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Staged treatment of plantar midfoot ulceration with use of a Hemisoleus Muscle Flap, application of external fixation and split-thickness skin graft

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Muscle flaps are a versatile option for limb salvage that can provide coverage for chronic ankle and foot defects that fail to heal from other conservative and surgical treatments. We discuss the use of a medial hemisoleus muscle flap for treatment of a chronic foot ulcer following dehiscence of an intrinsic pedicled muscle flap. Hemisoleus muscle flaps are utilized for soft tissue defects of the distal third of the lower extremity but are not commonly utilized for coverage of defects on the plantar foot.

Keywords: wound care, muscle flap, lower extremity, hemisoleus muscle flap, medial hemisoleus muscle flap

We discuss the use of a medial hemisoleus (MHS) flap for treatment of a chronic foot ulcer following dehiscence of an intrinsic pedicled muscle flap. This case study presents our treatment of a chronic wound that failed to heal despite local wound care and several attempts at primary closure. We present our surgical technique for mobilizing the MHS flap and recommend concomitant use of external fixation to decrease motion of the flap on the wound bed, allowing for neovascularization and full incorporation.

Case Study

A case is presented of a fifty-seven-year-old male who underwent a plantar fasciotomy with a subsequent postoperative soft tissue infection. This resulted in a chronic, painful wound to the plantar medial left foot after the infection resolved. Non-invasive vascular studies and clinical vascular examination were normal. He failed conservative therapy including local wound care and offloading and elected to undergo primary closure eight months after the plantar fasciotomy. A fissure developed along the incision six weeks postoperatively and persisted for nine months despite continued wound care. A second attempt at primary closure was made and approximately three weeks later the incision partially dehisced. Progressive healing was achieved for three months, but the patient fell at this time which resulted in the wound reopening. An MRI was obtained and ruled out osteomyelitis or presence of a foreign body. The patient then elected to undergo scar excision with the placement of an abductor hallucis muscle flap. The patient had an uneventful postoperative course and was transitioned to heel weight bearing at twelve weeks postoperatively. At four months postoperatively, the incision partially dehisced and became a chronic ulcer (Figure 1).

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Figure 1 Preoperative (A) Chronic ulceration to plantar medial left foot (B) Ellipsoid excision of the ulcer.

At this time, the patient was given the option of a below-knee amputation and he declined. After five months of additional conservative therapy with no improvement in appearance of the wound, another attempt at closure was made by performing a medial hemisoleus flap. The decision was made to utilize an external fixator to minimize motion of the flap within the wound bed. Three weeks later a split-thickness skin graft (STSG) was applied and the external fixator was removed at this time. The incisions healed and the graft and flap had completely incorporated at ten weeks postoperatively (Figure 4). The patient is ambulatory in accommodative shoe gear and has not had a recurrence of the soft tissue defect after twenty-three months of follow-up.

Surgical Technique

The patient was brought to the operating room and placed on the operating room table in the supine position. A tourniquet was not utilized during the procedure. An elliptical incision was made to encompass the wound (Figure 1). Due to previous surgeries, a significant amount of scar tissue was encountered that extended to the level of the plantar musculature. Attention was directed to the tarsal tunnel and dissection was carried through the flexor retinaculum. The wound was irrigated with copious amounts of normal saline and all nonviable soft tissue was excised; leaving a large soft tissue defect (Figure 2).

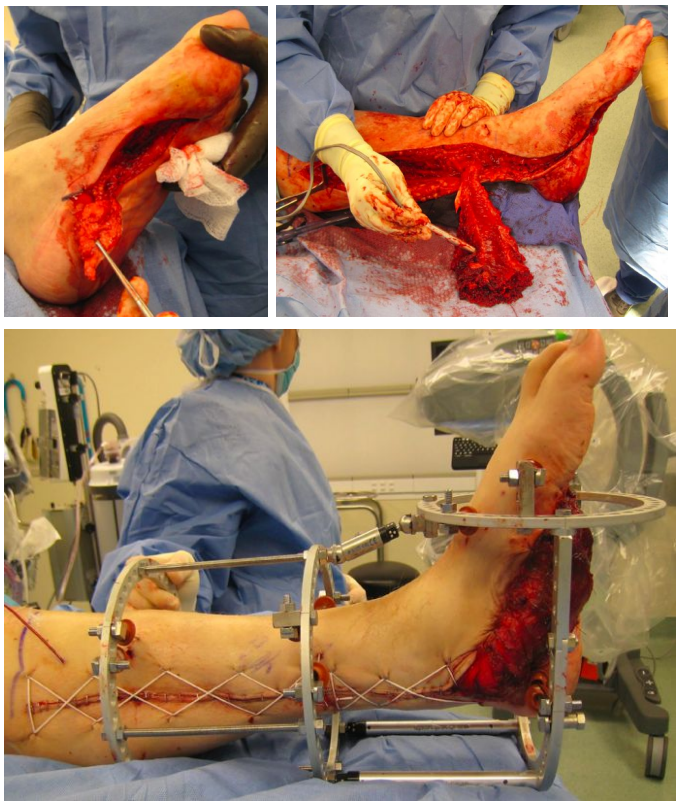

Figure 2 Intraoperative (A) Excision of Chronic Wound (B) Incision and dissection of medial soleus (C) Closure with application of External Fixation for ankle motion and flap protection.

