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Original Research Article

The medial plantar sensate flap: an effective option for heel reconstruction

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ABSTRACT

Background: The medial plantar sensate (MPS) flap is a reliable and versatile reconstructive option for heel defects. Heel reconstruction presents a unique challenge due to the need for durable, weight-bearing soft tissue that maintains protective sensation and supports normal ambulation. This study aimed to evaluate the outcome of MPA flaps for reconstruction of heel defects, focusing on the rate of complete flap survival and minor flap complications.
Methods: This retrospective observational study was conducted in the department of plastic surgery, national institute of burn and plastic surgery, and Green Life hospital. Ltd, Dhaka, Bangladesh, from January 2022 to December 2024. We included 30 patients who had an MPA flap with an evaluation of a soft tissue defect and heel lesion that had been present for several months.
Results: The mean age of the participants was 52.0±13.40 years, with a mean BMI of 24.85±5.18 kg/m^2. The majority of patients (40%) were over 60 years old, and males accounted for 70% of the study population. The primary indications for flap surgery were ulcers (46.7%), trauma (40.0%), and burns (13.3%). The most common clinical presentation was nonhealing ulcers on the heel (46.7%), followed by post-traumatic soft tissue loss (40%). Ulcers were most commonly located on the posterior heel (57%), with the anterior heel and lateral border being affected in 29% and 14% of cases, respectively. Postoperative complications included infection (10%), delayed wound healing (13.33%), flap necrosis (6.67%), and necrosis of the skin bridge (10%). Despite these complications, the overall flap healing success rate was high, with 90% of patients achieving satisfactory outcomes.
Conclusions: This study found that the MPS flap is a reliable and effective option for heel reconstruction. It offers a high flap healing rate with minimal complications. Flap surgery demonstrated a high success rate, with the majority of patients achieving satisfactory healing.

Keywords: Nonhealing ulcer, Medial plantar sensate flap, Heel reconstruction

INTRODUCTION

The plantar heel is a special anatomical location with unique properties, providing a weight-bearing surface through which the human foot alights to earth. When the full body weight is transmitted through the foot, the heel bears approximately 50 to 80%, with the distal sole and metatarsal heads bearing the remainder.[1,2] The heel possesses a thick epidermis intimately adherent to the underlying dermis with minimal subcutaneous tissue.[3] In addition, thick, dense septa can be found extending from deep fascia to skin.[3,4] Although fine two-point discrimination and light touch perception may not be critical for heel function, the presence of sensation certainly contributes a protective role in minimizing injury secondary to mechanical trauma.[1]

Reconstruction of heel defects presents a significant challenge due to the heel's specialized properties. The ideal reconstruction must provide durable, weight-bearing coverage while maintaining normal ankle motion and permitting the patient to wear shoes comfortably.[2] Many reconstructive strategies have been explored, but only a few have proven durable over time. Skin graft, for instance, might be simple but inadequate for the heel's weight-bearing surface because it lacks durability and sensation, making it prone to trauma and pressure-related injuries.[5]

The medial plantar flap may be raised as a sensate fasciocutaneous pedicled flap based on the medial plantar artery and transposed posteriorly to provide coverage of heel defects.[6,7] The flap is outlined over the medial instep of the foot in a non–weight-bearing surface centered over the medial plantar artery. When raising the flap, the branch of the medial plantar nerve supplying sensation to the instep may be harvested with the flap, permitting transposition of the flap to the heel while preserving sensation within it.[7] Thus, the medial plantar flap may allow the reconstructed heel to serve its normal weight-bearing function and permit the retention of a protective capacity to reduce subsequent trauma.

Reconstructing heel defects can be done in several ways, such as using skin grafts, local flaps, regional flaps, cross-leg flaps, or free tissue transfer. While skin graft might be a straightforward option, this option is not the best choice for the heel because it doesn't provide the durable tissue needed for weight-bearing and doesn't restore sensation, which is important for protecting the area. Free tissue transfer is another option, where tissue is taken from one part of the body and transplanted to the heel. This technique is helpful in situations where local or regional flaps aren't suitable. However, it has its downsides, including the risk of complications at the donor site, and it's a technically demanding procedure that requires specialized microsurgical skills.[8]

