

Soft Tissue Complications Following Calcaneal Fractures

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Since the 1990s, the orthopaedic surgeon's ability to manage calcaneal fractures has improved, increasing the popularity of open reduction and internal fixation. Calcaneal fractures account for most tarsal bone fractures and 2% of all fractures. Clinical studies have examined the effectiveness of operative versus nonoperative treatment of these fractures and the use of computed tomography (CT) has improved the ability to classify a fracture for more accurate comparisons. Howard and colleagues [1] found that significant complications following intra-articular fractures occurred whether treated operatively or nonoperatively and despite management by experienced surgeons. Most of these studies have not focused on soft tissue complications associated with calcaneal fractures. The surgeon's recognition of the various potential soft tissue complications may dampen his enthusiasm to perform operative fixation for these fractures. Soft tissue complications, such as compartment syndrome, fracture blisters, full thickness skin necrosis, and peroneal tendon pathology, can be seen in patients treated nonoperatively, illustrating the point that even conservative management can result in suboptimal outcomes.

The two most feared complications in treating calcaneal fractures with open reduction and internal fixation are wound necrosis and deep infection. Patient selection and timing of the surgical procedure may help reduce the incidence of wound healing problems and infection. When a wound complication occurs, debridement and local wound management play an important initial role. Often these wounds will heal with simple wound care. With the advent of vacuum-assisted wound closure (Wound VAC, KCI, San Antonio, Texas), many of the wounds that would have required a free flap are now being managed with this device. When a wound fails to respond to the above measures, soft tissue coverage is undertaken. Options for coverage

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range from skin grafts to microsurgical free flaps. Deep infections remain best treated with aggressive debridement and curettage of the bone in conjunction with intravenous antibiotics.

Less common, but potentially equally devastating, is the complication of compartment syndrome of the foot seen in association with calcaneal fractures. Saxby and colleagues [2] found in a series of 98 intra-articular calcaneal fractures that 13% had compartment pressures greater than 30 mm Hg.

Non-limb-threatening complications are also seen as a result of calcaneal fractures. Treatment of these problems is less acute and is typically diagnosed in the later stages of healing. Peroneal tendon tears, impingement, and subluxation have all been reported. Nerve complications, including tarsal tunnel and sural neuromas, have also been seen as sequelae of calcaneal fractures. Even less common, flexor hallucis longus impingement associated with a sustentacular fracture may be seen. Claw toe deformities are occasionally associated with calcaneal fractures, possibly secondary to a missed compartment syndrome of the foot. Often associated with the tongue-type fracture is the development of a Haglund's deformity with associated insertional Achilles tendonitis. The challenge for the surgeon is to recognize the complication and implement the simplest solution to improve the patient's outcome following a calcaneal fracture.

Patient assessment

Many of the wound problems surrounding calcaneal fractures can be attributed to poor decision making at the time of the initial procedure. Special attention to the preoperative assessment of patients before undertaking extensive procedures may lead to a lower incidence of wound complications. Most of this can be completed with a thorough history, a careful extremity exam, and diagnostic testing when necessary.

Medical history

Taking a complete history is important in the surgeon's quest to avoid wound-healing complications. Patients who have diabetes mellitus are at increased risk for the development of postoperative wound complications and infections (Fig. 1). The severity of the complications is not necessarily related to the severity of the disease itself, with type II diabetes accounting for most problems. A careful evaluation of the patient who has diabetes is necessary to document neuropathy, previous foot ulcerations, and adequacy of blood glucose control. A fasting blood glucose and hemoglobin A1c are simple blood tests to obtain and will aid the surgeon in assessing a diabetic patient's compliance and control of his disease. In addition, careful evaluation of the vascular integrity of the limb should be undertaken. Lack of distal pulses warrants further studies, such as arterial Doppler examination with waveforms, ankle-brachial indices, and toe pressures. Suboptimal Doppler results may be a contraindication to surgical management of the

