

Comparison between Free Anterolateral Thigh Flap and Free Medialsural Artery Perforator Flap in Reconstruction of Posttraumatic Soft Tissue Defects of Dorsum of the Foot

WALEED S. ABO ELHASSAN, M.Sc.*; TAREK A. ABULEZZ, M.D.*; AMR E. ALI, M.D.** and GAMAL Y. ELSAYED, M.D.*

The Departments of Plastic & Reconstructive Surgery, Faculty of Medicine, Sohag University and Hand & Reconstructive Microsurgery Unit**, Assiut University Hospital*

ABSTRACT

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

Patients and Method: The study was conducted on 40 patients with post traumatic soft tissue defects of the dorsum of the foot between August 2018 and August 2019. Patients were allocated randomly into two groups. In group 1 (20 patients), the defect was 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 all cases. Thirteen patients required secondary debulking procedures and scar revisions.

In group 2 (MSAP Flap), Complete flap survival was achieved in 17 cases 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 good alternative in soft tissue reconstruction of the dorsum of the foot. 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. ALT flap is better than MSAP flap in larger defects coverage but may need secondary debulking procedures or primary thinning at the time of reconstruction.

Key Words: ExAnterolateral thigh flap – Medial sural artery perforator flap – Foot reconstruction – Ankle reconstruction – Dorsum of the foot – Microsurgery.

Disclosure: No conflict of interest.

Ethical Committee: Approved by the Ethical Committee of Faculty of Medicine, Sohag University.

INTRODUCTION

The foot is of paramount importance in human. It maintains the standing posture and gives a stable

relationship between the body and the ground during walking. Foot function may be affected by many pathological processes that could result from many etiologies; however, trauma is by far the most frequent cause. Despite the recent advances in reconstructive options for foot defects such as, muscle flaps and perforator flaps, foot reconstruction is still complexing and challenging. The microsurgery has revolutionized the reconstructive options of the leg and foot. 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 its large skin island, minimal donor-site morbidity, long vascular pedicle and sufficient diameter for micro-anastomosis. The flap also can be thinned or accompanied with muscle to provide adequate contour for various defects and complicated needs [2] with possibility of two teams working simultaneously which will shorten the operative time.

Medial sural artery perforator flap (MSAP) has limited donor site morbidity with suitable thickness for shallow foot defects. Its long pedicle 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]. Many previous studies have 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 soft tissue defects of the dorsum of the foot.

PATIENTS AND METHODS

The study was approved by the medical research Ethics Committee of Sohag Faculty of Medicine. A written informed consent was obtained from each participant patient or his/her legal guardians.

The study was conducted on 40 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 group 1 (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.

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].

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 (Fig. 1).

Group 2 (Free MSAP Flap, 20 Patients):

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

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 (Fig. 2).

Surgical debridement was done for all cases before reconstruction. Vacuum assisted device was applied for some patients till reconstruction. One surgical team had 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 answer a simple questionnaire which included 4 points: The ability of normal foot wear fitting, quality of walking, the aesthetic appearance, and the donor site morbidity. According to the results we categorize them into 3 categories: Good, fair and poor.

