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Reconstruction of Various Moderate-Size Foot Defects with the Medial Plantar Flap

Celalettin Sever*, Yalçın Külahçı*

*GATA Haydarpaşa Eğitim Hastanesi Plastik Rekonstrüktif ve Estetik Cerrahi Servisi ve Yanık Merkezi, İstanbul

Background: Coverage of soft tissue defects of the foot has been a challenge to reconstructive surgeons. The medial plantar flap presents an ideal tissue, particularly for the reconstruction of foot defects.. In this study, we describe our experience with medial plantar flap for coverage of foot defects.
Patients and Methods: Eleven patients with soft-tissue defects over the plantar foot, distal forefoot,posterior heel, and ankle were treated. Preoperative data, the age and sex of each patients, cause and site of defects, dimension of flaps, postoperative results and complications were recorded.
Results: All patients were male, with ages ranging from 20 to 22 years (mean; 21 years). Postoperatively 10 flaps survived completely while partial necrosis was observed in one patient. Flap size varied from a width of 3 to 5.5 cm and a length of 2 to 6 cm. All survived flaps used to cover defects adapted well to their recipient areas, providing good color match and sufficient bulkiness. The mean follow-up period was 9 months.
Conclusion: The authors advocate that medial plantar flap is a versatile, reliable procedure, useful in reconstruction of modarate-size heel, ankle and distal forefoot defects. The surgical technique is safe, and provides alternative to microsurgical reconstruction.
Key Words: Medial Plantar Flap; Foot Defects.

Medial Plantar Flep ile Ayak Defektlerinin Onarımı

Amaç: Ayakta bulunan yumuşak doku defektlerinin onarımında Medial Plantar Flep ideal bir seçenektir. Ayak defektlerinin onarımında ince, ve duyusal bir flep düşünülüyorsa Medial Plantar Flep ilk önce akla gelmesi gereken lokal fleplerden biridir. Bu çalışmada, Medial Plantar Flep ile ilgili klinik tecrübelerimiz tartışılmaktadır.
Gereç ve Yöntemler: Bu klinik çalışmada ayak distalinde, topukta ve ayak bileği bölgesinde yumuşak defekti olan toplam 11 hasta opere edildi. Tüm hastaların yaşları, cinsiyetleri, mevcut olan defektlerin lokalizasyonu ve defektlerin nedeni, yapılan operasyonların sonucu ve komplikasyonları kaydedildi.
Bulgular: Hastaların tümü erkekti ve yaş ortalaması 21 olarak hesaplandı. Uygulanan 11 flebin sadece birinde parsiyel nekroz saptandı. Fleplerin ortalama genişliği 3 - 5.5 cm ve uzunluğu 2 - 6 cm olarak hesaplandı. Tüm flepler kapatılan defekt alanlarına adapte oldu ve tüm fleplerin kalınlığı defekt bölgesinin anatomisiyle uyumluydu. Hastaların ortalama takip süresi ise 9 ay olarak belirlendi.
Sonuç: Medial Plantar Flep, ayak bileği, topuk ve ayak distalinde bulunan orta büyüklükteki yumuşak doku defektlerin onarımı için idealdir. Uygulanan cerrahi işlemin tekniği basittir, güvenlidir ve bu flep mikrocerrahi onarım yöntemlerine bir alternatiftir.
Anaktar Sözcükler: Medial Plantar Flep; Ayak Defektleri..

Introduction

The instep region of the plantar surface of the foot presents an ideal tissue reserve for the reconstruction of particular areas that require a sensate and unique form of skin.[1] The epidermis and dermis of plantar skin are much thicker according to the other parts of the body. In addition, the fibrous septa binding plantar skin to plantar aponeurosis construct fat loculations that produce a shock-absorbing system. This special skin-aponeurosis system is crucial for the weight-bearing area of the foot.[1]

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Soft tissue coverage of the foot has been a challenge for the reconstructive surgeon over the years due to the limited local soft tissue availability. Trauma and other deforming processes of foot may involve soft tissue, underlying bone, ligamentous structures and defects that expose the tendon and bone directly in this region. The skin over these areas is tight and has poor circulation. Thereby, there is a limited number of local muscle or skin flaps available for reconstruction.