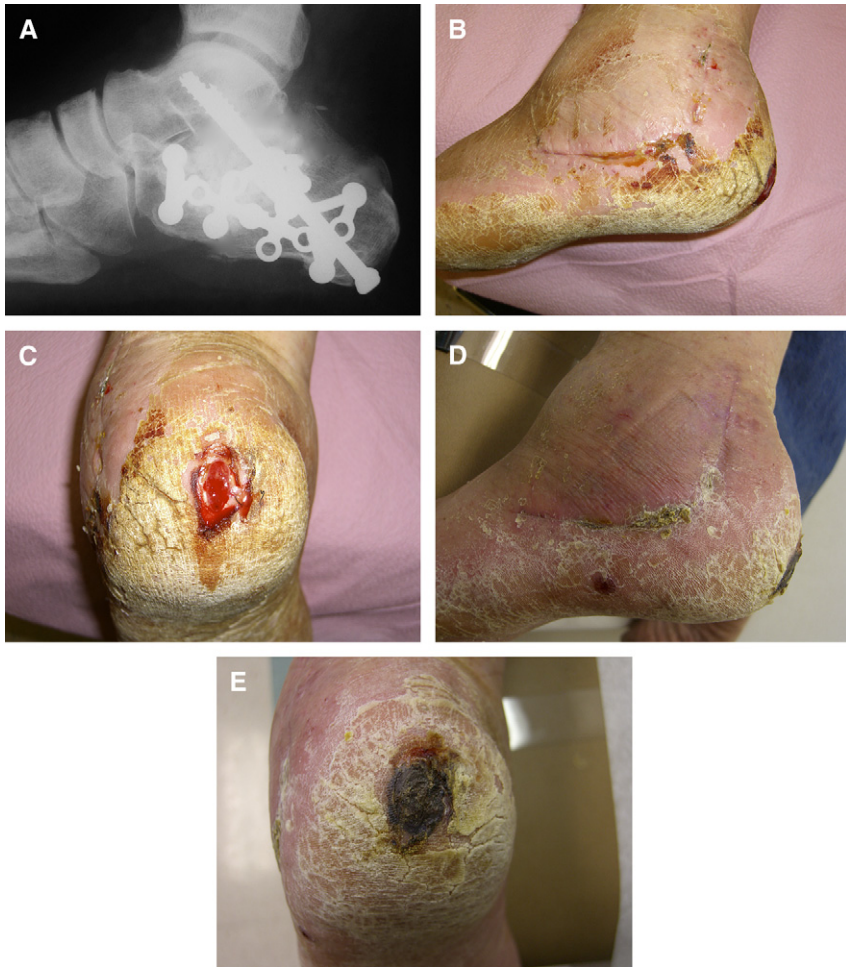


Fig. 1. A patient with type II diabetes presented with a Sander's type IV calcaneal fracture and was treated with open reduction and internal fixation and primary subtalar fusion (A). At 1 week from surgical intervention, a wound dehiscence was noted over the lateral wound and posterior heel from screw placement (B, C). The wounds were debrided in the office and the patient was placed into a removable CAM boot to allow for local care. One week later, wound exam in the office shows improvement in both areas (D, E).

fracture. Specialists should evaluate all comorbidities, such as renal failure, peripheral vascular disease, and heart disease, before undertaking any surgical procedure.

A careful evaluation of a patient's tobacco use is important in avoiding complications. A history of smoking affects wound healing adversely. Smoking is a relative contraindication to surgical intervention and should be taken into account with all other factors.

Discussing with the patient his social situation and his ability to comply with postoperative instructions can aide in prevention of serious complications. Any underlying psychiatric disorders should be documented. Observation of the patient preoperatively in the office may reveal potential noncompliance issues, which may be amplified once the patient is feeling better. Alcohol and drug abuse that could interfere with postoperative protocols may be a relative contraindication for surgery.

Extremity exam

Careful assessment of the soft tissue envelope is critical in the avoidance of postoperative wounds and infections. The initial surgery should take place only after soft tissue swelling has subsided. The surgical exposure should avoid fracture blisters, especially those filled with blood [3]. Serum-filled blisters are typically unroofed under sterile conditions and allowed to heal while the soft tissue swelling subsides. When the wrinkle test is positive (the skin wrinkles around lateral foot with ankle dorsiflexion indicating adequate reduction in swelling), surgical intervention can be performed safely (Fig. 2A).

