4.5 Displaced intraarticular fracture—sinus tarsi approach

Michael Swords, Candice Brady

1 Case description

A 56-year-old man fell approximately 1.5 meters off a ladder onto his right foot while working in construction. He experienced immediate pain on that heel. On arrival at the hospital, the patient underwent x-rays of the foot and ankle which demonstrated a right intraarticular, displaced, comminuted, joint depression fracture of the calcaneus (**Fig 4.5-1**). A thorough clinical examination ruled out additional injuries. There was no back pain. The injury was a closed. The right leg was placed in a well-padded splint with the ankle and hindfoot in neutral position.

Fig 4.5-1a–c Postinjury x-rays of the calcaneus.
a Lateral view.
b Axial view.
c Brodén view.

A computed tomographic (CT) scan is necessary for full 3-D understanding of the injury and operative planning. The CT revealed the fracture pattern and displacement to be an AO/OTA 82C2, Sanders 3AC (**Fig 4.5-2**). Given the amount of swelling, the patient was discharged home with strict orders to elevate the foot above the level of the heart and nonweight bearing. The next week he was followed up in the office for swelling and soft-tissue assessment.

Fig 4.5-2a–f Computed tomographic (CT) scans.
a–b Axial view showing comminution of the articular surface and loss of articular congruity and widening of the calcaneal body.
c–d Lateral view showing comminution, intraarticular extension, and posterior facet joint depression.
e–f Coronal view showing comminution, intraarticular extension, and number of articular fragments at the widest portion of the posterior facet.

2 Preoperative planning

Indications for surgery

The indications for surgical treatment in this patient included gross displacement and incongruity of the articular surface. The tuberosity was in significant varus. There was a marked decrease in the Bohler angle and an increase in the angle of Gissane consistent with a significant loss of calcaneal height.

Treatment options

Options for approaches include:

- Lateral extensile (Case 4.6: Complex articular fracture (Sanders 3/4): extensile approach)
- Sinus tarsi
- Percutaneous techniques (Case 4.4: Simple articular fracture (Sanders 2): minimally invasive screw fixation)

For this patient the sinus tarsi approach was chosen because it provides adequate visualization of the joint surface and causes limited soft-tissue disruption while still allowing restoration of overall calcaneal anatomy. A prerequisite for treating calcaneal fractures by a sinus tarsi approach is an in-depth understanding of the fracture patterns and reduction techniques necessary for successful fracture reduction. This approach should not compromise the quality of reduction.

A lateral plate can be used for maintaining the articular surface reduction. Several types of plates are available for calcaneal fractures. As the sinus tarsi approach is performed through a small incision, a smaller plate is typically used. A locking or a conventional T-plate 2.4 will maintain the articular surface of the posterior facet and attach it to the anterior process, maintaining the articular reduction. Variable angle (VA) anterolateral locking calcaneal plates 2.7 are also available and may be used in cases with more comminution or decreased bone density.

This patient is healthy, young, non-smoker, and non-diabetic, so a conventional plate (non-locking) can be used. Unlike the lateral extensile plates, the smaller sinus tarsi plates do not provide fixation into the tuberosity. Fixation of the tuberosity and maintenance of alignment is achieved using independent screws, typically 3.5 or 4.0 mm, placed percutaneously into the tuberosity (**Fig 4.5-3**).

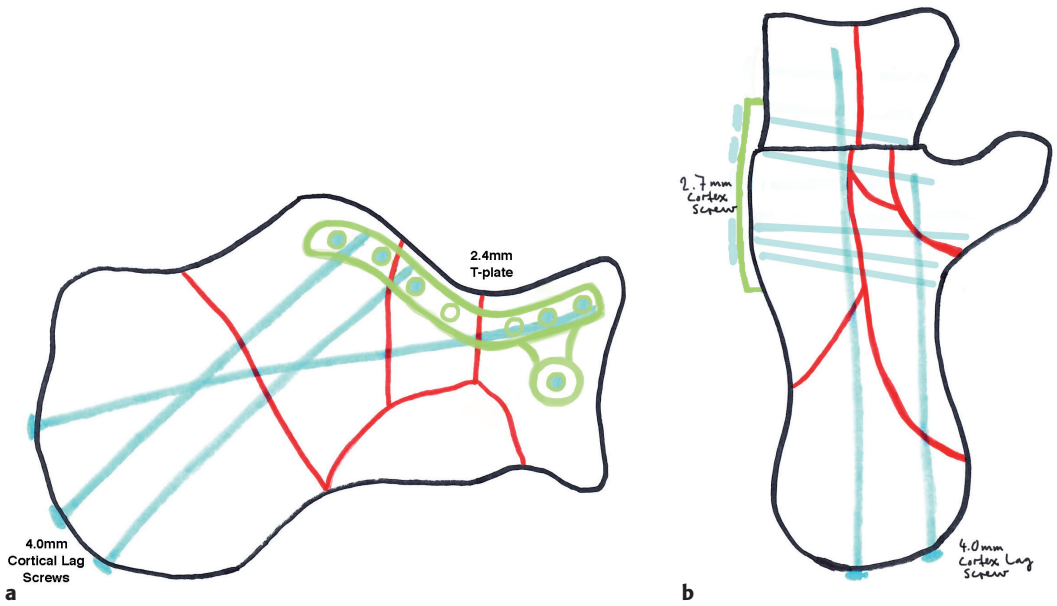

Fig 4.5-3a–b Preoperative plan. Through a sinus tarsi approach, a VA anterolateral locking plate 2.7 is used to maintain the posterior facet reduction, critical angle, and anterior process. Lag screws are inserted percutaneously to maintain the alignment of the medial wall reduction and tuberosity fixation.

