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Original Article

Evaluation of Loco-Regional Flaps for Heel Reconstruction

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ABSTRACT

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Background: Soft tissue defects reconstruction of the heel region represents a challenge for a plastic surgeon due to the limited availability of local soft tissue and the special structural and functional characteristics of this region.

The aim of the work: The current study aimed to evaluate the versatility of different loco-regional flaps for heel reconstruction.

Patients and Methods: This study included 20 patients with soft-tissue defects localized to the heel. Patients were divided into four groups according to type of flap used: medial plantar, reversed sural, V-Y advancement and lateral calcaneal flap. The main outcomes were donor site morbidity, flap sensation, stability and daily activities.

Results: The age of studied patients ranged between 21 and 56 years, 14 patients were males and 6 were females, 13 patients were right sided and 7 were left sided. Thirteen defects were traumatic, 6 neuropathic and 1 post-burn unstable scar. In reversed sural group, excellent results in 2 patients [20%], good in 6 patients [60%] and fair in 2 patients [20%]. In medial plantar flap group, excellent results in 3 patients [60 %] and good in 2 patients [40%]. In V-Y advancement flap group, all 3 patients [100%] with excellent results. In lateral calcaneal flap group, one patient was excellent [50%] and good in another patient [50%].

Conclusion: Loco-regional flaps were very useful to reconstruct soft-tissue defects in the heel defect. The flaps from plantar aspect [medial plantar and V-Y flap] were the best option for small and medium sized defects due to its minimal donor site morbidity, similar tissue to heel and protective sensation. Reversed sural and lateral calcaneal flap were another good option if the plantar flaps unavailable.

Keywords: Heel Defect; Medial Plantar Flap; Reversed Sural flap; V-Y Advancement Flap; Lateral Calcaneal Flap.



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INTRODUCTION

Heel is the important integrated part of the sole of the foot which is essential for smooth walking ^[1]. Without heel, the propelling function of the foot during walking is severely interrupted ^[2]. Reconstruction of heel defects still represents a surgical challenge that often requires high surgical expertise ^[3].

Defects of the heel occur mainly as a result of trauma that severely affects its function. Burns, infection, and tumors are among the other causes of soft tissue damage to the heel. Most of the times, trauma to the heel causes soft tissue damage, but may be complicated when it is associated with fracture of bones or the exposure of tendo-achilles ^[4].

Several reconstructive options have been

described, including skin grafts, local advancement flaps, cross-leg flaps, island pedicle flaps and microsurgical free flaps. Each of these procedures has advantages and disadvantages without entirely satisfactory results [5].

THE AIM OF THE WORK

The aim of this study is to evaluate the versatility of different locoregional flaps for heel reconstruction, regarding satisfactory results in terms of complete coverage, proper shoe fitting for ambulation, sensation, mechanical and thermal protection, and cosmetic appearance.

PATIENTS AND METHODS

This study was conducted at The Plastic Surgery Department of Al-Hussein and Bab Al-Sha'aria University Hospitals from April 2019 to May 2021. It included 20 patients with soft-tissue defects localized to the heel. Their ages ranged from 21 to 56 years. They were 14 males and 6 females. The injury was on the right side among 13 and on the left side among 7 patients. Thirteen defects were traumatic, six neuropathic and one was post-burn unstable scar. Patients with neuropathic defects had careful examination, full investigation, flap surgery practiced with caution and intense post-operative follow up.

Inclusion criteria:

Age between 18-60 years old, patients with soft-tissue defects localized to the heel, had healthy lower limbs vessels as ensured clinically and by duplex, and absence of significant comorbidities [cardiopulmonary problems and advanced liver or renal diseases].

Exclusion criteria:

Patient with major lacerations of ankle joint or lower third of the leg that may affect distal vascularity, unfit for major surgery and patients with congenital malformation or chronic lymphatic obstruction of the affected limb. Each patient signed an informed written consent. The study protocol was introduced and accepted by the local research and ethics

committee of the faculty of medicine, Al-Azhar University, Egypt. All stages of research till submission for publication were in accordance with declaration of Helsinki for research conduct and reporting.

