Versatility of Lateral Calcaneal Artery Skin Flap for Coverage of Posterior Heel Defects - Our Experience

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ABSTRACT

Aim: To describe our early experience of five patients treated with the lateral calcaneal artery skin flap for reconstruction of posterior heel defects.
Methods: Our case series was conducted at department of Plastic Surgery Sheikh Zayed Hospital, Rahim Yar Khan from July 2009 to June 2012. Five patients (4 male and 1 female) with soft-tissue defects over the posterior heel underwent reconstruction using a lateral calcaneal artery skin flap. The etiology was trauma in two patients, chronic ulcer in two and surgical wound dehiscence in one. The flap sizes ranged from 3.5 × 2.0 cm to 6.5 × 3.5 cm and the mean follow up was 10 months.
Results: All five flaps survived completely with no subsequent breakdown of the skin, even after regularly wearing normal shoes. The skin flap donor sites were grafted with split thickness skin grafts in all patients. One donor site showed secondary healing and developed hyperkeratosis at graft and planter skin junction. And one patient showed marginal flap skin desquamation.
Conclusion: The lateral calcaneal artery skin flap can be used safely to provide sensory skin coverage to the posterior heel in one stage.
Keywords: Foot, posterior heel, soft tissue defect, lateral calcaneal artery skin flap.

INTRODUCTION

Soft tissue defects of the posterior heel with or without exposure of the tendoachilles, whether from recent trauma or from chronic lesions, presents difficult reconstructive problems due to the bony prominence, limited availability of local tissue, requirement for specialized tissue, and the limitations imposed by donor site morbidity[1]. This area is subject to weight-bearing and shearing forces that exceed those of any other area of the body. Therefore a defect of the heel can be a difficult problem for the patient because of the inability to wear normal shoes. On the other hand, reconstruction of a defect on the heel has been a challenging problem to the plastic surgeon. Many reports have been published on methods of reconstructing a soft tissue defect of the heel, which include skin grafts, local skin flaps, cross-leg flaps, muscle flaps, musculocutaneous flaps, and free flaps[2].

The basic principal is," tissue defects should be replaced with like tissue". This is very difficult in the case of heel because of paucity of expandable local tissue. Skin grafts may not take or may be inappropriate. Local rotation, advancement, and transposition flaps are limited by the availability of mobile skin. Several types of reverse flow island flaps have been developed in the form of fasciocutaneous or cutaneous flaps but they require sacrifice of an important leg artery and create obvious contour deformities at the donor site[3,4,5,6]. The use of free flaps has improved the ability to cover soft tissue defects. However, the flap bulk, the need for secondary procedures, and the risk of vascular failure are considerable drawbacks[7]. For larger defects free flaps may be required but there are other options for smaller defects. One of these is the neurovascular lateral calcaneal flap, first described by Grabb and Argenta in 1981[8].

A lateral calcaneal artery skin flap is an axial pattern flap that includes the lesser saphenous vein, the sural nerve and the lateral calcaneal artery[9,10]. Since its development, this flap has been demonstrated to be both an effective and reliable local flap for reconstructing soft tissue defects about the posterior heel and both malleoli[11]. Modifications of this flap include island arterial flap[12], distally based flaps[13] and free flaps[14], all of which have a wide variety of clinical applications. Lin et al[15] modified this flap as an adipofascial flap and used it to reconstruct soft tissue defects of the posterior heel as well as the lateral malleolar and lateral supramalleolar areas.

The purpose of this study is to describe our early experience of five patients treated with this flap for reconstruction of posterior heel defects with or without exposure of tendo-Achilles.

PATIENTS & METHODS

This case series was conducted at department of Plastic Surgery, Sheikh Zayed Medical College and Hospital, Rahim Yar Khan between July 2009 and June 2012. Five patients (4 male and 1 female) with soft-tissue defects over the posterior heel underwent reconstruction using a lateral calcaneal artery skin flap. Soft-tissue defects were caused by acute trauma in two patients, a chronic ulcer in two, and surgical wound dehiscence for repair of tendoachilles in one patient. The flaps ranged in size from 3.5 × 2.0 cm to 6.5 × 3.5 cm. The patient's ages ranged from 10 to 35 years (mean=25.4 years), and the follow-up period ranged from 6 to 14 months (mean=10 months).

