SOCIEDADE BRASILEIRA DE ORTOPEDIA E TRAUMATOLOGIA

RBO REVISTA BRASILEIRA DE ORTOPEDIA

www.rbo.org.br

Original article

Reconstruction of soft-tissue lesions of the foot with the use of the medial plantar flap☆

Jefferson Lessa Soares de Macedo[a,b,*], *Simone Corrêa Rosa*[a], *Altino Vieira de Rezende Filho Neto*[a], *Adilson Alves da Silva*[a], *Alex Corcino Silva de Amorim*[a]

[a] *Hospital Regional da Asa Norte, Brasília, DF, Brazil*
[b] *Escola Superior de Ciências da Saúde, Curso de Medicina, Brasília, DF, Brazil*

ARTICLE INFO

Article history:
Received 15 August 2016
Accepted 4 October 2016
Available online 19 October 2017

Keywords:
Heel
Reconstruction
Wounds and injuries
Foot injuries

ABSTRACT

Objective: To study use of the medial plantar flap for reconstruction of the heel and foot.
Method: The authors share their clinical experience with the use of the medial plantar artery flap for coverage of tissue defects around the foot and heel after trauma. Twelve cases of medial plantar artery flap performed from January 2001 to December 2013 were included.
Results: Of the 12 patients, ten were male and two were female. The indications were traumatic loss of the heel pad in ten cases and the dorsal foot in two cases. All the flaps healed uneventfully without major complications, except one case with partial flap loss. The donor site was covered with a split-thickness skin graft. The flaps had slightly inferior protective sensation compared with the normal side.
Conclusion: From these results, the authors suggest that the medial plantar artery flap is a good addition to the existing armamentarium for coverage of the foot and heel. It is versatile flap that can cover defects on the heel, over the Achilles tendon and plantar surface, as well as the dorsal foot. It provides tissue to the plantar skin with a similar texture and intact protective sensation.

© 2016 Sociedade Brasileira de Ortopedia e Traumatologia. Published by Elsevier Editora Ltda. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).

Reconstrução de lesões de partes moles de pé com o uso de retalho plantar medial

Palavras-chave:
Calcanhar
Reconstrução
Ferimentos e lesões
Traumatismos do pé

RESUMO

Objetivo: Estudar casos de retalho plantar medial na reconstrução do calcanhar e do pé.
Método: Os autores apresentam sua experiência com o uso do retalho baseado na artéria plantar medial para cobertura de defeitos teciduais no pé, especialmente do calcanhar. Doze retalhos da artéria plantar medial, feitos entre janeiro de 2001 e dezembro de 2013, foram incluídos.

☆ Study conducted at Hospital Regional da Asa Norte, Brasília, DF, Brazil.

* *Corresponding author.*
E-mail: jlsmacedo@yahoo.com.br (J.L. Macedo).

http://dx.doi.org/10.1016/j.rboe.2017.10.009

2255-4971/© 2016 Sociedade Brasileira de Ortopedia e Traumatologia. Published by Elsevier Editora Ltda. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).

Resultados: Dos 12 pacientes, dez eram homens e duas mulheres. As indicações foram perda traumática do coxim do calcanhar em dez pacientes e dorso do pé em dois casos. Todos os retalhos cicatrizaram sem maiores complicações, exceto um caso com perda parcial. A área doadora foi coberta com enxerto de pele parcial. Os retalhos apresentaram uma sensibilidade protetora levemente inferior ao lado normal.

Conclusão: De acordo com os resultados, o retalho plantar medial é uma boa opção para cobertura do pé, especialmente da região do calcanhar. A versatilidade do retalho permite a cobertura de defeitos no calcanhar, sobre o tendão de Aquiles e apoio plantar, assim como o dorso do pé. Esse retalho confere para região plantar uma pele de textura similar e sensibilidade protetora intacta.

© 2016 Sociedade Brasileira de Ortopedia e Traumatologia. Publicado por Elsevier Editora Ltda. Este é um artigo Open Access sob uma licença CC BY-NC-ND (http://creativecommons.org/licenses/by-nc-nd/4.0/).

Introduction

The reconstruction of the distal third of the leg remains a challenge for reconstructive surgeons. Anatomical characteristics, such as the scarcity of soft tissues and thin skin, lead to great difficulties in the treatment of soft tissue lesions at this location.

