Fasciocutaneous Flap Choices to Treat Dorsal Surface of Foot Defects

Ayak Dorsalindeki Yumuşak Doku Defektlerinin Onarımında Fasyokutan Flep Seçenekleri

Ayak Dorsalindeki Yumuşak Doku Defektlerinin Onarımı / Treatment of Dorsal Surface of Foot Defects

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Özet

Amaç: Ayak ve ayak bileğinde bulunan yumuşak doku defektlerinde tendon ve kemikler ekspose olmuş ise bu defektler lokal veya serbest flepler ile onarılmalıdır. Son yıllarda ayak ve ayak bileğindeki defektlerin onarılması için fasyokutan flepler sıkça kullanılmaya başlanmıştır. Ancak, bu fleplere ait olan komplikasyonlara literatürlerde nadir olarak rastlanmaktadır. Gereç ve Yöntem: 2005 ve 2010 yılları arasında kliniğimizde toplam 20 hastanın ayak dorsumunda bulunan yumuşak doku defektleri distal tabanlı lateral supramalleolar flep, distal tabanlı yüzeyel sural arter ada flebi ve torakodorsal perforatör arter flebi kullanılarak onarıldı. Bu klinik çalışmada uygulanan tüm fasyokutan flepler cerrahi teknik ve komplikasyonları açısından değerlendirildi. Bulgular: Ayak dorsumunda bulunan yumuşak doku defektlerinin onarılmasında en iyi fonksiyonel ve kozmetik sonucun torakodorsal perforatör arter flebi ile tedavi edilen hastalarda olduğu değerlendirildi. Sonuç: Torakodorsal perforatör arter flebinin diğer fleplerle karşılaştırıldığında daha uzun bir pedikülü olduğu ve ayak dorsumu defektleri için en uygun anatomik özelliği taşıdığı görüldü. Torakodorsal perforatör arter flebi hem kalınlığı hem de büyüklüğü açısından ayak dorsumunda bulunan yumuşak doku defektlerinin tedavisinde tercih edilmelidir.

Anahtar Kelimeler

Ayak Defektleri; Fasyokutanöz Flepler; Torakodorsal Perforatör Flep

Abstract

Aim: Defects of the foot and ankle with exposed tendons or bone require either local or free flap coverage. Several publications in recent years have proven popularity of fasciocutaneous flaps for the coverage of defects of the foot and ankle. However, complications of these flaps are being discussed rarely in literatures. Material and Method: We used distally based superficial sural artery island flaps, distally based lateral supramalleolar flaps and free thoracodorsal artery perforator (TDAP) flaps for the reconstruction of dorsal foot defects in 20 patients between 2005 and 2010. The surgical techniques and complications for each of fasciocutaneous flaps are discussed. Result: Better results were obtained with free TDAP flaps according to the other fasciocutaneous flaps. Discussion: As compared to other flaps, the free TDAP flap is a reliable flap with consistent anatomy and a long, constant pedicle diameter. Its versatility, in which thickness and volume may be adjusted, leads to a perfect match for reconstruction of dorsal foot defects.

Keywords

Foot Defects; Fasciocutaneous Flaps; Thoracodorsal Artery Perforator Flap

DOI: 10.4328/JCAM.484 Received: 20.11.2010 Accepted: 07.12.2010 Printed: 01.01.2012 J Clin Anal Med 2012;3(1):21-5
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Introduction

Skin defects over the dorsal surface of the foot and ankle are difficult to cover. These areas are easily susceptible to trauma and are the site of numerous trophic problems (e.g., pressure sores, chronic ulcers, and penetrating injuries). Several reconstructive procedures have been selected for repair of these defects, including local cutaneous flaps, pedicled fasciocutaneous flaps, pedicled muscle flaps, and microsurgical flaps [1,2]. Each procedure has its own advantages and disadvantages regarding technical requirements, flap size, range of vascular pedicle, and limitations of the patient's local and general conditions. An ideal resurfacing should be stable, thin and well contoured, able to withstand friction caused by footwear and should allow good tendon gliding. In addition, the flap chosen should be easy to execute quickly with minimal discomfort to the patient and should provide durable coverage for the defect.