The use of ipsilateral medial plantar artery (MPA) flaps has garnered significant interest both historically and in contemporary practice. While several techniques are available for foot reconstruction, the medial plantar artery flap and the reverse sural artery flap remain the most commonly utilized options for heel reconstruction. First described by Harrison and Morgan in 1981, the medial plantar artery island flap involves harvesting tissue from the instep of the foot, utilizing either a vascular pedicle or a perforator as its base.[9] The flap's blood supply is derived from the medial plantar artery and the cutaneous digital branches of the medial plantar nerve, which allows it to retain sensation.[9] The MPA flap can be designed as either a fasciocutaneous or a musculocutaneous flap, depending on the specific needs of the defect. Additionally, the donor site is located on a relatively expendable, non-weight-bearing surface of the foot, minimizing functional compromise.[10]

Since its introduction, the MPA flap has proven to be a reliable method for heel coverage. It offers thick, weight-bearing, and sensitive skin that is resistant to friction, making it a durable and effective solution for challenging heel reconstructions.[11]

Therefore, in this study, we aimed to evaluate the outcome of MPA flaps for reconstruction of heel defects, focusing on the rate of complete flap survival and minor flap complications.

METHODS

This retrospective observational study was conducted in the department of plastic surgery, national institute of burn and plastic surgery, and Green Life Hospital. Ltd, Dhaka, Bangladesh, from January 2022 to December 2024. We included 30 patients who had an MPA flap with an evaluation of a soft tissue defect and heel lesion that had been present for several months.

These are the following criteria to be eligible for enrollment as our study participants: a) Patients aged up to 80 years; b) Patients with nonhealing ulcers on heel; c) Patients with post-traumatic soft tissue loss; d) Patients with post-traumatic wound on the heel were included in the study And a) Patients with complete loss of plantar sensation; b) Patients with uncontrolled DM or other systemic conditions that may impair wound healing; c)Patients with severe musculoskeletal deformities; d) Patients who were not willing to participate were excluded from our study.

Surgical technique

The artery was first identified by palpation and confirmed using a Doppler device, and its location was carefully marked. A single dose of preoperative antibiotics was administered. With the tourniquet in place, the ulcer excision site was outlined, aiming to remove all unhealthy tissue and extend to healthy skin when possible. The same dimensions were then marked on the instep of the foot, ensuring the artery remained at the center. The flap procedure was initiated 1 cm proximal to the metatarsal head, just above the weight-bearing area. The neurovascular structures were easily located between the abductor hallucis and flexor digitorum brevis muscles. The flap was elevated in a subfascial plane, with the medial plantar nerve preserved in cases where plantar sensation was intact. Fibrous septae anchoring the flap to deeper structures were carefully released, progressing from distal to proximal. The flap was then raised on its neurovascular pedicle, including the surrounding fat until it could be positioned over the defect without tension. For defects located further back on the foot, the abductor hallucis muscle was partially divided to provide additional reach.

The donor site was covered with a split-thickness skin graft harvested from the thigh. At two weeks

postoperatively, the donor site was inspected, and all sutures were removed. Ambulation was typically initiated at five weeks, using an 8 mm microcellular rubber (MCR) insole, except in cases of delayed healing. Most patients were given a cup-type heel orthosis and a raised instep for 6 months to try to offload the heel. The patients are put through our standard trial walking routine, with gradually increasing, 2 to 3 times-daily walking, starting with 5 minutes, checking for any evidence of trauma after each session. These are fully weight-bearing within 1 week if no problems are encountered.

Data collection and analysis

Patient demographic data, cause of soft tissue defect, presence/absence of sensation of foot, size, and location of the lesion, complications, and follow-up were recorded. All data were recorded systematically in preformed data collection form. Quantitative data was expressed as mean and standard deviation; qualitative data was expressed as frequency distribution and percentage. Data were analyzed using SPSS (statistical package for social sciences) for Windows version 10.

Figure 1 (A-D): Before medial plantar flap surgery; postoperative flap surgery.

RESULTS

Figure 2 shows that the majority (40%) of our patients were in age group of >60 years, followed by 30% aged 51-60 years, 13.3% of patients were in 31-40, and 10% were in 41-50 years age group respectively. Only 6.7% of patients were in the age group of ≤30 years old.

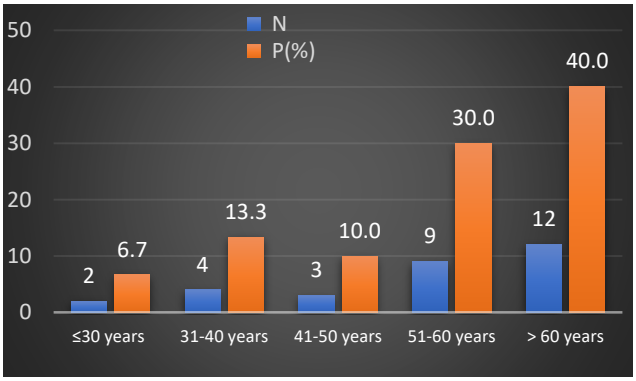

Figure 2: Age distribution of our study patients.

