

Calcaneus Fractures

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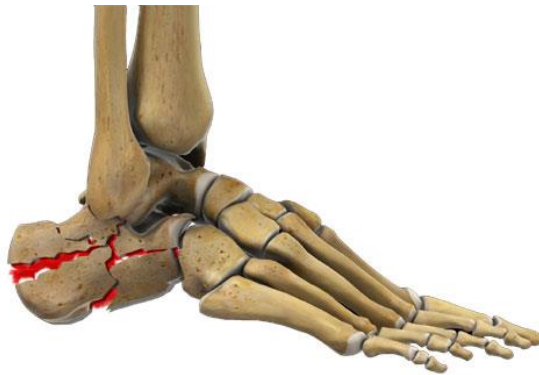
Some fractures are notorious to be difficult to treat and may require a prolonged healing period. A calcaneus fracture or a fracture of the heel bone is one of those fracture which request a special attention. Some can be approached conservatively especially when we are dealing with a non-displaced fracture or when the fracture pattern does not involve a joint. We will review conservative treatment and surgical treatment over the years of such a difficult fracture which can represent a challenge for many orthopedic surgeons.

Not all patients can be a candidate for a surgical fixation, but a simple fracture, not involving any joint can be expected to be treated in a non-invasive but conservative way. Elderly, smokers, patients with vascular diseases or Diabetes Mellitus are not good candidates to undergo surgical treatment. Complications like blood loss and infections can be expected because these patients present many risks when a surgical option is offered to them. Often, such patient may recuperate better with a non-surgical option.

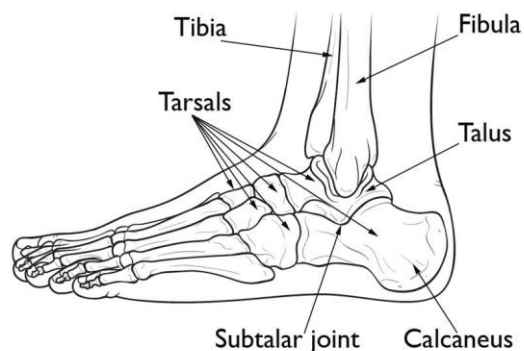
A calcaneus fracture of the heel bone is a painful and a disabling injury most often seen following a high-energy event like a motor-vehicle accident, or a fall from high (ladder), deforming the heel bone in foreshortening or widening or deforming the heel. Those fractures can be quite severe requiring extensive reconstruction of the anatomy. Many will develop long-term complications with pain, swelling, loss of motion, degenerative arthritis. Labor intensive jobs can be affected when a return to full duty is expected for such patients.

Let us review the anatomy of the foot for a better comprehension of the impact of this fracture on the life of the one who become a victim. The foot is commonly divided in three parts the Hindfoot, the midfoot and the forefoot. There are seven bones forming the tarsal bones and making up the hindfoot and the midfoot. The calcaneus bone is the largest of the tarsal bones in the foot and is also part of the hindfoot. It forms the heel, on the back of the foot and just under the ankle joint which is formed with the end of the tibia (shinbone), the fibula and the talus, sitting above the calcaneus, serving as a hinge joint between the tibia and the fibula.

Lateral view of a foot showing a broken calcaneus bone with extension of the fracture to the subtalar joint and also the mid-tarsal joint.



The calcaneus and the talus form the “subtalar joint” which allow a side-to-side motion of the hindfoot. This movement is necessary to enhance or stabilize this part of the foot, while we venture on an uneven or slippery surface.



Foot anatomy in which, the calcaneus (heel bone) and talus form the subtalar joint, which moves the foot side to side while one is walking.

Calcaneus fractures are uncommon and counts for 2% of all adult fractures while representing half of all tarsal bones’ fractures. In most fractures, at least, of the foot, the subtalar joint is involved, damaging the articular cartilage and causing long-term complications like degenerative arthritis, chronic pain or loss of motion. The more fracture fragments and their size, the more joint involvement (especially the subtalar joint) and the amount of cartilage destroyed as well as the quality of the soft tissue, the more the approach of these fractures exposes their complexity. These perspectives will also predict the outcome.

