Cross-Foot Reversed Medial Plantar Artery Flap for Management of Persistent Wound after Complex Heel Reconstruction

—— *A Case Report*

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Background:

Reconstruction of soft tissue defects around the heel remains a challenging problem for plastic and reconstructive surgeons. There have been rare reports on the usage of cross-foot procedures instead of free flap transfers.

Aim and Objectives:

We report a case in which a cross-foot reversed medial plantar artery flap (instep flap) was used to manage a persistent ulcer involving a fasciocutaneous flap previously transferred to the right heel.

Materials and Methods:

A 28-year-old female patient had a history of a complex calcaneus facture with skin defect of the right foot caused by a traffic accident 10 years prior to the initial presentation. Several operative treatments were performed, including a right free anterolateral thigh (ALT) flap transferred to the right heel; the recipient vessel in this case was the contralateral posterior tibial artery. A persistent ulcer on the flap at the site of the right heel was noted after prolonged weight bearing. Given the vascular disruption of both feet, an instep flap reconstruction was indicated.

Results:

The surgery and postoperative period were unremarkable, and weight bearing was encouraged 8 weeks postoperatively. At her 1-year follow-up, the patient was ambulating well and experienced no flap or donor site morbidity. No further skin breakdown on the weight-bearing area during the follow-up period was observed.

Conclusions:

In the case of complicated vessel disruption and persistent wounds after complex heel reconstruction, we successfully used the instep flap for reconstruction. We suggest that the cross-foot reversed instep flap should be considered as an alternative treatment option for weight-bearing plantar foot reconstruction when pedicled instep

flaps and distant free flaps are not available. (J Taiwan Soc of Plast Surg 2016;25:153～162)

Key words: heel reconstruction, cross-foot flap, reversed medial plantar artery flap, instep flap

Introduction

Reconstruction of soft tissue defects around the heel remains a challenging problem for plastic and reconstructive surgeons despite the variety of options available. The plantar skin is a thick, durable, glabrous skin that can withstand the shearing stresses during walking and prolonged weight bearing. The uniqueness of the plantar skin makes it difficult to replace it by different skins from distant sites. Many surgical reconstructive options have been used previously, such as skin grafts, local flaps, and free flaps; each has unique advantages and disadvantages. The ideal goal is to replace the heel pad with similar tissue that can withstand the stress of body weight and has sensation to prevent pressure sores. The cross-foot reversed medial plantar artery flap (instep flap) is currently?an accepted option to cover small- or moderate-sized defects of the weight-bearing area to match the above demands with low donor-site morbidity[1-5].

The availability of the types of instep flap has expanded, and now includes the instep free flap[6-9], the cross-foot pedicled flap[9-11], and the reversed-flow medial plantar island flap[9,12-14]. The cross-foot instep pedicled flap can be employed to reconstruct plantar defects in situations where the ipsilateral instep flap was not available or did not have a recipient vessel suitable for microvascular anastomosis[11]. The reversed-flow medial plantar island flap can be used to cover limited-sized defects of the distal forefoot, toe, and webspace[13]. With the usage of these characteristics of cross-foot and reversed-flow medial plantar flaps, traumatic skin defects with vascular disruption of the heel can be resolved. We report a case in which an instep flap was used to manage a persistent ulcer involving a fasciocutaneous flap previously transferred to the right heel.

Materials and Methods

A 28-year-old female patient had a history of complex calcaneus facture with skin defect of the right foot caused by a traffic accident 10 years prior to the initial presentation. She had previously undergone several surgical procedures at another hospital, including a right free anterolateral thigh (ALT) flap transferred to the right heel via the contralateral posterior tibial artery ,and regained a?limited range of motion of the right ankle (dorsiflexion:0-10 degrees and plantarflexion: 0-20 degrees) . Unfortunately, a deep, ulcerative wound (2.0 × 2.0 × 0.8 cm) on the flap transferred site of the right heel in addition to osteomyelitis involving the right calcaneus developed after prolonged weight bearing (Figures 1 ,2 and 3); she has been following up in our department since 2011. Despite aggressive antibiotics, surgical debridement, wound care with dressing, and cushioned shoe pads, there were significant fluctuations in the state of her wound. Computed tomography angiogram of bilateral lower limbs showed poor identification of the right distal posterior tibial and right plantar arteries, and a discontinued left distal posterior tibial artery (Figure 4). The instep flap was subsequently indicated and advised.