In addition, the extremity vascularity should be assessed, with the lack of peripheral pulses leading to a vascular consult. Lymphedema and venous stasis of the extremity may be contraindications to surgery. Neuropathy should also be noted and a discussion with the patient of the potential complications arising from the lack of sensation discussed preoperatively.

Diagnostic testing

In addition to the typical preoperative laboratory values obtained, the surgeon may want to consider other basic indices of nutrition that may indicate poor wound healing potential. The most basic of these include total lymphocyte count ($>1,500/\mu\text{L}$), serum albumin ($>3.5\text{ g/dL}$), serum total protein ($>6.2\text{ g/dL}$), hemoglobin ($>11\text{ g/dL}$) and hematocrit ($>32\%$) [4].

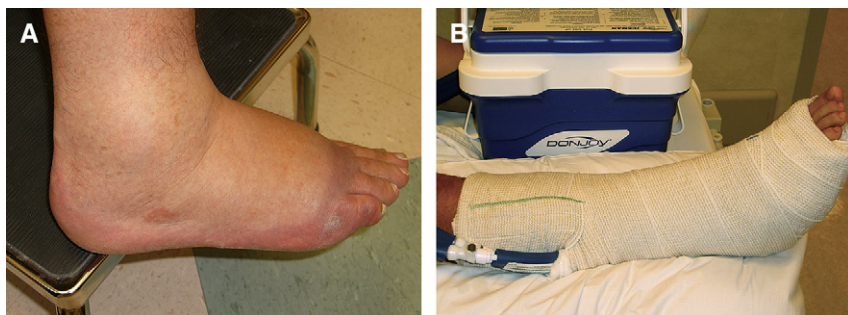


Fig. 2. Closed calcaneal fracture with substantial swelling and failure of the wrinkle test (A). Ice therapy and elevation recommended preoperatively to decrease swelling (B).

Wound necrosis

The most commonly used approach for operative fixation of calcaneal fractures is the extensile lateral approach popularized by Benirschke and Sangeorzan [5]. In studies reporting wound necrosis complications, the incidence ranges between 2% and 27% [5–9]. The extensile lateral approach was advocated to lessen the number of postoperative wound complications being seen in association with fixation of calcaneal fractures. The lateral flap is supplied entirely by the peroneal artery and its terminal branches. Compromise of this artery from the injury, peripheral vascular disease, and surgical exposure can lead to wound necrosis over the lateral hindfoot. Once a wound develops postoperatively, the surgeon is faced with decisions in the management of the soft tissues. Most of these wounds respond to local wound care modalities, such as debridement and dressing changes. As reported by Folk and colleagues [6] in their series, however, 21% of patients treated operatively required surgical management of their wound complications. Options in the treatment of wound necrosis range from simple wound care to free flaps.

Prevention of wound complications

Many cases of wound necrosis following open reduction and internal fixation of the calcaneus can be avoided with careful surgical planning and patient selection. Often the patient who has a calcaneal fracture presents to the office several days following the initial traumatic event as a referral from the emergency room. Fracture blisters and substantial swelling may be present. Cold therapy and use of a bulky splint are helpful in decreasing swelling and preparing the foot for an operative procedure (Fig. 2B). Use of pneumatic foot pumps can also help decrease swelling if tolerated by the patient. It is not uncommon to wait 1 to 2 weeks for an adequate decrease in swelling as noted with the wrinkle test before safely proceeding with operative fixation. On rare occasion, swelling and blistering may be a relative contraindication to an acute surgical procedure and discussion with the patient of a late reconstruction may be appropriate.

While waiting for subsidence of the swelling, appropriate medical clearance should be obtained. Malnourished patients should undergo laboratory workup with total lymphocyte count, serum albumin, serum protein, hemoglobin, and hematocrit. Patients who have diabetes should undergo a fasting blood glucose and HgA1c level (>8% associated with poor wound healing in diabetic ulcers) [10]. Uncontrolled diabetes should be addressed before surgical intervention. Consultation with an endocrinologist may be helpful in quickly correcting blood glucose levels. Additionally, it should be stressed to the diabetic patient that postoperative tight control of blood glucose levels reduces the rate of wound complications and infections. The lack of

palpable pulses is an indication to move forward with an arterial Doppler exam with ankle-brachial indices (ABIs). Patients who have an ABI of <0.8 may have difficulty with wound healing and vascular consult should be obtained with consideration given to nonoperative treatment. Patients who have a history of significant tobacco use or alcohol abuse may not be surgical candidates. Smoking cessation perioperatively may considerably lower the postoperative wound complication rate and patients should be warned of the potential risks of flap necrosis.