Several publications in recent years have proven popularity of superficial sural artery flaps and lateral supramalleolar flaps for the coverage of defects of the foot and ankle. These flaps can be raised easily and substituted for microsurgical flaps for distal lower leg and foot and ankle reconstruction in certain circumstances. These flaps have advantages of certain degrees of rotation, constant vascularity, and easy and quick elevation and acceptable donor-site morbidity. However, some complications have been reported, such as flap congestion and partial flap failure caused by inadequate venous return, complete flap failure caused by torsion or compression of the wide and thick adipofascial pedicle under subcutaneous tunnel, and donor site morbidity [1-3]. Baumeister et al found an overall complication rate of up to 59% in a realistic analysis of 70 flaps, which included a broad patient group with and without comorbidities [4].

The other reconstructive procedures for dorsal surface of the foot and ankle defects are microsurgical free flaps. The transfer of microsurgical free flaps may increase the blood supply to compromised areas and provide coverage of exposed vital tissues in one stage [5-8]. The free thoracodorsal artery perforator flaps [TDAP] are able to resurface defects of any size and provide different types of tissue for reconstruction of composite defects. To the best of our knowledge, there are a few reports demonstrating the free TDAP flap for reconstruction of dorsal surface of foot defects in literatures [9-11].

In this study, the surgical techniques and complication used in our department to reconstruct soft tissue defects of the dorsal surface of the foot and ankle for each of fasciocutaneous flaps are discussed.

Material and Method

Between June of 2005 and November of 2010, 20 patients with soft-tissue defects over the dorsum of the foot and ankle underwent reconstruction using fasciocutaneous flaps. The defects were respectively treated by 3 different repairing methods, 12 patients, underwent the reconstruction procedure using the distally based sural neurofasciocutaneous flap transfer. In 5 patients a lateral supramalleolar neurofasciocutaneous flap was used. In addition, we performed 3 free TDAP flaps during this period.

The length of the defect varied between 5 and 15 cm and the width between 3 and 10 cm. The average age of the patients was 31.3 years (ranged from 20 to 58 years). The causes of soft-tissue defects included trauma in 5 patients, chronic ulcer in 1 patient, unstable scar in 1 patient, tumor resection in 2 patients, and burn contracture in 11 patients.

Results

The patients' data are shown in Table 1. Of the 20 patients, 12 underwent the repair with the coverage by distally based superficial sural artery island flaps; 8 achieved a complete survival of the flaps, 1 developed a complete necrosis, 2 developed partial necrosis over the distal part, and one of them was treated suc-

Table1. The patient's data

Patients	Age / Sex	Etiology	Flap	Comorbidity	Size of Defect (cm)	Size of Flap (cm)	Complication	Follow- up (months)
1	21 / M	Trauma	Sural neurofasciocutaneous flap	None	4 X 5	5 X 6	Partial necrosis	12
2	28 / M	Burn contracture	Sural neurofasciocutaneous flap	None	10 X 11	11 X 12	Partial loss of skin graft	7
3	58 / M	Tumor excision	Sural neurofasciocutaneous flap	None	10 X 10	11 X 12	None	9
4	22 / M	Burn contracture	Sural neurofasciocutaneous flap	None	8 X 8	10 X 10	None	13
5	22 / M	Burn contracture	Sural neurofasciocutaneous flap	Smoking	10 X 12	10 X 13	Partial necrosis	13
6	22 / M	Burn contracture	Sural neurofasciocutaneous flap	Smoking	8 X 12	9 X 14	Wound dehisence	11
7	21 / M	Unstable scar	Sural neurofasciocutaneous flap	None	4 X 5	4.5 X 6	None	12
8	23 / M	Burn contracture	Sural neurofasciocutaneous flap	None	5 X 6	5 X 7	None	16
9	22 / M	Burn contracture	Sural neurofasciocutaneous flap	None	9 X 13	9 X 14	Partial loss of skin graft	10
10	32 / M	Tumor excision	Sural neurofasciocutaneous flap	None	5 X 8	6 X 9	None	9
11	22 / M	Burn contracture	Sural neurofasciocutaneous flap	None	5 X 10	6 X 11	None	12
12	22 / M	Burn contracture	Sural neurofasciocutaneous flap	Diabetes mellitus	8 X 13	9 X 14	Total flap loss, Desquamation at the donor site	2
13	26/ M	Trauma	Lateral supramalleolar flap	None	5 X 8	6 X 9	None	6
14	21 / M	Trauma	Lateral supramalleolar flap	None	4 X 5	5 X 6	None	10
15	20/ M	Chronic ulcer	Lateral supramalleolar flap	Smoking	3 X 5	4 X 5	Infection, partial flap loss Partial loss of skin graft	8
16	20 / M	Burn contracture	Lateral supramalleolar flap	Smoking	4 X 5	5 X 6	Total flap loss	22
17	21 / M	Burn contracture	Lateral supramalleolar flap	None	4 X 5	5 X 6	Infection Hematoma	4
18	27 / M	Burn contracture	Free TDAP flap	None	9 X 15	9 X 16	None	10
19	22 / M	Trauma	Free TDAP flap	None	10 X 12	10 X 13	None	6
20	23 / M	Trauma	Free TDAP flap	None	9 X 15	10 X 16	None	14