The medial plantar artery island flap, first described by Harrison and Morgan in 1981. The medial plantar flap is a fasciocutaneous island flap raised from the

nonweightbearing instep of the plantar foot. The dominant vascular pedicle of the flap consists of the medial plantar artery and venae comitantes.[2] The medial plantar flap has been effectively used in the reconstruction of soft tissue defects localized on plantar foot, forefoot, posterior heel, and ankle.[3,4] The medial plantar flap provides glabrous plantar skin to soft-tissue defects of the weightbearing areas of foot. This flap may be transferred to the defect as a proximally or distally pedicled island flap.[5]

We have used this flap in many designs, depending on the needs of the recipient areas in fasciocutaneous and musculocutaneous fashions. We present our experience with the reconstruction of soft tissue defects using the medial plantar flap. We will hereby define the correct indications for this flap and specify some technical points.

Patients and Methods

Nine proximally pedicled medial plantar island flaps and 2 distally based medial plantar fasciocutaneous island flap were used in a total of 11 patients with skin and soft-tissue defects over the distal forefoot,posterior heel, and ankle. Patients' demographic data, cause of soft tissue defects, size and location of the defects, complications, and follow-up were recorded. The diagnosis was burn contracture in 7 patients, nonhealing ulcer in 2 patients burn scar in 2 patients (Table 1).

All patients underwent Doppler evaluation of the arterial systems before the surgery. The dorsalis pedis and posterior tibial arteries were evaluated in all patients. All operations were performed under general anesthesia and loupe magnification. After proper debridement of the defect areas, the templates of the defects were transferred to the instep and the medial plantar flaps were planned the same size as the defects. Subsequently, all flaps were raised on its neurovascular pedicle, from a plane just superficial to the plantar fascia, including surrounding fat, until the flap could easily reach the defect. Designs of the medial plantar flaps and localizations of the soft tissue defects were reported in table 1. When transposing the flap as an island flap, an incision was made between the flap donor site and the defect, and a proper tunnel was prepared by removing some subcutaneous tissue. The incision was then closed primarily at the end of the procedure. The donor sites of the flaps were covered with split-thickness skin grafts. The sutures were removed on postoperative day 14, and a compressive tubular bandage was applied including the flap for avarage 3 months.

Table 1. Designs of the medial plantar flaps and localizations of the defects.

Patient no.	Age	Defect	Localization	Flap dimension (cm)	Follow – up (months)
1	20	Burn contracture	Ankle	4x4	8
2	22	Burn contracture	Distal forefoot	4.5x4	25
3	22	Burn contracture	Ankle	3x5	10
4	20	Burn eschar	Posterior heel	5x 6	6
5	21	Burn contracture	Ankle	4x4	6
6	20	Burn contracture	Ankle	4x4.5	5
7	22	Burn contracture	Distal forefoot	3x3	12
8	22	Nonhealing ulcer	Posterior heel	3x6	8
9	20	Burn scar	Ankle	4x 2	7
10	21	Burn contracture	Ankle	5.5x4	3
11	21	Nonhealing ulcer	Posterior heel	4x5	9

Results

All patients were male, with ages ranging from 20 to 22 years (mean; 21).Operation time ranged between 2 hour to 4 hours. Postoperatively 10 flaps survived completely while partial necrosis was observed in one patient. The complete skin graft lost in the donor site required regrafting in one patient. Partial skin graft loss at the donor site was observed in two patients. All survived flaps used to cover defects adapted well to their recipient areas, providing good color match and sufficient bulkiness. No additional debulking procedure was necessary. Flap size varied from a width of 3 to 5.5 cm and a length of 2 to 6 cm. The postoperative follow-up period ranged from 3 to 25 months (average, 9 months). All patients were fully mobile as early as 2 months after treatment. Although four patients experienced subjective pain while walking and this complaint dissipated within a period of 3 months after oral analgesic treatment. Protective deep-pressure sensation appeared by the end of the fourth month.

