

Heel Reconstruction with Sensate Medial Plantar Flap

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Abstract

Background: The heel had distinctive anatomical feature that serve as weight bearing structure and any defect in heel result in gait instability and therefore the tissue used to reconstruct the heel area must be resistant, innervated, and adapted to adjust to the body weight. The aim of study is to evaluate the outcomes of heel reconstruction using the Sensate medial plantar flap in group of patients, emphasizing its efficacy in restoring function and sensation.

Patients and Methods: The study is prospective-descriptive case series conducted from 2020-2024, in four hospitals, patients who presented with heel soft tissue defects of various etiologies. SMPF is used in reconstructive.

Results: The study involved 26 patients, majority of them being male (92.3%) and the remaining (7.7%) were female, with participants' mean age was (35.42) years, most of patients present with size defect >3cm in (76.9%), with non-neurotrophic ulcer in (73.1%), preoperative doppler US is used in (69.2%). The overall survival rate of flap (96.15%) and with complication rate (19.15%), (11.5%) necessitate reoperation, these uneventfully complications like total flap loss (3.8%) which

reoperated and, partial flap necrosis (3.8%). Donor site covered with split thickness skin graft, with complications such as graft loss / dehiscence which healed with secondary intention (7.7%), (3.8%) total graft loss require reoperation.

Conclusion: the use of SMPF for reconstructing heel defect is highly adaptable technique and is widely regarded as one of the best options for repairing soft tissue defect of heel. This is due to its sensitivity and ability to replace the damaged area with similar structure following the idea of “like with like”.

Keywords: Heel Defect, Heel Reconstruction, Sensate Medial Plantar Flap, Sensation.

Introduction

Heel reconstruction the challenge of providing a productive life to patients with soft-tissue defects who require sensitive and durable tissue remains significant. Heel deformities are frequently observed in the working Yemeni population due to the repetitive damage experienced by the weight-bearing heel. The heel is a specialized tissue in the body that consists of a thick epidermis and dermis. It is securely attached to the plantar aponeurosis by perpendicular fibrous septa, which serve to avoid shearing force. Additionally, there are fat loculi located between these vertically oriented septa, which act to absorb shock. Heel deformities, which are typically caused by trauma, chronic ulceration, and oncologic resection, require restoration techniques that can endure the mechanical load of weight-bearing while also preserving feeling. The sensate medial plantar flap is an ideal option for complex restorations due to its anatomical and sensory features. The objective of the study was to assess the functional and sensory results of reconstructing heel defects using the sensate medial plantar flap. Additionally, the study aimed to determine the rate of complications and overall patient satisfaction with this reconstruction technique.

Material and Methods

Under an active institutional review board approved protocol for this prospective case series study, which was conducted by a team of plastic surgeons at four hospitals (the typical police hospital; al-Elite hospital; military hospital Algamhori hospital), from January 2020 to January 2024. Include 26 patients who underwent sensate medial planter. Flap reconstruction for heel soft tissue defects, with informed consent obtained from them. Data were collected and involved the patient's demographics including age, gender, smoking, and application of a tourniquet. And use of loupe magnification, and the underlying etiology of the soft tissue defect, using a doppler preoperatively to study of the vascularity of the affected foot and to check antegrade flow of the posterior tibial artery and continuity with the medial plantar artery and hospitalization time were collected. Also, regarding the defect characteristics, such as size, and associated injuries, were documented. Surgical details, including flap design, dimensions, and intraoperative findings, complications, and follow-up period, all photographically recorded. The exclusion criteria were adapted. such as immunosuppressed vasculopathy and coagulopathy. Patients were excluded. The primary outcome measure is about the proportion of flaps that fully survive. without any necrosis or loss, defect size, and skin graft for donor site viability, underlying etiology, and secondary the outcome measures included evaluating the complications. rate of recurrent ulceration, partial or complete flap loss, delay wound healing, sensory hypo/hypersensitive of forefoot and hindfoot.