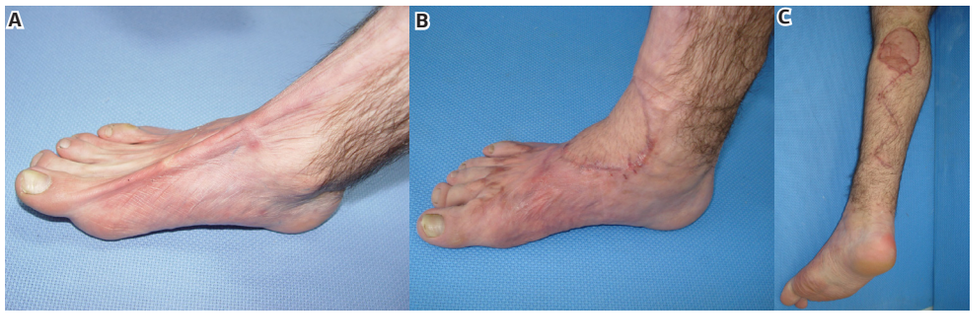

Figure 1. Preoperative view: ankle contracture because of burn scar (A), Postoperative view at 7th months (B), The donor site view after partial skin grafting (C).

Figure 2. Preoperative view: ankle contracture because of burn scar (A). Intraoperative view (B). Planning of flap(C). Transferring flap to the defect (D). Wound dehiscences at the donor site (E).

cessfully by debridement and grafting with split-thickness skin graft. The other was managed by daily dressings and healed by secondary intention without further complications. One of the patients required a secondary debulking procedure. Desquamation of the donor-site wound occurred in one patient which subsequently healed. The donor sites were grafted with split-thickness skin graft. 2 patients had a partial loss of the split-thickness skin graft on the flap associated with a thin hematoma beneath the skin graft. However, this spontaneously healed without a secondary graft. The 5 patients underwent the repair with the coverage by lateral supramalleolar flaps. Of the 5 flaps, 3 had a complete survival. 1 flap failed and 1 developed partial necrosis over the distal part, and partial necrosis was treated successfully by debridement and grafting with split-thickness skin graft. The donor sites of lateral supramalleolar flaps were grafted with split-thickness skin graft. The other 3 patients underwent the repair with the coverage by free TDAP flap. All TDAP flaps survived completely, and no secondary local flap was required. Follow-up ranged from 2 months to 22 months, with an average 11.3 months. Primary closure of the donor site of TDAP flap was a major advantage and the appearance of the donor-site linear scar was highly satisfactory.

The thinness of the each flap was appreciated by the patients, as they did not have any problem in wearing footwear. The flap developed protective sensations in the form of touch and pain. Dorsoflexion and plantar flexion at the ankle joint were near normal for each flap.

Case 2

A 28-year-old patient had a severe ankle contracture from burn injury in childhood. When contraction was released by an operation, a wide defect was created. The distally based neurofasciocutaneous reverse sural flap, 11 X 12 cm in size was transferred to the defect through the subcutaneous tunnel. The donor site was covered with a skin graft. Partial loss of skin graft was occured at the donor site at the early postoperative period. Delayed split-thickness skin grafting was performed on the seventh postoperative day. Seven months after the operation, he is recurrence-free and shows good results (Figure 1).

