Evidence for the Best Treatment for Displaced Intra-articular Calcaneal Fractures

Doklady a fakta pro optimální léčení dislokovaných intraartikulárních zlomenin patní kosti

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SUMMARY

In conclusion, this clinical scenario has proved to be a clinic conundrum. Unfortunately the surgical team may focus on the fracture and may overlook significant patient characteristics that could help in guiding optimal patient care. Operative management is the treatment of choice as long as complications can be minimized. Nonoperative care can lead to successful results in select patients in a high percentage of cases. Percutaneous fixation and arthroscopic reduction are new areas for scientific study.

Key words: calcaneus intraarticular fracture, treatment options.

INTRODUCTION

Patients who present with a displaced intra-articular calcaneal fracture should be treated initially with rest, ice, compression and elevation. After initial assessment of the injured patient, decision making becomes much more difficult. Certain factors in patients with displaced intra-articular calcaneal fractures are critically important in deciding whether to operate. It is nice to break the patient down into rationale components. Basically there are reasons to operate because of the patient's foot, because of the patient's limb, or because of the patient and his or her demographics (8, 11).

An early (1976) Level II study (1) demonstrated that more patients in the group who had a surgical reduction of their subtalar joint had resumed heavy work. Other studies, reviews, and meta-analyses have shown consistent direction that surgical treatment provides slight advantages in certain circumstances for individual patients with defined patient and fracture factors (2–7, 14, 15, 17, 19, 20).

TREATMENT OPTIONS

Nonoperative treatment

A common theme among prospective trials of operative versus nonoperative treatment for displaced intra-articular calcaneal fractures is that the hindfoot becomes stiff when it is immobilized. Because of this, nonoperative care was thought best without immobilization (1, 7, 15). One small, randomized, controlled trial was quick to dismiss nonoperative care because operative care was much better in their Level II trial (20). However, nonoperative care has withstood the test of time in certain patient populations, especially those patients who are elderly, presenting with multiple medical problems, distal vascular insufficiency or incorrigible smoking habits. Each of these patient particularities, provides very high risk for operative treatment. This means that nonoperative care and ice, elevation, tensoring and early range of motion will be very satisfactory for treatment. Weightbearing is established at 6 weeks. These patients, especially sedentary patients (8, 7), have reasonable long term results with nonoperative care (Figure 1).

Percutaneous fixation

No Level I or II trials exist showing efficacy for percutaneous fixation versus operative care in those patients where surgery has been chosen as the best option for treatment. In situations where the medical circumstance dictates that less surgery may be a better option for an individual patient, percutaneous fixation done with the aid of fluoroscopy, usually from the lateral or medial side, may result in rational care for an individual patient (Figure 2, a–c).

Operative reduction

The debate has raged for many years as to whether operative care is better than nonoperative care in many randomized clinical trials (1, 7, 14, 15, 20). However, one thing becomes clear with careful review of well performed Level II studies with good follow up and computerized tomography. Those cases where an operative reduction has been done perfectly, end in a better result (7, 18). Nonoperative care, when compared with opera-

Fig. 1. Nonoperative care of calcaneal fracture after 15 years. Patient has mild pain but was older and a heavy smoker.

tive care has consistently less successful results. Interestingly, the worst outcomes appear to be in those patients who have had operative reduction and internal fixation with a less than optimal anatomic reduction proved by computerized tomography post operatively (7, 18). This is also reinforced by a study (18) in which all prospective randomized trials were reviewed to judge operative reduction. This study suggested there was only weak evidence to support open reduction and internal fixation versus nonoperative care. There was weak evidence to show an improved plain radiographic anatomic alignment in this group of radiographic studies (15, 19, 20).

A common theme with these studies and the earlier mentioned randomized, controlled trials is that patient selection is important. Simple displaced fractures that can be easily reduced (Sanders type II) (19) are best reduced surgically. Sanders type III and IV fractures (comminuted) are more difficult to reduce accurately and to maintain reduction (13).

The favoured approach for the treatment of displaced fractures is the Seattle approach or the extended lateral approach. This approach is most satisfactory for all calcaneal fractures that need surgery except for the sustentacular fracture which requires a medial approach. This medial approach is uncommonly used but follows the medial neurovascular bundle and is directly applied to come down upon the medial fragment. Occasionally, for percutaneous surgery, a direct but very limited approach is used to apply minimally invasive techniques to calcaneal fixation. Examples would occur when reducing large tongue-type fractures or large joint-depression type fractures with very small incisions.