The sensate medial plantar flap was marked, and the flap design which depend on an axis extending from the base of the first metatarsal distally to the sustentaculum tali with avoidance incorporating weight-bearing skin areas of the foot into the flap, then harvested to cover the defects.

The procedure done under general anesthesia, tourniquet control, and loop magnification ⁽¹⁾. plantar incision is made, and the dissection is performed in a

subfascial plane. above the abductor hallucis muscle in a dorsal direction, until the pedicle of the flap is visualized. See figure (1,2).



Figure 1: Flap marking



Figure 2: skin incision and harvesting

Started flap elevation from distal to proximal in a plain-tell appearance of abductor hallucis and planter fascia included MPA is explored in the septum between abductor hallucis and extensor digitorum brevis, where it was divided and elevated within the flap. See figure (3).



Figure 3. elevation of the flap

Neurovascular bundle is obtained and MPN is identified in which splinting cutaneous part of the nerve is included within flaps made it sensitive, and obligatory continuous dissection proximally until a sufficient arc of rotation of the flap is made cover to the flap inset. See figure (4,5).



Figure 4. neurovascular bundle



Figure 5. rotation of flap

The donor site was covered by split thickness skin graft. A tie-over closure dressing was used to further secure the skin graft. See Figure (6).



Figure 6: split thickness for flap donor site

In some patients where the heel defect less or equal to 3 cm flap elevation, then advance posteriorly, without division of MPA or splinting MPN as keystone flap see figure (7).



Figure 7: keystone flap

Postoperative a comprehensive follow-up protocol applied to monitor healing progress regularly, mainly the first 48 hours to monitor the flap survival each 4 hours through observation, the color and hotness of the flap average follow-up time of 12 months.

Statistical Analysis

We analyzed the data using SPSS version 26. We used descriptive statistics to summarize the patient demographics, intraoperative details, and postoperative outcomes. For outcomes, a p-value less than 0.05 was considered statistically significant.

Results

Analysis of 26 patients with heel defect underwent SMPF show, there were 24 males and 2 females, with a male to female ratio of 12:1. The participants average age was 35.42 years, with a range from 1 to 60 years. The most common cause of heel defect is acute trauma 69.25% (N=18), followed by neurological disease 26.9% (N= 7), burn 3.8% (N=1), and about 73.1% (N =19) which they had non- neurotrophic ulcer and rest had neurotrophic ulcer 26.9% (N=7) most of them present with defect size more than 3cm 76.9% (N=20) need split thickens skin grafting for flap donor site and lest less than 3cm 23.1% (N=6) patients covered their defect by MPAP keystone flaps, 19.2% (N=5) they were smokers with little impact on survival since they instructed to stop smoking at least 2 weeks before operation and most of patient are nonsmoker 80.8% (N=21) , Preoperative diagnostic imaging of the arterial system of the lower extremities was performed by Doppler ultrasound or Angio since are mandatory. Done in 69.2% (N=18), Additional investigation of the CT angiography is done in high-risk patients. 23.1% (N=6). with high flap survival rate about 96.25, and Only 5 cases had complications; the most common issues for donor is graft loss with dehiscence (7.7%) one case observed to heal with secondary intention, another case is reoperated (3.8%), with smaller percentages experiencing complete flap loss requiring reoperation (3.8%) or the other case had partial flap loss, which not operated (3.8%). No venous congestion, flap infection, and seroma.

Discussion

Surgeons have had a tough time replacing heel soft tissue defects with durable tissue. This is primarily due to the unique structure of the skin at this level. Over time, it has evolved to be able to handle the weight and pressure of the whole body, as well as the load of daily activity ⁽²⁾. Furthermore, when in a standing position, the heel

absorbs approximately 80% of the body weight, providing shock resistance at this level.