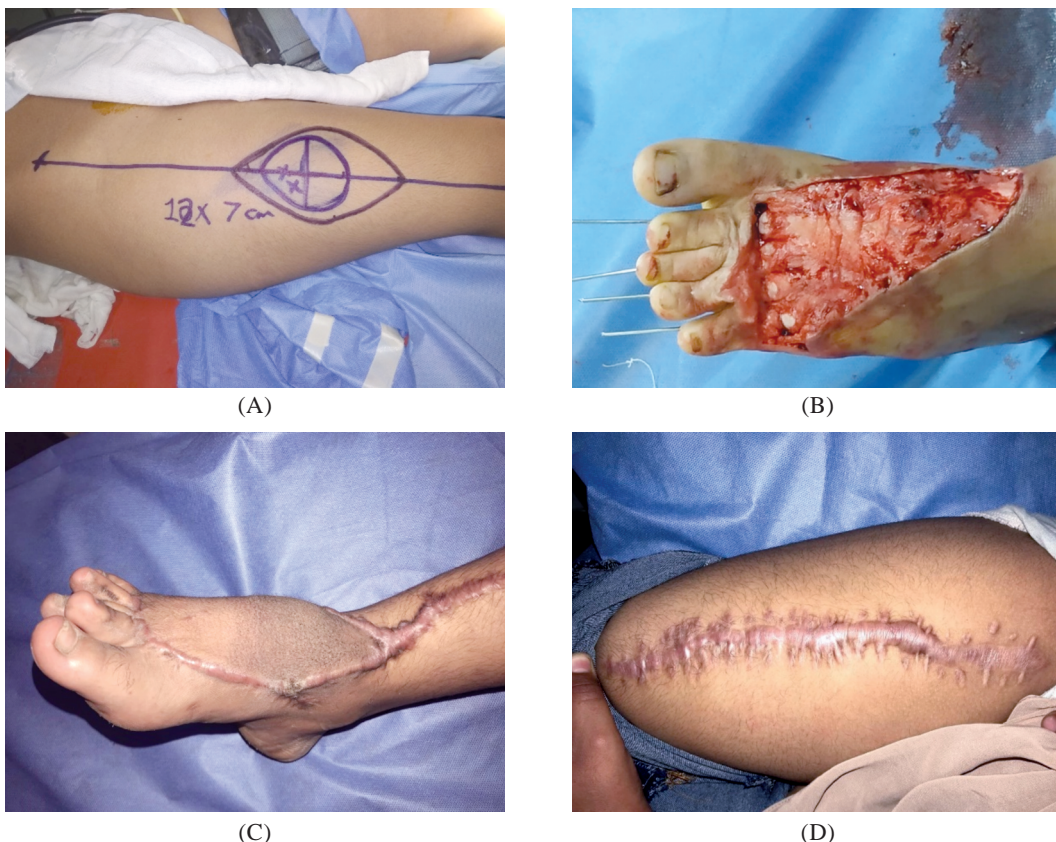


Fig. (1): A case reconstructed with ALT flap: (A) ALT flap planning view. (B) Dorsal foot defect view. (C) ALT flap 6 months post-operative view. (D) ALT donor site 6 months post-operative view.



Fig. (2): A case reconstructed with MSAP flap: (A) MSAP flap planning view. (B) Dorsal foot defect view. (C) MSAP flap 6 months post-operative view. (D) MSAP donor site 6 months post-operative view.

RESULTS

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. Patient's demographic data were summarized in Table (1).

Table (1): Shows 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

Group 1 ALT Flap:

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. Flap vascular pedicle length ranged from 8cm to 15cm, it was tailored according to flap size and site. Complete flap survival occurred in 20 patients. Numbers of early and late complications occurred. Three cases developed infection in the first post-operative 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 (8 of 20 patients). Patient satisfaction was as follow: 3 patients poor, 8 patients fair and 9 patients good (Table 2).

Table (2): Showing flap survival, need for secondary procedures and complications.

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

Group 2 MSAP Flap:

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. Vascular pedicle length ranged from 8cm to 14cm. Number of perforators was one in 9 patients, two in 8 patients, three in 2 patients and 5 in one patient. 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.

Complete flap survival was achieved in 17 cases. 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 and the patient was put on VAC treatment for 2 weeks then the defect was reconstructed with skin graft. Two patients presented with distal end necrosis, the first flap managed with dressing and healed secondary. The second flap managed with a small skin graft. Infection occurred in two cases, which was responded well to conservatives.

Late complications were 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). Two cases required secondary procedures, one patient needed scar revision and the other patient needed flap advancement. Complications of the two flaps were summarized in Table (3).

Table (3): Showing complications of the ALT and MSAP flaps.

	Total Flap loss	Partial flap loss	Infection	Hypopig- mentation	Hyperpig- mentation	Hypertrophic scarring	Total complications
ALT flap	0	0	3	0	1	4	8
MSAP flap	1	2	2	1	0	0	6

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 good 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 no muscle or just 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 15cm 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 in literature which greatly decrease flap bulkiness and improving aesthetic outcome [20,21,22]. 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 [23]. ALT flap thinning was not done in our series because we are not familiar with the technique and needed good experience. Unfortunately, we had 13 patients who requested secondary procedures for debulking and scar revision.

