Surgical management of a mangled foot by a free vascularized fibular graft: A case report

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Abstract

The human foot serves as an important part to support the body weight and accounts for the majority of our movements. A mangled limb involves injury to at least three out of four systems, namely the soft tissues, nerves, blood supply and bone. While amputation is indicated in some cases of mangled limb, with proper planning, limb salvaging surgical management is also a viable option. Special consideration to the skeletal stabilization, control of infection, vascular status and soft tissue coverage is paramount to the success of limb salvaging surgery. We present a case of mangled limb which was successfully treated with limb salvaging surgical management. Initial debridement, Kirschner wires insertion and cross ankle external fixation were used for skeletal stabilization. An antibiotic spacer was inserted for local antibiotic and to maintain the length left due to the loss of medial and intermediate cuneiform bones. The anterior tibialis artery and its venae comitantes were utilized for free vascularized fibular graft to provide bony reconstruction as well as soft tissue coverage for the mangled foot.

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Introduction

Since humans evolutionally adapt to a bipedal gait, the foot is important to allow humans to stand up, walk, run, and to jump.[1] Without the soft tissues and bones at the foot and ankle, our lower limbs cannot support the weight of the body.[1] A mangled limb is a consequence of high energy trauma leading to combined bone and soft tissue loss or destruction.[2] A mangled limb is defined as a lower limb with an injury to at least three out of four systems, namely the soft tissues, nerves, blood supply and bone.[3] In treating a mangled limb, the dilemma for the treating surgeons includes whether to amputate or to attempt a reconstruction. There are multiple scoring systems such as the Limb Salvage Index (LSI), the Predictive Salvage Index (PSI), Nerve injury, ischemia, soft tissue/injury, skeletal injury shock and age of patient score (NISSSA), Hannover Fracture Scale-97 (HFS-97) and Mangled Extremity Severity Score (MESS) which guide the treating surgeons in making a decision whether to amputate the injured lower extremity. However, it should not be considered as a strict rule and each patient should be assessed carefully and have an individualized approach to treatment. Multiple reports exist to remind us that limb salvaging management is a viable option.[2] Special consideration to the skeletal stabilization, control of infection, vascular status and soft tissue coverage is paramount to the success of limb salvaging surgery. We present a case of a mangled foot which was successfully treated with limb salvaging surgical management by following these principles.

Case Report

Mr IZ, a 40-year-old gentleman with no underlying medical illness, was involved in a high impact motor-vehicle accident. His left foot was trapped between the car and the road divider, requiring extrication by the emergency services. He sustained a mangled left lower limb with a 10 cm x 10 cm degloving wound at the dorsal aspect, extending from the ankle to the metatarso-phalangeal joint, exposing all the tarsal and metatarsal bones. The dorsalis pedis pulse was not palpable but the posterior tibial pulse was felt. The capillary refill time of all toes was approximately 2 seconds. The sensation over the dorsum of the foot was lost with intact plantar sensation. There was no other associated injury. Plain radiographs of the left foot showed fractures of all five metatarsal bones with tarso-metatarsal joint dislocations of the first and second toes, associated with medial and intermediate cuneiform bone loss (Figure A). In the emergency department, there was an episode of transient hypotension which resolved after fluid resuscitation. His calculated MESS was 6 (MESS score of 7 or more is highly predictive of lower limb amputation).

During the initial wound debridement, the irreparable dorsalis pedis artery was ligated. The ruptured extensor digitorum longus and extensor hallucis brevis were repaired. All the fractured metatarsal bones were fixed