The position and course of the calcaneal artery is marked on the skin. With the leg dependent, the course of the lesser saphenous vein is also marked out. The length and width of the desired flap are planned in reverse, using a cloth pattern over the defect and transposing it to lie over the previously demarcated artery[Fig.1 & 2 C]. The flap can be designed as a short vertical flap or a long flap that curves forward to the base of the fifth metatarsal according to the defect size to be covered. Dissection is begun at the lateral aspect of the calcaneal tendon and is carried down distally to the periosteum of the calcaneus. The plane is then developed leaving the periosteum intact. The anterior incision is made immediately behind the lateral malleolus and carried down through the subcutaneous tissues. Finally the distal horizontal incision is made and the flap is raised in a retrograde fashion. The neurovascular structures lie in the deep surface of the subcutaneous tissues and can be visualized if the dissection is too superficial. Optimally, the vessels are not exposed and therefore not traumatized. Dissection is carried out in a retrograde fashion to the level of the lateral malleolus. The pedicle of both versions of the flap lies immediately above the level of the lateral malleolus. Immediately above the malleolus, the calcaneal artery begins to sink to a deeper level. A minimal amount of dissection can facilitate rotation, but deeper dissection may be dangerous. The base of the flap is usually left intact and optimally should be at least 4 cm wide. If the flap is elevated as an island, care must be taken to avoid trauma to the lesser saphenous vein during rotation. Rotation to the defect is then performed, and the flap is inset. No deep sutures are used. A small silicone drain is left in the bed of the lesion, especially if underlying bone has been removed. A split-thickness skin graft is placed over the donor defect and immobilized with a tie over dressing[Fig 2 D]. Postoperatively, the patient is kept in bed with the leg elevated for 5 to 7 days. This prolonged elevation minimizes skin graft loss as well as dehiscence of the flap secondary to edema.

RESULTS

Table 1 shows the patient's clinical data. All five flaps had good perfusion and survived completely. No venous congestion was noted but flap edema lasted for 3-4 days. The skin grafts on the flap donor site had taken well in 4 patients. In one case (case 1) there was partial loss of the split-thickness skin graft that healed spontaneously without the need for a secondary graft, but developed hyperkeratosis at the junction of skin graft and planter skin, that resolved by excision and secondary graft. In another case (case 4) there was marginal superficial desquamation of flap skin but the whole flap survived without any further intervention (Fig. 2G). All patients became ambulatory after wound healing, and ankle motion was not restricted. There was no subsequent breakdown of the flap and the grafted skin with the regular wearing of shoes.

Table 1: Clinical data of ptients

Case	Age (yr), Sex	Cause of defect	Site of defect	Size of flap (cm)	Duration of follow-up (mon)	Complication
1	10, M	Acute trauma	Posterior heel	3.5 x 2.0	14	Partial loss of split-thickness skin graft and Hyperkeratosis
2	32, M	Chronic ulcer	Posterior heel & tendoachilles	5.4 x 3.5	10	None
3	30, M	Postsurgical	Posterior heel	4.0 x 2.5	12	None

		wound dehiscence	&tendoachilles			
4	20,M	Chronic ulcer	Posterior heel	3.5 x 2.4	8	Marginal desquamation of flap skin
5	35,F	Acute trauma	Posterior heel & tendoachilles	6.5 x 3.5	6	None

Fig.1: (Case 2): (A) Chronic ulcer in a 32-year-old male, (B) After wound debridement exposure of the Achilles tendon, (C) Design of the lateral calcaneal artery skin flap, (D) Early postoperative results showing complete survival of flap and complete graft take on the donor site.

Fig. 2: (case 4): (A) Chronic ulcer on the posterior heel in a 20-year old male, (B) Defect after wound debridement, (C) Marking of long version of lateral calcaneal artery skin flap, (D) Tie over dressing on the grafted donor site, (E) Flap passed under the intact skin bridge between donor and recipient sites, flap circulation is ok but it is little bit edematous, (F) Well healed donor site, (G) Marginal flap skin discoloration but flap survived completely without any further intervention.