The vertical fibrous septa between the fascia and dermis divide the subcutaneous fat into distinct regions, potentially serving as multiple "shock absorbers" ⁽³⁾. Furthermore, it's critical to recognize that using this flap provides significant benefits. The flap yields both functional and aesthetic results, and its innervation contributes to its protective sensitivity. Numerous centers have studied flaps extensively, proving their effectiveness and durability.

The MPA island flap was first described by Harrison and Morgan ⁽⁴⁾, in which the distal end of the medial plantar artery was divided and elevated with the flap.

In 2004, Benito-Ruiz et al. carried out a study involving six medial plantar flaps, achieving an 83% survival rate. Only a single case ⁽⁵⁾ showed complete necrosis. Also In 2022, Vijay Kumar et al. reported performing 22 MPF flaps. He had two partial graft losses of 9% and one total graft loss of 4.5%. In one case (4.5%), he experienced a complete flap loss, and in two cases, he experienced a partial flap loss.9%, a survival rate of 95.5%, and a complication rate of 31.5% ⁽⁶⁾. In our study of a total of 26 patients who underwent ipsilateral SMPF for reconstruction, the youngest patient was the most active. as many studies share same age interval and by noting that trauma is the leading cause of heel defects (69.25%), the same result as the Maourougan study (2006), which reported that trauma is the leading cause of defects. In our study of 26 patients, we performed reoperations on one case of total flap loss and one case of partial flap necrosis. And most of the flaps survived—92.4%. Additionally, the 2010 Ma Kalam study used the sural reverse flap to manage one medial plantar flap loss ⁽⁷⁾. In addition, the N. Senthilkumar study from 2024 shows that MPF can help reconstruct a heel defect after acral melanoma and SCC, which is similar to our results and supports them. Also, Sanjay's study aligns with our findings, as it expands on our findings advantage of involving post-electric and post-

debridement and outcomes ⁽⁸⁾ Donor site complications such as graft loss or dehiscence in two cases and one loss graft. in 2018. Michaela Peral et al. study on 5 patients, show better results on 5 patients with SMPF shows no immediate necrosis and no ulceration ⁽⁹⁾. Deepak Krishna et al. study, on 8 cases, report 2/8 (25%). with late further necrosis in 8 patients with medial plantar flap for a neurotrophic heel defect and gain sensation in the same period of 5-8 months ⁽²⁾, and also. Sunkit Study 2023 show closed results 1/10 flap necrosis and 2/10 suture site

dehiscence attributed to the comorbidity of patients, unlike our studies in which trauma is most common. ⁽¹⁰⁾

In our study, good preservation of sensation is uniform observed across the flap, with no focal regions found in 16 patients, and the other 11 patients experience hypo/hyperesthesia. With ignored follow-up. Snice Included are the medial plantar fascicles of the cutaneous nerve. The nerve does not permanently impair tactile sensation. However, the nerve may temporarily impair the sensation of the toes. diminished due to neurapraxia. ⁽¹¹⁾. All sensate flaps Careful postoperative follow-up led to the restoration of tactile and protective sensation following surgery, albeit over a variable period. The results of this study seem to agree with those of the study by Derrick G. wan ⁽¹²⁾ et al., which showed that a versatile medial plantar flap can provide immediate sensation and cover heel defects with little harm to the donor site. Thorough neurologic testing has demonstrated that by carefully dissecting the flap while preserving its sensory organs, it is possible to maintain normal sensation. throughout the flap. The same report by Trevatt ⁽¹³⁾ et al., which demonstrated two-point discrimination testing, also found that the sensitivity of the medial plantar flap is almost normal after 1 year. Four months after the surgery, patients begin to regain their sensitivity. Patient satisfaction is at its maximum in all cases. Thus, we conclude that the innervated medial plantar fasciocutaneous flap is the best options for reconstructing the heel's soft tissue defects since it should to be resilient, innervated,

and have an area-like texture. They are capable of taking over and supporting the body weight. having minimal donor site morbidity ⁽⁴⁾.

