CASE REPORT

Severe degloving injury of the sole and heel treated by a reverse flow sural artery neurofasciocutaneous flap and a modified off-loading external fixation device

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Introduction

Degloving injuries about the foot and ankle present a significant reconstructive challenge due to the superficial nature of tendon, joint and neurovascular structures essential for proper acceptance of weight bearing and shear forces associated with bipedal gait. A degloving injury to the sole and heel can cause serious functional limitations for the patient and make the use of specialized shoe gear and brace therapy difficult. In the past, free tissue transfer with microvascular anastomosis, random pattern local, cross-leg and pedicle flaps have been used for closure of acute traumatic soft tissue injuries about the lower extremity and heel.1,2,3,4,6

We present a case report involving a crush injury to the osseous and soft tissue components of the heel with an associated large degloving defect and a simultaneous dislocation of the ankle. A reverse flow sural neurofasciocutaneous flap with an off-loading hybrid external fixation system was used to provide closure of the surgical site, aid in the reduction of the ankle dislocation and hindfoot and off-load the soft tissue flap reconstruction.

Case report

A 54-year-old man was brought to the emergency room with complaints of left heel pain after sustaining a severe degloving injury while at work. The injury was sustained when his left foot was crushed...
between the forklift he was driving and a steel bar. This patient was a healthy male with no contributing medical problems. Radiographic examination revealed a posterior calcaneal tubercle fracture and widening of the medial gutter of the left ankle. The patient was taken to the operating room for incision and drainage with ORIF of the calcaneal fracture. The medial side of the degloving heel pad injury was re-approximated and sutured back in place. The remainder of the wound was left open.

Figure 1 Intra-operative appearance of the devascularized heel pad (A and B), external fixation placement (C) and negative pressure system (D) application.
to allow for drainage. A CT scan performed after the ORIF of the calcaneus revealed anatomic alignment of the calcaneal tuberosity fracture fragment and medial tilt and anterior translation of the talus.

A second procedure was done 4 days later due to ischaemic changes that occurred to the lateral heel and fat pad. During this extensive débridement, the skin, abductor hallucis muscle belly and plantar fat pad were noted to be non-viable and haemorrhagic.

Figure 2 Intra-operative picture before the definite soft tissue reconstructive procedure (A), dissection of vascularized pedicle flap (B), rotation, placement and final appearance with split thickness skin grafting at the donor and remaining non-weight bearing surfaces of the sole and heel (C).
The débrided skin, muscle and soft tissue were sent to pathology for further evaluation. Results revealed superficial and deep acute inflammation, haemorrhage, necrosis and focal epidermal necrosis consistent with progression of his severely traumatized soft tissues. During this surgical procedure, attention was also directed to the dislocated ankle joint and talus. Under image intensification and manual manipulation, the ankle joint was repositioned and the talus was reduced with the help of an external fixation device and transfixion pins thru the talus and calcaneus which also provided maintenance of the reduction. A negative pressure device was further applied to the plantar aspect of the sole and heel to stimulate granulation tissue, provide drainage and reduce bacterial bioburden prior to the final reconstructive procedure. Intraoperative cultures revealed no bacterial growth (Fig. 1).

The patient was brought back for the definitive soft tissue reconstructive procedure 10 days after the initial injury. Pre-operatively, the presence of a patent perforating peroneal artery was performed by a Doppler examination and a lesser saphenous vein mapping was also performed to further assist with the dissection of the vascular pedicle flap. The pedicle flap was raised to the pivot point 5 cm proximal to the lateral malleolus and rotated 180° without kinking the neurovascular pedicle. The flap was sutured to the deep tissues using buried simple interrupted absorbable sutures in order to firmly seat the flap and limit the potential for post-operative haematoma formation. The cutaneous portion of the flap was then sutured to the perimeter of the wound using multiple, widely spaced simple interrupted non-absorbable sutures. Multiple split thickness skin grafts were then taken from the medial and lateral aspect of the ipsilateral lower extremity to cover the donor site as well as the remaining non-weight bearing surfaces of the sole and heel. A bolster type dressing was used to provide compression at the recipient skin grafting sites. The pedicle flap was left exposed to allow for immediate post-operative monitoring (Fig. 2).