DISCUSSION

Use of the lateral calcaneal artery skin flap for heel reconstruction has been reported since1981[15]. The flap is an axial pattern fasciocutaneous flap that is simple, stable and sensate. It is nourished by the lateral calcaneal artery, which is a terminal branch of the peroneal artery, is drained by the lesser saphenous vein and is innervated by the sural nerve[9]. It is preferred in small sized isolated posterior heel defects with exposed Tendoachilles or Calcaneum and normal skin in flap vicinity[16]. Peroneal vessels are last to be affected by age, diabetes mellitus or smoking, making it a safe flap in these patients[13]. Because this fasciocutaneous flap is moved as a transposition flap from the area below the lateral malleolus so a 'dog-ear' or kinking of the pedicle may occur. Bulkiness and occurrence of the dog-ear have been noted as late complications of fasciocutaneous flaps[17,18]. Disadvantages of the flap are that donor site requires grafting, which is put on the periosteum giving a depression, and causes a poor cosmetic appearance. Patients also have sensory disturbance at the lateral part of the dorsum of foot[18]. In their series of seven patients by Hovius et al[19], two donor sites showed secondary healing and one donor site showed hyperkeratosis resulting from inappropriate planning of the flap. In our series of 5 patients, one of the donor sites showed minimal donor site loss and hyperkeratosis at graft and planter skin border which required excision and secondary grafting.

Island modification of this flap has been described to prevent the problems associated with classic lateral calcaneal artery skin flaps such as kink in the pedicle, dog-ear deformity, and the need for sacrificing the normal skin bridge for flap inset[12]. It also has a greater arc of rotation, but it could not solve the problems associated with the donor-site area[20]. Another disadvantage is the possible compression over the pedicle by the skin bridge between the donor site and the recipient site. In our study we passed the flap under the intact skin bridge after de-epithelialisation in one case (Case 4) without any problem (Fig. 2E).

In 1996, use of the lateral calcaneal artery adipofascial flap was reported for small defects on the ankle by Lin et al[15]. The advantages of this type of adipofascial flap are that it preserves the sural nerve and does not require skin grafting of the donor site[16]. Usually, adipofascial flaps are suitable for soft tissue reconstruction on the extremities where a thin flap is desirable, there is no excess skin around the lesion, and a skin graft is not acceptable for aesthetic purposes. The main shortcoming of this procedure is that additional skin grafts are applied to raw adipofascial flap surfaces. Most surgeons use a split-thickness skin graft. However a full-thickness skin graft rather than a split-thickness graft minimizes the breakdown of grafted skin.

Overall, lateral calcaneal artery skin flaps should be included in the surgical armamentarium to cover difficult wounds of the posterior heel of the foot. They do not require sacrifice of a major artery to the leg or foot, are relatively thin with acceptable morbidity at the donor sites. In addition, the flap dissecting

technique is Straightforward; vascular pedicle is constant and surgical transfer easy. Lateral calcaneal artery flaps are limited in size but can fill defects of the posterior heel satisfactorily. In the present case series, we can confirm the usefulness of the lateral calcaneal artery flap in the cure of intractable posterior heel defects with bone or tendon exposure with minimal donor site morbidity that it offers.

CONCLUSION

The goal of reconstruction is to provide sensate and stable coverage for posterior heel soft tissue defect with minimal donor site morbidity. The lateral calcaneal artery skin flap fulfills all these requirements and therefore should be included in the surgical armamentarium to cover difficult wounds of the posterior heel of the foot in a single stage.