The decision was made to transpose a medial hemisoleus muscle flap for coverage of the defect. Continuing the incision from the tarsal tunnel, a longitudinal incision was made over the medial aspect of the calf. The incision was carried down to the crural fascia. The fascia was incised longitudinally allowing exposure to the gastroc-soleus muscle complex. The soleus muscle belly was identified and the medial portion of the muscle was transected proximally and freed from lateral muscle belly along the central raphe down to the level of the tarsal tunnel. An intraoperative doppler was utilized during this dissection to identify perforators of the muscle. With sharp dissection, the epimysium was excised. The muscle was transposed through the tarsal tunnel and placed within the plantar soft tissue defect. 3-0 nylon was used to secure the flap in the proper position, with no tension on the flap. The medial incision was closed in layers and the skin was closed with staples. Vessel loops in a zig-zag pattern were used to reduce tension to the edges of the incision.

Figure 3 Intraoperative (A) status post 3 weeks from muscle flap (B) Fenestrated STSG applied to debrided muscle flap.

An external fixator consisting of a tibial block with two full rings and a distal block with a full ring was used to encompass the forefoot. Opposing olive wires were inserted using standard techniques.

Three weeks following the frame application, the patient was brought back to the operating room for debridement of the muscle flap and application of a split-thickness skin graft (STSG). The external fixator was removed and extremity was prepped and draped in a sterile manner. The muscle flap was debrided of eschar tissue, leaving a mixture of bleeding granular and muscular tissue (Figure 3). The muscle flap measured 3cm x 9cm. The site was covered with an intermediate STSG harvested from the proximal left thigh with use of a dermatome. The skin graft was meshed and sutured in place using 3-0 Monocryl. The skin graft was covered with a sterile dressing and a wound VAC was applied. The STSG was fully incorporated after 10 weeks of local wound care (Figure 4).

Discussion

MHS flap reliability has been questioned due to variability in vascularity, but successful coverage of distal lower extremity defects have been reported. Our use of a MHS flap for plantar foot defects is a novel application.

The performing surgeon should have an in-depth knowledge not only of the muscular but also of the vascular anatomy. There are many classifications within the literature discussing mapping the vasculature of the lower leg.

Figure 4 Clinical images (A) healing STSG five weeks postoperatively and (B) fully incorporated split thickness skin 10 weeks graft.

Angiosomes should always be acknowledged throughout the surgical planning and intervention. Angiosomes are a unit consisting of the skin, subcutaneous tissue, fascia, muscle, and bone being supplied by a source artery. The human body has forty angiosomes, with six being located in the foot and four located within the lower leg [1,2]. Mathes and Nahai's classification divides muscle flaps accordingly to their blood supply. The soleal muscle flap is a type II flap, meaning it has one major pedicle and several minor pedicles [2,3]. Its dominant pedicle is the posterior tibial artery and the perforating branches of this artery are the secondary pedicles [2,4-7]. The vascular supply of the medial soleus muscle body is mainly from the posterior tibial artery (PTA) via multiple minor pedicles [4,5,8]. The medial soleus has perforators from the PTA extending the length of the muscle [9,10].

Ward, et al. state that perforators can be found on the posterior border of the tibia roughly 5 cm, 10 cm, and 15 cm proximal to the ankle joint [11]. Similarly, Raveendran, et al. report the distal perforating arteries of the PTA averaged 6.5 cm, 11.6 cm, and 16.8 cm from the medial malleolus [12].

When planning for coverage, the entire soleal muscle can cover defects approximately 26 cm^2 [2]. However, the MHS has an extended arc of rotation compared to a full soleal flap which allows a greater percentage of coverage [6,7,13,14]. The medial soleus belly averages 25.4 cm in length, 6.9 cm in width, and has a mean surface area of 87.5 cm^2 [15]. Techniques, such as excising the epimysium, can also increase the flap's range by 20% [4].

Prior to incision, perforators should be marked appropriately along the posterior border of the tibia [9,11]. For the surgical approach, we prefer a medial incision overlying the posterior compartment. Preserving the saphenous neurovascular bundles can be achieved and blunt dissection can be utilized to separate the gastrocnemius from the soleus [2,11]. It is highly encouraged to use intraoperative doppler examination throughout the surgery to confirm the major pedicle is viable and only minor perforators are being ligated [2]. The medial body of the soleus should be dissected from the lateral portion at the "C-point", or the perforator located approximately 15 cm from the ankle joint [11]. Bourdais-Sallot et al. reported the pivot point for MHS is 14.5 cm from the top of the medial malleolus or 32.5% of the tibial length [15]. The lateral soleal muscle body is left intact to help maintain plantar-flexion at the ankle [9,2].

Conclusion

To our knowledge, the use of a MHS flap for coverage of a plantar foot soft tissue defect has not been previously described. MHS flaps have been used to cover defects in the proximal and distal lower extremity [7,10]. Techniques can be used to extend the range of coverage of the medial soleus in order to reach the plantar foot. With careful and proper planning, the MHS flap is an option for coverage of soft tissue defects of the plantar foot.

The goal of our staged procedure was to heal the chronic ulceration and provide a functional lower extremity for ambulation. Within ten weeks of MHS flap with external fixator and STSG, the patient was able to ambulate with a well adhered and fully incorporated graft. No dehiscence has occurred in twenty-three months.

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