The use of fasciocutaneous flaps in the reconstruction of lesions of the lower third of the lower limb, especially of the foot, is well indicated due to the similarities with the tissues of the region. Among these flaps, the medial island flap is noteworthy.[1,2]

The medial plantar flap was initially described by Harrison and Morgan.[3] It is based on the medial plantar artery and consists of a fasciocutaneous flap that uses skin from the plantar arch of the foot, an ideal tissue to cover defects of the heel and other regions of the foot, due to the structural similarity. The innervation of this flap is preserved, giving it sensation, which is a protective factor.[4]

This study aimed at presenting a series of cases in which the medial plantar flap was used for the treatment of foot injuries, especially of the heel, from 2001 to 2013.

Methods

This is a retrospective study of all patients admitted to hospital during the study period who underwent reconstruction of the lower limbs due to loss of cutaneous coverage with the use of the medial plantar flap. The following variables were assessed: gender, age, trauma etiology, presence and location of the fracture, characteristics of the loss of substance, and presence of bone exposure.

The inclusion criteria were patients treated with lower limb trauma in the study period who underwent reconstruction with a medial plantar flap. Doppler assessment of the arterial system of the foot was performed in all patients. The dorsal artery of the foot and the posterior tibial artery were patent in all patients.

The exclusion criteria were hemodynamically unstable patients, tibial nerve lesions, or lesions in the plantar donor area.

The defect was only measured after preparation of the receptor site, and then transferred to the donor site. The flap must be slightly larger than the receiving area.

The study was approved by the Research Ethics Committee under the CAAE (Certificate of Presentation for Ethical Consideration) number: 47391715.6.0000.5553, Recommendation No.: 1.167.841.

Surgical technique

The surgical technique was as follows: the lower limb is placed in the supine position, with the hip flexed and externally rotated, knee flexed, and foot in maximum supination. The area of skin to be transferred from the plantar cavus was marked off, according to the size of the lesion to be covered, limited by the margins of the foot area that does not bear weight. The midline of the plantar surface of the foot and the prominence of the navicular bone determine the lateral and medial borders of the cutaneous territory, that is, 10–12 cm long and 4–6 cm wide. The origin of the medial plantar artery (superficial branch) is identified at the septum between the abductor hallucis muscle and the flexor digitorum brevis muscle and emits several branches through the intermuscular septum to the medial plantar skin. This artery continues along the medial border of the foot, anastomosed with the first plantar metatarsal artery. The medial plantar artery is generally smaller than the dominant lateral plantar artery.[5–7]

The medial plantar artery is attached distally to the flap, and the proximal stump is sutured to the flap. Subfascial dissection of the flap is then performed; the flap is elevated in a distal-to-proximal direction. The abductor hallucis muscle is sectioned to achieve a greater length of the neurovascular pedicle. The flap is rotated carefully in order to avoid bending the pedicle. The fascicles of the cutaneous nerve are maintained in the flap, and an interfascicular dissection is made proximally. Subsequently, a partial skin graft is performed in the donor area, at the same surgical time.

Results

During the study period, 12 patients with complex wounds caused by lower limb trauma who required the use of a medial plantar flap to cover these lesions were treated. These patients

were admitted on an outpatient basis, after clinical/surgical control of their wounds by other specialties, such as orthopedics and general surgery. The mean age of the patients at the time of initial care was 32 years (range: 2–53), with a predominance of the 20–29 age group. A male predominance was observed, representing 83.3% of the sample. Regarding the etiology of trauma, motorcycle accidents (50%) were noteworthy, followed by run-over injuries (33.3%), and motor vehicle accident (16.7%). Regarding the location of the lesions, the most frequent were loss of soft tissue in the plantar support region of the anterior heel (58.3%), the posterior heel over the Achilles tendon (25%), and the dorsum of the foot (16.7%) (Figs. 1–3). Regarding the presence of fracture, 83.3% of the patients did not present fractures, while 16.7% presented a metatarsus fracture. Bone exposure was observed in 58.3% of the patients; the other 41.7% presented soft tissue loss without bone or tendon exposure. Regarding surgical treatment, in 83.3% of the cases a medial plantar island flap was used.