Defect sizes range from 6*12cm to 12*25cm 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 [3,24-32].

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 [33]. In 2009, Kim et al reported distal flap end necrosis in diabetic wound in forefoot and midfoot defect out of 11 cases [32]. Furthermore, in 2013, Wang et al., reported two cases with partial flap loss out of nine cases and healed secondary with dressing [34]. In 2014, Hallock et al., reported one case of total flap loss due to venous congestion which required a second free flap [24]. All complications occurred in MSAP flap can be managed with skin graft or healing secondary, which was confirmed with our study [24,31-33].

In comparing complications between the two flaps, we find that late complications occurred more in ALT flap due to bulkiness. In contrast in MSAP flap we find early complications occurred more due to small vessels of the flap for anastomosis and venous congestion [35].

In 2013 Wang et al., described a preparation of supplementary superficial vein for anastomosis if needed [34]. 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*8cm to 11*18cm so only 5 cases donor sites closed primary, in one of them,

the flap width was 8cm. Fifteen cases were closed with skin graft but were well accepted by the patients.

In previous studies, average number of perforators was 2.2 in average of 11.7 to 18cm from the popliteal crease. Along the line drawn from the popliteal fossa to medial malleolus the first perforator was at 8cm [36]. In this series number of perforators ranges from 1 to 5 with a mean of 1.8 perforator. Site of perforators ranged from at 8cm to 12cm 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 15cm [37]. In this series, the pedicle length ranged from 8cm to 14cm, 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 our work, ALT flap 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 [38]. 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 [39], which was confirmed in our work.

On the other hand, medial sural artery perforator flap is a good method for small and medium sized defects in dorsal foot [40]. The flap is quite thin even in overweight patients. Thin flap offers favorable solution for shallow defects of dorsal foot. MSAP flap is aesthetically accepted and allow 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 good alternative flap for dorsal foot defect coverage.

Conclusion:

In conclusion, MSAP flap is a favorable option of reconstruction for small and moderate sized dorsal foot defects. It has many advantages as, thin, fitted to normal footwear, accepted aesthetic

appearance, less hairy and no need for secondary procedures in most cases. ALT flap is superior in larger defects coverage due to large flap size, hidden donor site scar, long vascular pedicle.

REFERENCES

- 1- Khurram M.F., Ahmad I. and M.N.: 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.*, 1 (7): 1031, 2014.
- 2- Hong J.P. and Kim E.K.: Sole reconstruction using anterolateral thigh perforator free flaps. *Plast. Reconstr. Surg.*, 119 (1): 186-93, 2007.
- 3- Chen S.L., Chuang C.J., Chou T.D., Chen T.M. and Wang H.J. Free medial sural artery perforator flap for ankle and foot reconstruction. *Ann. Plast. Surg.*, 54: 39-43, 2005.
- 4- Song Y.G., Chen G.Z. and S.Y.L.: The free thigh flap: A new free flap concept based on the septocutaneous artery. *Br. J. Plast. Surg.*, 37: 149-55, 1984.
- 5- Cavadas PC1, Sanz-Giménez-Rico J.R., Gutierrez-de la Cámara A., Navarro-Monzonis A. and Soler-Nomdedeu S. M-SF: The medial sura artery perforator flap. *Plast. Reconstr. Surg.*, 108 (6): 1609-15, 2001.
- 6- Fitzgerald O'Connor E., Ruston J., Loh C.Y.Y. and Tare M.: Technical refinements of the free medial sural artery perforator (MSAP) flap in reconstruction of multifaceted ankle soft tissue defects. *Foot Ankle Surg.*, 26 (2): 233-8, 2020.
- 7- Zhang Q., Qiao Q., Gould L.J., Myers W.T. and Phillips L.G.: Study of the neural and vascular anatomy of the anterolateral thigh flap. *J. Plast. Reconstr. Aesthetic Surg.*, 63 (2): 365-71, 2010.
- 8- Yener Demirates, M.D., *Osman Kelahmetoglu, M.D., Mehmet Cifci, M.D., Volkan Tayfur, M.D., Ahmet Demir, M.D. and Ethem Guneren M.: Comparison of free anterolateral thigh flaps and free muscle-musculocutaneous flaps in soft tissue reconstruction in lower extremity. *microsurgery*, 30: 24-31, 2010.
- 9- Zhu Y.L., Wang Y., He X.Q., Zhu M., Li F.B. and Xu Y.Q.: Foot and ankle reconstruction: An experience on the use of 14 different flaps in 226 cases. *Microsurgery*, 33: 600-4, 2013.
- 10- Khan U., Smitham P. and Pearse M.N.J.: Management of severe open ankle injuries. *Plast. Reconstr. Surg.*, 119 (2): 578-89, 2007.
- 11- Wei F.C., Jain V., Celik N., Chen H.C. and Chuang D.C. L.C.: Have we found an ideal soft-tissue flap? An experience with 672 anterolateral thigh flaps. *Plast. Reconstr. Surg.*, 109: 2219-2226, 2002.
- 12- Masia J., Moscatiello F., Pons G., Fernandez M. and Lopez S. SP: Our experience in lower limb reconstruction with perforator flaps. *Ann. Plast. Surg.*, 58: 507-512, 2007.
- 13- Ohjimi H., Taniguchi Y., Kawano K. and Kinoshita K. M.T.: A comparison of thinning and conventional free-flap transfers to the lower extremity. *Plast. Reconstr. Surg.*, 105: 558-566, 2000.
- 14- Yazar S., Lin C.H., Lin Y.T. and Ulusal A.E. WF: Outcome comparison between free muscle and free fasciocutaneous