Preoperative assessment: Preoperative preparation included detailed history, general examination and local examination of both lower extremities with a focus on the neurovascular examination of injured lower extremity. The clinical evaluation focused on the defect analysis, bone affected, missed functions and available reconstructive options. The size was small [from 3x3 to 5x4 cm²]; in five patients, medium [from 5x4 to 7x5 cm²] in 5 patients and more than 8x6 cm² in 10 patients. The investigations work up included radiological [Plain X-ray on the foot, Duplex ultrasound], and routine laboratory investigations [e.g., complete blood count, blood sugar, liver and kidney function tests].

Operative techniques:

Surgical interventions were performed under general or spinal anesthesia in a bloodless field obtained by placing a tourniquet on the thigh. All wounds were prepared by wound excision and debridement. Patients divided into four groups according to the type of the flap available, site and size of defect and donor site morbidity.

Group I: The reverse sural flap [Figures 1 - 3]: Distally based sural [DBSA] flap was done in 10 cases presented by large defect more than 8x6 cm². In 3 cases, the defect was at weight bearing heel [plantar], 4 cases at posterior non-weight bearing and weight bearing heel, 1 case at lateral non-weight bearing and weight bearing heel, and 2 cases at the complete heel area [weight bearing and non-weight bearing heel]. The technique was completed as described previously by Ciofu *et al.* [6].

Briefly, the patient was in the prone position. The flap was marked on the skin. The mark was an ellipse centered on the raphe between the two bodies of the gastrocnemius muscle. The incision started on the superior lateral borders of the flap, deepened in the subfascial planes till identification of the median raphe of the sural

nerve. Then, the incision continued to other borders of the flap with subfascial dissection and all perforators were ligated. The muscular septa were included in the flap and sural nerve was attached to the fascia at the superior border of the flap.



Figure [1]: Distally based sural flap design [12x10 cm] with 2 pivot points [*], first point 7 cm, the second is 1 cm proximal to lateral malleolus.



Figure [2]: Distally based sural flap raised based on distal perforator [retromalleolar].



Figure [3]: Sural flap covered the defect with cannulation to resolve venous congestion, split thickness skin graft for donor site covering.

Group II: The Medial plantar flap

[Figure 4]: Medial plantar [MPA] flap was done in 5 cases presented by medium sized defect [ranging from 5x4 to 7x5 cm²]. In 3 cases, the defect was at weight bearing heel [plantar], and 2 cases at lateral non-weight bearing and weight bearing heel. The procedure was completed as described by Khan *et al.* [7]. The patient was in the lateral decubitus position. The medial plantar and dorsalis pedis arteries were localized by the aid of Doppler ultrasound with a 8- Mhz probe.



Figure [4]: Medial plantar artery flap elevation for weight bearing heel defect coverage.

An incision was made parallel to the abductor hallucis muscle, the flap [fasciocutaneous] was raised superficially to flexor hallucis muscle and advanced in a retrograde direction.

The perforator [superficial] branch of medial plantar artery was imaged with careful identification of the neurovascular plantar bundle. To gain additional length, the lateral sensory branch of medial plantar nerve, attached to the flap was resected. Then, the flap was rotated to cover the heel defect and donor site was covered by split-thickness skin graft.

Group III: V-Y Advancement Flap

[Figure 5]: V-Y advancement flap was done in 3 cases presented by small defect [less than 5x4 cm²] with defect at weight bearing heel [plantar]. The procedure was completed as described by Hayashi and Maruyama [8].

Preoperative Doppler was done to assure patency and position of the lateral calcaneal artery [LCA]. A triangular flap was created in the territory of the LCA beside the defect.

The pedicle of the flap is a subcutaneous bundle included lateral calcaneal artery, sural nerve and lesser saphenous vein. The lower and upper lines of the triangular flap were bent upwards to cope with the wrinkled line of the dorsal foot.