In all cases, partial skin grafting was performed on the donor area, at the same time. Surgical complications observed were partial loss of the skin graft in one case (8.3%) and partial loss of the flap in one case (8.3%). In the latter case, the patient later underwent a reverse flow sural fasciocutaneous flap, without complications. In the other cases, the use of the medial plantar flap was enough to cover the lesion, allowing good esthetic and functional results. Cutaneous sensation was preserved in all flaps. No cases of dysesthesia were detected.

Discussion

The first option for the reconstruction of the foot and calcaneal plantar region should be the use of fasciocutaneous flaps; the medial plantar flap is in a prominent position for providing a resistant skin covering that appears close to normal, as it is a regional flap.[5] Therefore, it allows a reconstruction of similar tissue with similar tissue, that is, it brings to the reconstruction region a globular skin with a fatty cushion and fibrous septa fixed to the skin that are resistant to shear trauma and weight-bearing.[5,6]

The medial plantar flap is relatively easy to perform, with great versatility, based on a well-defined vascular anatomy pattern.[7] This flap has even been used in patients with diabetes mellitus.[8]

From a practical standpoint, in the reconstruction of the soft tissue of the heel, it is important that the heel is divided into weight-bearing regions (anterior or plantar) and non-weight-bearing regions (posterior, on the Achilles tendon).[9] The skin of the heel and plantar arch have the same characteristics; therefore, this is the main reason for the preferential use of medial plantar flap in lesions of the anterior heel. The fact that this flap is innervated by the cutaneous branch of the medial plantar nerve is relevant as it provides sensitivity, an important requirement for patient ambulation. The flap is created a little larger than or the same size as the defect, as there is no significant primary contraction of the flap due to its specific fibroadipose tissue characteristics.

The medial plantar flap has also been indicated for patients with diabetic neuropathy who present chronic ulcers in areas of sensory loss, with a low rate of ulcer recurrence in the long term. Since diabetic patients may have vascular problems, this flap may only be indicated for those with good vascular flow to the flap region.[8]

Locoregional fasciocutaneous flaps are an alternative to free flaps for lower limb reconstruction, especially in the heel region. Free flaps would be indicated for more complex cases, when none of the locoregional flaps are available.[9]

Free flaps are good options for rebuilding large losses of soft tissue on the heel and lower third of the leg. Microsurgery may require longer surgical time than locoregional flaps, and a specialized team is needed.[10]

In calcaneal reconstructions, the reverse sural flap is also a good option.[11,12] This flap was successfully used in one case of partial loss of the medial plantar flap in the reconstruction of the heel. The disadvantage of the reverse sural flap is loss of sensation in the lateral malleolus, the lateral side of the foot, and on the fifth toe, due to ligature of the sural nerve.

In the present study, distal based reverse flow medial plantar artery flaps were not made. This type of flap is indicated for the reconstruction of distal defects in the plantar region of the metatarsal heads. These flaps are based on retrograde blood flow from the distal medial plantar artery to the dorsal artery of the foot through the first dorsal metatarsal communicating branches. The disadvantage of this flap is its sensory loss.[13]

Free flaps based on the medial plantar artery are also a good option for reconstruction of distal defects of the plantar region, and they can be flap innervated.[14,15] Moreover, the medial plantar flap can be made crosslegged, with the donor region of the flap being the contralateral foot.[16]

One disadvantage of the flap based on the medial plantar artery is the loss of a foot artery. However, the main irrigation plantar arch of the foot is the deep one, which is formed mainly by the lateral plantar artery, allowing the formation of an anastomotic network between the two main arteries of the foot (dorsal artery of the foot and lateral plantar artery).

The deep plantar arch also forms four plantar metatarsal arteries and some perforating arteries. The contribution of the medial plantar artery to the deep plantar arch is small and is limited to the lateral branch of its deep branch.[17]

Another disadvantage of the medial plantar flap is its limitation in size and on coverage of deep and extensive cavity defects. Therefore, larger muscle or fasciocutaneous flaps should be used to cover such defects.

The options for reconstruction in complex lesions are numerous; the choice of an adequate surgical planning based on the patient's age, gender, and occupation, as well as the size and location of tissue loss, is paramount. Furthermore, the presence of trauma and associated injuries must always be considered, especially in trauma caused by the impact of high energy. The concern with the donor area and the quality of the results in the recipient area has been increasing.

Regardless of the flap used in the reconstruction of the limbs, its indication must be as early as possible, since success is not exclusively associated with the incidence of success of the flaps, but rather with the mobility of the limb joints, with normal gait, and finally, with the return of the patient to work.