Another article has stated the significance of avoiding complications (12). Complications will often result in a less than optimal long term result with problems such as pain, stiffness or infection lessening the long term outcome (7, 8, 12). It clear that complications occur regardless of management strategy (even by experienced surgeons). Complications are a cause of significant morbidity, especially failure to obtain and maintain a reduction, infection and late and long term stiffness (12). Surgeon decision making was thought to be crucial for patient outcome. The right patient must receive surgery to minimize possible complications (long term problems from nonoperative care) (Figure 3). The right patient should also be treated without surgery (to minimize operative complications in that patient deemed more suitably treated without surgery) (8, 12). The patient and fracture factors thought to be important include age, sex, smoking history, compensation claim information, workload on foot, fracture classification, bilaterality, and description of whether the calcaneus is an open or closed fracture.

Fig. 2a. Axial view of patient who was thought best treated with ;percutaneous fixation note one large piece of posterior facet.

Fig. 2b. Lateral view of preop xray on percutaneous candidate note one large posterior facet piece confirmed on CT.

Fig. 2c. Lateral view of fixation after 8 weeks in patient treated percutaneously with wires alone.

EVIDENCE

Nonoperative care

No Level I evidence provides guidance for treatment of displaced intra-articular calcaneal fractures. There are combinations of demographic groups or types of patients who are best treated by nonoperative care (7, 8). Older patients (>60 years), medically unwell patients or unrepentant smokers, sedentary workers, or those with simple fracture patterns such as extra-articular types can be treated without surgery (7, 8). The non operative protocol for these patients includes early range of motion, ice, elevation and good follow up. These decisions are based on the proviso that a computerized tomographic calcaneal scan demonstrates that the foot does not have any significant morphologic shape changes or significant deformities. One of the features that was important from Howard and co-authors (12), article was that foot deformity treated without surgery will respond poorly but given the fact that no gross foot deformity (marked varus or valgus) exist, this patient should have little in the way of complications and my be a candidate for nonoperative care.

Percutaneous fixation

For those displaced fractures where full surgical approaches are not advisable (skin or soft tissue concerns, elderly patients with vascular problems, or patients with diabetes), percutaneous fixation may be used. Essex-Lopresti (11) introduced the use of the reduction technique with the posterior joy stick elevating the depressed posterior facet. Tornetta (21) reintroduced the percutaneous techniques for posterior facet percutaneous reduction more recently with a Level IV study. No Level I or II studies suggest that percutaneous reduction provides better long term results for displaced intra-articular calcaneal fractures.

Operative reduction

Once soft tissues have settled (7–10 days), operative treatment is suggested by a number of Level II studies (1, 2, 5–7, 17, 18, 20). Young patients are found to respond better than older, adult patients (7). Female patients may respond better than male patients with displaced intra-articular calcaneal fractures (7). Open fractures, because of the amount of energy and violence imparted with the foot injury, will have marked foot deformities and have better outcomes with operative care. If a patient presents with a Böhler's angle of greater than 15 degrees, than operative care may be suggested because these patients will do better with operative strategies (7). Bone graft is not required to fill the defect that is left after reduction (13). Those with a Böhler's of less than 0 degrees show equivocal results with operative care, although at least one study by Thordarson and Krieger (20) suggest much better results with operative care. Simple fracture patterns, such as Sanders fracture types II and III, respond better with operative care (5, 7). Fractures that are severely comminuted provide treatment dilemmas. Fractures with Sanders type

Fig. 3. Postoperative day 5 with wound slough and early postoperative soft tissue compromise.

IV characteristics can be treated with primary operative repair or primary fusion treatment. One study demonstrated that the amount of initial injury involved with a displaced intra articular calcaneal fracture was a primary prognostic determinant of long term patient outcome (10). Patients with Böhler's angle presentation of less than 0 degrees were 10 times more likely to require late subtalar fusion than a Böhler's angle presentation of greater than 15 degrees, whereas a Sanders type IV presentation was 5.5 times more likely to be fused than a simple Sanders type II fracture. Workers with insurance claims were 3 times more likely to need fusion than those without an insurance claim, whereas non operative care resulted in fusion 6 times more likely than in those patients treated with initial open reduction and internal fixation (10).