Conclusions

The sensate medial plantar fasciocutaneous flap is an ideal technique for reconstruction of heel soft tissue defects due to its pressure resistant, innervated skin and minimum donor site morbidity. It provides constant, durable, and sensate glabrous skin with low complication rates and long term results. The sensate flap is better free flap in term of time and operation cost.

Conflicts of Interest

- The authors declare no conflicts of interest related to this study

References

1. Krishna D., Chaturvedi G., Khan MM., Prakash Rao Cheruvu V., Laitonjam M., Minz R. Reconstruction of Heel Soft Tissue Defects: An Algorithm Based on our Experience. *World J Plast Surg.* 2021;10(2):63–72. Doi: 10.29252/wjps.10.3.633:
2. Miyamoto Y, Ikuta Y, Shigeki S, et al. Current concepts of instep island flap. *Ann Plast Surg* 19:97-102, 19874:
3. Paget JT, Izadi D, Haj-Basheer M, Barnett S, Winson I, Khan U. Donor, site morbidity of the medial plantar the artery flap was studied with gait and pressure analysis. *Foot Ankle Surg.* 2015; 21(1): 60-6. PMID: 25682409, DOI: 10.1016/j.fas.2014.09.0095:
4. Harrison DH, Morgan BD. The instep island flap to resurface plantar defects. *Br J Plast Surg* 34:315–318, 1981.2:
5. Benito-Ruiz J, Yoon T, Guisantes-Pintos E, Monner J, Serra-Renom JM. Reconstruction of soft-tissue defects of the heel with local fasciocutaneous flaps. *Ann Plast Surg.* 2004; 52(4): 380–4. PMID: 15084883.6:
6. Kumar, V. N., Kakola, M. G., Raj, P. S., & Chandrashekar, M. S. (2022). Medial plantar artery flap: an indispensable classic for sensate heels reconstruction. *The International Journal of Health Sciences*, 6 (S6), 2977–2983. <https://doi.org/10.53730/ijhs.v6nS6.105317>:

7. MA Kalama, SR Faruqueeb, SA Rahmanc, and HN Uddin, Reconstruction of the Heel: Options and Strategies, *Bangladesh Journal of Plastic Surgery* (2010), Vol. 118:
8. N. Senthilkumar, G. Balamurugan, N. Selvaraj, Medial Plantar Artery Flap for Heel Pad Reconstruction - Loco Regional Flap of Choice and Alternative to Free Flap/Reverse Sural Flap, *Int J Acad Med Pharm* 2024; 6 (2); 234–237, DOI: 10.47009/jamp.2024.6.2.499:
9. Mihaela Pertea, Natalia Velenciuc, Oxana Grosu, Bogdan Veliceasa, Vladimir Poroch, Sorinel Lunca, Reconstruction of heel soft tissue defects using sensate medial plantar flap, *J. Mind Med Sci.* 2018; 5(2): 250-254, doi: 10.22543/7674.52. P250254
10. Sunkit Shah SB, Shah A, Tomar J, Patel DV, Ribadia P. Medial plantar artery flap: a versatile workhorse flap for foot reconstruction, our experience. *Int J Res Med Sci* 2023; 11:3002-811-
11. Acikel C, Celikoz B, Yuksel F, Touam C. Various applications of the medial plantar flap to cover the defects of the plantar foot, posterior heel, and ankle. *Ann Plast Surg* 2003;50: 498e503.
12. Derrick C. Wan, M.D. Joubin Gabbay, M.D. Benjamin Levi, M.D. J. Brian Boyd, M.D. Jay W. Granzow, M.D, Quality of Innervation in Sensate Medial Plantar Flaps for Heel Reconstruction, DOI: 10.1097/PRS.0b013e3181fed76d13-
13. Trevatt AE, Filobbos G, UI Haq A, Khan U. Long term sensation in the medial plantar flap: a two-centre study. *Foot Ankle Surg.* 2014; 20(3): 166-9. PMID: 25103702, DOI: 10.1016/j.fas.2014.03.001