Under general anesthesia, surface marking was done before incision and tourniquet application. The nonviable tissue on the right heel pad was debrided as thoroughly as possible until the tissue appeared to be healthy. A 7.0 × 7.0-cm left instep flap was dissected retrogradely, and the medial plantar artery was ligated at the proximal edge of the flap (Figure 5). Then, the tourniquet was released and circulation of the flap was assessed. After adequate hemostasis, the flap was rotated to cover the defect of the right heel, and interrupted tensionless sutures were applied to hold the

flap in place. A single 3.0-mm Kirschner wire was applied to immobilize both feet from the right distal tibia and fibula to the left calcaneus. The donor area was covered with a 7.5 × 8 cm, 1:1.5 meshed, split-thickness skin graft (STSG) harvested from the right thigh and fixed with a tie-over method (Figure 6). A small window was left in the surgical site to allow for monitoring of flap circulation. Postoperatively, both feet were elevated by placing a pillow below both the lower legs.

The first dressing change was on the 3rd postoperative day, and subsequent daily dressing changes were made. Two weeks postoperatively, the delayed procedure of the cross-foot flap was performed. The division between the donor site incision and the flap was carried out 1 week apart from when the residual skin defect of the donor site was covered with STSG (Figure 7). The patient was discharged 1 week after the final surgery.

Results

The postoperative period was unremarkable, and weight bearing was encouraged 8 weeks postoperatively. At her 1-year follow-up, the patient was doing well with good ambulation, and no flap or donor site morbidity was observed. The contour of the right heel was also preserved and enabled the patient to use normal footwear. No further skin breakdown on the weight-bearing area during the follow-up period was observed (Figures 8 and 9).

Fig. 1. Hyperkeratosis and necrotic tissue with a central, deep ulcer (2.0 × 2.0 × 0.8 cm) on the flap transferred site of the right heel pad.

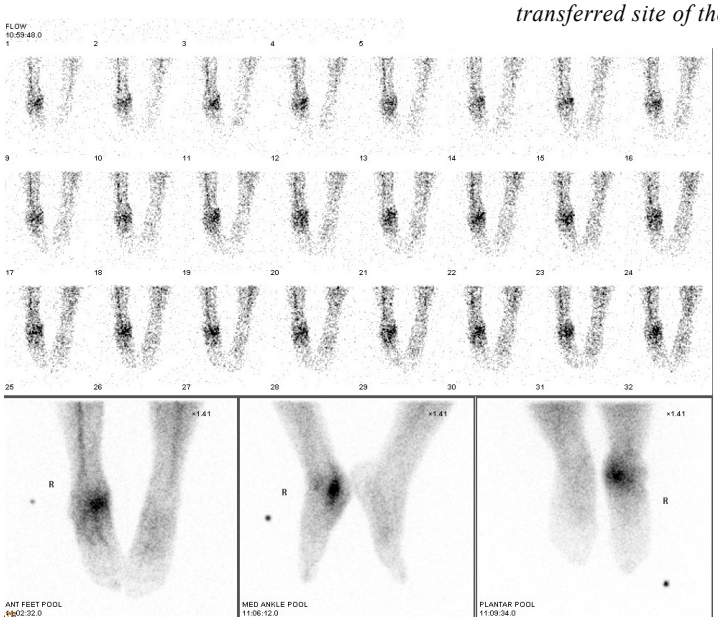

Fig. 2. The Tc-99 m MDP triple phase bone scan and gallium-67 study revealed chronic osteomyelitis involving the right calcaneus. This patient took antibiotics for a long period of time to control the chronic osteomyelitis.

Fig. 3. X-ray of right calcaneus. (a) Heel PA axial oblique view (b) Heel axial view (c) LE-P-30 Ankle AP view. Focal sclerosis with deformity of right calcaneal bone indicating post-traumatic change. Retention of surgical clips in the surrounding soft tissue of right lower tibia and fibula is seen.

Fig. 4. (a) Anterior view, (b) Posterior view. Computed tomography angiogram of bilateral lower limbs shows poor identification of right distal posterior tibial and plantar arteries and a discontinued left distal posterior tibial artery.

Fig. 5. A 7.0 × 7.0-cm left instep flap was dissected retrogradely and the medial plantar artery was ligated at the proximal edge of the flap.

Fig. 6. (a) The reversed instep flap was rotated to cover the defect of the right heel under the proper flap position. (b) One 3.0-mm Kirschner wire was applied to immobilize both feet. The donor area was covered with STSG and fixed with the tie-over method.