Case 6

A 22-year-old patient had a severe ankle contracture from burn injury in childhood. The contraction bands were released and a wide defect was created over the ankle. The distally based neurofasciocutaneous reverse sural flap, 9 X 14 cm in size was designed to cover the defect. The flap was harvested and transferred to the defect through the subcutaneous tunnel. The donor site was covered with a skin graft. However, wound dehiscences were observed at the donor site at the early postoperative period. It was closed primarily with the preserved skin without grafting. Ten months after the operation, flap contour was good, and no debulking procedures or special shoes were required. (Figure 2).

Case 15

A 20-year-old man had a chronic ulcer in the lateral malleolar region. In the operation a wide and radical excision of the ulcer was performed. The lateral supramalleolar flap 4 X 5 cm in size was planned. Subsequently, flap was harvested and inset into the defect. The donor site was covered with a skin graft. Moderate venous congestion was observed in the postoperative period. The congestion resolved spontaneously. As a result of the congestion, partial necrosis developed over the distal part of flap. In addition, partial loss of skin graft was observed at the postoperative period. Partial necrosis was treated successfully by debridement and grafting with split-thickness skin graft (Figure 3).

Case 20

A 23-year-old boy had sustained an injury to the right foot dor-

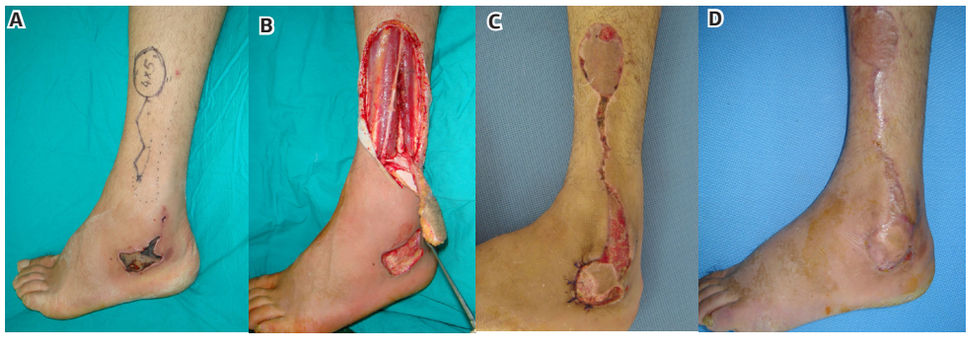

Figure 3. Preoperative view (A). Planning of flap (B). The partial necrosis over the distal part of flap and partial loss of skin graft at the donor site (C). Postoperative view at 8th months (D).

sum while driving a motorbike. He had referred to another center, where the dorsum defect was skin-grafted. Ten years after the initial trauma, he applied to our clinic. The free TDAP flap 10 X 16 cm in size was designed and harvested to cover the defect. The thoracodorsal artery and vein of flap were anastomosed to the posterior tibial artery and vein. The flap donor site was closed primarily with the preserved skin without grafting. The patient was fully mobilized 3 weeks after the reconstruction. The follow-up period was 14 months. Flap contour was good, and no debulking procedures or special shoes were required. No complication occurred regarding ambulation or donor site. A simple linear scar characterizes the donor site, and durable wound coverage resulted (Figure 4).

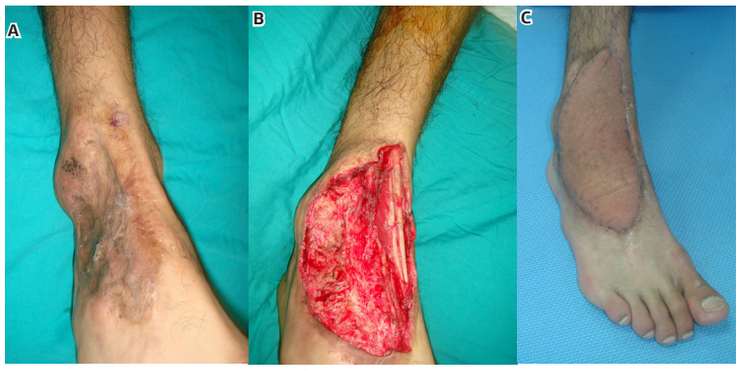

Figure 4. Preoperative view (A). Intraoperative view of soft tissue defect (B). Postoperative view (C).