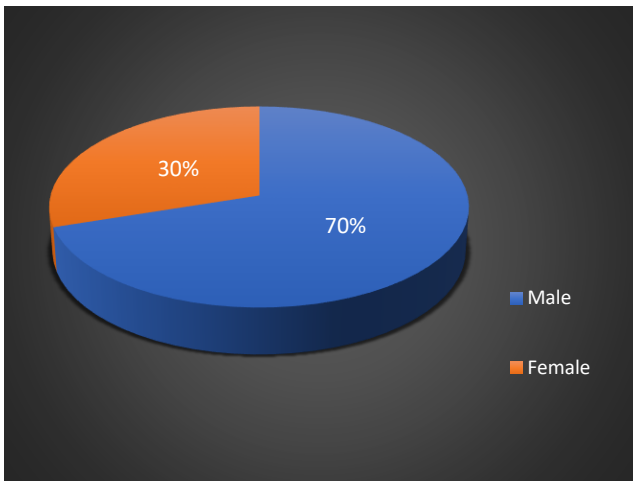

Figure 3: Gender distribution of our study patients.

The pie chart shows that most of our study patients (70%) were male and 30% were female. The male and female ratio was 2.33:1 in our study.

Table 1: Distribution of our study patients by baseline characteristics, (n=30).

Variables	N	Percent (%)
Baseline characteristics		
Mean age (in years)	52.0±13.40	
Mean BMI (kg/m^2)	24.85±5.18	
Mean diameter of the ulcer (cm)	6.12±2.08	
Mean follow-up (months)	12.05±4.13	
Indications for flap		
Trauma	12	40.0
Ulcer	14	46.7
Burn	4	13.3
Clinical presentation		
Nonhealing ulcer on heel	14	46.7
Post-traumatic soft tissue loss	12	40.0
Post-traumatic wound on the heel	4	13.3
Co-morbidities		
Diabetes mellitus	8	26.7
Hypertension	7	23.3
Arthritis	5	16.7

Table 1 shows the mean age of the participants was 52.0 years with a standard deviation of 13.40 years. The mean BMI was recorded at 24.85±5.18 kg/m^2. Regarding the indications for flap surgery, trauma was the primary indication in 12 patients (40%), followed by ulcers in 14 patients (46.7%), and burns in 4 patients (13.3%). The clinical presentation showed that 14 patients (46.7%) had nonhealing ulcers on the heel, 12 patients (40%) presented with post-traumatic soft tissue loss, and 4 patients (13.3%) had post-traumatic wounds specifically on the heel. Among the study population, the most common comorbidity was diabetes mellitus (26.7%), followed by hypertension (23.3%), and arthritis was reported in 5 patients (16.7%).

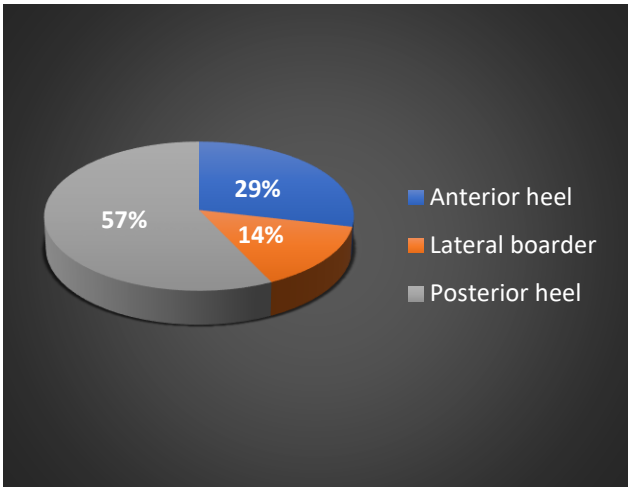

Figure 4: Distribution of study patients by location of the ulcer, (n=14).

Figure 4 presents the distribution of ulcer locations among the study participants. The majority of ulcers (57%) were located on the posterior heel, followed by ulcers on the anterior heel accounted for 29% of cases, while the lateral border of the heel was the least affected area, with only 14% of ulcers observed.

Table 2: Distribution of study patients by complications and complete flap healing rate.