Figure [5]: Reconstruction of weight bearing heel defect by V-Y flap

Group IV: Lateral calcaneal artery flap [Figure 6]:

Lateral calcaneal artery flap was done in 2 cases presented by small defect [less than 5x4 cm²]. In one case, the defect at weight bearing heel [plantar] and another case at posterior non-weight bearing heel. The procedure was done as described by Woo *et al.* [9]



Figure [6] Lateral calcaneal flap for weight bearing heel defect coverage

Postoperative Care and follow up

Early postoperative care: Compression was avoided on flap or pedicle with careful flap monitoring. All patients were discharged from the hospital on the 4th day following the operation and the sutures were removed after 2 weeks post operatively.

Late postoperative care: Weight-bearing was avoided and walking was restricted for 6 to 8 weeks. Physiotherapy was allowed 6 weeks postoperatively.

Patient was evaluated according to donor site morbidity, flap stability, sensation, related complication, satisfactory results in terms of complete coverage, proper shoe fitting for ambulation, mechanical and thermal protection and cosmetic appearance Flaps sensation was evaluated [6 months to 1 year postoperative] for pain sensation [with a disposable pin], light touch, static two-point discrimination and deep pressure.

In reversed sural flap group, there were two patients showed distal flap necrosis, managed by debridement and secondary sutures, one patient of sural flap group developed an ulcer between the flap and planter skin after six months postoperatively of ambulation and resuming his usual work, managed by excision of the devitalized tissue followed by closure of the defect with flap advancement and sutures [figures 7, 8].

Protective sensation not obtained in all reversed sural flaps, return of deep sensation obtained in 7 patients 1 year postoperative. Flaps were unstable [sliding] during walking in 7 patients, and patients need special foot wear.

Statistical analysis: Data were analyzed using Statistical package for the Social Science [SPSS] version 24 [IBM Inc., USA]. Quantitative data were expressed in the form of arithmetic mean, as a measure of central tendency and dispersion was presented by standard deviation [SD]. The categorical data, on the other side, were expressed by their relative frequencies and percentages. The association between categorical data was assessed by Chi square or Mann Whitney tests. P value < 0.05 was considered significant



Figure [7]: Developed ulcer between the sural flap and planter skin after 6 months postoperatively of ambulation and resuming his usual work



Figure [8a]: Preoperative unstable scar on the left heel.



Figure [8b]: Postoperative reconstruction by sural flap, [I] 4weeks postoperative, [II] 3 months postoperative, [III] 6months postoperative & [IV] 1year postoperative

RESULTS

This study was done at Al-Azhar University hospitals included 20 patients, their ages ranged between 21 and 56 years with a mean age of 36.5 ± 10.03 , 14 males and 6 females, 13 patients right sided and 7 left sided. Thirteen defects were traumatic, 6 neuropathic and 1 post-burn unstable scar. As regards the site, defect divided into weight bearing heel defect [WBA] in 10 patients. Posterior heel defect that located on the non-WBA over the insertion of the Achilles tendon into the calcaneus bone in one patient, posterior non-WBA and weight bearing heel defect in 4 patients, lateral non-WBA and weight bearing heel in 3 patients, and complete heel area defect [WBA & non-WBA] in 2 patients [Table 1].

Fifteen flaps healed uneventfully, 2 patients of reversed sural flap group showed distal 2cm flap necrosis, managed by debridement and secondary sutures, 1 patient of the same group developed an ulcer between the flap and plantar skin after six months postoperatively of ambulation and resuming his usual work, managed by excision and flap advancement, one patient of medial plantar group flap's wound healed by secondary intention, one patient of the

same group had marginal hyperkeratosis six months postoperatively and managed by topical keratolytic. No significant difference was found between different techniques [Table 2].

As regard to donor site morbidity, there were hypertrophic scars in 3 patients [30%] in sural group, and keloid formation in 1 patient [20%] in MPAF group. As regard to stability, flaps were stable except 7 patients [70%] in sural group flaps were unstable [sliding] during walking. There was significant difference between groups regarding donor site morbidity. All patients in reverse sural group, MPAF and lateral calcaneal group had morbidity in the

donor site, compared to none in the V-Y group. Hyperpigmentation represented the most reported comorbidity [reported in 70.0%, 80.0% and 100.0% of reverse sural, MPAF and lateral calcaneal groups respectively] [Table 3]. In this series, in reverse sural group, there were excellent results in 2 patients [20%], good in 6 patients [60%] and fair in 2 patients [20%]. In medial plantar flap group, excellent results in 3 patients [60 %] and good in 2 patients [40%]. In V-Y advancement flap group, all 3 patients [100%] with excellent results. In lateral calcaneal flap group, one patient was excellent [50%] and good in another patient [50%] [Table 4].