Discussion

For many years, great efforts have been made in reconstructive procedures for soft tissue defects of the ankle, and foot. However, the choice of flap to reconstruct some areas in the foot remains controversial. Local rotation, advancement, and transposition flaps are limited by the area of the mobile skin available for the large defects [12,13]. In these situation, several flaps have been developed to provide coverage. Reverse pedicle peroneal, posterior tibial, and anterior tibial flaps and other fasciocutaneous, septocutaneous, and fasciosubcutaneous flaps may provide alternative methods for reconstruction in these areas [12-14]. The ideal reconstruction has the following characteristics: 1) sensibility, 2) stability, and 3) satisfactory appearance [15].

Distally based fasciocutaneous flaps on the leg were first introduced in 1983 [16]. The main advantages of distally based flaps for coverage of lower leg, ankle, and foot skin defects are a well-defined potential surface independent from a length-width ratio and the preservation of the main vascular axis. The lateral supramalleolar flap and the distally based sural flap should be defined exactly as neurofasciocutaneous flaps [17].

The distally based superficial sural artery flap has become increasingly popular for distal leg reconstruction. Donski and Fogdestam described a distally based fasciocutaneous flap from the sural region in 1983. The blood supplies of the flap include an adipofascial pedicle, along with a vascular network of sural nerves, accompanying arteries with the lesser saphenous vein, and cutaneous perforating branches of the posterior tibial and peroneal artery [18]. The length and thinness of the fascial pedicle facilitate mobilization of the flap. The procedure of dissecting this flap is technically simple and rapid. The reconstructions of the defects of the foot and ankle with sural flaps are mainly safe and reliable in healthy patients with no comorbidities according to authors' experiences [13, 19-22]. However, complications of these flaps are being discussed rarely in literatures. There are some certain factors that increase flap necrosis in the case of concomitant diseases such as arterial hypertension, diabetes, peripheral vascular disease, and vasculitis. In addition, the rotation of wide and thick adipofascial and vascular network pedicles and the venous drainage from flaps remain significant problems in practice. Compression, tension, twisting of pedicle, postoperative hematoma, and external pressure to the pedicle may endanger flap circulation. These five factors are salient and should always be taken into consideration in both intra- and postoperative period. Baumeister et al found an overall complication rate of up to 59% in a realistic analysis of 70 flaps, which included a broad patient group with and without comorbidities [4]. In addition; most authors have paid attention to the congestion of the distally based neurofasciocutaneous reverse sural flap and even partial or total flap necrosis. There is partial or total flap necrosis in variable ratio. This rate is reported by Hasegawa et al (5%), Touam et al (5%), Yilmaz et al (12%), Rajacic et al (14%), Fraccalvieri et al (17%), Meyer et al (21%), Almeida et al (26.3%)[1,19-23]. According to our clinical experience, the reverse sural flap is a good option for coverage of small-to-moderate soft-tissue defects around the lower leg and ankle. However, there are certain risk factors such as smoking, arterial hypertension, diabetes, peripheral vascular disease, and vasculitis. The other disadvantage of this flap is poor cosmetic effect on the donor site.

The lateral supramalleolar flap was described in 1988 [24]. The lateral supramalleolar is a distally based fasciocutaneous flap vascularized by branches of a perforating branch of the dorsal peroneal artery. The lateral supramalleolar flap is reliable and useful in coverage small-to-moderate defects of lower leg, ankle, and foot skin defects. In recent years, some authors testified that the distally based sural flap is more reliable than the lateral supramalleolar flap, especially regarding the venous congestion [4]. In our clinical experience, the lateral supramalleolar flap offers a range of coverage similar to that of the sural neurocutaneous flap. However, the procedure is more difficult to perform and offers no advantage over the sural flap. The harvest of a sural neurocutaneous island flap takes 45 to 60 minutes whereas the supramalleolar flap takes twice that time. The long dissection time required by the supramalleolar vessels is also responsible for spasm, which may explain the difficult postoperative period and higher incidence of complications [1].