- flaps for reconstruction of distal third and ankle traumatic open tibial fractures. *Plast. Reconstr. Surg.*, 117: 2468-2475, 2006.
- 15- Yildirim S. and Gideroglu K. AT.: Anterolateral thigh flap: Ideal free flap choice for lower extremity soft-tissue reconstruction. *J. Reconstr. Microsurg.*, 19: 225-233, 2003.
 - 16- Ozkan O. and Coşkunfirat O.K. OH.: The use of free anterolateral thigh flap for reconstructing soft tissue defects of the lower extremities. *Ann. Plast. Surg.*, 53: 455-461, 2004.
 - 17- Hollenbeck S.T., Toronto J.D., Taylor B.J., Ho T.Q., Zenn M.R., Erdmann D., et al.: Perineal and lower extremity reconstruction. *Plast Reconstr Surg.*, 128 (5): 551e-63e, 2011.
 - 18- Park J.E., Rodriguez E.D., Bluebond-Langer R., Bochicchio G.C., M.R. and Bochicchio K. ST.: The anterolateral thigh flap is highly effective for reconstruction of complex lower extremity trauma. *J. Trauma*, 62: 162-5, 2007.
 - 19- Jandali Z., Lam M.C., 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*, 38 (1): 34-45, 2018.
 - 20- Kimura N., Satoh K., Hasumi T. and Ostuka T.: Clinical application of the free thin anterolateral thigh flap in 31 consecutive patients. *Plast. Reconstr. Surg.*, 108: 1197-208, 2001.
 - 21- Agostini T., Perello R. and Spinelli G.: Suprafascial Anterolateral Thigh Flap Dissection: Limits and Advantages. *Plast. Reconstr. Surg.*, 139 (3): 809e-810e, 2017.
 - 22- Yang W.G., Chiang Y.C., Wei F.C., Feng G.M. and Chen K. Te.: Thin anterolateral thigh perforator flap using a modified perforator microdissection technique and its clinical application for foot resurfacing. *Plast. Reconstr Surg.*, 117 (3): 1004-8, 2006.
 - 23- Alkureishi L.W.T., Shaw-Dunn J. and Ross G.L.: Effects of thinning the anterolateral thigh flap on the blood supply to the skin. *Br. J. Plast. Surg.*, 56: 401-408, 2003.
 - 24- Hallock G.G.: Medial sural artery perforator free flap: Legitimate use as a solution for the ipsilateral distal lower extremity defect. *J. Reconstr. Microsurg.*, 30 (3): 187-92, 2014.
 - 25- Chen S.L., Yu C.C., Chang M.C., Deng S.C., Wu Y.S. and Chen M.: Medial sural artery perforator flap for intraoral reconstruction following cancer ablation. *Ann. Plast. Surg.*, 61: 274-9, 2008.
 - 26- Choi J.W., Nam S.Y., Choi S.H., Roh J.L., Kim S.Y. and Hong J.P.: Applications of medial sural perforator free flap for head and neck reconstructions. *J. Reconstr. Microsurg.*, 29: 437-42, 2013.
 - 27- Kao H.K., Chang K.P., Chen Y.A., Wie F.C. and Cheng M.: Anatomical basis and versatile application of the free medial sural artery perforator flap for head and neck reconstruction. *Plast. Reconstr. Surg.*, 125: 1135-45, 2010.