An open fracture requires immediate washout with antibiotic therapy while temporary stabilization can be offered to a closed injury. It is always better to place such patient in a Jones Dressing and a posterior splint waiting for the swelling to subside. Precautions for blister formation following calcaneus fractures are generally taken. Surgical treatment can be delayed.

The calcaneus bone is often fractured during a fall from high or in a motor vehicle accident causing a violent impact on the bone, manifested by a single crack or in a comminuted fracture. In landing on the feet from a jump or a fall, the bodyweight is downward directed while in the motor vehicle crash, at impact, the calcaneus is driven up against the talus, inversely, making a similar pattern of compression to produce the bony destruction. In such mechanism, other injuries will need to be ruled out on the spine and the hip areas while the talus is forced downward acting as a wedge to fracture the calcaneus.

In minor calcaneus fractures, the pain may not be enough to stop you from ambulating, but often one suffering from a mild fracture may limp or show the inability to step on any unequal surface because of the relation between the Achille's tendon and the calcaneus bone while the weight is being supported. The same is seen when the calcaneus bone is completely deformed from the injury, the muscle and the tendons will be unable to generate enough power to support the weight. Considerable swelling and bruising, deformity and inability to bear weight on a painful extremity are generally the symptoms experienced by the one suffering from this injury.

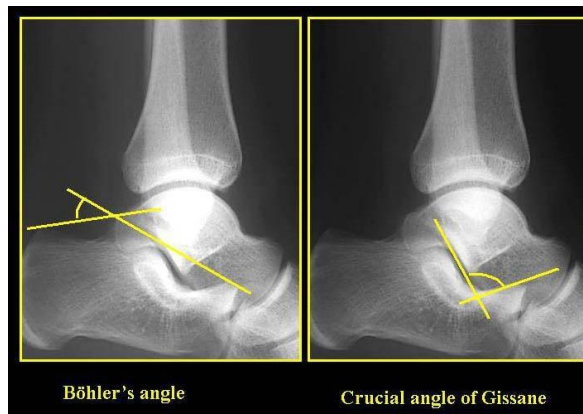
Jumping from height to land on a concrete surface or falling from a ladder are the typical way for crushing the heel bone. A short stay in the Emergency room following the accident and a consultation with your orthopedist will direct you toward a medical work-up for a controlled Diabetes, a quest for any medicine uptake but when a surgical treatment becomes necessary, poor habits like smoking and drinking may become the topic of discussion because it may contribute to poor surgical wound healing.

After medical work-up and careful examination of the foot an ankle and assurance that no other part of the body (leg, pelvis, spine and hip) is injured a careful planning of the treatment can be initiated, once the blood supply is assessed and no open wounds are appreciated. Standard X-Rays and other imaging techniques like CT-Scan will produce detailed images for

a better appreciation of the calcaneal fractures and the involvement of the joints adjacent because of the complex anatomy of the calcaneus. Valuable information will allow us to better diagnose and treat such fractures in their complexity.

We have used different classifications to appreciate a calcaneus fractures:

- A) Malgaine (1843), a French surgeon, was the first one to try to classify these fractures before the advances in radiology. He described two mechanisms of injury: an avulsion injury through a muscle-pull and a crushing injury.
- B) Bohler (1931) described the first comprehensive calcaneal fracture classification with intra-articular and extra-articular involvement and different parts.
- C) Essex-Lopresti (1952) used also a lateral radiograph to describe two types of intra-articular fractures depending on the exit point. The fracture lines which generally create either a “tongue type” or a “joint depression” at the subtalar joint through a vertical fracture deforming the angle of Gissane, flattening the Bohler’s angle or separating the anterior and the posterior portion of the body of the calcaneus.

