

2023

Review of Orthoplastic Techniques for Lower Extremity Reconstruction: Part One

Benjamin Heddy

Rochester Regional Health System, Benjamin.Heddy@rochesterregional.org

Brady Webb

brady.webb@rochesterregional.org

Follow this and additional works at: <https://scholar.rochesterregional.org/advances>



Part of the [Plastic Surgery Commons](#), and the [Podiatry Commons](#)

Recommended Citation

Heddy B, Webb B. Review of Orthoplastic Techniques for Lower Extremity Reconstruction: Part One. *Advances in Clinical Medical Research and Healthcare Delivery*. 2023; 3(1). doi: 10.53785/2769-2779.1144.

ISSN: 2769-2779

This Review is brought to you for free and open access by RocScholar. It has been accepted for inclusion in *Advances in Clinical Medical Research and Healthcare Delivery* by an authorized editor of RocScholar. For more information, please contact Advances@rochesterregional.org.

Review of Orthoplastic Techniques for Lower Extremity Reconstruction: Part One

Abstract

Orthoplastic techniques are effective tools for limb salvage in the lower extremity. In order to apply proper techniques successfully, a surgeon must be aware of all the different types of flaps available. Proper pre-operative evaluation and patient selection are also important factors. The following review covers six papers that give surgeons a strong foundation in the anatomical basis and surgical technique of intrinsic muscle flaps and other fasciocutaneous or adipofascial flaps of the foot. These flaps, along with split thickness skin grafts, external fixation, and dermal regenerative templates, quickly close soft tissue deficits in the foot and ankle that often lead to infection and amputation. Successfully treating soft tissue defects of the foot and ankle extend life, preserve limbs, and increase function for patients.

Keywords

Lower extremity, orthoplastic, muscle flaps

Conflict of Interest Statement

The authors of this paper have no conflict of interest to report.

REVIEW

Review of Orthoplastic Techniques for Lower Extremity Reconstruction: Part One

Benjamin Heddy*, Brady Webb

Rochester Regional Health System, USA

Abstract

Orthoplastic techniques are effective tools for limb salvage in the lower extremity. In order to apply proper techniques successfully, a surgeon must be aware of all the different types of flaps available. Proper pre-operative evaluation and patient selection are also important factors. The following review covers six papers that give surgeons a strong foundation in the anatomical basis and surgical technique of intrinsic muscle flaps and other fasciocutaneous or adipofascial flaps of the foot. These flaps, along with split thickness skin grafts, external fixation, and dermal regenerative templates, quickly close soft tissue deficits in the foot and ankle that often lead to infection and amputation. Successfully treating soft tissue defects of the foot and ankle extend life, preserve limbs, and increase function for patients.

Key words: Lower extremity, Orthoplastic, Muscle flaps

Orthoplastic limb salvage involves techniques used to cover small and large soft tissue deficits of the foot and ankle. The longer a soft tissue wound exists, the more risk there is for soft tissue infection, osteomyelitis, and minor and major lower extremity amputation. Fasciocutaneous and adipofascial flaps, along with split thickness skin grafts and external fixation for flap protection, allow for faster closure of foot and ankle soft tissue deficits. In order to perform these procedures effectively, surgeons need to know which flaps are possible and how to evaluate patients individually for specific flap viability. The following articles cover the anatomic basis for muscle, adipofascial and fasciocutaneous flaps of the foot and ankle. By our evaluation, all articles referenced here are a low level of evidence, levels four and five, as they are expert opinions and a review of case series¹.

Without these procedures, patients are often given the option to close by secondary intention with the aid of negative pressure wound therapy or a proximal amputation. These procedures save limbs, increase quality of life, and extend life for patients who would otherwise end up with below

knee or above knee amputations along with all the complications and costs associated with them.

The studies included in this review are listed below:

Study A: Oexeman S, Ward KL. Understanding the Arterial Anatomy and Dermal Perfusion of the Lower Extremity with Clinical Application. *Clin Podiatr Med Surg.* 2020; 37 (4):743–749. doi:10.1016/j.cpm.2020.07.003²

Study B: 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; 37 (4):751–764. doi:10.1016/j.cpm.2020.06.002³

Study C: Vazales R, Masadeh S. First Dorsal Metatarsal Artery Flap for Coverage of Soft Tissue Defects of the Distal Foot: Delayed Technique, Proximal and Distally Based Fasciocutaneous and Adipofascial Variants. *Clin Podiatr Med Surg.* 2020; 37 (4):765–773. doi:10.1016/j.cpm.2020.07.001⁴

Study D: Craig GC. Intrinsic Muscle Flaps for Coverage of Small Defects in the Foot. *Clin Podiatr*

Accepted 2 July 2023.
Available online ■■■

* Corresponding author.
E-mail address: Benjamin.heddy@rochesterregional.org (B. Heddy).