Case Reports

Case 3

A 22-year-old man had severe scar contracture resulting from a flame-burn injury on the right foot (Figure 1). This severe contracture resulted in limited motion of the ankle joint and disturbed walking. After extensive release of the contracture on the medial aspect of the foot, a medial plantar flap (3x5 cm) was planned and elevated.Subsequently, the plantar fascia was not included in the flap, and defatting of the flap was

performed. The medial plantar flap was transferred to cover the skin defect on the medial malleol. The other skin defect on the right foot and the donor site defect at the instep region was covered by grafts (Figure 2). However, a few days later partial necrosis of the distal part of the flap was noted (Figure 3). An additional 2 weeks later, the necrotic tissue was excised and the defect was covered with another skin graft (Figure 4). The patient was fully mobile three months after the reconstruction and returned to his profession as a safety guard. Evaluation at ten months follow-up demonstrated excellent adaptation of the flap with regard to thickness and durability (Figure 5).

Case 4

A 21-year-old man had burn scar on the lateral aspect and posterior heel of left foot (Figure 6). He presented with a pain at the posterior heel while walking with shoes. The medial plantar flap (5×6 cm) was used to cover the defect seen with the excision of the burn scar tissue at the posterior heel. The donor site defect at the instep region was covered by graft (Figure 7). Postoperative compressive tubular bandage had been used for 6 months. Neither late circular contracture nor bulkiness was seen. The postoperative course of the patient was uneventful, and the contour of the posterior heel and lateral foot was restored well (Figure 8).

Case 7

A 22-year-old man had severe scar contracture resulting from a flame-burn injury on the pulp aspect of his first toe of right foot. Loss of the plantar skin at themetacarpophalangeal joint had created severe contracture (Figure 9). This severe contracture resulted in limited motion of the interphalangeal joint and disturbed walking. Through release of the skin contracture with the contracted joint ligaments, the flexor tendon of the finger was exposed widely (Figure 10). A retrograde medial plantar flap (3x3 cm) was elevated and transferred to cover the resulting skin defect (Figure 11). The postoperative course was uneventful as long as 1 year follow-up (Figure 12).

Case 11

A 21-year-old man had nonhealing ulcer on the posterior heel of left foot (Figure 13).He presented with a pain at the posterior heel while walking with shoes. The medial plantar flap (4×5 cm) was used to cover the defect. The donor site defect at the instep region was covered by graft. The postoperative course of the patient was uneventful, and the contour of the posterior heel and lateral foot was restored well (Figure 14).

Figure 1. Preoperative view of a patient with burn scar contracture on the right foot.

Figure 2. Intraoperative view.

Figure 3. The partial necrosis of the distal part of the flap.

Figure 4. Intraoperative view of second reconstruction.

Figure 5. Ten months after operation.

Figure 6. Preoperative view of burn contracture.

Figure 7. Intraoperative view.

Figure 8. Postoperative view.

Figure 9. Preoperative view of burn contracture.

Figure 10. Release of the skin contracture.

Figure 11. A retrograde medial plantar flap.

Figure 12. One year after operation.

Figure 13. Nonhealing ulcer on the heel.

Figure 14. The postoperative follow-up picture 9 months after the reconstruction.

Discussion

The reconstruction of the soft tissue defects of the foot region represents nowadays a challenge because of the limited local soft tissue availability and the special structural characteristics of this area. The ideal reconstruction of foot should provide anatomical contour, durable skin, protective sensibility, and relative soft-tissue fixation to the underlying structures that may stand the stress of ambulation. In addition, the ideal reconstruction should allow the patient to walk properly and wear normal shoes.