Reconstruction of the defects by free flaps has been widely performed for the last two decades. Free perforator flaps can provide the same amount of tissue and the same vascular supply as a musculocutaneous flap. In addition, the perforator flaps have better cosmetic and reconstructive results with minimal donor site morbidity compared with muscle flaps. For this reason, free TDAP flaps have gained popularity among reconstructive surgeons. The widespread use of the thoracodorsal artery perforator flap is attributable to the following characteristics: basically reliable anatomy, the ability to thin the flap without compromising its blood supply, the possibility of obtaining a long pedicle, the pliability of the flap, and the lack of significant donor-site morbidity [25, 26]. The thickness of a free TDAP flap is between that of a radial forearm and scapular flap. It is not bulky, yet consists of a dermis and subcutaneous tissue with sufficient thickness to provide stability. To the best of our knowledge, there are a few reports demonstrating the free TDAP flap for reconstruction of dorsal surface of foot defects in literatures [9-11]. For reconstruction of the foot and ankle defects, the ideal free flap should have minimal donor-site morbidity and a sizable pedicle for microsurgical anastomosis. A fasciocutaneous flap represents a good alternative to other flaps. Among the fasciocutaneous free flap alternatives, the lateral arm flap, the scapular flap, the radial flap, the anterolateral thigh flap, superficial circumflex inferior artery flap, superficial inferior epigastric artery flap can be used [2,27,28]. However, these flaps have some drawbacks, such as severe donor-site morbidity; a short pedicle; the need for a secondary defatting procedure; requirement for a change of position during the operation, hindering a two-team approach. Our study revealed that the free TDAP flap is a reliable alternative for the reconstruction of soft-tissue defects in the foot and ankle region. According to our clinical experience;

1. The free TDAP flap is a suitable alternative for soft tissue reconstruction of the lower extremity but they require microsurgical expertise and prolonged operating time.
2. The pedicle length of free TDAP flap is sufficient to be able to perform the anastomosis out of the zone of injury. In some cases the skin island may harvest along with intercostal nerve branches, this gave us the potential to develop a sensate flap.
3. The free TDAP flap is effective in cases where poor distal vascularity of the leg or local trauma precludes the reliability of a distally based fasciocutaneous flap.
4. Free flaps provide tissue with adequate volume to cover whatever defect is created. The free TDAP flap is an alternative option if the defect over the foot is too extensive and too distal to be reached for distally based neurofasciocutaneous flaps.
5. The free TDAP flap provide stable coverage with an acceptable aesthetic appearance for both the donor and reconstruction sites and the functions of foot eversion and plantar flexion are better according to the distally based neurofasciocutaneous flaps in long-term follow-up.