AREAS OF TREATMENT UNCERTAINTY

Age

Ceccarelli and colleagues (9) provided long term follow up care on calcaneal fractures in children. Children were defined as younger than 17 years. Those patients who presented with fractures when they were younger than 14 responded well regardless of non operative or operative care. Those patients who were 15–17 years old responded better with operative care. This level II study also showed that extra articular fractures could be treated without surgery.

Worker's compensation (Insurance claims)

Buckley and colleagues (7) determined that results were equivocal with their Level II study when these patients suffered displaced intra-articular calcaneal fractures. Any patients without Worker's Compensation Insurance claim did better with operative care, where those patients with an insurance claim did not score as well on the standard scoring scales (scores 20 point less on a 100 point scoring scale) (7).

Fig. 4. Open fracture with medial Type 2 wound where the sustentaculum penetrates medial skin often with neurovascular compromise as well.

Bilateral

Patients with bilateral calcaneal fractures seemed to have less successful outcomes than in patients with one fracture only (7). Gait and occupation are compromised. Treatment strategies are unclear.

Open fractures

Open fractures increase the foot trauma based on the severity of soft tissue injury. The soft tissue injury is usually on the medial side of the hindfoot. This is where the soft spike of sustentaculum lacerates the medial skin often injuring neurovascular structures as well. Treatment strategies are much more difficult because of the severity of soft tissue injury. Amputation rates nearing 10 percent are not uncommon. Treatment strategies may involve closed reduction without fixation, k-wire fixation or formal lateral open reduction and internal fixation after aggressive soft tissue management (3) (Figure 4).

Subtalar fusion

Patients with severe fractures (Sanders type IV) on initial presentation, may be treated operatively with primary reconstruction or fusion. No evidence has been reported that one is better than the other in the literature. However, late subtalar fusion is predicted by a number of presenting patient features (10). Importantly, those patients who have late fusion (greater than 6 months after injury) demonstrated outcome scores similar to those treated with surgery early (10). Level II evidence suggests if someone is treated without surgery initially because of ongoing medical circumstance but may require a late subtalar fusion for pain, their outcome will be similar to patients who had early operative care. (Figure 5, a–c).

Type of fixation to be used for calcaneal fractures

The best type of fixation for calcaneal fracture fixation is certainly unknown. Different surgeons are using many different types of fixation methods. For percutaneous fixation, generally small or large calibre threaded pins or Steinmann pins are presently being used. Occasionally, screws too are used in isolation or with the use of wires. For open calcaneal fracture surgery, using the Seattle or extended lateral approach, fixation type is variable. For many surgeons treating simple fractures, thin, low-profile plates are sufficient. For more comminuted

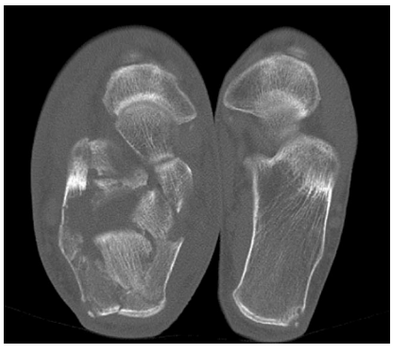

Fig. 5a. Axial ct preop of Sanders 4 calcaneal injury.

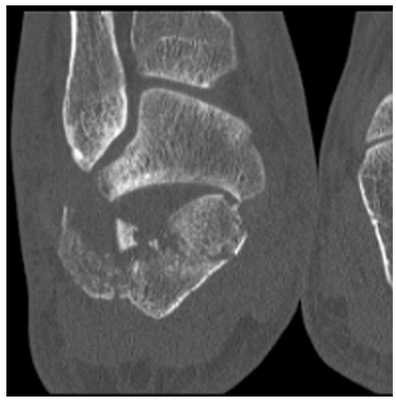

Fig. 5b. Coronal ct preop of Sanders 4 calcaneal injury.