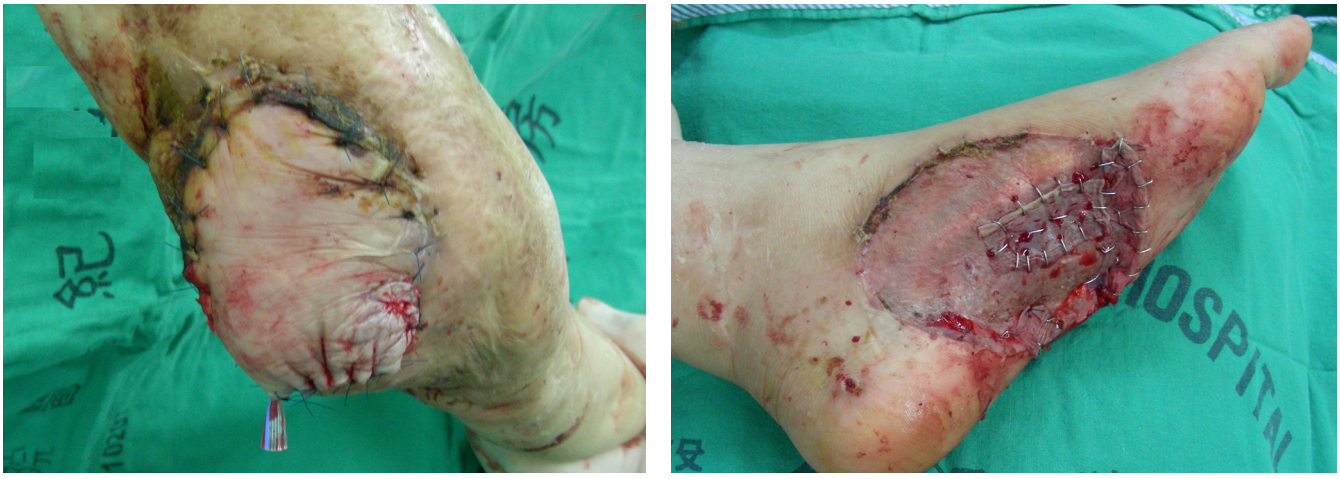

Fig. 7. (a) Postoperative results of the reversed instep flap after the division surgery.
(b) The residual skin defect of the donor site (left instep area) was covered with STSG and fixed with skin staples.

Fig. 8. (a) Good survival of the flap at 3 months after surgery.
(b) The STSG at donor site healed well at 3 months after surgery.

Fig. 9. Good survival of the flap at 6 months (a) and 1 year (b) after surgery. No further skin breakdown on the weight-bearing area during the follow-up period was observed.

Discussion

The plantar skin is anatomically different from the rest of the skin with respect to glabrousness, thickness, and microanatomy, making it able to withstand the shearing stress and continuous weight-bearing during walking. The unique characteristics of plantar skin provide a challenge to the plastic and reconstructive surgeons in covering skin defects over the weight-bearing areas of the sole.

Plantar defects have a variety of causes. In young individuals like our patient, trauma is the leading cause, typically from traffic or work-related accidents. Other causes include vascular diseases, metabolic diseases, and defects after infection or tumor excision. In rare cases, neurologic deficits following congenital malformations also lead to neuropathic plantar ulcers.

The purpose of plantar reconstruction of the heel is to provide sustained coverage with a normal appearance, making the sole capable of both withstanding shearing stresses and having sensation to prevent pressure sores[2]. Different surgical procedures have been performed, ranging from skin grafting to placing ipsilateral local flaps, free flaps, and cross-foot flaps[15]. Skin grafting is the simplest procedure to repair a defect of the heel, but it does not provide stable soft tissue coverage and can give rise to graft breakdown and plantar ulceration under the influence of pressure and constant shearing forces[16,17]. Ipsilateral instep flaps can provide similar tissue for heel reconstruction without compromising the weight-bearing area of the foot[2-5]; however, in a situation where the defects expand to the instep area, the ipsilateral instep is not available for flap elevation. Other local flaps have been previously reported, including the reversed sural flap[18], lateral supramalleolar flap[19], and lateral calcaneal flap[20]. The disadvantages of these local flaps include improper flap thickness, poor tissue match, and limited protective sensation even after nerve anastomosis. With advances in surgical technique and instrumentation, the microvascularized free flap for complex defect reconstruction is the first choice in many centers. For heel defects, free flap not harvested from the plantar area (i.e., the free ALT flap) can only provide subcutaneous tissue coverage, but lacks the skin characteristics of the sole, potentially leading to recurrent skin ulceration. Thus, surgical options for free flaps are limited.