Figure 3 Intra-operative application of an off-loading external fixation foot ring (A) and post-operative appearance maintaining visual monitoring of the pedicle flap (B).

Figure 4 Final post-operative picture before patient was allowed to full weight bear in a supportive shoe gear.
With the traditional bulky post-operative dressings and off-loading methods, visual monitoring of the vascular pedicle flap becomes extremely difficult. Therefore, a modification was made to the existed external fixation device that remained in place. An additional foot ring was attached to the external fixation device to allow for quick and repeated evaluation of the flap while maintaining sound immobilisation of the lower limb, ankle and foot. Post-operatively, the pedicle flap and split thickness skin grafts remained viable and went on to heal without complications (Fig. 3).

The final stage of the procedure involved removal of the external fixation device at approximately 6 weeks. The bolster dressings were removed at about 4 weeks. A below the knee cast immobilisation was applied after the modified external fixation system was removed. The patient remained non-weight bearing for a total of 12 weeks. He was then allowed to apply light weight to the affected limb with an assistance device. At 4 months, the patient was allowed to take full weight in a supportive shoe gear (Fig. 4).

**Discussion**

Reconstructive procedures for complex hindfoot and ankle fractures with soft tissue injury are exceedingly difficult to treat. Regardless of approach, the goal is to provide a stable, durable and well-contoured weight bearing surface that can be placed in a modest shoe with or without brace support. In this case report, a calcaneal fracture with a severe degloving injury and a simultaneous ankle dislocation was presented. A sural neurofasciocutaneous flap with a modified off-loading external fixation device was used for the treatment of this severe injury.

The sural artery flap has been used as the reconstructive choice for small to medium soft tissue injuries in the lower leg, ankle and heel. Prior to performing this procedure, it is important to request non-invasive vascular studies and vein mapping in order to aid in the surgical dissection of the lesser saphenous vein as it courses to the perforating artery. The anatomic structures that supply the sural flap are the peroneal artery, lesser saphenous vein and sural nerve. The arc of rotation of this pedicle flap is 5 cm above the lateral malleolus. At this level, the peroneal artery can maintain its integrity and provide adequate vascular supply to the reverse flow sural flap. If the pedicle donor site from the proximal leg is small in size, it can be closed primarily. Due to the size of the soft tissue defect on the heel, it was necessary to close the donor site with a split thickness skin graft from the lower leg. This flap has a good arterial supply and it is important to monitor venous congestion post-operatively. If venous congestion occurs, the area of necrosis is usually the distal tip of the flap. It has been documented that venous congestion can be avoided in most cases when the pedicle is not buried within a subcutaneous tunnel. This flap survives better when it is transferred and laid directly on the defect area.

The ankle dislocation was corrected and maintained with an external fixator and transfixion pins thru the talus and calcaneus. This external fixation device was converted into an off-loading frame by attaching several clamps and a circular ring to the inferior aspect of the pre-existing device. The off-loading aspect to this device was crucial to the healing process of the vascularized pedicle flap. The off-loading frame helped insure that there would be no direct pressure to the sole and heel that would cause the flap to fail.

**Conclusion**

The sural artery flap can be successful in the treatment of large soft tissue defects about the posterior and plantar heel. It is a reliable, durable and relatively easy to perform procedure without sacrificing a major neurovascular bundle(s). However, a common problem during the post-operative recovery period for sural artery flaps has been preventing pressure over the flap, pedicle and donor site that come in direct contact with the splint, pillows and bedding. A new modified off-loading external fixation device is presented on a severe degloving injury of the sole and heel with a simultaneous calcaneal fracture and ankle dislocation. This is a novel technique that allows increased stability, ability to perform concomitant osseous surgery and weight-shearing according to the individual patients needs.

**References**


