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EFFICACY OF VARIOUS OPTIONS FOR COVERAGE OF HEEL DEFECTS

Plastic Surgery

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ABSTRACT

Heel consists of a plantar surface and a posterior surface. Plantar heel defects present a challenging problem for reconstruction because of lack of locally available tissues, the weight-bearing requirement of the region and the presence of glabrous skin. Posterior heel defects on the other hand, present the challenge of requirement of gliding of the soft tissues over the tendoachilles. In this prospective study conducted in a tertiary care centre from April 2020 to September 2021, 20 consecutive patients presenting with heel defects were recruited. Thirteen of the patients presented with plantar heel defects while seven of the patients presented with posterior heel defects. Medial plantar artery flap (N=6), reverse sural artery flap (N=5), peroneus brevis muscle flap (N=3), abductor hallucis myocutaneous flap (N=3) and posterior tibial artery perforator flap (N=3) were used for resurfacing the heel defects. Although, the medial plantar artery flap and the abductor hallucis myocutaneous flap were noted to be the best suited for plantar heel defects since these flaps met the requirements of the region of like tissue replacing like and the need of sensory innervation, the abductor hallucis myocutaneous flap was found to be better in terms of the additional procedures required. On the other hand, the reverse sural artery flap and the peroneus brevis muscle flap was noted to be the best suited for the posterior heel defects.

KEYWORDS

Heel Defects, Flap, Options, Reconstruction

INTRODUCTION

The heel is a unique and complex structure, adapted specifically to its function of weight bearing and shock absorption.

The plantar heel consists of superficial and deep fascia with tightly packed adipose tissue and fibrous septa travelling throughout and connecting with the underlying dermis, thus providing sufficient padding to withstand stress and shear forces.[1]

On the other hand, posterior aspect heel has thin skin and lacks fat and muscle coverage.[1] It is thus, specifically adapted to its requirement of gliding over the tendoachilles.

Despite a palpable pulse at the ankle, seemingly good pedal perfusion and aggressive wound care, heel defects often fail to heal. This might be due to a number of factors namely, limited soft tissue over the calcaneus, the frequent development of osteomyelitis, difficulty in keeping pressure off the wound and differences in regional pedal perfusion.[2]

The lack of locally available tissues for transposition, relatively poor skin condition, a low modulus of shear across the constituent planes, the protective sensation and the weight bearing requirements, makes the reconstruction of this region challenging.[3,4]

For plantar heel defects, skin grafts being vulnerable to trauma and pressure, do not meet the requirements of this special area. Pedicled local flaps may provide immediate sensation but have the disadvantage of limited tissue supply, difficult flap dissection and tissue transfer from the trauma zone. Free flaps have also been popularized for the reconstruction of heel defects due to advances in the microsurgical technique.[5]

Although a number of reconstructive options are available, it is important to assess the efficacy of different procedures as far as functional recovery is concerned. This study aims to evaluate the outcomes of the various reconstructive options available thus helping us in their better understanding.

MATERIALS AND METHODS

This article presents a prospective study of 20 consecutive patients requiring reconstruction of unilateral heel defects following any aetiology like trauma, infection, tumour excision etc., attending Plastic Surgery OPD at Medical College and Hospital, Kolkata from April 2020 to September 2021. Patients with underlying bone loss and with soft tissue defects of other regions of the sole were excluded from the study.

The choice of flap was based upon the site and size of the defect, availability and quality of donor tissue and the reach of the flap to cover the defect. The flaps used were the medial plantar artery flap (N=6), reverse sural artery flap (N=5), peroneus brevis muscle flap (N=3), abductor hallucis myocutaneous flap (N=3) and posterior tibial artery perforator flap (N=3).

Post-operatively, the flaps were monitored for any colour change, the character of bleeding on scratch and the type of flap necrosis – full/partial. Donor site morbidity and any additional procedures required were noted. The patients were followed-up for a period of 6 months.

RESULTS

Males (85%) were more commonly involved than females and trauma was the commonest aetiology involving 80% of the patients. 65% of the defects involved the plantar heel.

For plantar heel defects, the medial plantar artery flap had the highest incidence of congestion (83%) followed by the reverse sural artery flap (67%). Partial flap loss in medial plantar artery flap, abductor hallucis myocutaneous flap and reverse sural artery flap was noted to be the same i.e., 33%.

One case of partial graft loss occurred in each of medial plantar artery flap and abductor hallucis myocutaneous flap. Secondary procedure requirement in the form of removal of sutures followed by reinsetting or debridement followed by reinsetting was highest in medial plantar artery flap (83%) followed by abductor hallucis myocutaneous flap (67%) and reverse sural artery flap (67%).

All the cases were able to bear weight painlessly. All the cases of medial plantar artery flap and the abductor hallucis myocutaneous flap were associated with sensation.

For the posterior heel defects, all the flaps survived completely. Congestion was reported in only 1 case of posterior tibial artery perforator flap.