Variables	N	Percent (%)
Complications		
Infection	3	10
Delayed wound healing	4	13.33
Flap necrosis	2	6.67
Necrosis of the skin bridge	3	10.00
Pressure sore	2	6.67
Complete flap healing		
Satisfactory	27	90
Unsatisfactory	3	10

Table 2 shows the postoperative complications and flap healing outcomes. Infection was reported in 10% of cases, while delayed wound healing occurred in 13.33%. Flap necrosis and skin bridge necrosis were observed in 6.67% and 10% of patients, respectively. Additionally, pressure sores were noted in 6.67% of cases. Among all study participants, the complete flap healing rate was 90%, while 10% experienced unsatisfactory healing results.

DISCUSSION

The findings of this study revealed that the MPS flap for heel reconstruction is associated with a high flap survival rate (90%), and complications (10%). The results from this study are consistent with the largest study on the use of MPA (medial plantar artery) or heel reconstruction by Schwarz with a flap survival rate of 98%.[11] One other flap that has been used for heel reconstruction is the reverse sural artery flap. A few studies have compared this flap to the medial plantar artery flap for heel reconstruction and have found the medial plantar artery flap to have fewer associated complications.[12,13] Moreover, the donor tissue used in the sural artery flap does not provide the glabrous tissue that the instep provides. Another advantage of the medial plantar artery flap is the ability to transfer it as a sensate flap. This is very important to protect the foot from injuries including the development of heel ulcers. Of the few studies that attempted to compare the reconstructed flap to the contralateral normal side, most concluded the presence of protective sensation although was inferior to the contralateral side.[14-17]

This feature of the MPA makes it superior to skin grafts, local flaps, and other non-sensate flaps. The MPA flap has proven its place in the reconstruction of the hindfoot over the years since its first description by Harrison and Morgan.[18] It replaces “like tissue with like,” an important issue in the sole, with its specialized fat pad that contains

fibrous septae that help protect against trauma from shearing. As such, it should be more durable than a reverse sural flap or other flaps from extra plantar areas. They concluded that there is an innate mechanical property that allows the sole to withstand weight-bearing and shearing forces and that this is as important as the presence of protective sensation in preventing trauma from ambulation.[19,20] The findings of the study are supported by the Gravem study, which reported that only 1 of 14 patients developed recurrent ulceration in those patients with long-term follow-up.[21]

While empirically the MPA flap should be more durable than flaps from extra plantar areas, a direct comparison of the 2 types of tissue has not been carried out to date. Rashid et al compared the MPA flap with the reverse sural flap and found that the MPA flap had fewer complications and a shorter time before return to work, although long-term results (i.e., recurrences) were not reported.[12]

In this study, none of our patients had recurrent ulceration within the mean follow-up of 12 months. Benito-Ruiz et al reported no cases of recurrent ulcers in patients with either MPA flaps or reverse sural flaps after 1 to 2 years of follow-up. The MPA flap is versatile and capable of covering large skin defects, up to 8 cm in diameter, as demonstrated in this study. It is particularly effective for addressing posterior heel defects and even those extending beyond the heel to the Achilles tendon insertion. When the medial plantar nerve is intact, it is relatively straightforward to preserve sensation in both the forefoot and the flap by carefully dissecting the branches of the medial plantar nerve that supply the flap.[22]

Other reports note intact but decreased sensation in the flap following surgery, and Miyamoto et al reported that 7/13 patients with long-term follow-up had hypo- or hypersensitivity in the forefoot.[21,23-25] Small heel ulcers are generally treated by different means, either by conservative treatment or a bucket-handle flap. Those with neither an intact dorsal pedis nor peroneal artery are not candidates for this flap. Also, for those with occlusion of the MPA or trauma to, or cancer, the instep would be unsuitable.[19] The current study also demonstrates that using an MPA flap to just cover the plantar defect is adequate, and there is no need to mobilize and transpose the entire posterior plantar surface. In the present study, complications occurred in 4 (13.33%) patients out of 30 patients. While Chaudhry et al found complications occurred in 05/21 procedures (25%).[19]

Limitations

This study took a small sample size due to the short study period. After evaluating those patients, we did not follow up with them for the long term and did not know about other possible interference that may happen in the long term with these patients.

CONCLUSION

In our study, we found that the MPS flap is a reliable and effective option for heel reconstruction. It offers a high flap survival rate with minimal complications, both at the recipient and donor sites. Additionally, the flap provides a protective sensation to the reconstructed heel, although it may not be as robust as the sensation on the unaffected side. The procedure ensures adequate soft tissue coverage while preserving sensation in patients with intact plantar nerves, contributing to improved postoperative outcomes and quality of life. However, proper management of comorbid conditions and careful postoperative monitoring are also crucial to minimize complications and improve surgical outcomes.

So further study with a prospective and longitudinal study design including a larger sample size needs to be done to validate the findings of our study.

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