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Case Report

The medial femoral condyle free osteocutaneous flap for osteomyelitis in pilon fractures

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ABSTRACT

Background: High energy tibial plafond (pilon) fractures are known to have a high rate of complication, particularly wound dehiscence and infection. Wound infection, requiring debridement of both soft tissue and bone can be especially challenging to reconstruct due to the combination of high load-bearing requirements within a thin soft tissue envelope.
Method: We present a case of a pilon fracture with a post-operative complication of wound dehiscence and infection necessitating bone debridement, ultimately resulting in chronic osteomyelitis. We used a medial femoral osteocutaneous free flap to provide vascularised structure to the defect. Included is a comprehensive literature review for the use of the MFC osteocutaneous free flaps in lower extremities.
Results: This flap provided restoration of the medial column of the ankle. The use of vascularised bone resulted in rapid post-operative bony union. The vascularised bone flap was press fit into the defect ruling out the potential for further hardware related infections. We report follow up of over one year.
Conclusion: The MFC free osteocutaneous flap is a good option for small bone and soft tissue defects of lower extremities, especially in setting of chronic osteomyelitis. It can be custom fabricated and either fixated or press fit into a chronic pilon fracture cavity to obliterate dead space with vascularised bone.
Level of evidence: Level IV, retrospective case study.

Introduction

Pilon fractures are high energy intra-articular fractures of the tibial plafond [1]. These are relatively uncommon injuries, accounting for 7% of all tibial fractures and 1% of all lower extremity fractures [2,3]. Aetiology is generally trauma secondary to a fall from height or motor vehicle accident [4]. There is considerable discussion regarding these injuries due to the historically high complication rates. The ankle joint conducts a significant load over a relatively small surface area [5]. While an anatomic reduction of the articular surface is important, fracture comminution can make this a challenging goal. Treatment is further complicated by the relatively thin soft tissue envelope and subcutaneous nature of the medial tibia. This combination of fracture comminution, requirement of an anatomic reduction and the tenuous soft tissue envelope generates challenging reconstructive problems [6,7].

Given the variable patterns of displacement and fracture comminution, the management of pilon fracture varies from casting for non-displaced fractures to open reduction and internal fixation (ORIF) to achieve limb alignment or articular reduction [8]. However, single staged ORIF, commonly performed till early 1990s often resulted in an unacceptably high rate of wound breakdown, infection and arthrodesis [9,10]. In high-energy fractures with ORIF, infection rates were reported as high as 55% with equally concerning rates of osteomyelitis and amputation [11,12]. Given these findings, there was a shift in surgical approach with more focus on minimising soft tissue damage and waiting for soft tissue swelling to resolve before definitive surgery. This led to the advent and popularisation of a two-staged surgical approach which involved wound debridement and external fixation immediately post-injury followed by definitive fixation in the ensuing weeks (after resolution of soft tissue swelling) [13,14]. Even with such improved surgical techniques, the thin and already tenuous soft tissue envelope around the fracture provides a set-up for wound infection and osteomyelitis, requiring extensive debridement, and

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often resulting in soft tissue and occasionally bone defects [15]. Such soft tissue/bone defects in the distal third of the tibia can be very difficult and challenging to manage, necessitating further debridements, antibiotics, and in rare cases, microvascular limb salvage.