<https://doi.org/10.53785/2769-2779.1144>
2769-2779/© 2023 Rochester Regional Health.

Med Surg. 2020; 37 (4):789–802. doi:10.1016/j.cpm.2020.07.006⁵

Study E: Masadeh S, Rodriguez P, Dierksheide AJ, Crisologo PA. Utility of the Digital Fillet Flap. *Clin Podiatr Med Surg.* 2020; 37 (4):775–787. doi:10.1016/j.cpm.2020.07.009⁶

Study F: Henning JA, Liette MD, Laklouk M, Fadel M, Masadeh S. The Role of Dermal Regenerative Templates in Complex Lower Extremity Wounds. *Clin Podiatr Med Surg.* 2020; 37 (4):803–820. doi:10.1016/j.cpm.2020.07.010⁷

1. Study A

Understanding the arterial anatomy and dermal perfusion of the lower extremity with clinical application.

Reviewed by: Benjamin Heddy, DPM

Level of Evidence: 5

Purpose: describe lower extremity vascular anatomy to help surgeons choose correct surgical procedures and provide optimal healing.

Methods: Review of anatomic articles on angiosomes, vasculature, and perforator arteries of the lower extremity

Results: Detailed review of the six angiosomes of the foot and ankle: anterior communicant angiosome, dorsalis pedis angiosome, lateral plantar angiosome, lateral calcaneal angiosome, medial calcaneal angiosome, and medial plantar angiosome. Perforating arteries range between 3 and 8 in linear clusters coming off of the posterior tibial, anterior tibial, and peroneal arteries. Perforator arteries and veins can be located with a doppler or infrared camera in a physical examination and with computed tomography angiography preoperatively.

Limitations: Review of anatomical studies. No clinically correlated information or results present in this study.

Conclusion: Angiosome boundaries guide incision placement for all surgeries in the foot and ankle. Understanding of angiosomes and individual patient vascular status is crucial for successful flap procedures.

Importance: Detailed anatomic knowledge and proper tools for physical exam allow individualized understanding of a patient's angiosomes and vascular status. This leads to better flap design for orthoplastic procedures and lower complication rates due to venous congestion and avascular necrosis. Incision and flap planning is based on anatomic knowledge. Flaps are more successful when the vascular status can be verified by pre-

operative evaluation using doppler, infrared cameras, and computed tomography angiography.

Suggested Citation

Oexeman S, Ward KL. Understanding the Arterial Anatomy and Dermal Perfusion of the Lower Extremity with Clinical Application. *Clin Podiatr Med Surg.* 2020; 37 (4):743–749. doi:10.1016/j.cpm.2020.07.0032

2. Study B

Medial plantar artery flap for wound coverage of the weight-bearing surface of the heel.

Reviewed by: Brady Webb, DPM

Level of Evidence: Level 5

Question: What are the long-term outcomes for patients who receive a medial plantar artery flap for wound coverage of the weight-bearing surface of the heel?

Methods: The authors performed a literature review searching for articles that evaluated the long-term efficacy of the medial plantar artery fasciocutaneous flap for coverage of soft tissue deficits of the heel.

Results: 96 patients and 98 flaps were performed with follow up that ranged from 9 to 78 months. Ulcer recurrence was noted in 7 patients while 6 patients had complications.

Limitations: None

Conclusion: The medial plantar artery fasciocutaneous flap is an effective option for providing soft tissue coverage for deficits of the heel. Its success is secondary to helping provide a functional skin unit for the plantar heel while also maintaining protective sensation for the weight-bearing surface. The maintenance of protective sensation is important to reducing recurrence and complications.

Importance: Multiple considerations are made for patients with plantar heel ulcerations. When considering a flap for the patient the source needs to be able to withstand elevated pressure and unique forces to prevent re-ulceration. One of these concerns is restoring the heel pad which provides shock absorption to the rearfoot. The tissue from the non-weight bearing portion of the medial longitudinal arch is ideal to be durable enough to withstand the unique pressures of the plantar heel. The technique for this flap as described by Bibbo, creates a sensate flap by splitting the plantar hallucal nerve through intra-neural and extrafascicular dissection. This technique is paramount for keeping protective sensation to the plantar heel which will lead to better outcomes.

Suggested Citation 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; 37 (4):751–764. doi:10.1016/j.cpm.2020.06.0023

3. Study C

First dorsal metatarsal artery flap for coverage of soft tissue defects of the distal foot: delayed technique, proximal and distally based fasciocutaneous and adipofascial variants

Reviewed by: Benjamin Heddy, DPM

Level of Evidence: 5

Purpose: Describe surgical technique for proximal and distal based adipofascial and fasciocutaneous first dorsal metatarsal artery flaps for forefoot soft tissue defects.