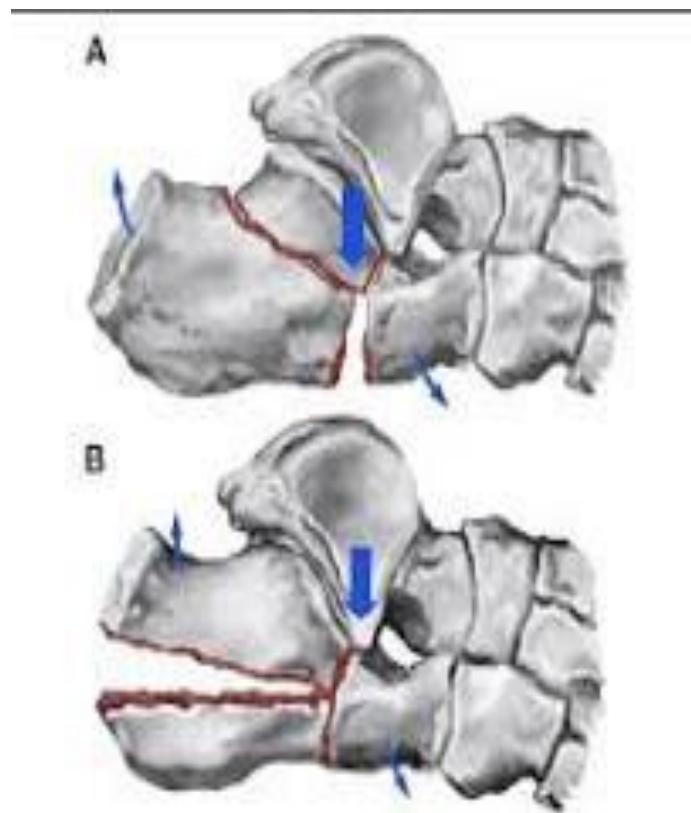


- D) Soeur and Remy (1975) proposed a classification based on the number of articular fragments displaced on radiographs or involving the posterior facet involvement to recommend surgical treatment.
- E) In the 1980, the advent of the CT has changed the way calcaneus fractures would be classified. Crosby and Fitzgibbons were the first one to use CT for evaluation of these fractures and once an intra-

articular involvement is suspected, a surgical option was found to be best for treatment.

F) Sanders (1993) extended the ideas of the Soeur and Remy classification and the notion of articular involvement using the coronal and axial views of the CT scan for surgical options. One or two Fractures may involve the posterior articular facets as well. It is presently the most used classification of calcaneal fractures.

G) Finally, a recent AO classification came with the 3 types A, B, C where the C stand for an intra-articular involvement for evaluation of such fractures.



Essee-Lopresti Classification: with lateral radiographic views and fracture-lines

In jumping from height, the body weight is driven through the talus in the calcaneus, like described in the image above, wedging the calcaneus through the talo-calcaneal joint. This classification helps in planning the restauration of the calcaneus through a surgical treatment.

Unfortunately, with the amount of comminution noted on the lateral radiographs, no conservative treatment can be offered with immobilization, Casting, Splinting, or Bracing in avoiding weight bearing for 5-8 weeks. In the past we used to treat a comminuted fracture of the calcaneus like a “bag of bone” and allow it to heal naturally. Over the years, we have learned how to approach the calcaneus surgically.

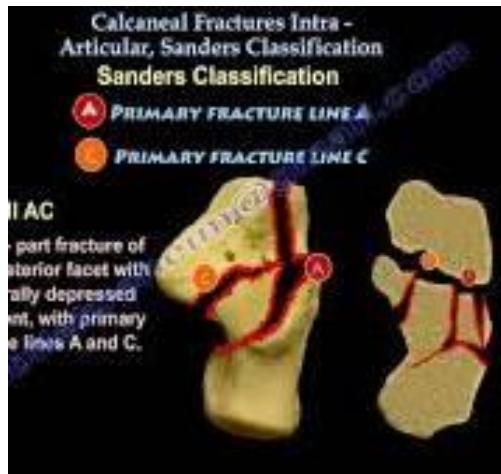
‘The first who attempted a minimally invasive surgical technique was Essex-Lopresti who manipulated the bony fragments in using a large Steinman pin, through a stab wound to perform a “calcaneoplasty” through an elevation and manipulation of the comminuted fragments allowing the restoration of the Gissane angle and the articular surface. (Trans-cutaneous approach). The fluoroscopy machine is used while the fragments are manipulated.