DISCUSSION

Reconstruction of heel defects is challenging since it should result in safe painless weight bearing and should also be associated with atleast protective sensation.

Thus, the reconstructive ladder principle does not hold true for the reconstruction of heel defects.[5] Although grafts can provide simple and effective coverage, it results in unstable coverage with recurrent ulceration. Since goal of any reconstructive procedure is reconstruction of like with like tissue, the medial plantar artery flap and the abductor hallucis myocutaneous flap seems to be the best reconstructive option, however due to limited availability of tissue, regional flaps and free flaps are utilized.

A number of options have been used in this study for resurfacing the heel defects – medial plantar artery flap in 30%, reverse sural artery flap in 25%, peroneus brevis muscle flap, abductor hallucis myocutaneous flap and the posterior tibial artery perforator flap in 15% each.

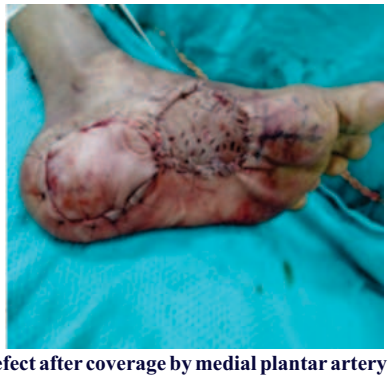
The choice of flap depended on the location and extent of the defect, the blood supply of the area, pre-operative localization of the perforators with the hand-held doppler and the availability of the local tissues.

Keeping in mind the reconstruction of like with like tissue, and the restoration of sensation to the heel, medial plantar artery flap along with the abductor hallucis myocutaneous flap was found to be best suited for plantar heel defects.

Congestion occurred in 5 out of 6 cases of the medial plantar artery flap. Thus, 83% of the cases required an intervention for minor complications. In 2 of the cases (33%), this resulted in partial flap loss resulting in debridement followed by reinset, while in the rest only reinset was required. In 1 case there was partial graft loss. 4 out of the 6 cases survived completely resulting in a 67% survivability. All the flaps were successfully able to bear weight painlessly. Additionally, all the flaps were sensate.

A - flap markings

B- flap harvest showing the nerve supplying to the flap



C - heel defect after coverage by medial plantar artery flap

Figure 1 : Medial Plantar Artery Flap

Schwarz et al.[6] in his study noted that the medial plantar artery island flap with its specialized fat pad contains fibrous septae which helps to protect the heel against trauma thus, allowing the sole to withstand weight bearing and shearing forces. Complications occurred in 25% of cases with 6% of cases requiring a secondary procedure against 83% requiring a secondary procedure as in our study. A recurrence rate of 18% was reported in this study while no recurrence of any ulceration was noted in our study.

Gravem[7] in his study of 24 leprous patients with long standing heel ulcers noted a complication rate of 43% with 14% of cases requiring a secondary procedure. One case of recurrent ulceration was reported out of 14 cases. He concluded this to be a reliable flap, useful for heel reconstruction even in leprosy.

Regarding the abductor hallucis myocutaneous flap, 2 out of 3 cases resulted in congestion. Thus, 67% of the cases required an intervention, with one case requiring reinsetting of the flap and the other case of congestion progressing to partial flap loss requiring debridement and reinsetting of flap. It was noted that 67% of the flaps survived completely. All were successfully able to painlessly bear weight and were sensate.

A - flap markings

B - heel defect

C - flap harvest

D - after coverage of defect

Figure 2 : Abductor Hallucis Myocutaneous Flap

Okada et al.[8] in his study of five abductor hallucis myocutaneous flap noted a 100% complete survival of the flap in comparison to 67% in our study. No recurrent ulceration was observed and all the patients reported painless weight bearing with the presence of sensation similar to our study.

In our study secondary procedure requirement was observed to be lower for the abductor hallucis myocutaneous flap in comparison to the medial plantar artery flap. This was mostly due to the lower rate of congestion in the abductor hallucis myocutaneous flap due to the incorporation of the muscle in the flap. One case each of partial graft loss was observed in both the medial plantar artery flap and the abductor hallucis myocutaneous flap. This might be because of the blood collection underneath the graft due to the oozing present after the fine dissection done for these flaps.

In this study, reverse sural artery flap was done in 25% of cases. Three flaps were utilized for resurfacing plantar heel defects while rest two flaps were utilized for resurfacing posterior heel defects. In 2 out of 3 flaps utilized for resurfacing plantar heel defects, there was congestion, one of which progressed to partial flap necrosis, requiring debridement and reinsetting while in the other flap only removal of suture and reinsetting was required.

Thus, 67% of the flaps required a secondary procedure. A 80% survivability was reported for this flap. Although, all the patients were able to bear weight painlessly, no flap was associated with return of protective sensation during the follow-up period. Out of the rest two flaps used for resurfacing posterior heel defects, 100% flaps survived completely with no flaps requiring any additional procedures.