Control of intraoperative factors can also reduce the risk for wound healing complications. Extensile exposure allows for some relaxation of the lateral flap with less chance of postoperative breakdown. Use of 0.62-mm Kirschner wires, one placed longitudinally in the fibula and the other placed into the talar neck, may be helpful in providing gentle retraction of the soft tissues. The wires are then bent back providing an excellent retractor of the lateral skin flap (Fig. 3). The surgeon's attention to sharp dissection and avoidance of extensive subcutaneous exploration will lead to fewer soft tissue complications. Care should be taken to avoid injury to the sural nerve and peroneal tendons in the distal portion of the incision.

Once fixation of the calcaneus has been completed, the tourniquet is deflated and hemostasis is obtained. This critical step does take an extra few minutes but can help avoid a postoperative hematoma and its resultant pressure on the lateral skin flap. Occasionally, a small drain can be placed to avoid a hematoma formation although this is not necessary if a dry wound is confirmed after tourniquet release. Nylon suture material is typically preferable to staples. The sutures are placed in a horizontal mattress fashion. The operative foot is then placed into a bulky dressing with a plaster splint and an ice therapy unit, if available, applied.



Fig. 3. Extensile lateral approach for ORIF of calcaneal fractures. Note placement of K-wires to allow for gentle retraction of lateral flap.

Treatment of wound complications

Previous studies have illustrated the incidence of wound complications following open reduction and internal fixation to be between 2% and 27%. Once a wound is discovered in the postoperative period there are several measures that can be used in the healing process. Combinations of many of these modalities may be helpful in expediting the healing process and thereby preventing the development of a deep infection. For most post-operative wounds, simple wound care options will likely lead to successful healing.

Local measures

Many of the wounds seen following calcaneal fracture fixation are slight wound dehiscence with minimal drainage. Although the wounds are concerning to the practitioner, most will heal with local measures. Debridement of unhealthy or nonviable tissue remains the most important step in treating all wounds [11]. This procedure is best completed in the office with a #15 scalpel blade and pick-ups with teeth to minimize traumatic injury to the remaining viable soft tissues. A curette can also be an effective tool in the office. Following debridement, wet-to-dry saline dressing changes, when done correctly, are an effective wound healing adjunct. Caustic agents, such as Dakin's solution, should be avoided because they can be irritating to the surrounding soft tissues and lead to a delay in wound closure [12]. With the advent of newer topical debriding preparations containing proteases, papain derivatives, and collagenases, the traditional wet-to-dry dressings are becoming outdated. Preventative oral antibiotics are usually administered to prevent a deep infection and persistent wound healing problems. Dressings should be occlusive in nature while providing for absorption of any exudate.

Vacuum-assisted wound closure

Vacuum-assisted wound closure (VAC) in the treatment of calcaneal wound necrosis has vastly improved the orthopaedic surgeon's ability to manage this complication (Fig. 4). Debridement remains the critical treatment, but the wound VAC can provide substantial assistance. Wounds that formerly would have required a microsurgical free flap are now, in some cases, successfully treated with VAC (Fig. 5) [13].

