close the donor sites in 15 cases. Hypertrophic scarring, itching, and paresthesia occurred in 5 cases. Patients have been counseled prior to the operation and they were informed about these possible complications; they were more accepting them. This is shown in patient's satisfaction which is nine patients scored their own satisfaction as good, eight patients scored it as fair, and three patients had poor satisfaction.

The medial sural perforator flap was firstly described by Cavadas 2001 for lower limb reconstruction [5]. The medial sural artery perforator flap offers a thin and pliable flap even in obese patient. Other tissue units are available in the flap if needed.

Many authors have found the MSAP flap a reliable option for reconstruction of oral cavity defects, head and neck, upper limb, lower extremities and feet [3,23-31].

Complications found in our series are considered low when compared to other studies in literature (our complications are similar to literatures in ALT). We had total loss of one flap due to venous congestion and the defect was covered with skin graft. We also had two flaps suffered distal end necrosis treated with debridement and dressing then the residual raw area was covered with a skin graft. In 2005 Chen et al reported one case of partial flap necrosis out of

thirteen cases in reconstruction of tendon Achilles which was salvaged with skin graft [3]. In 2006, Kim reported partial necrosis of one flap out of nine cases in reconstruction of medial malleolus defect [32]. In 2009, Kim et al. reported distal flap end necrosis in diabetic wound in forefoot and midfoot defect out of 11 cases [31]. Furthermore, in 2013, Wang et al reported two cases with partial flap loss out of nine cases and healed secondary with dressing [33]. In 2014, Hallock et al reported one case of total flap loss due to venous congestion which required a second free flap [23]. All complications occurred in MSAP flap can be managed with skin graft or healing secondary, which was confirmed with our study [23,31,32].

In 2013 Wang et al described a preparation of supplementary superficial vein for anastomosis if needed [33]. In our series we prepared a superficial vein, but we did not use it for anastomosis.

Donor site closure method is much affected with flap width. Varying degree of morbidity occurred. In 2018, Jandali et al closed 14 cases primary out of 22 cases [19]. In the study, flaps width range from 5*8 cm to 11*18 cm so only 5 cases donor sites closed primary, in one of them, the flap width was 8 cm. Fifteen cases were closed with skin graft but were well accepted by the patients, thanks for the patients counseling were done prior to surgery.

In previous studies, average number of perforators was 2.2 in average of 11.7 to 18 cm from the popliteal crease. Along the line drawn from the popliteal fossa to medial malleolus the first perforator was at 8cm [34]. In this series number of perforators ranges from 1 to 5 with a mean of 1.8 perforator. Site of perforators ranged from at 8 cm to 12 cm from the popliteal fossa crease. Nine flaps were raised on 1 perforator; eight flaps were raised on 2 perforators, two flaps on 3 perforators and one flap on 5 perforators.

MSAP flap offered a reliable long vascular pedicle which was long enough to reach the recipient vessels outside the trauma zone. Pedicle length of MSAP flap may reach up to 15 cm [35]. In this series, the pedicle length ranged from 8 cm to 14 cm, each flap is tailored according to the defect size and site and perforator site.

Fortunately, MSAP flap is quite thin and pliable. Only two cases required secondary debulking procedures. Patient's satisfaction was as follow: 16 patients with good, 3 patients with fair and one patient with poor satisfaction. The flap thinness, pliability and normal footwear turned a blind eye to the unsightly scar of the donor site.

In comparison between ALT flap and MSAP flap; ALT flap was considered excellent method for head and neck defects reconstruction. It was not superior method for reconstruction of dorsal foot defects. The flap is bulky especially in obese patient which need thinning whether primary or secondary and more than one stage of debulking. It is better for large defect coverage. The donor site is concealed especially for women and children. The ALT flap is recommended for large dorsal defects of the foot due to large sized flap and long pedicle. On the other hand, medial sural artery perforator flap is a good method for head and neck and upper and lower extremities reconstruction. It was perfect in small and medium sized defects in dorsal foot. The flap is quite thin even in overweight patients. Thin flap offers favorable solution for shallow defects of dorsal foot. MSAP flap is pliable, aesthetically accepted and allow a normal fitted footwear. However, the unsightly scar in the donor site

may be upsetting to women and children. From our point of view, the MSAP flap is superior to ALT flap in resurfacing dorsal foot defect.