Fig. 5c. 16 week follow-up X-ray showing healed subtalar fusion.

and displaced fractures, that have large central defects, the locking plate is an option. It is especially useful for Sanders III or IV fractures where postoperative fracture displacement is more common. Surgeons who use locking plate fixation as championed by Zwipp (22, 23) (Figure 6), feel that this fixation eliminates the need for any substance that would fill the central bony defect that is left after reduction and fixation because the locking plate is so stable. Other surgeons, including this author favour smaller, low profile nonlocking plates and the use of bone substitute to fill the defect left after reduction and fixation. This type of fixation provides no hardware beneath the incision, should it breakdown. However, the Zwipp locking plate technique provides a much more stable calcaneal construct but when the wound breaks down, it is vulnerable to plate exposure.

Fig. 6. Locking plate on calcaneus.

Cost effectiveness

At least one study has described cost effectiveness for treatment of displaced intra-articular calcaneal fractures. Brauer et al (4) suggested that patients got back to work 100 days quicker when treated operatively on average versus nonoperatively. As well based on 2005 Canadian dollars, overall treatment costs were $ 3500.00 less when patients had operative care. This was based on the fact that patients treated nonoperatively were in need of readmission for late subtalar fusion more commonly, costing the system money (4).

FINAL GUIDELINES

The spectrum of care for displaced intra-articular calcaneal fractures is dependent on patient factors and fracture factors. Level II evidence suggests that young patients, any patient without a worker compensation insurance claim, and simple fracture types with good soft tissue will have optimal results with operative care (7, 8, 18). Importantly, a surgeon must be wary of patient complications during surgery (12). This is a fracture that should be operated upon by surgeons with experience in this area. This should not be an operative intervention which is performed by the part-time or casual calcaneal surgeon. Should complications occur, the outcome for the patient significantly lessens because of further surgical needs. The surgical team must be adept at provision of an accurate reduction (Figure 7a, b). Level II evidence (7, 18) suggests that if the operative reduction is not well achieved and the surgical team is able only to achieve a partial reduction, then long term outcome for the patient is compromised. Lastly, for patients who are medically unwell, older, have extra-articular fractures or perform light or sedentary work, Level II evidence suggests nonoperative care may be the best choice. It is unclear when percutaneous fixation should be chosen and this area needs much more scientific investigation.

RECOMMENDATIONS

Patients must be carefully assessed to ensure they are good operative candidates. Smoking cessation attempts and good soft-tissue care are mandated. Investigation with plain radiographs and computed tomographic scanning can quantify and qualify the type of fracture present. When nonsurgical management is chosen, functional care is preferable to casting with early motion, non-weight bearing, and stretching. At 6 weeks, pro-

Fig. 7a. Accurate reduction of calcaneal fracture note large hole filled with bone substitute – axial view.

Fig. 7b. Accurate reduction of calcaneal fracture on lateral X-ray note large defect below subtalar joint filled with bone substitute.

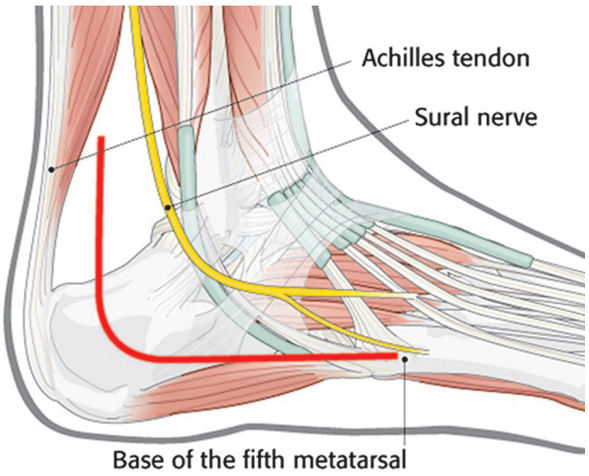

Fig. 8. „Seatle“ extended lateral surgical approach

gressive weight bearing can be started with use of custom orthoses and good footwear (8).

Percutaneous operative treatment is best utilized in patients who are medically unwell or who have simple fracture patterns. With careful use of small incisions and intraoperative fluoroscopy, posterior facet reduction is accomplished and maintained with limited internal fixation (K-wires). Knowing that an anatomic reduction provides the best result, this particular technique should be saved for those patients who, for medical reasons, should not have a large incision for open reduction and internal fixation.