VAC exposes the wound bed to negative pressure by way of a closed system. Polyurethane foam dressing is placed into the wound and attached to an evacuation tube, which is connected to the vacuum device. The negative pressure created by this system increases tissue perfusion, removes wound debris and fluid, and enhances proliferation of granulation tissue. Cell proliferation is believed to result from a stretching of the cells and cytoskeletal elements. The application of micromechanical forces to a wound may

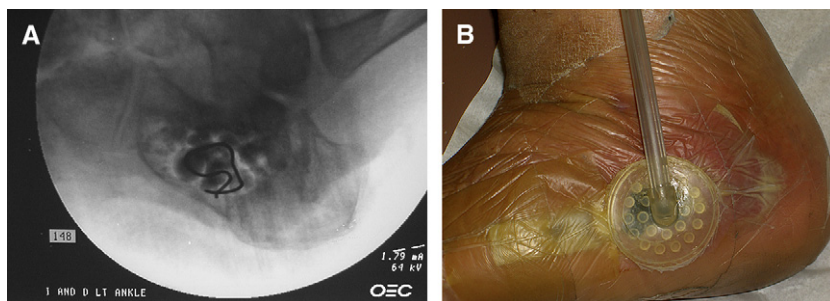


Fig. 4. Wound associated with osteomyelitis of the calcaneus treated with debridement, curettage and placement of antibiotic beads (A). VAC was successfully used in conjunction with surgical debridement (B).

stimulate healing through promotion of cell proliferation, angiogenesis, and local elaboration of growth factors [14]. In addition to these benefits, VAC may also decrease bacterial cell counts within a wound [15]. This technique can be used in an attempt to close wounds with underlying exposed bone and in some instances exposed hardware (Fig. 6) [16]. In the author's experience, closure of some of these deep wounds in fairly short duration (2 to 6 weeks) has been observed.



Fig. 5. Lateral wound necrosis noted at two weeks after ORIF of a calcaneal fracture (A). Wound treated with debridement in the office and placement of VAC. Four-week (B), 6-week (C), and 12-week (D) follow-up after VAC placement with closure of the wound.



Fig. 6. Lateral wound necrosis with exposed hardware. Successful treatment with VAC eliminated need for pedicle or free flap.

Hyperbaric oxygen

Hyperbaric oxygen (HBO) is currently being used in the treatment of chronic, nonhealing wounds. This typically is not advocated as the sole treatment but rather as an adjunct to other modalities, including local wound care and debridement. Published studies have been criticized for their lack of standardization in data collection making it difficult to interpret the results. Additionally, most studies have a small cohort and lack a comparable control group. One randomized, double-blinded study showed a statistically significant difference in wound size in a group treated with HBO and wound care versus a group that received wound care only. This study only had 16 patients all of whom were nonsmokers and non-diabetics who had normal ABIs, however [17]. Others have found HBO to be ineffective in the treatment of chronic wounds. Ciaravino and colleagues [18] found HBO difficult to justify based on the lack of clinical evidence that it works, its high cost, and potential complications. A meta-analysis on HBO, including randomized and nonrandomized studies, suggests a moderate benefit of the treatment of chronic wounds, although certainly large randomized and controlled studies need to be done to more clearly outline the benefits [19]. The author believes this topic remains a gray area given the conflicting evidence-based research. Use of HBO may serve as a useful adjunct but should not replace traditional proven techniques. Transcutaneous oxygen measurements after an oxygen challenge should increase in those patients who are most likely to benefit from the treatment. Debridement and local wound care remain at the forefront in the treatment of a chronic wound.

Autologous platelet gel

A complex cascade of events that are ultimately modulated by interacting molecular signals, primarily cytokines, and growth factors (GF), mediates wound healing. Several clinical trials have demonstrated that chronic

wounds may, in some cases, lack the availability of GF. This lack can be the result of decreased production, decreased release, trapping, excess degradation, or a combination of the above. Deficiencies of GF in chronic wounds suggest a role for therapeutic use to accelerate the tissue-healing process. Several studies have documented the efficacy of topical GF management on animal models and human subjects with promising results [20–22].

Platelets play a critical role in wound healing. During the coagulation and inflammation phases of healing, the formation of a blood clot induces adhesion, aggregation, and degranulation of circulating platelets. Platelet alpha granules release numerous growth factors important to tissue remodeling [20]. Autogenous platelet gel is created by treating platelet concentrates with autologous thrombin obtained by differential centrifugation of whole blood. This gel is then applied to the wound with an occlusive dressing. Further clinical trials will need to be done to elucidate the efficacy of this treatment of chronic foot and ankle wounds.