A - heel defect

B - flap markings

C - after coverage of defect
Figure 3 : Reverse Sural Artery Flap

Lu et al.[9] in his study of complex heel reconstruction with sural fasciomyocutaneous perforator flap noted a survival rate of 95%, with only one flap progressing to venous congestion requiring debridement and split thickness skin graft in his study of 19 patients as opposed to a survival rate of 80% with a 40% of flaps requiring a secondary procedure in our study. But, a survival rate of 100% was noted for the reverse sural artery flap done exclusively for posterior heel defects in our study. Only one case of recurrent ulceration was noted in this study after a follow-up period of 25 months. But in the study of Lu et al.[9] a cuff of gastrocnemius muscle was preserved in the base of the flap to improve the arterial supply and the venous drainage of the flap which might have resulted in the better overall outcome of this flap.

In this study, the peroneus brevis muscle flap done for the reconstruction of posterior heel defects did not show any congestion or flap loss in the total of 3 cases which were done. Thus, a 100% survivability of this flap was reported.

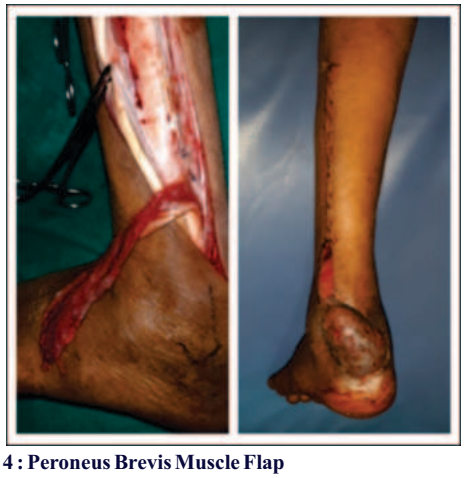


Figure 4 : Peroneus Brevis Muscle Flap
Coverage of heel defect after harvest of peroneus brevis muscle flap

Bach et al.[10] in his study of distally based peroneus brevis muscle flap noted that this flap provided stable coverage. The usefulness of this flap in patients with severe vascular risk was also noted. 90% of the flaps survived completely as opposed to 100% survivability reported in our study. A complication rate of 36% was noted in his study.

Although, the complication rate for both the reverse sural artery flap and the peroneus brevis muscle flap was nil and the survivability of both the flaps was 100%, as noted from our study the reverse sural artery flap was noted to be more durable as compared to the peroneus brevis muscle flap. The peroneus brevis muscle flap was more prone to recurrent ulceration on long term follow-up due to the wear and tear from wearing shoes. On the other hand, the reverse sural artery flap was more bulky resulting in difficulty in the regular use of shoes whereas cases with peroneus brevis muscle flap did not face difficulty in the regular use of shoes due to the better contour of this flap.

Three cases of posterior tibial artery perforator flap was performed in our study. In one of the flap there was congestion resulting in the requirement of reinsetting of flap. Thus, a 100% survivability of this flap was noted.

Akhtar et al.[11] in his study of posterior tibial artery perforator flap for heel defects noted a survival rate of 88% with a complication rate of 38%.

Overall, this study confirms the fact that the perforator flaps are associated with more chances of congestion.

El-Shazly et al.[12] have conducted a retrospective study comparing the various options available for the reconstruction of heel defects. In his study split thickness skin grafting, medial plantar flap, reverse sural flap, free radial forearm flap, free rectus abdominis flap and free latissimus dorsi flap were used for reconstruction of heel defects.

In his study, medial plantar flaps were used in 20 patients. The flap was used for defects of less than 4 cm in diameter. A 5% complication rate was observed in his study with 100% survivability of this flap as opposed to our study wherein, there was a complication rate of 83% with a 67% of survivability of the flap.

Reverse sural flap was used for 12 patients with a defect of greater than 4 cm in diameter. Complications occurred in 25% of cases as opposed to 40% in our study. Whereas, 100% survivability was reported in this study, our study reported a 80% survivability for this flap. In this study, deep sensation developed over the follow-up period whereas, in our study deep sensation failed to developed in the follow-up period.

The study concluded that the needs of the patients and the preferences of the surgeon were the determining factors regarding the choice of reconstruction of heel defects.

Benito-ruiz et al.[13] in his study concluded that the instep flap for the anterior heel and the reverse sural artery flap for the posterior heel to be the first choice in the algorithm for the reconstruction of heel defects.

From our study, it was noted that for plantar heel defects, the abductor hallucis myocutaneous flap was best suited in terms of being sensate and replacing like tissue with like and also in terms of complications. On the other hand, for the posterior heel defects, both the reverse sural artery flap and the peroneus brevis flap was noted to be well suited for the region in terms of survivability and the number of additional procedures required. The reverse sural artery flap had the advantage of being a durable but bulky flap. On the other hand, the peroneus brevis muscle flap gave a better contour but resulted in recurrent ulceration on long term follow-up.

Our study has certain short comings like small sample size and a small period of follow-up. Thus, studies taking into consideration the above mentioned factors are required to establish any superiority of one flap over another.

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