Essex-Lopresti technique of reduction through a minimally approach and the use of K wires.

Indeed, surgery can restore the articular surfaces of a calcaneus fracture but at what price. Unfortunately, complications like wound healing, infection, nerve damage, mal-union and non-union can result from different attempts at treating such fracture. We have already discussed complications related to the non-surgical treatments and their long-term complications like excessive pain, degenerative arthritis, painful limp and disability.

The classifications using CT-Scan and specially with the Sanders classification, has divided such intra-articular calcaneus fractures in four types based on the number of fragments and their locations (Sander’s classification). It becomes the most used classification nowadays as well as the AO classification, both based on the concepts of the Soeur and Remy.



It remains after a fracture of the calcaneus, that, if no breakdown in the skin is observed, we like to perform a Jones dressing and add a posterior splint to the lower extremity involved in order to facilitate elevation for a better control of the swelling, prior to perform any conservative or surgical treatment. This is part of the timing for optimal condition. This can improve the overall recovery and decrease the risk of infection. Open fracture must be treated immediately with proper irrigation and lavage of the wounds, antibiotic therapy, stabilization and definitive fixation. Achilles tendon injury can be also seen and may require an earlier intervention especially when an avulsion is imminent.

Procedures can be numerous like the transcuteaneous Essex Lopresti procedure already described above with the introduction of a large Steinman pin through the greater tuberosity of the calcaneus allowing the manipulation of the fragments and a reduction of the subtalar joint to reconstruct the Bohler and the Gissane angles. Percutaneous screw fixation through multiple stab-wounds has also permitted an adequate fixation of fractures of the body of the calcaneus. Occasionally, special cannulated screws can be used for better fixation.



A displaced fracture of the body of the calcaneus reduced and held in position by two screws.

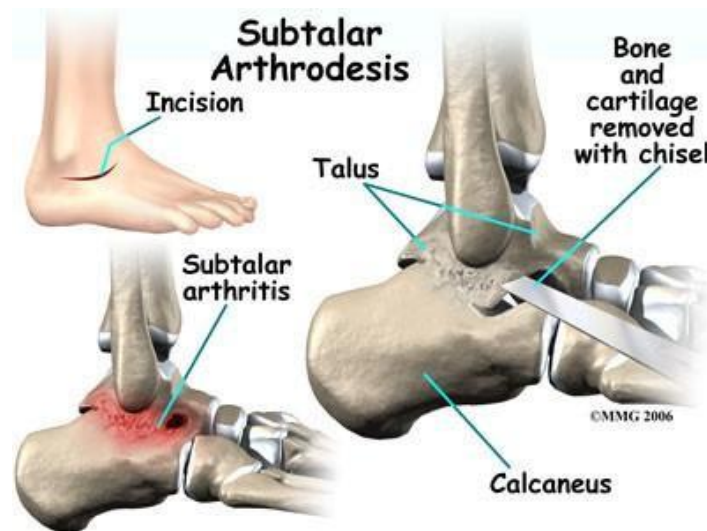
Open reduction and internal fixation via stab-wound incisions has allowed an anatomical alignment of the bony fragments. Different types of screws are being used to hold the fragment in position. Regular screws or cannulated screws, but generally cancellous have been used for better purchase of the bone.

The surgical correction of a calcaneus fracture should be left in the hands of an extremely skilled surgeon, because it can be risky. Each fracture has a pattern and each fracture needs to be approached individually. Swelling must have subsided and it is better to wait two weeks or more prior to approach the foot surgically in order to avoid wound healing problems like a dehiscence or an infection when a surgical intervention is dictated.