Coverage for larger wounds

In rare cases, the postoperative wound complication around a calcaneal fracture may require more substantial measures to close the wound. Options for closure of these difficult wounds include skin grafts, local flaps, pedicle flaps, and microsurgical free flaps.

Skin grafting requires a clean, well-vascularized base. A skin graft will typically not take if there is underlying infection or fibrous tissue present. VAC is an excellent technique to prepare the wound for skin grafting because it promotes granulation tissue and decreases bacterial cell counts. In fact, VAC can be used over a skin graft to promote take of the graft. Application of a nonadherent dressing with a bolster, topical antibiotics, and a compressive dressing can be helpful in increasing the rate of take of the graft.

Local flaps are flaps whose success depends on a length-to-width ratio (1:1) with no specific blood flow at their base. An example of such a flap is a rotation flap. These flaps are typically not useful in lateral hindfoot wounds because there is little skin redundancy for skin coverage, and they are therefore not recommended [13].

In contrast to local flaps, the pedicled flaps have a defined blood supply at their base. This type of flap brings in vascularized tissue that can cover exposed bone and hardware. Wounds that are smaller than 4 to 5 cm² can be considered for a pedicled flap. These flaps are typically easy to harvest, provide a vascularized coverage of the exposed area, and the donor site can be closed primarily. The disadvantages of these flaps are their limited bulk and reach [23]. The main workhorse for lateral hindfoot and distal ankle wounds is the abductor digiti minimi muscle flap, which is supplied by the lateral plantar artery. The donor site can be primarily closed following harvest [13]. One other flap that is commonly used for lateral ankle and

hindfoot defects is the sural artery flap. This flap is capable of covering defects up to 10 cm × 13 cm [24]. This flap provides for primary closure of the donor site but has disadvantages, including venous congestion and a complication rate of up to 25% in high-risk patients [25].

Microsurgical free flaps provide certain advantages over those flaps discussed above. These flaps can cover large defects and improve perfusion of infected bone. The disadvantages include longer operating times, increased perioperative complications, and technical difficulty. Microsurgical technique allows the surgeon to obtain healthy tissue from a distant site and transfer it to the lateral calcaneus area where the vascular pedicle is anastomosed to the local existing blood supply.

Open calcaneal fracture management

There currently is no widely accepted protocol in the treatment of open calcaneal fractures. These tend to be high-energy fractures and the initial insult to the soft tissues is significant resulting in a higher incidence of postoperative complications. Although much has been written on the treatment of other open fractures, little has been written about the management of open calcaneal fractures [9,26–29]. The reason for the paucity of literature is likely because of the low frequency of these fractures. Over a 9-year period, Heier and associates [27] treated 43 open calcaneal fractures and 503 closed fractures. Open calcaneal fractures thus represented only 7.9% of all calcaneal fractures in their institution.

Most investigators concur that management of the soft tissues and intravenous (IV) antibiotics compose the initial phase of treatment. Surgical irrigation and debridement (I & D) urgently from the emergency room and every 24 to 48 hours thereafter until the wound is clean typically is recommended. There is great controversy over placement of hardware, internal fixation versus percutaneous pin fixation, and the timing of such a procedure. Even with appropriate wound management, patients should be apprised of the possibility of a soft tissue complication. Thorton and colleagues [29], in an attempt to answer some of these questions, designed a treatment protocol algorithm for open calcaneal fractures. Initial management involved I & D of the traumatic wound until clean. They concluded that calcaneal fractures with any size lateral wound, a medial wound greater than 4 cm, a wound that cannot be closed, and an unstable wound at 7 to 10 days following the injury should be treated with open reduction and percutaneous stabilization. In patients who have a medial wound less than 4 cm that has been closed and stable for 7 to 10 days, standard techniques for open reduction and internal fixation can be used. Complication rates using this protocol were 29% (9/31). Future studies in this area should examine other algorithms and consideration should be given to initial soft tissue management followed by late reconstruction.