REFERENCES

1. Lee ET. A new wound closure achieving and maintaining device using serial tightening of loop suture and its clinical applications in 15 consecutive patients for up to 102 days. Ann Plast Surg. 2004;53(5):436-41.
2. Foot and ankle soft-tissue deficiencies: who needs a flap? Levin LS.Am J Orthop (Belle Mead NJ). 2006 Jan; 35(1):11-9
3. Anatomic study and clinical application of distally-based neuromyocutaneous compound flaps in the leg. Yu AX, Deng K, Tao S, Yu G, Zheng X. Microsurgery. 2007;27(6):528-32.
4. Distally based sural neuro-lesser saphenous veno-fasciocutaneous compound flap with a low rotation point: microdissection and clinical application. Zhang F, Lin S, Song Y, Zhang G, Zheng H.Ann Plast Surg. 2009 Apr; 62(4):395-404.
5. The distally based sural artery flap for ankle and foot coverage. Cheema TA, Saleh ES, De Carvalho AF. J Foot Ankle Surg. 2007 Jan-Feb;46(1):40-7.
6. Modified distally based peroneal artery perforator flap for reconstruction of foot and ankle. Chang SM, Zhang F, Yu GR, Hou CL, Gu YD.Microsurgery. 2004; 24(6):430-6.
7. Functional total and subtotal heel reconstruction with free composite osteofasciocutaneous groin flaps of the deep circumflex iliac vessels. Peek A, Giessler GA. Ann Plast Surg. 2006 Jun;56(6):628-34.
8. Grabb WC, Argenta LC. The lateral calcaneal artery skin flap (the lateral calcaneal artery, lesser saphenous vein, and sural nerve skin flap). Plast
9. Reconstr Surg 1981;68:723
10. Vascularity of the lateral calcaneal flap: a cadaveric injection study. Borrelli J Jr, Lashgari C. J Orthop Trauma. 1999 Feb;13(2):73-7.
11. The lateral calcaneal artery. Andermahr J, Helling HJ, Landwehr P, Fischbach R, Koebke J, Rehm KE. Surg Radiol Anat. 1998;20(6):419-23.
12. Application of flap in repair of heel skin and soft tissue defect]. Li L, Xue C, Li J, Zhang J, Xing X. Zhongguo Xiu Fu Chong Jian Wai Ke Za Zhi. 2008 Jul;22(7):800-2. Chinese.
13. Reappraisal of island modifications of lateral calcaneal artery skin flap. Demirseren ME, Gokrem S, Can Z.Plast Reconstr Surg. 2004 Apr 1;113(4):1167-74.
14. Distally based lateral and medial leg adipofascial flaps: need for caution with old, diabetic patients. Demirtas Y, Ayhan S, Sariguney Y, Findikcioglu F, Cukurluoglu O, Latifoglu O, Cenetoglu S. Plast Reconstr Surg. 2006 Jan;117(1):272-6.
15. Lateral calcaneal artery as a recipient pedicle for microsurgical foot reconstruction. Chang H, Kwon SS, Minn KW. J Plast Reconstr Aesthet Surg. 2010 Nov;63(11):1860-4.
16. Lin SD, Lai CS, Chiu YT, Lin TM. The lateral calcaneal artery adipofascial flap. Br J Plast Surg. 1996;49(1):52-7
17. Lateral calcaneal artery adipofascial flap for reconstruction of the posterior heel of the foot. Chung MS, Baek GH, Gong HS, Rhee SH, Oh WS, Kim MB, Lee KH, Kim TW, Lee YH. Clin Orthop Surg. 2009 Mar;1(1):1-5.
18. Modified distally based sural neuro-veno-fasciocutaneous flap: anatomical study and clinical applications. Zhang FH, Chang SM, Lin SQ, Song YP, Zheng HP, Lineaweaver WC, Zhang F.Microsurgery. 2005; 25(7):543-50.
19. DicksonWA,DicksonMG,RobertsAH.The complications of fasciocutaneous flaps. Ann Plast Surg 1987;19:234—7.
20. HoviusSE,HofmanA,vanderMeulenJC.Experienceswith the lateral calcaneal artery flap. Ann Plast Surg 1988;21:532-5.
21. Long-term results of lateral calcaneal artery flap for hindfoot reconstruction. Omokawa S, Yajima H, Tanaka Y, Ryu J. J Reconstr Microsurg. 2008 May;24(4):239-45.