Method: Literature review of published case studies.

Results: This flap is indicated for soft tissue defects of the forefoot including traumatic injuries, severe infections, failed surgical incisions, and tumor resection where other flap techniques are not suited. Contraindicated in instances of poor circulation, inability to reach or fill tissue defect, and when another flap is indicated. Relative contraindications include smoking, obesity, diabetes, peripheral vascular disease, venous insufficiency, and old age. A delayed technique, waiting several days to a couple weeks between lifting the graft and transplanting it, is indicated in any high-risk patient. Delay technique increases fluid exchange and decreases venous congestion and tissue necrosis. The distal communicating arterial branch is necessary for distal based flaps as it is the main blood supply for this flap. The first dorsal metatarsal artery is the main arterial supply for the proximally based flaps. Use a lazy S incision for the adipofascial flap and a peninsula incision encompassing the skin paddle for the fasciocutaneous flap. Preserve extensor tendons and paratenon to reduce donor site morbidity.

Limitations: Clinical information is from case studies alone. No case series or randomized controlled study has been done to evaluate the effectiveness of this flap or how pre-operative planning and surgical technique affect surgical outcomes.

Conclusion: The first dorsal metatarsal artery flap is a versatile flap that effectively treats forefoot soft tissue defects without the morbidity and change in biomechanics that come with digital or metatarsal amputations and digital file flaps.

Importance: The first dorsal metatarsal artery flap provides another tool in a surgeon's armamentarium for forefoot orthoplastic procedures. Forefoot wounds and ulcers often are complicated by exposed bone and tendon. Fasciocutaneous and

adipofascial flaps provide excellent coverage with improved wound healing and decreased morbidity.

Suggested Citation

Vazales R, Masadeh S. First Dorsal Metatarsal Artery Flap for Coverage of Soft Tissue Defects of the Distal Foot: Delayed Technique, Proximal and Distally Based Fasciocutaneous and Adipofascial Variants. *Clin Podiatr Med Surg.* 2020; 37 (4):765–773. doi:10.1016/j.cpm.2020.07.001

4. Study D

Intrinsic muscle flaps for coverage of small defects in the foot

Reviewed by: Benjamin Heddy, DPM

Level of Evidence: 5

Purpose: Describe the available intrinsic muscle flaps of the foot to aid surgeons in the reconstruction of the foot and ankle in the effort to salvage limbs with soft tissue defects.

Methods: literature review of the anatomy, vasculature, and surgical technique for the five intrinsic muscle flaps of the foot.

Results: The intrinsic muscles of the foot are Mathes and Nahai type II: muscles with one dominant vascular pedicle and one or more distal minor pedicles. The extensor digitorum brevis muscle flap can be proximally, medially, and distally based. It can also be a vascularized nerve flap when harvested with the deep peroneal nerve. The abductor digiti minimi is a proximally based flap used for coverage of the lateral calcaneus and lateral malleolus. The flexor hallucis brevis muscle flap is used to cover first metatarsal phalangeal joint deficits. The abductor hallucis muscle can be used as a proximally or distally based flap to cover the medial midfoot and forefoot with deficits of 18 square centimeters or less. The flexor digitorum brevis muscle flap is a proximally based flap that can be used to cover the posterior rearfoot, lower Achilles tendon, and the medial and lateral malleoli. Immobilization is required for flap viability. Muscle flaps are often covered with split thickness skin grafts for wound closure.

Limitations: No clinical results from this study. Case series and randomized controlled trials are needed to evaluate the effectiveness and complications of the intrinsic muscle flaps of the foot.

Conclusion: Intrinsic muscle flaps provide effective one-stage procedures to close soft tissue defects of the foot. Muscle can provide the soft tissue bulk to close even plantar foot deficits.

Importance: This article describes five effective muscle flaps for the foot, giving wide coverage for soft tissue defects including those caused by osteomyelitis. Muscle fills dead spaces and increases

healing potential. These procedures provide surgeons the tools they need to quickly and effectively close soft tissue deficits of the foot that would otherwise lead to infection and possibly minor or major lower extremity amputations.

Suggested Citation

Craig GC. Intrinsic Muscle Flaps for Coverage of Small Defects in the Foot. *Clin Podiatr Med Surg.* 2020; 37 (4):789–802. doi:10.1016/j.cpm.2020.07.006

5. Study E

Utility of the Digital Fillet Flap

Reviewed by: Brady Webb, DPM

Level of Evidence: Level 4

Purpose: To describe the digital fillet flap and give updated data on its value.