Compartment syndrome of the foot

Little has been written about compartment syndromes associated with calcaneal fractures. In fact, controversy surrounds whether or not this represents a clinically significant entity in the face of a calcaneal fracture and what, if any, treatment is necessary. Clinical suspicion arises based on examination that shows pain out of proportion to what is typically seen with a calcaneal fracture and tense swelling of the foot. Compartment pressures are then obtained with multistick invasive catheterization, especially of the calcaneal compartment of the hindfoot. Approximately 10% of calcaneal fractures develop compartment syndromes of the foot. Previous reports commented on the need for immediate fasciotomy to prevent the development of ischemic contractures [30]. More recently, however, Myerson and colleagues [31] concluded that the use of intermittent compression foot pumps decreases elevated compartment pressures associated with calcaneal fractures and may obviate the need for acute fasciotomies. Late reconstruction can then be performed, if necessary. Sequelae of compartment syndromes of the foot can include chronic neurogenic pain and neurovascular compromise leading to sensory disturbances in the medial or lateral plantar nerve distribution and ischemic contractures, including claw toe deformities (Fig. 7). Early treatment of the claw toe deformities may include a simple toe flexor tenotomy to prevent further deformity. Late treatment is best provided with proximal interphalangeal joint resection and pinning or flexor to extensor transfer if the deformity is flexible.

Neuritis

Nerve problems, including neuromas and compression syndromes, can be seen as late sequelae in the treatment of calcaneal fractures. Most commonly this is in the form of a sural neuritis/neuroma or tarsal tunnel syndrome.



Fig. 7. Claw toe deformities seen following a calcaneal fracture.

The extensile approach allows for identification of the sural nerve proximally and occasionally distally. This approach usually results in avoidance of nerve injury to the sural nerve. Nonetheless, sural nerve injuries do occur, possibly from retraction, contusion from the original injury, or cut by the surgeon. Diagnosis is mainly clinical and a differential injection with steroid may be trialed to alleviate symptoms. Often, surgical intervention is necessary to excise the painful neuroma. The site of the neuroma is marked before surgery. Dissection should identify the neuroma, which is then transected. The remaining nerve is then carefully dissected from the soft tissue scar and traced proximally into the distal ankle region where it can be buried in the peroneal brevis muscle belly without tension.

Tarsal tunnel syndrome after calcaneal fractures can be seen as a result of scarring or heel widening secondary to the original fracture [32,33]. Tarsal tunnel release is indicated if compression of the tibial nerve is noted by clinical exam. The author prefers to have supporting neurodiagnostic evidence of tarsal tunnel syndrome before proceeding with release of the tarsal tunnel. The surgeon should delay surgery several months following the index procedure allowing for all swelling to subside and potential nerve contusions to recover before surgical intervention.

Tendon pathology

In the evaluation of the patient following a calcaneal fracture, persistent pain over the lateral hindfoot could be secondary to painful retained hardware, sural nerve pathology, arthritis of the subtalar or calcaneocuboid joint, or peroneal tendon pathology. To differentiate the potential sources of pain, differential injections can be used. Subtalar joint injections are relatively easy to do in the office without the need for fluoroscopic guidance. If the calcaneocuboid joint is suspected as being the pain generator, use of fluoroscopy will ensure correct placement of the injection. Finally, the peroneal tendon sheath and sural nerve can be injected to differentiate these areas. Myerson and Quill [34] found these blocks were helpful in 87.5% of their patients in determining the underlying cause of pain.

The peroneal tendons should be palpated along their course. Resisted eversion may aggravate symptoms and testing for peroneal subluxation can detect this entity. Often, subclinical peroneal tendon subluxation goes undetected with the focus being treatment of the calcaneal fracture. Additionally, especially in the calcaneal fracture treated nonoperatively, calcaneofibular abutment may lead to impingement of the peroneal tendons and chronic pain. CT can sometimes aid the practitioner by identifying subfibular impingement and allowing examination of the integrity of the subtalar and calcaneocuboid joints (Fig. 8A).

Treatment of peroneal tendon tears involves either tubularization (if <50% of the tendon is involved) or tenodesis to the neighboring tendon



Fig. 8. Patient presented with a grade II open calcaneal fracture with substantial swelling and questionable infection over medial wound. Treated with irrigation and debridement, IV antibiotics, and elevation. Nonoperative management chosen for treatment of the fracture because swelling remained significant at 6 weeks. Patient later presented with subfibular impingement of the peroneal tendons and subtalar joint arthritis (A). Lateral calcaneal wall decompression and subtalar fusion performed as delayed reconstruction (B).