Table [1]: The defect classification according to etiology, size, and site

| Total patients No. = 20 [100%] | | No. of patients |
|--------------------------------|---|-----------------|
| Cause | Traumatic | 13 [65%] |
| | Neuropathic | 6 [30%] |
| | Post-burn unstable scar | 1 [5%] |
| Size | small sized defect ranging from 3x3 to 5x4 cm ² | 5 [25%] |
| | medium sized defect ranging from 5x4 to 7x5 cm ² | 5 [25%] |
| | large sized defect more than 8x6 cm ² | 10 [50%] |
| Site | Weight bearing heel | 10 [50%] |
| | Posterior heel [non-WBA] | 1 [5%] |
| | Posterior non-WBA & weight bearing heel | 4 [20%] |
| | Lateral non-WBA& weight bearing heel | 3 [15%] |
| | Non-WBA & weight bearing heel | 2 [10%] |

Table [2]: Post-operative assessment flaps related to complications

| | R.Sural [n = 10] | | MPAF [n = 5] | | V-Y [n = 3] | | Lat.Cal. [n = 2] | | P |
|--|---------------------|-----|-----------------|-----|----------------|------|---------------------|------|------|
| Nil | 5 | 50% | 4 | 80% | 3 | 100% | 2 | 100% | 0.67 |
| Venous congestion | 2 | 20% | 0 | 0% | 0 | 0% | 0 | 0% | |
| Marginal hyperkeratosis | 0 | 0% | 1 | 20% | 0 | 0% | 0 | 0% | |
| Distal flap necrosis | 2 | 20% | 0 | 0% | 0 | 0% | 0 | 0% | |
| Ulcer between flap and plantar skin | 1 | 10% | 0 | 0% | 0 | 0% | 0 | 0% | |

Table [3]: post-operative assessment related to donor site morbidity & stability

| Parameters | | Flaps | | R.Sural [n = 10] | | MPAF [n = 5] | | V-Y [n = 3] | | Lat.Cal. [n = 2] | | P |
|-----------------------------|-------------------|-------|-----|---------------------|------|-----------------|------|----------------|------|---------------------|------|--------|
| Donor site morbidity | Nil | 0 | 0% | 0 | 0% | 3 | 100% | 0 | 0% | 0 | 0% | 0.002* |
| | Keloid formation | 0 | 0% | 1 | 20% | 0 | 0% | 0 | 0% | 0 | 0% | |
| | Hyperpigmentation | 7 | 70% | 4 | 80% | 0 | 0% | 2 | 100% | 0 | 0% | |
| | Hypertrophic scar | 3 | 30% | 0 | 0% | 0 | 0% | 0 | 0% | 0 | 0% | |
| Stability | Stable | 3 | 30% | 5 | 100% | 3 | 100% | 2 | 100% | 2 | 100% | 0.013* |
| | Unstable | 7 | 70% | 0 | 0% | 0 | 0% | 0 | 0% | 0 | 0% | |

Table [4]: Post-operative assessment of the flap groups

| | | R. Sural [n = 10] | | MPAF [n = 5] | | V-Y [n = 3] | | Lat. Cal. [n = 2] | | P |
|------------------|-----------|----------------------|------|-----------------|-----|----------------|------|----------------------|-----|--------|
| Sensation | Sensate | 0 | 0% | 3 | 60% | 3 | 100% | 1 | 50% | 0.001* |
| | Insensate | 10 | 100% | 0 | 0% | 0 | 0% | 0 | 0% | |
| | Lack | 0 | 0% | 2 | 40% | 0 | 0% | 1 | 50% | |
| Outcome | Fair | 2 | 20% | 0 | 0% | 0 | 0% | 0 | 0% | 0.27 |
| | Good | 6 | 60% | 2 | 40% | 0 | 0% | 1 | 50% | |
| | Excellent | 2 | 20% | 3 | 60% | 3 | 100% | 1 | 50% | |

DISCUSSION

The reconstruction of the soft tissue defects of the heel region represents a challenge for a plastic surgeon due to the limited local soft tissue availability that reduces the therapeutic options and also due to the special structural and functional characteristics of the anatomic region to be reconstructed. Before the selection of a suitable graft or flap, the blood supply to the region should be assessed. The surgeon has a number of factors to consider in regard to selecting a reconstructive method that is likely to be successful^[10].