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with Kirschner wires and antibiotic cement spacer was inserted to fill the gap caused by the loss of medial and intermediate cuneiform bones. A cross-ankle external fixation was done to stabilize the ankle and foot (Figure B). He underwent a series of wound debridement and 3 cycles of negative-pressure wound therapy (NPWT) to prepare the wound bed. A definitive reconstruction and wound closure was carried out on day 29 of admission using a free osteocutaneous fibular flap. An 8.5 cm fibular bone together with its overlying skin measuring 22 cm x 14 cm was raised from the contralateral leg based on the peroneal vessels to reconstruct the bony and soft tissue defects. The vascularized fibula was fixed to the navicular bone proximally and to the head of the first metatarsal bone distally with a one-third tubular plate. The skin paddle covered most of the soft tissue defect leaving only two small areas on the lateral and medial edges requiring split skin graft. The peroneal artery and its venae comitantes were anastomosed end-to-end with the anterior tibial artery and its venae comitantes respectively. Post-operatively, both the donor and recipient sites healed without complications. Both bony union and soft tissue recovery were achieved. A flap debulking surgery was subsequently performed to facilitate footwear fitting. The sensation was intact over the plantar aspect of the foot as well as the flap. He recovered well with good range of movement of the left ankle without any instability. He was able to return to work at six months post trauma. He was pleased with the outcome of the surgery.

Discussion

Management of a mangled extremity is difficult. With the advent of surgical techniques and technologies, comprehensive reconstructions are viable to salvage the extremity.[2] Attention should be given to skeletal stabilization, early soft tissue coverage, and control of infection.[3] Some authors practice immediate soft tissue coverage but in our case, we prepare the wound bed with NPWT prior to flap closure as described by Bakota et al in view of high risk of infected wound secondary to initial contamination.[2]

In order to salvage and reconstruct the foot of this patient, we needed to solve two technically demanding problems, namely soft tissue coverage and bony reconstruction. From the aspect of soft tissue coverage, limited amount of transferable soft tissue makes local and regional flaps impractical in this case.[1] The risk of flap congestion and restricted rotational reach make reverse sural artery flap a suboptimal choice as well. A large soft tissue defect of the foot can be covered with a free antero-lateral thigh flap and has been shown to have good outcomes.[1] In this case, the bony gap caused by the loss of medial and intermediate cuneiform bones as well as the proximal part of the first metatarsal bone requires a bone strut to stabilize the tarso-metatarsal joint. Autologous cortico-cancellous iliac bone graft has been described for the reconstruction of the first metatarsus in cases of tumour resection.[4] However, in cases of traumatic bone loss, the blood supply of the surrounding tissue can be highly unreliable to ensure success of such a graft. Hence, the treatment of choice is a free vascularized bone graft. The fibula flap is an extremely versatile flap where it can be raised with a large skin paddle as well as muscle if required. The structural similarity between the fibula and the metatarsal bone makes fibula an ideal choice for filling up the defect of the first metatarsus.[5] In this case, we use a longer fibular graft to occupy the large bone gap. The fibular osteocutaneous flap requires recipient artery and vein to anastomose for it to survive. Option of recipient artery in this mangled foot is limited as the foot is surviving on the posterior tibialis artery and its branches alone. Any attempt to channel the blood supply from the posterior tibialis to the flap will lead to gangrene of the foot as the irreparable dorsalis pedis artery had been ligated. We harvested a larger fibular osteocutaneous flap with the peroneal artery and its venae comitantes to anastomose end-to-end with the anterior tibial artery and its venae comitantes, proximal to the ligated dorsalis pedis site.

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Figure A shows the initial appearance of the left foot post-trauma with the associated plain radiographs in antero-posterior, oblique and lateral views respectively (from left to right).

Figure B shows the plain radiographs (antero-posterior and oblique views) after wound debridement, Kirschner wires insertion, antibiotic cement spacer insertion and cross-ankle external fixation.

Figure C shows the appearance of the wound at his left foot after multiple cycles of vacuum-assisted closure therapy and the planned donor site for osteocutaneous fibular flap at the contralateral leg.

Figure D shows the appearance of the wound after debridement and removal of the antibiotic cement. The osteocutaneous fibular flap is raised from the contralateral leg based on the peroneal vessels (green arrow) to reconstruct the bony and soft tissue defects.

Figure E shows the harvested osteocutaneous fibular flap used for reconstruction of the left foot. The fibular graft was anchored to the navicular bone proximally and to the head of the first metatarsal bone distally with a one-third tubular plate.

Figure F shows both bony union and soft tissue recovery of the left foot. The flap is of acceptable size for shoe fitting after a debulking surgery. Multiple vascular clips are used for ligation of the irreparable dorsalis pedis artery.

Figure G shows the range of movement of his left ankle in full dorsiflexion (left) and plantar flexion (right).