Fig. 1 – (A) 53-Year-old patient, victim of a motorcycle accident, with loss of substance in the Achilles tendon topography. (B) Flap donor area. (C) Medial plantar flap covering the Achilles tendon three months postoperatively.

Fig. 2 – (A) 5-Year-old child, victim of a run-over injury, with loss of substance in the dorsum of the foot with compound metatarsal fractures associated with toe amputation. (B) Dissected medial plantar island flap, with its neurovascular pedicle. (C) Flap positioned in the recipient area, on the dorsum of the foot. (D) Donor area of the medial plantar flap with skin graft, four months postoperatively.

Fig. 3 – (A) 26-Year-old patient, victim of a motorcycle accident with loss of calcaneal substance. (B) The donor area of the skin graft flap, five months postoperatively. (C) Advancing flap of the medial plantar region and the posterior region of the heel covering the loss of substance in the heel.

Conclusion

The medial plantar flap has been shown to be a good treatment option for injuries of the heel and dorsum of the foot, with a high success rate and easy reproducibility. The main advantages of the flap are the presence of sensation it provides and the fact that it brings specialized plantar tissue to the reconstructed recipient area, with low morbidity in the donor area.

Conflicts of interest

The authors declare no conflicts of interest.

REFERENCES

1. Martins GB, Moreira AA, Viana FO. Reconstrução de lesões de partes moles do calcanhar com uso de retalhos faciocutâneos. Rev Bras Cir Plast. 2009;24(10):104–9.
2. 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.
3. Harrison DH, Morgan DG. The instep island flap to resurface plantar defects. Br J Plast Surg. 1981;34(3):315–8.
4. Mourougayan V. Medial plantar artery (instepflap) flap. Ann Plast Surg. 2006;56(2):160–3.
5. Macchi V, Tiengo C, Porzionato A. Correlation between the course of the medial plantar artery and the morphology of the abductor hallucis muscle. Clin Anat. 2005;18(8):580–8.
6. Drake RL. Terminologia anatômica International Anatomical Terminology. Stuttgart: Thieme; 2011.
7. Rodriguez-Vegas M. Medialis pedis flap in the reconstruction of palmar skin defects of the digitis: clarifying the anatomy of the medial plantar artery. Ann Plast Surg. 2014;72(5):542–52.
8. Schwarz RJ, Negrini JF. Medial plantar artery island flap for heel reconstruction. Ann Plast Surg. 2006;57(6):658–61.
9. Barreiro GC, Batista RR, Busnardo F, Olivan M, Fereira MC. Reconstrução de planta de pé de acordo com o conceito das subunidades anatômicas. Rev Bras Cir Plast. 2010;25 Supl:81.
10. Siddiqi MA, Hafeez K, Cheema T, Rashid H. The medial plantar artery flap: a series of cases over 14 years. J Foot Ankle Surg. 2012;51(6):790–4.

11. Garcia AM. Retalho sural reverso para reconstrução distal da perna, tornozelo, calcanhar e do pé. Rev Bras Cir Plast. 2009;24(1):96–103.
12. Al-Qattan MM. The reverse sural fasciomusculocutaneous mega-high flap: a study of 20 consecutive flaps for lower-limb reconstruction. Ann Plast Surg. 2007;58(5):513–6.
13. Coruh A. Distally based perforator medial plantar flap: a new flap for reconstruction of plantar forefoot defects. Ann Plast Surg. 2004;53(4):404–8.
14. Zelken JA, Lin CH. An algorithm for forefoot reconstruction with the innervated free medial plantar flap. Ann Plast Surg. 2016;76(2):221–6.
15. Lykoudis EG, Seretis K, Lykissas MG. Free sensate medial plantar flap for contralateral plantar forefoot reconstruction with flap reinnervation using end-to-side neurorrhaphy: a case report and literature review. Microsurgery. 2013;33(3):227–31.
16. Acikel C, Celikoz B, Yuksel F, Ergun O. Various applications of the medial plantar flap to cover the defects of plantar foot, posterior heel, and ankle. Ann Plast Surg. 2003;50(3):498–503.
17. Ozer MA, Gousa F, Bilge O. Anatomic study of the deep plantar arch. Clin Anat. 2005;18(6):434–42.