This case series focused on evaluation of loco regional flaps for heel reconstruction that was very informative for reconstructive surgeons who cannot perform free flap surgery in rural area. In this series four flaps evaluated for heel reconstruction: medial plantar artery [MPA] flap, distally based sural [DBSA] flap, lateral calcaneal flap and V–Y advancement of the local heel tissue. The use of specific flap had been decided according to the size, site of defect, and available options. A total of 20 patients presented with soft-tissue defects localized to the heel.

The medial plantar flap has been the subject of study for a long time in different centers, demonstrating its efficiency and viability. In the current work, it was associated with 100% stability and good to excellent outcome.

Macedo *et al.*^[11] reported that the instep [medial plantar] is provide durable and stable skin, with quality similar to the rest of the heel [reconstructing like by like]. Thus, it is one of the favored local regional tissue flaps. It provides thin, pliable, easily contoured and potential for sensitization.

Löfstrand and Lin^[12] reported lower donor site morbidity as another advantage of the medial plantar flap.

Furthermore, Langat *et al.*^[13] reported no short or term complications in their case, treated by medial plantar flap. In our series, 4 patients had hyperpigmentation and one had keloid formation.

Liette *et al.*^[14] reported that, medial plantar flap offers a unique ability to restore sensation and normal function of the heel, with minimal donor-site morbidity. They concluded that, it provides a long-lasting solution which could prevent future ulceration.

Pertea *et al.*^[15] studied medial plantar flap on five patients, and recorded no complete or partial necrosis of the medial plantar flap.

Yang *et al.*^[16] showed protective sensation in all 15 flaps.

Gu *et al.*^[17] studied 11 medial plantar flaps, and revealed no complications were observed. No donor site morbidity occurred, and all patients were able to walk normally with regular foot wear.

Regarding distally based sural flap, Singh *et al.*^[18] used it for 7 heels were and reported excellent results in four and good in three patients. There was partial loss in two DBSA flaps. They believed that this flap is a good method for large defects and offers relatively better heel pad. Two flaps had minor complications in the form of distal marginal necrosis, managed by excision followed by secondary suturing. One patient showed venous congestion, that was improved with loosening of sutures and multiple superficial incisions. One flap had superficial skin necrosis, which healed with dressings only.

In this series, ten heels were reconstructed with distally based sural [DBSA] flaps. Their wounds healed with primary intention with no problems except two patients of sural flap group showed distal flap necrosis, managed by debridement and secondary sutures, one patient of sural flap group developed an ulcer between the flap and plantar skin after six months postoperatively of ambulation and resuming his usual work, managed by excision of the devitalized tissue followed by closure of the defect with flap advancement and sutures. The donor site of the sural flaps was covered with a split-thickness skin graft. As regard to donor site morbidity, there were hypertrophic scar in 3 patients [30%].

As regard V–Y advancement flap, Singh *et*

al.^[18] did V–Y advancement flaps for heel reconstruction of 3 cases with fairly good results. The V–Y advancement flap was done in patients where the defect was 3 to 5 cm in dimension. Three patients with V–Y advancement flaps had shown excellent results with one requiring delay before final closure.

All three patients reconstructed by V-Y flap in the current work healed by primary intention with no problems, excellent outcome, complete sensation and stability with no donor site morbidity.