An open reduction generally on the outer side (lateral) aspect of the heel, can provide a nice approach to carefully re-positioned the bony fragments and facilitate their reduction with an adequate fixation using plates and screws. This will allow healing of the calcaneus fracture, but one has to remember that the more comminution, the longer time it may take to a full recovery. An incision over the heel like a "L" shape or called a hockey stick because it is similar to the stick used to play hockey, is generally the standard approach used. Other may use a more vertical or a more horizontal approach to the calcaneus and especially the subtalar joint. Attention must be given to the terminal branches of the lateral peroneal nerve (sural nerve) which cross over the lateral aspect of the foot. In anyway, the bony fragments can be exposed and reduced anatomically for adequate fixation. The surgeon may also choose to approach the heel via multiple little incisions to re-align the fragments and visualize them via C-Arm radiographic machine while a plate or multiple screws may be inserted to hold the fragments in position. A tourniquet can be used to avoid any loss of blood.

More severe injuries to the forefoot structure can bring some degree of permanent loss of function and disability, no matter what kind of treatment is offered. The plates are used to hold in position the sub-talar joint which is responsible for the stability while walking on an uneven or a slippery surface. If the joint is destroyed, one can decide to perform a fusion between the calcaneus and the talus removing all motion between the two bones. This procedure may take care of the deformities and the instability of that joint as well as the degenerative arthritis, The goal of the fusion will facilitate the control of pain and restore stability to allow a more comfortable ambulation.



The subtalar joint may develop degenerative arthritis and pain following a fracture. An operation can be performed through a transverse or a vertical incision to allow the exposition of the subtalar joint for debridement and bone grafting with allograft or autograft.

The surgical procedure can be performed as an out-patient procedure or patient may go home in 24 hours, on pain medication, with instruction to perform elevation of the involved extremity and no weight bearing for around six weeks. A posterior splint or a cam-walker will provide adequate external support. Occasionally, an anti-inflammatory medication can be added but I like to stay away from these medications because they suppress the inflammatory effect necessary for better healing at the grafted area.

The narcotics are used for pain control but can become addictive. I tend to avoid using them after a week to ten days, in order to avoid any dependency. A strict rehabilitation program in the immediate post-operative period, will facilitate a faster recovery of the ankle and the foot as

soon as possible especially after wound healing. Muscle strengthening exercises will play an important role in the rehabilitation.

In expert hands, the surgical procedure should bring nice results, once the fusion become solid. Complications can occur in the orthopedic treatment of a calcaneus fracture. They can be minor with delayed wound healing to wound dehiscence, nerve injury to tendon irritation or loss of efficiency, joint stiffness to chronic swelling, deep infection to post-traumatic arthritis of the forefoot. The last complications can be seen without any surgical procedure. This is the reason why a patient diabetic or heavy smoker become a risk for wound healing when surgical treatment is contemplated. In case of a deep infection, or poor wound healing, the problem can be such that if the infection can't be under control, the patient can be offered to have a lower extremity amputation, if necessary