 - 28- Nugent M., Endersby S., Kennedy M. and 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.*, 53: 461-3, 2015.
 - 29- Song X., Wu H., Zhang W., Chen J., Ding X., Ye J., Wu Y. and Yuan Y.: Medial sural artery perforator flap for postsurgical reconstruction of head and neck cancer. *J. Reconstr. Microsurg.*, 31: 319-26, 2015;.
 - 30- Zheng H., Liu J., Dai X. and Schilling A.F.: Free conjoined or chimeric medial sural artery perforator flap for the reconstruction of multiple defects in hand. *J. Plast. Reconstr. Aesthet. Surg.*, 68: 565-70, 2015.
 - 31- Chen S.L., Chen T.M. and Lee C.H.: Free medial sural artery perforator flap for resurfacing distal limb defects. *J. Trauma*, 58: 323-7, 2005.
 - 32- Kim E.S., Hwang J.H., Kim K.S. and Lee S.Y.: Plantar reconstruction using the medial sural artery perforator free flap. *Ann. Plast. Surg.*, 62: 679-84, 2009.
 - 33- Kim H.H., Jeong J.H., Seul J.H. and Cho B.: New design and identification of the medial sural perforator flap: An anatomical study and its clinical applications. *Plast. Reconstr. Surg.*, 117: 1609-18, 2006.
 - 34- Wang X., Mei J., Pan J., Chen H., Zhang W. and Tang M.: Reconstruction of distal limb defects with the free medial sural artery perforator flap. *Plast. Reconstr. Surg.*, 131: 95-105, 2013.
 - 35- Toyserkani N.M. and Sørensen J.A.: Medial sural artery perforator flap: A challenging free flap. *Eur. J. Plast. Surg.*, 38 (5): 391-6, 2015.
 - 36- Chalmers R.L., Rahman K.M.A., Young S., Kennedy M., Endersby S., Adams J.R., et al.: The medial sural artery perforator flap in intra-oral reconstruction: A Northeast experience. *J. Plast. Reconstr Aesthetic Surg.*, 69 (5): 687-93, 2016.
 - 37- Ives M. and Mathur B.: Varied uses of the medial sural artery perforator flap. *J. Plast. Reconstr. Aesthetic Surg.*, 68 (6): 853-8, 2015.
 - 38- Lubek J.E. and Engroff S.L.: Anterolateral Thigh Flap [Internet]. *Current Therapy in Oral and Maxillofacial Surgery*. Elsevier Inc., 584-588 p. Available from: <http://dx.doi.org/10.1016/B978-1-4160-2527-6.00071-2>, 2012.
 - 39- Tarek A. El-Gammal, M.D., 1* Amr El-Sayed, M.D., 1 Mohamed M. Kotb, M.D., 1 Waleed Riad Saleh, M.D. 1, Yasser Farouk Ragheb, M.D., 1 Omar El-Refai, M.D., 1 and Mohammed Hassan Ali EL Fahar MD. dorsal foot resurfacing using free anterolateral thigh (ALT) flap in children. *Microsurgery*, 504-6, 2013.
 - 40- Özkan H.S., İrkören S., Aydın O.E. and Eryılmaz A.: KHM sural artery perforator flap in head and neck reconstruction. *EAO*, 273 (12): 4431-4436, 2016. doi:10.1007/s0040.-016-4078-2. Medial sural artery perforator flap in head and neck reconstruction. *Eur. Arch. Otorhinolaryngol.*, 273 (12): 4431-6, 2016.