Xiao *et al.*^[19] reported on V-Y flaps for 9 children. The flap survival was complete with primary healing. No different color of the flap than surrounding structures. The ankle function was completely normal and all parents were completely satisfied with aesthetic and functional results. However, Tang *et al.*^[20] reported postoperative complications among three out of 11 patients. The complications were complete necrosis of distal flap that required secondary intervention and light necrosis among two patients, which were healed after three weeks of regular dressings. Other flaps were all survived after primary healing. Flaps were normal in color, texture and overall appearance. The function of the ankle was normal and at the end of the study 10 patients restored fine sensations and one had protective feeling after amputation.

Regarding lateral calcaneal flap, Chowdhury *et al.*^[21] showed that all flaps of 20 patients had good perfusion and survived completely. Three patients had partial loss of skin graft, who later developed hypertrophied scar with conservative management.

In addition, Chung *et al.*^[22] reported on five patients managed by lateral calcaneal flap. All were completely survived with no subsequent complications, even with regular wearing of normal shoes. The primary healing was the rule in all flaps.

We could conclude that, the flaps from plantar aspect [MPA and V-Y flap] were the best option for small and medium sized defects. It provided similar tissue of the heel, protect sensation, with minimal donor morbidity.

Lateral calcaneal flap is another good option for coverage of small and medium sized lateral calcaneal and posterior heel defects. However, the reversed sural flap was a good option for large defects and provides relatively better heel pad, it was another option if MPA flap unavailable.

The main limitation of the current work is the small sample size [especially in each group], which is an evitable limitation due to the nature of injury and tailoring of treatment according to injury criteria. Thus, systematic reviews and meta-analyses are recommended to build solid evidence.

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REFERENCES

1. Simonsen EB. Contributions to the understanding of gait control. *Dan Med J.* 2014 Apr;61[4]: B4823. PMID: 24814597.
2. Dubin A. Gait: the role of the ankle and foot in walking. *Med Clin North Am.* 2014 Mar;98[2]:205-11. DOI: 10.1016/j.mcna.2013.10.002.
3. Marchesi A, Parodi PC, Brioschi M, Riccio M, Perrotta RE, Colombo M, Calori GM, Vaianti L. Soft-tissue defects of the Achilles tendon region: Management and reconstructive ladder. Review of the literature. *Injury.* 2016 Oct;47 Suppl 4: S147-S153. DOI: 10.1016/j.injury.2016.07.053.
4. Rammelt S, Pitakveerakul A. Hindfoot Injuries: How to Avoid Posttraumatic Varus Deformity? *Foot Ankle Clin.* 2019 Jun;24[2]:325-345. DOI: 10.1016/j.fcl.2019.02.006.
5. Elgohary H, Nawar AM, Zidan A, Shoulah AA, Younes MT. Functional and Aesthetic Outcomes of Reconstruction of Soft-Tissue Defects of the Heel with Free Flap. *JPRAS Open.* 2018 Nov 15; 19:35-44. DOI: 10.1016/j.jptra.2018.10.008.
6. Ciofu RN, Zamfirescu DG, Popescu SA, Lascar I. Reverse sural flap for ankle and heel soft tissues reconstruction. *J Med Life.* 2017 Jan-Mar; 10[1]: 94-98. PMID: 28255387.
7. Khan FH, Beg MSA, Obaid-Ur-Rahman. Medial Plantar Artery Perforator Flap: Experience with Soft-tissue Coverage of Heel. *Plast Reconstr Surg Glob Open.* 2018 Dec 14;6[12]: e1991. DOI: 10.1097/GOX.0000000000001991.
8. Hayashi A, Maruyama Y. Stepladder V-Y advancement flap for repair of postero-plantar heel ulcers. *Br J*