In some patients, where a local flap (i.e., transposition and island fasciocutaneous flap) cannot be used because of vascular injuries or where extension of the defect extends to the ipsilateral instep area, the instep region of the contralateral foot serves as an identical tissue reserve[9-11,21]. The cross-foot island instep flap allows well-vascularized tissue, supplied by the contralateral foot, to cover the defect of the sole and heel. The advantage of the cross-foot island instep flap is similar to the ipsilateral instep flap described above. It can be a lifeboat for foot salvage when no suitable recipient vessel exists in the neighboring regions of the defect. The cross-foot immobilization results in numerous complications, such as joint stiffness, pressure sores, deep vein thrombosis, and emotional stress. The following delay and division surgery may also prolong hospitalization. However, if the failure risk of a microvascularized free flap is high, as it was in our patient, these risks may be justified. Pre-operative communication about post-operative limb immobilization is also required. The traditional methods of the cross-foot or cross-leg immobilization, such as external skeletal fixation, splinting or casting may require more efforts to change dressing and increase the risk of pressure sore. Using one 3.0-mm Kirschner wire to immobilize the cross-foot flap is an effective and simple method ,and it also can prevent the merits described above in our case. The distally based, reversed-flow medial plantar flap has been used to reconstruct distal plantar forefoot defects, including those extending to the toes and webspaces[12,13]. This flap is supplied by communications from the first three plantar metatarsal arteries, which are branches of the deep plantar arch. The deep plantar arch receives contributions from both the lateral plantar artery and the deep plantar artery (metatarsal perforating branch of the dorsalis pedis)[22]. In our case, the reversed-flow instep flap was indicated given that the left posterior tibial artery was the recipient vessel in the previous free flap surgery for the right heel defect. In accordance with the vascular disruption in our patient

and the merits of the instep flap described above, the instep flap is the most ideal reconstructive procedure to provide prolonged immobilization in our case. In addition, we did not perform neural coaptation in our patient, predominantly due to the lack of a healthy recipient neural stump in the severely damaged recipient area. Protective sensation in our flap was expected to arise from pressure receptors in the deeper structures and peripheral neurotization. The patient had a satisfactory outcome during the 1-year follow-up period, but long-term follow-up is needed to better evaluate the long-term prognosis.

Summary

In the case of complicated vascular disruption of both feet and persistent wounds after complex heel reconstruction, we successfully performed reconstruction using the cross-foot reversed instep flap. We suggest that the instep flap should be considered as an alternative treatment option for similar challenging cases, when pedicled instep and distant free flaps are not available.

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使用交足式逆行內側足底動脈皮瓣處置複雜腳跟創傷重建後之持續性傷口 —— 病例報告

尤傑銘 張世幸 董光義 黃文成 胡桂嘉

背　景：

對於整形外科醫師而言，重建進行腳跟處軟組織缺損的重建是具有挑戰性的。而使用交足式逆行內側足底動脈皮瓣取代自由皮瓣的重建在文獻報告上更是罕見。

目的及目標：

我們提出一個先前已使用自由皮瓣手術重建的右腳跟上有持續性傷口的案例，再利用交足式逆行內側足底動脈皮瓣重建術後的結果及追蹤。

材料及方法：

一名 28 歲女性患者，10 年前因車禍造成右跟骨複雜性骨折併皮膚缺損，接受多次手術治療，包括使用對側脛后動脈做爲受體血管的右大腿前外側自由皮瓣重建手術。長時間負重下，導致在皮瓣重建的右腳跟處有持續性傷口發生。因爲病患雙足的血管損傷缺陷，故可利用交足式逆行內側足底動脈皮瓣來進行重建。

結　果：

手術過程及術後恢復良好，病患在首次手術後 8 周開始進行腳跟負重訓練。持續追蹤一年，病患覺得滿意且行走負重良好，沒有皮瓣或皮瓣供應區的併發症出現。截至目前也沒有再次因負重而導致局部皮膚缺損出現。

結　論：

我們成功使用交足式逆行內側足底動脈皮瓣爲雙腳血管有損傷缺陷、且於先前皮瓣重建處有持續性傷口的案例進行重建。若有此類較複雜，無法使用蒂根內側足底動脈皮瓣或遠端自由皮瓣進行重建的腳跟負重處有皮膚缺損的類似案例，可以考慮使用交足式逆行內側足底動脈皮瓣做爲另一種的手術治療選項。