The medial femoral condyle (MFC) flap has been described in the literature as a useful option for vascularised bone grafts. It was first described as a pedicled periosteal flap based on the descending genicular artery in 1989 by Hertel and Masquelet [16]. It was subsequently used as a free corticoperiosteal vascularised flap for non-unions of the humerus and ulna in a series of six patients [17]. The MFC flap has a dual blood supply, from the descending genicular as well as the medial superior genicular vessels. The descending genicular artery, a branch of superficial femoral artery, is typically longer and easily identified and has a saphenous and osteoarticular branch, which allows for chimeric osteocutaneous flaps [18]. The MFC flap has an average of 30 perforators, which run perpendicular to the cortex, underscoring its value as a bone flap [18]. Over the past decade, MFC flaps have been successfully used in the treatment of non-unions of the clavicle, tibia, humerus, mandible, maxilla and scaphoid [19–24]. Vascularised bone flap have advantages over conventional bone grafts in terms of osteocyte survival, mechanical properties, rapid union and are especially indicated in long-standing infection and avascular necrosis [25]. We present a case of a patient with long standing osteomyelitis of the ankle pilon fracture repair with open reduction and internal fixation, who presented with a 5 cm × 4 cm soft tissue and 4 cm × 2 cm bony defect after debridement of infected and devitalised bone. It was decided to use a MFC free osteocutaneous flap for coverage of his composite defect.

Case report

The patient is a 52-year-old male who sustained injury to his right ankle secondary to a fall which resulted in a Gustilo type IIIA, comminuted and displaced intra-articular fracture of the right distal tibia and fibula, with a medial wound at the level of the fracture (Fig. 1). This was initially brought to the operating room for debridement of the medial wound and temporarily stabilised with external fixation to maintain length, alignment, and rotation as well as to protect the soft tissue envelope. Three weeks later, after resolution of his soft tissue swelling, he underwent open reduction and internal fixation of the right pilon fracture through an anterolateral approach, however a 1/3 tubular plate was placed percutaneously to buttress and reduce the medial malleolus and to minimise insult to the medial soft tissues (Fig. 2). Unfortunately, his post-operative course was complicated by wound infection one month after surgery requiring wound debridement. His hardware was left in situ as it was well fixed and his fracture had not yet healed. His wound culture was positive for Coagulase-negative *Staphylococcus aureus* and after consulting with Infectious Disease, he was started on Trimethoprim-Sulfamethoxazole and Rifampin. The hardware was maintained for ten months post-injury till until complete bony-union.

Once his fracture was healed, he was brought back for removal of the hardware and debridement. An area of necrotic bone was discovered after removal of the medial plate which was then debrided to healthy tissue. This resulted in a soft tissue/bone defect in distal tibia and plastic surgery was consulted to help with closure of his defect (Fig. 3). It should be noted that we performed additional bone debridement during our index procedure to ensure viable tissue bed resulting in a bigger bone defect than suggested in Fig. 3. It was decided to proceed with an osteocutaneous free flap as compared to a bone graft in a hostile wound bed since he was both chronically infected and an active smoker. He also had significantly impaired vascular inflow to his lower extremity distally as both his posterior and anterior tibial vessels were reconstituted from the peroneal artery, most likely related to the recent injury and surgery. As he only had a peroneal vessel to his foot, it was decided to utilise the proximal posterior tibial vessel outside the zone of injury for our free flap anastomosis. Since MFC osteocutaneous free flaps consists of periosteum, cortical and cancellous bone that can be easily dissected with a long pedicle, it seemed to be the best choice for our patient. It was decided to use descending genicular and saphenous artery, with cutaneous and interosseus branches allowing dissection of a chimeric free flap.

Fig. 1. Extensively comminuted and displaced fracture of distal tibia and fibula with significant soft tissue swelling, Right Pilon Fracture – Type IIIA.

The surgical technique has been well described in the literature [19–23]. However, briefly, we began by elevating the saphenous artery flap based upon its dominant perforator on the medial aspect of the knee. We traversed down to fascia and created a 5 cm × 4 cm skin paddle based on the saphenous artery. We then traced the saphenous artery back to a perforating branch to the medial condyle of the femur. The osseous portion of the bone was then harvested using piezoelectric saw and osteotomes to develop a bone flap slightly larger than the defect, which was measured as 4 cm × 2 cm after debridement. After that, we traced the saphenous artery underneath the sartorius and vastus medialis back to the level of superficial femoral artery, ensuring the maximum length of the vascular pedicle (Fig. 4). After harvesting, we inset the bony portion of the free flap by press fitting it into the bony defect