Conclusion

In conclusion, MSAP flap is a favorable option of reconstruction for dorsal foot defects, and it is superior to ALT flap. It has many advantages as, thin, pliable, fitted to normal footwear, less hairy and no need for secondary procedures in most cases.

Ethical Approval

The institutional ethical committee has approved the clinical study.

Statement of human and animal rights

All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2008.

Comparison between Free Anterolateral Thigh Flap and Free Medial Sural Artery Perforator Flap in Reconstruction of Post Traumatic Soft Tissue Defects of Dorsum of the Foot.

References

1. Khurram MF, Ahmad I. Soft tissue reconstruction of foot and ankle defects: free vs pedicled flaps with the use of 6 different flaps in 50 cases of road traffic accidents. *Austin J Surg.* 2014; 1: 1031.
2. Hong JP, Kim EK. Sole reconstruction using anterolateral thigh perforator free flaps. *Plast Reconstr Surg.* 2007; 119: 186-193.
3. Chen SL, Chuang CJ, Chou TD, Chen TM, Wang HJ. Free medial sural artery perforator flap for ankle and foot reconstruction. *Ann Plast Surg.* 2005; 54: 39-43.
4. Song YG, Chen GZ. The free thigh flap: A new free flap concept based on the septocutaneous artery. *Br J Plast Surg.* 1984; 37: 149-155.
5. Cavadas PC, Sanz-Giménez-Rico JR, Gutierrez-de la Cámara A, Navarro-Monzonis A, Soler-Nomdedeu S M-SF. The medial sura artery perforator flap. *Plast Reconstr Surg.* 2001; 108: 1609-1615.
6. Fitzgerald O'Connor E, Ruston J, Loh CYY, Tare M. Technical refinements of the free medial sural artery perforator (MSAP) flap in reconstruction of multifaceted ankle soft tissue defects. *Foot Ankle Surg.* 2020; 26: 233-238.
7. Zhang Q, Qiao Q, Gould LJ, Myers WT, Phillips LG. Study of the neural and vascular anatomy of the anterolateral thigh flap. *J Plast Reconstr Aesthetic Surg.* 2010; 63: 365-371.
8. Demirates Y, Kelahmetoglu O, Cifci M, Tayfur V, Demir A, Guneren ME. Comparison of free anterolateral thigh flaps and free muscle-musculocutaneous flaps in soft tissue reconstruction in lower extremity. *microsurgery.* 2010;3 0: 24-31.
9. Zhu YL, Wang Y, He XQ, Zhu M, Li FB, Xu YQ. Foot and ankle reconstruction: An experience on the use of 14 different flaps in 226 cases. *Microsurgery.* 2013; 33: 600-604.
10. Khan U, Smitham P, Pearse MNJ. Management of severe open ankle injuries. *Plast Reconstr Surg.* 2007; 119: 578-589.
11. Wei FC, Jain V, Celik N, Chen HC, Chuang DC LC. Have we found an ideal soft-tissue flap? An experience with 672 anterolateral thigh flaps. *Plast Reconstr Surg.* 2002; 109: 2219-2226.
12. Masia J, Moscaticello F, Pons G, Fernandez M, Lopez SSP. Our experience in lower limb reconstruction with perforator flaps. *Ann Plast Surg.* 2007; 58: 507-512.
13. Ohjimi H, Taniguchi Y, Kawano K, Kinoshita KMT. A comparison of thinning and conventional free-flap transfers to the lower extremity. *Plast Reconstr*