- Plast Surg. 1997 Dec;50[8]:657-61. DOI: 10.1016/s0007-1226[97]90516-6.
9. Woo KJ, Park JW, Mun GH. The lateral calcaneal artery as an alternative recipient vessel option for heel and lateral foot reconstruction. *Microsurgery*. 2018;38[2]:164-171. DOI: 10.1002/micr.30148.
 10. Montenegro SS, Costa AC, Meves R. Reconstruction of the Lower Limb with Fasciocutaneous Flap of the Distal Pedicle - Modified Technique of Monteiro, Series of 15 Cases. *Rev Bras Ortop [Sao Paulo]*. 2020 Dec;55[6]:736-741. DOI: 10.1055/s-0040-1712494.
 11. Macedo JLS, Rosa SC, Neto AVRF, Silva AAD, Amorim ACS. Reconstruction of soft-tissue lesions of the foot with the use of the medial plantar flap. *Rev Bras Ortop*. 2017 Oct 19;52 [6]: 699-704. DOI: 10.1016/j.rboe.2017.10.009.
 12. Löfstrand JG, Lin CH. Reconstruction of Defects in the Weight-Bearing Plantar Area Using the Innervated Free Medial Plantar [Instep] Flap. *Ann Plast Surg*. 2018 Mar;80[3]:245-251. DOI: 10.1097/SAP.0000000000001274.
 13. Langat AS, Wan Sulaiman WA, Mat Johar SFN. Heel Pad Reconstruction with Medial Plantar Flap. *Cureus*. 2021 Mar 19;13[3]: e13987. DOI: 10.7759/cureus.13987.
 14. Liette MD, Ellabban MA, Rodriguez P, Bibbo C, Masadeh S. Medial Plantar Artery Flap for Wound Coverage of the Weight-Bearing Surface of the Heel. *Clin Podiatr Med Surg*. 2020 Oct;37[4]:751-764. DOI: 10.1016/j.cpm.2020.06.002.
 15. Perteau M, Velenciuc N, Grosu O, Veliceasa B, Poroch V, Lunca S. Reconstruction of heel soft tissue defects using sensate medial plantar flap. *Journal of Mind and Medical Sciences* 2018; 5[2]: 250-254. DOI: 10.22543/7674.52.P250254
 16. Yang D, Yang JF, Morris SF, Tang M, Nie C. Medial plantar artery perforator flap for soft-tissue reconstruction of the heel. *Ann Plast Surg*. 2011; 67:294-8. DOI: 10.1097/SAP.0b013e3181f9b278.
 17. Gu JX, Huan AS, Zhang NC, Liu HJ, Xia SC, Regmi S, Yang L. Reconstruction of Heel Soft Tissue Defects Using Medial Plantar Artery Island Pedicle Flap: Clinical Experience and Outcomes Analysis. *J Foot Ankle Surg*. 2017;56[2]:226-229. DOI: 10.1053/j.jfas.2016.11.022.
 18. Singh K, Kundu ZS, Singh B, Dakshinamurthy P, Punia S, Potalia RS. Heel defect reconstruction using local vascularized flaps: Results and Clinical Outcomes in 16 Patients. *Journal of Foot and Ankle* 2018; 4 [3]: 16-20. DOI: 10.5005/jp-journals-10040-1083
 19. Xiao Z, Mingyu X, Yongjun R, Yajun X, Li Q, Heping Z. [Reconstruction of small skin defect on children heel with V-Y advanced flap pedicled with perforator of peroneal artery at posterior lateral malleolus]. *Zhonghua Zheng Xing Wai Ke Za Zhi*. 2015 Jul; 31 [4]: 288-91. Chinese [English Abstract]. PMID: 26665931.
 20. Tang X, Wang B, Wei Z, Wang D, Han W, Zhang W, Li S. [Application of V-Y Advanced Sense-Remained Posterior Tibial Artery Perforator Flap in Repairing Wound Around Ankle]. *Zhongguo Xiu Fu Chong Jian Wai Ke Za Zhi*. 2015 Dec;29[12]:1515-8. Chinese [English Abstract]. PMID: 27044221.
 21. Chowdhury MA, Sultana T, Hossain S, Islam S. Use of Lateral Calcaneal Flap for the Reconstruction of Posterior Heel Defect. *J Bangladesh Coll Physicians and Surgeons* 2020; 38[3]: 116-120. DOI: 10.3329/jbcps.v38i3.47058
 22. Chung MS, Baek GH, Gong HS, Rhee SH, Oh WS, Kim MB, Lee KH, Kim TW, Lee YH. Lateral calcaneal artery adipofascial flap for reconstruction of the posterior heel of the foot. *Clin Orthop Surg*. 2009 Mar;1[1]:1-5. DOI: 10.4055/cios.2009.1.1.1.

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