Methods: Using PubMed and Google Scholar they searched articles from November 20,2019 using the search terms digital, flap, fillet flap, filleted flap, or ulcer using both websites. No restrictions were placed on cause of soft tissue deficit, complications, or duration of follow up.

Results: From 51 reviewed articles 10 were included. 40 patients with an average age of 50.7 years were included in the study. Follow up was only reported for 22 patients and average follow up was 15.9 months. 12 of 40 patients had reported complications. Some examples of the complications include, wound dehiscence, ray resection, BKA, NSTI, Flap revision and new ulcers.

Limitations: Research regarding digital fillet flaps is limited with only one systematic review that was recently published.

Conclusion: The digital fillet flap is a valuable option for a patient with a soft tissue deficit. Previously described for use to help with heel soft tissue deficits, this flap has more recently been illustrated to be an option for other areas of the foot and ankle.

Importance: There are multiple options for digital fillet flaps including, finger and toe flaps, island flaps which are isolated on the neurovascular bundle, free flaps, and others. With multiple options for donor sites, digital fillet flaps are able to provide versatility with soft tissue defects in multiple areas of the foot and ankle.

Suggested Citation

Masadeh S, Rodriguez P, Dierksheide AJ, Crisologo PA. Utility of the Digital Fillet Flap. *Clin Podiatr Med Surg.* 2020; 37 (4):775–787. doi:10.1016/j.cpm.2020.07.009

6. Study F

The role of dermal regenerative templates in complex lower extremity

Reviewed by: Brady Webb, DPM

Level of Evidence: 5

Purpose: Provide a literature review outlining the usefulness of dermal regenerative templates (DRTs).

Methods: The authors provide a literature review outlining skin structure and function, phases of wound healing and how dermal regenerative templates make an impact.

Limitations: High quality trials are needed to further assess the efficacy of dermal regenerative templates.

Conclusion: The literature is encouraging in illustrating the value of dermal regenerative templates. Success of DRTs have been documented as being useful for tissue defects of the extremities. Higher quality trials are still needed in order to determine more optimal use of DRTs.

Importance: Dermal regenerative templates are useful in providing a scaffolding for host cell migration which helps create a vascularized wound bed. They are useful for wounds with exposed deep structures, such as bone, tendon and joint capsule. DRTs have less incidence of contracture of skin grafts due to recreating the dermis and its elastic properties. Success with DRTs requires adequate blood flow to the extremity, adequate removal of non-viable or necrotic tissue, as well as a site free of infection. When these conditions are met, DRTs are to properly fulfill their role to recreate the dermal layer of skin.

Suggested Citation

Henning JA, Liette MD, Laklouk M, Fadel M, Masadeh S. The Role of Dermal Regenerative Templates in Complex Lower Extremity Wounds. *Clin Podiatr Med Surg.* 2020; 37 (4):803–820. doi:10.1016/j.cpm.2020.07.010

Conflict of interest

The authors of this paper have no conflicts of interest.

References

1. Wright JG, Swiontkowski MF, Heckman JD. Introducing levels of evidence to the journal. *J Bone Joint Surg Am.* 2003;85(1):1–3.
2. Oexeman S, Ward KL. Understanding the Arterial Anatomy and Dermal Perfusion of the Lower Extremity with Clinical Application. *Clin Podiatr Med Surg.* 2020;37(4):743–749. <https://doi.org/10.1016/j.cpm.2020.07.003>.

3. 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;37(4):751–764. <https://doi.org/10.1016/j.cpm.2020.06.002>.
4. Vazales R, Masadeh S. First Dorsal Metatarsal Artery Flap for Coverage of Soft Tissue Defects of the Distal Foot: Delayed Technique, Proximal and Distally Based Fasciocutaneous and Adipofascial Variants. *Clin Podiatr Med Surg.* 2020;37(4):765–773. <https://doi.org/10.1016/j.cpm.2020.07.001>.
5. Craig GC. Intrinsic Muscle Flaps for Coverage of Small Defects in the Foot. *Clin Podiatr Med Surg.* 2020;37(4):789–802. <https://doi.org/10.1016/j.cpm.2020.07.006>.
6. Masadeh S, Rodriguez P, Dierksheide AJ, Crisologo PA. Utility of the Digital Fillet Flap. *Clin Podiatr Med Surg.* 2020;37(4):775–787. <https://doi.org/10.1016/j.cpm.2020.07.009>.
7. Henning JA, Liette MD, Lakloul M, Fadel M, Masadeh S. The Role of Dermal Regenerative Templates in Complex Lower Extremity Wounds. *Clin Podiatr Med Surg.* 2020;37(4):803–820. <https://doi.org/10.1016/j.cpm.2020.07.010>.