(if > 50% of the tendon is involved) (Fig. 9) [35]. Often lateral calcaneal wall decompression is necessary at the time of peroneal tendon repair as determined by the CT scan. This decompression is accomplished with a wide osteotome and mallet. Care should be taken to ensure adequate bony decompression so that the lateral calcaneal wall no longer abuts the distal fibula (Fig. 8B). In addition, as indicated by Myerson and Quill [34], attention to the subtalar joint is necessary to avoid later need for subtalar fusion. If peroneal tendon dislocation is noted, a fibular groove-deepening procedure with reefing of the superior extensor retinaculum may be indicated. Other procedures, such as those discussed by Chrisman and Snook [36] and

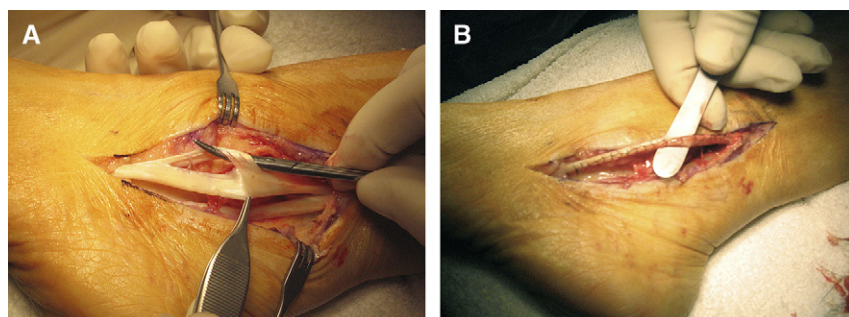


Fig. 9. Peroneal tendon tears may be associated with calcaneal fractures (A). Tubularization is preferred for tears that represent less than 50% of the tendon (B).



Fig. 10. Haglund's deformity with secondary pain at the insertion of the Achilles tendon was seen in this patient with an old, well-healed, tongue-type fracture of the calcaneus. Also note significant subtalar joint arthrosis.

modified by Acevedo and Myerson [37], can also be helpful in the patient with dislocating peroneal tendons.

Flexor hallucis longus (FHL) tendon scarring, tears, and impingement can also be seen over the medial hindfoot, especially in cases that involve a sustentacular tali fracture. CT scan should rule out a nonunion of this fracture as the cause of pain and may show exostosis impinging the FHL tendon. This rare late sequelae is best treated by exostectomy and tenosynovectomy or repair of the FHL as needed.

Tongue-type fractures displaced by the unopposed pull of the Achilles tendon can be the cause of soft tissue embarrassment and require urgent reduction and fixation. Because of the tenuous soft tissue coverage posterior to the tuberosity of the calcaneus, this type of fracture may tent the skin requiring emergent reduction to avoid disastrous wound complications. The late complications of nonunion and malunion, or perhaps those treated successfully with open reduction and internal fixation, are insertional Achilles tendonitis and Haglund's deformity (Fig. 10). This complication is best diagnosed by physical exam and a weight-bearing lateral radiograph of the foot. Treatment consists of hardware removal if present and a decompression of the Achilles tendon. Haglund's resection and distal reattachment of the Achilles tendon with bioabsorbable suture anchors can resolve symptoms. Care is taken to keep some distal fibers of the Achilles tendon attached to bone while performing the ostectomy of the calcaneus. Equinus contractures should be addressed through a gastrocnemius recession.

Summary

Soft tissue complications following calcaneal fractures can be frustrating to the patient and present reconstructive challenges for the surgeon.

Preoperative patient assessment may define a group of patients who are best treated nonoperatively in an effort to avoid disastrous soft tissue complications. Late sequelae will continue to be seen and through the use of differential injections, physical exam, and appropriate intervention the practitioner can usually decrease symptoms and improve a patient's function. Further studies in the treatment of open calcaneal fractures are necessary to better define treatment algorithms. A working knowledge of these complications and their management is necessary for the surgeon treating calcaneal fractures.

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