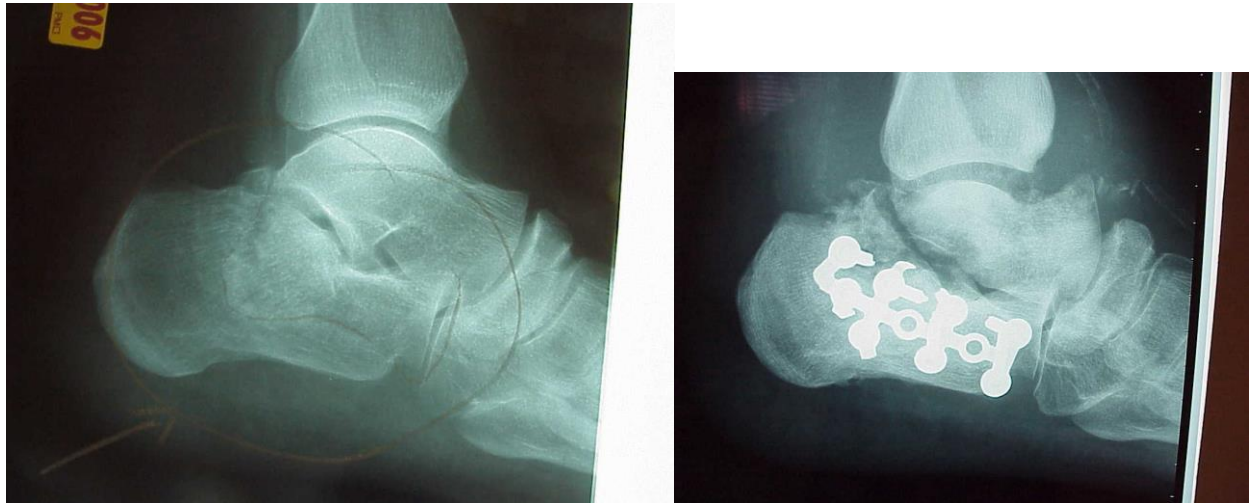


Subtalar fusion following an involvement of the subtalar joint with bone grafting.

In spite of our best efforts, a calcaneus fracture remains a challenge for the orthopedist who cares for these patients especially if surgery becomes mandatory. Recovery can take more than a year prior to have a pain-free foot and functional. A patient may never regain the normal foot and ankle function or may require modifications of life style at work or during recreational activities, especially avoiding prolonged standing,

Foot wear may need to be modified, especially high heels in women, because the Achilles tendon may be also affected. The gait can be modified especially if the motion between the talus and the calcaneus is altered. This

may change the way of walking especially on uneven ground or grassy surfaces or on hills. You still may develop subtalar pain if the heel anatomy is not perfectly restored, or if the fracture displacement persists. Last, the pain can be also due to the hardware (plates or screws) and once the fracture heals, they can be removed.



A 20-year-old gentleman with type one diabetes Mellitus and an acute calcaneus fracture (type 3 Sanders) and after medical clearance, he benefited from an ORIF of the calcaneus with plate fixation. Pre-op X-rays and 8 months post op are shown above. He has developed a Charcot hindfoot with on a well healed surgical wound and no drainage. An infection which did not answer to any conservative treatment. More, the patient was in kidney failure with an uncontrolled diabetes. He needed a below the knee amputation. Those are these unfortunate cases, which may force inexperienced surgeons to stay away from the surgical treatment of a comminuted calcaneus fracture.

In case of chronic pain, orthotics can provide some support in the discomfort. You may develop a mild leg length discrepancy with the wear of a small heel pad or a lift inside or outside the shoe or the use of special shoes. Additional surgery may become necessary if the calcaneus remains deformed or if degenerative arthritis sets up in the subtalar joint. This procedure will limit the hindfoot motion.

In a room full of Orthopedic traumatologists, I have rarely seen any universal agreement among experts for the treatment of choice at fixing surgically, a calcaneus fracture. Each case shows its difference and more deformation in the sub-talar joint does not mean more pain or discomfort after subtalar fusion. Some studies have shown significant improvement with surgical treatment, others have demonstrated that a conservative treatment has provided as good results. We are still trying to improve in the ways of treating such challenging fractures.

I want to dedicate this paper, to all the young interns and residents whom I had the privilege to teach my surgical techniques of fixation of calcaneus fractures, during their orthopedic rotations with me in Haiti, the United States, South America (Brazil, Columbia, Panama, Peru, Mexico), in Africa (Ethiopia and Egypt). Although they may recognize some of the cases in which they may have participated in the treatment, I would like them to transmit as well, the knowledge, to the generation of young surgeons to come, the way we have approached such challenging calcaneus fracture and especially, the way we have given a special attention to the subtalar joint for an optimal surgical approach. Remember, always that the goal of a successful outcome is to restore the shape of the heel bone in the best way possible, in order to assure a return of function with minimal discomfort.

I want also to dedicate this paper to a dear friend of mine Judith who is scheduled to undergo hindfoot reconstruction (subtalar joint) , following a year and half old, neglected mal-union left calcaneus fracture, with subtalar joint involvement. Best of luck.

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(Boca Raton FL May 2024)

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