References

1. Touam C, Rostoucher P, Bhatia A, Oberlin C. Comparative study of two series of distally based fasciocutaneous flaps for coverage of the lower one-fourth of the leg, the ankle, and the foot. Plast Reconstr Surg. 2001; 107 (2):383-92.
2. Ulusal BG, Lin YT, Ulusal AE, Lin CH, Yen JT. Reconstruction of foot defects with free lateral arm fasciocutaneous flaps: analysis of fifty patients. Microsurgery. 2005; 25 (8):581- 8.
3. Masquelet AC, Romana MC, Wolf G. Skin island flaps supplied by the vascular axis of the sensitive superficial nerve: anatomic study and clinical experience in the leg. Plast Reconstr Surg 1992; 89(6): 1115-1121.
4. Baumeister SP, Spierer R, Erdmann D, Sweis R, Levin LS, Germann GK.A realistic complication analysis of 70 sural artery flaps in a multimorbid patient group. Plast Reconstr Surg. 2003; 112 (1):129- 40.
5. Francel, T. J., Kolk, C. A. V., Hoopes, J. E., Manson, P. N., and Yaremchuk, M. J. Microvascular soft-tissue transplantation for reconstruction of acute open tibial fractures: Timing of coverage and long-term functional results. Plast Reconstr Surg. 1992;89(3): 478-87.
6. Godina, M. Early microsurgical reconstruction of complex trauma of the extremities. Plast Reconstr Surg. 1986;78(3): 285-92.
7. Byrd, H. S., Cierny, G., and Tebbetts, J.B. The management of open tibial fractures with associated soft tissue loss: External pin fixation with early flap coverage. Plast Reconstr Surg. 1981;68(1): 73-82.
8. Heller, L., and Levin, L. S. Lower extremity microsurgical reconstruction. Plast Reconstr Surg. 2001;108(4): 1029-41.
9. Van Landuyt K, Hamdi M, Blondeel P, Monstrey S. The compound thoracodorsal perforator flap in the treatment of combined soft-tissue defects of sole and dorsum of the foot. Br J Plast Surg. 2005;58(3):371- 8.
10. Kim SE, Rhyou IH, Suh BG, Chung KC. Use of thoracodorsal artery perforator flap for soft tissue reconstruction in children. Ann Plast Surg. 2006; 56(4): 451- 4.
11. Lin CT, Huang JS, Yang KC, Hsu KC, Chen JS, Chen LW. Reliability of anatomical landmarks for skin perforators of the thoracodorsal artery perforator flap. Plast Reconstr Surg. 2006; 118(6):1376- 86.
12. Hong G, Steffens K, Wang FB. Reconstruction of the lower leg and foot with the reverse pedicled posterior tibial fasciocutaneous flap. Br J Plast Surg. 1989; 42(5): 512– 516.
13. Lai CS, Lin SD, Chou CK. Clinical application of the adipofascial turnover flap in the leg and ankle. Ann Plast Surg 1992; 29(1): 70-75.
14. Wee JT. Reconstruction of the lower leg and foot with the reversepedicled anterior tibial flap: preliminary report of a new fasciocutaneous flap. Br J Plast Surg. 1986;39(3): 327–337.
15. Stevenson TR, Mathes SJ. Management of foot injuries with freemuscle flaps. Plast Reconstr Surg 1986; 78(5): 665-671.
16. Donski PK, Fogdestam I. Distally based fasciocutaneous flap from the sural region: a preliminary report. Scand J Plast Reconstr Surg. 1983; 17(3): 191–196.
17. Voche P, Merle M, Stussi JD. The lateral supramalleolar flap: experience with 41 flaps. Ann Plast Surg. 2005; 54(1):49- 54.
18. Chai Y, Zeng B, Zhang F, Kang Q, Yang Q. Experience with the distally based sural neurofasciocutaneous flap supplied by the terminal perforator of peroneal vessels for ankle and foot reconstruction. Ann Plast Surg. 2007;59(5):526- 31.
19. Hasegawa M, Torii S, Katoh H, et al. The distally based superficial sural artery flap. Plast Reconstr Surg. 1994; 93(5): 1012–1020.
20. Rajacic N, Darweesh M, Jayakrishnan K, et al. The distally based superficial sural flap for reconstruction of the lower leg and foot. Br JPlast Surg. 1996; 49(6): 383–389.
21. Fraccalvieri M, Vern G, Dolcet M, et al. The distally based superficial sural flap: our experience in reconstructing the lower leg and foot. Ann Plast Surg. 2000; 45(2): 132–139.
22. Almeida MF, da Costa PR, Okawa RY. Reverse-flow island sural flap. Plast Reconstr Surg. 2002;109(2): 583-591.
23. Yilmaz M, Karatas O, Barutcu A. The distally based superficial sural artery island flap: clinical experiences and modifications. Plast Reconstr Surg.1998; 102(7): 2358-67.
24. Masquelet AC, Beveridge J, Romana C, et al. The lateral supramalleolar flap. Plast Reconstr Surg. 1988;81(1): 74–81.
25. Uygur F, Kulahci Y, Sever C, Duman H. Reconstruction of postburn thenar contractures using the free thoracodorsal artery perforator flap. Plast Reconstr Surg. 2009;124(1): 217- 21.
26. Uygur F, Sever C, Tuncer S, Alagöz S. Reconstruction of postburn antebrachial contractures using pedicled thoracodorsal artery perforator flaps. Plast Reconstr Surg. 2009;123(5): 1544- 52.
27. Nasir S, Aydin MA. Reconstruction of soft tissue defect of lower extremity with free SCIA/SIEA flap. Ann Plast Surg. 2008;61(6):622- 626.
28. Engel H, Gazyakan E, Cheng MH, Piel D, Germann G, Giessler G. Customized reconstruction with the free anterolateral thigh perforator flap. Microsurgery. 2008;28(7):489- 94.