- Surg. 2000; 105: 558-566.
14. Yazar S, Lin CH, Lin YT, Ulusal AE. Outcome comparison between free muscle and free fasciocutaneous flaps for reconstruction of distal third and ankle traumatic open tibial fractures. *Plast Reconstr Surg.* 2006; 117: 2468-2475.
 15. Yildirim S, Gideroglu KAT. Anterolateral thigh flap: Ideal free flap choice for lower extremity soft-tissue reconstruction. *J Reconstr Microsurg.* 2003; 19: 225-233.
 16. Ozkan O, Cos_kunfirat OK. The use of free anterolateral thigh flap for reconstructing soft tissue defects of the lower extremities. *Ann Plast Surg.* 2004; 53: 455-461.
 17. Hollenbeck ST, Toronto JD, Taylor BJ, Ho TQ, Zenn MR, Erdmann D, et al. Perineal and lower extremity reconstruction. *Plast Reconstr Surg.* 2011; 128: 551e-563e.
 18. Park JE, Rodriguez ED, Bluebond-Langer R, Bochicchio GC, Bochicchio KST. The anterolateral thigh flap is highly effective for reconstruction of complex lower extremity trauma. *J Trauma.* 2007; 62: 162-165.
 19. Jandali Z, Lam MC, Aganloo K, Merwart B, Buissink J, Müller K, et al. The free medial sural artery perforator flap: Versatile option for soft tissue reconstruction in small-to-moderate size defects of the foot and ankle. *Microsurgery.* 2018; 38: 34-45.
 20. Kimura N, Satoh K, Hasumi T, Ostuka T. Clinical application of the free thin anterolateral thigh flap in 31 consecutive patients. *Plast Reconstr Surg.* 2001; 108: 1197-1208.
 21. Alkureishi LWT, Shaw-Dunn J, Ross GL. Effects of thinning the anterolateral thigh flap on the blood supply to the skin. *Br J Plast Surg.* 2003; 56: 401-408.
 22. K VL. The anterolateral thigh flap for lower extremity reconstruction. *Semin Plast Surg.* 2006; 20: 127-132.
 23. Hallock GG. Medial sural artery perforator free flap: Legitimate use as a solution for the ipsilateral distal lower extremity defect. *J Reconstr Microsurg.* 2014; 30: 187-192.
 24. Chen SL, Yu CC, Chang MC, Deng SC, Wu YS, Chen TM. Medial sural artery perforator flap for intraoral reconstruction following cancer ablation. *Ann Plast Surg.* 2008; 61: 274-279.
 25. Choi JW, Nam SY, Choi SH, Roh JL, Kim SY, Hong JP. Applications of medial sural perforator free flap for head and neck reconstructions. *J Reconstr Microsurg.* 2013; 29: 437-442.
 26. Kao HK, Chang KP, Chen YA, Wie FC, Cheng M. Anatomical basis and versatile application of the free medial sural artery perforator flap for head and neck reconstruction. *Plast Reconstr Surg.* 2010; 125: 1135-1145.
 27. Nugent M, Endersby S, Kennedy M, Burns A. Early experience with the medial sural artery perforator flap as an alternative to the radial forearm flap for reconstruction in the head and neck. *Br J Oral Maxillofac Surg.* 2015; 53: 461-463.
 28. Song X, Wu H, Zhang W, Chen J, Ding X, Ye J, et al. Medial sural artery perforator flap for postsurgical reconstruction of head and neck cancer. *J Reconstr Microsurg.* 2015; 31: 319-326.
 29. Zheng H, Liu J, Dai X, Schilling AF. Free conjoint or chimeric medial sural artery perforator flap for the reconstruction of multiple defects in hand. *J Plast Reconstr Aesthet Surg.* 2015; 68: 565-570.
 30. Chen SL, Chen TM, Lee CH. Free medial sural artery perforator flap for resurfacing distal limb defects. *J Trauma.* 2005; 58: 323-327.
 31. Kim ES, Hwang JH, Kim KS, Lee SY. Plantar reconstruction using the medial sural artery perforator free flap. *Ann Plast Surg.* 2009; 62: 679-684.
 32. Kim HH, Jeong JH, Seul JH, Cho B. New design and identification of the medial sural perforator flap: An anatomical study and its clinical applications. *Plast Reconstr Surg.* 2006; 117: 1609-1618.
 33. Wang X, Mei J, Pan J, Chen H, Zhang W, Tang M. Reconstruction of distal limb defects with the free medial sural artery perforator flap. *Plast Reconstr Surg.* 2013; 131: 95-105.
 34. Chalmers RL, Rahman KMA, Young S, Kennedy M, Endersby S, Adams JR, et al. The medial sural artery perforator flap in intra-oral reconstruction: A Northeast experience. *J Plast Reconstr Aesthetic Surg.* 2016; 69: 687-693.
 35. Ives M, Mathur B. Varied uses of the medial sural artery perforator flap. *J Plast Reconstr Aesthetic Surg.* 2015; 68: 853-858.