Surgery is the standard of care for most displaced intra-articular fractures of the calcaneus. Skeletally mature patients (9), young adult patients (7), and any patient without an insurance claim (7) should have operative reduction internal fixation with an experienced surgical team. Simple fracture types are more easily reduced and the fracture reductions maintained using the Seattle extended lateral approach (Figure 8). Difficult reductions occur in the Sanders type III and IV fractures, and the surgeon must always be aware that „the achievement of a reduction and the maintenance of a reduction“ determines whether a patient will have a good result (7, 18). If the result is compromised with a less than adequate surgical procedure, then the patient will probably have results that are equal to or no better than nonoperative care (7). Complications must be avoided because patients with complications will have less successful results and long-term outcome (8, 12). Subtalar arthritis, if it does occur, may be treated with late subtalar distraction bone block arthrodesis (10) with good results.

The AO LCP calcaneal plate (Zwipp) is a locking plate designed for the calcaneus. It is especially useful in very comminuted fractures where rigid locking fixation is required. It is good for achieving three point fixation in the three most important parts of the calcaneus – posteriorly in the tuberosity, superiorly below the subchondral posterior facet joint surface, and anteriorly in the anterior portion of the calcaneus. This fixation maintains the Böhlers angle and the crucial angle of Gissane. Loss of fixation is rare after this procedure. On the other hand, this plate does have some problems. This plate is thick because it is a locking plate with a necessity for the screw heads to lock into the plate. This makes the plate thicker in an area anatomically, which does not easily accommodate a thick implant. A thinner implant should be used where a locking plate is not necessary. As well, because of the size of the plate (covering the whole lateral aspect of the calcaneus) this plate becomes very commonly visible when the wound breaks down through the common corner of the standard “L” approach. Because this plate is so large, it should only be used in soft tissues that are appropriate and not in areas where the skin is compromised.

The “Seattle” extended L surgical approach, as promoted by many surgeons in the AO, is an excellent approach for the whole of the lateral calcaneus. Any calcaneal fractures can be fixed through this particular approach, except for the medial sustentacular fractures. These must be fixed through buttress plate fixation on the medial side of the calcaneus (medial approach to the middle facet). This approach is completely utilitarian, allowing fixation, revision or fusion procedures to be done. The negative side of this particular approach is its extreme exposure with a high infection rate of 6–15% as described by the literature. However, when soft tissues are appropriate for surgery, this extended approach is used universally world-wide.

My preference for surgery in these particular fractures is to take a global approach to the patient. Generally, I operate on about 70% of the fractures that present to me with roughly 30% of the patients being treated nonoperatively. The patients that would be treated nonoperatively are medically unfit, elderly, severe diabetics, or unrepentant chronic smokers who have bad soft tissues. Patients who require surgery are those who are younger and understand the significance of their problem. This is a fracture where the patient must be aware that they are going to be part of a long process (six months) of rehabilitation after surgery, and they need to understand the seriousness of their commitment to wellness. Without this commitment nonoperative care provides very reasonable results, as demonstrated by the literature (7, 8). Personally, I am trending towards doing more percutaneous surgery where it is indicated to minimize complications. This must be present in all surgeon’s minds who do calcaneal fracture work. Avoidance of complications is of the highest priority. By treating soft tissues wisely, appropriate timing for surgery will minimize complications, allowing a higher percentage of patients to undergo successful surgery. Operative care, in my mind, does provide the best long-term outcome, except in patients with Sanders IV fractures where fusion can be primarily undertaken. The literature would endorse this. A recent publication by Poeze (16) in 2008 also states that surgeons should be adept at this fracture and its management (at least 1 calcaneal fracture per month treated operatively) or they risk

a much higher rate of infection and patient complications including subtalar arthritis. Newer techniques, such as percutaneous surgery using fluroscopy and arthroscopy will become more prevalent in the future as regional and local experts in this area become more common.

In conclusion, this clinical scenario has proved to be a clinic conundrum. Unfortunately the surgical team may focus on the fracture and may overlook significant patient characteristics that could help in guiding optimal patient care. Operative management is the treatment of choice as long as complications can be minimized. Nonoperative care can lead to successful results in select patients in a high percentage of cases. Percutaneous fixation and arthroscopic reduction are new areas for scientific study.

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