To select the ideal reconstruction method, factors like dimensions of the defect, involvement of surrounding structures, and less invasive procedures should be considered for each case. Many methods for reconstructing a skin defect over distal forefoot, posterior heel, and ankle have been reported, such as skin grafts, local skin flaps, fasciocutaneous flaps and free muscle flaps with skin grafts.[2,3,6] Reconstruction of foot defects with skin grafting is difficult because the graft have to be secured to a concave and mobile area. Thereby, skin grafts often fail because of poor vascularization and repeated mechanical irritation under the influence of pressure and constant shearing forces. In addition, secondary contracture of the skin graft may occur. May and coworkers advocated that the defects of the foot, the free muscle flaps covered with a thick split-thickness skin graft appears to be the best method for reconstruction.[7,8] However, the authors also reported that delayed skin graft breakdown in usual footwear was sustained by those patients after a period of weight bearing and improper care.[1-3]

The medial plantar fasciocutaneous flap is a versatile flap because it may be transferred to defects on two different pedicles.[2] Different studies have been conducted with respect to the anatomy of medial plantar vessels, and their clinical applications.The medial plantar artery arise from the posterior tibial artery and passes distally along the medial side of the foot with the medial plantar nerve. The medial plantar artery divides into lateral and medial branches proximal to the navicular-cuneiform line. The medial branch divides into a deep and a superficial branch. The superficial branch emerges deep to the abductor hallucis muscle, then travels between to the abductor hallucis muscle and the flexor digitorum brevis muscle, anastomoses with the first plantar metatarsal artery. Perforating vessels from the medial plantar artery run through and around the abductor hallucis muscle to provide cutaneous blood supply to the instep region. The first, second, and third plantar metatarsal arteries communicate through the superficial digital branches of the medial plantar artery. The plantar metatarsal arteries arise from the deep plantar arch, which is supplied mainly by the lateral plantar artery, with contribution from the dorsalis pedis through the deep plantar artery. When the medial plantar artery is ligated proximally, flow is reversed and the flap is supplied in a retrograde fashion by the communications with the deep plantar arch.[4] It is possible to reach the proximally based medial plantar flap through the lateral malleolus in the long axis and the proximal third of the dorsal foot in the short axis by mobilizing the pedicle until the point

of lateral plantar artery division.[1] In addition, distally based medial plantar flap may reach distal forefoot defects

Dissection of the medial plantar flap is tedious and technically demanding and this delicate procedure should be performed under pneumatic tourniquet with loupe magnification. The major problem encountered with the medial plantar flap is its unreliability. It may be compromised by venous congestion and peripheral arterial insufficiency when the flap is transferred with its pedicle tunnelled subcutaneously. For this reason, the pedicle should be mobilised enough to allow adequate rotation. The pedicle should be laid open instead of transporting through a tunnel and exposed pedicle should be skin grafted when risk of compression is noted. Donor site of the medial plantar flap may cause minimal depression deformity in the early postoperative period.

The medial plantar fasciocutaneous flap provides structurally similar tissue to distal forefoot posterior heel, and ankle defects with its thick glabrous plantar skin, shock-absorbing fibrofatty subcutaneous tissue. The medial plantar flap has limited size and bulk compared with other flap options such as muscle flaps or large fasciocutaneous flaps. For this reason, according to us, reconstruction of foot defects with medial plantar fasciocutaneous flap is ideal for reconstructing moderate-size soft-tissue defects. The medial plantar flap may transfer to defects on two different pedicles. Thereby this flap may reach as far as the heel pad, dorsal aspect of the ankle, and forefoot. The procedure is a single-stage operation. Elevation of the flap is safe, easy, and less time-consuming. There is no significant morbidity at the donor site.

We advocate that all reconstructive surgeons dealing with these anatomic regions should keep in mind the medial plantar flap as an option for reconstruction of moderate-size soft-tissue defects of foot.

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Corresponding author: Celalettin SEVER, MD.
GATA Haydarpaşa Eğitim Hastanesi.
Plastik ve Rekonstrüktif Cerrahi Servisi.
Kadıköy/İSTANBUL
Cep: 0 532 7181775
e-mail: drcsever@hotmail.com