3 Operating room set-up

Patient positioning	Lateral decubitus on a radiolucent table (injured side up)
Anesthesia options	General, spinal, or regional
C-arm location	Monitor on the opposite side of the table and the image intensifier entering at an oblique angle from the foot of the bed
Tourniquet	At the surgeon's discretion. Generally, improves fracture visualizatio
Tips	Appropriate C-arm position allows all necessary images to be obtained without moving the limb. This is important as a large amount of the reduction and insertion of hardware is performed using the C-arm with the sinus tarsi approach

For illustrations and overview of anesthetic considerations, see Chapter 1: General considerations in foot and ankle surgery. For illustrations and overview of patient and C-arm positioning for calcaneal fracture treatment in the lateral decubitus position refer to Chapter 4: Calcaneal fractures.

Equipment

- Osteotome
- Small elevator (Freer)
- K-wires and olive wires
- Small plate (VA anterolateral locking plate 2.7, locking T-plate 2.4, or conventional T-plate)
- 2.7 mm fully threaded self-tapping cortex screws
- 4.0 mm fully threaded self-tapping cortex screws
- 4.0 mm Schanz pin
- Headlight for improved visualization

4 Surgical procedure

The skin is examined to ensure it wrinkles and no traumatic wounds or extensive fracture blisters are present where the sinus tarsi incision will be placed (**Fig 4.5-4**). A tourniquet may be used at surgeon's discretion. Joint visualization is often improved with tourniquet use.

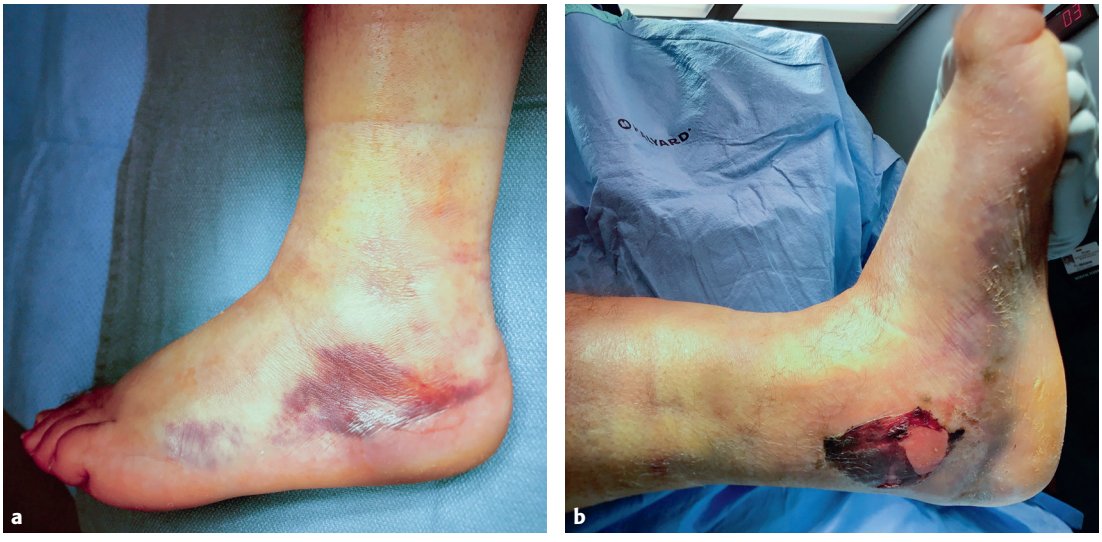

Fig 4.5-4a–b The skin at the beginning of the case showing appropriate swelling resolution with no traumatic skin issues laterally (**a**) and a large medial fracture blister (**b**).

An incision is made over the sinus tarsi just plantar to the tip of the fibula above the peroneal tendons and extended distally to the anterior process. This incision is along the superior aspect of the calcaneus, slightly lower than typically used to expose the subtalar joint for arthrodesis (**Fig 4.5-5**). Be aware that the sural nerve is plantar to the incision and the superficial peroneal nerve is dorsal. The peroneal tendons are identified and elevated off the lateral wall of the calcaneus.

Dissection is then carried down to the joint with a retractor protecting the peroneal tendons. The sinus tarsi soft tissue must be removed to allow visualization, and the lateral capsule of the subtalar joint incised if it is still intact. A small bump of towels can be placed proximal to the malleoli with the foot unsupported in inversion to help improve visualization. A small elevator is inserted into the fracture line just below the posterior facet and used to disimpact the lateral fragment of the posterior facet. A small incision is made on the lateral aspect of the tuberosity and a 4.0 mm Schanz pin is inserted from lateral to medial (**Fig 4.5-6**).

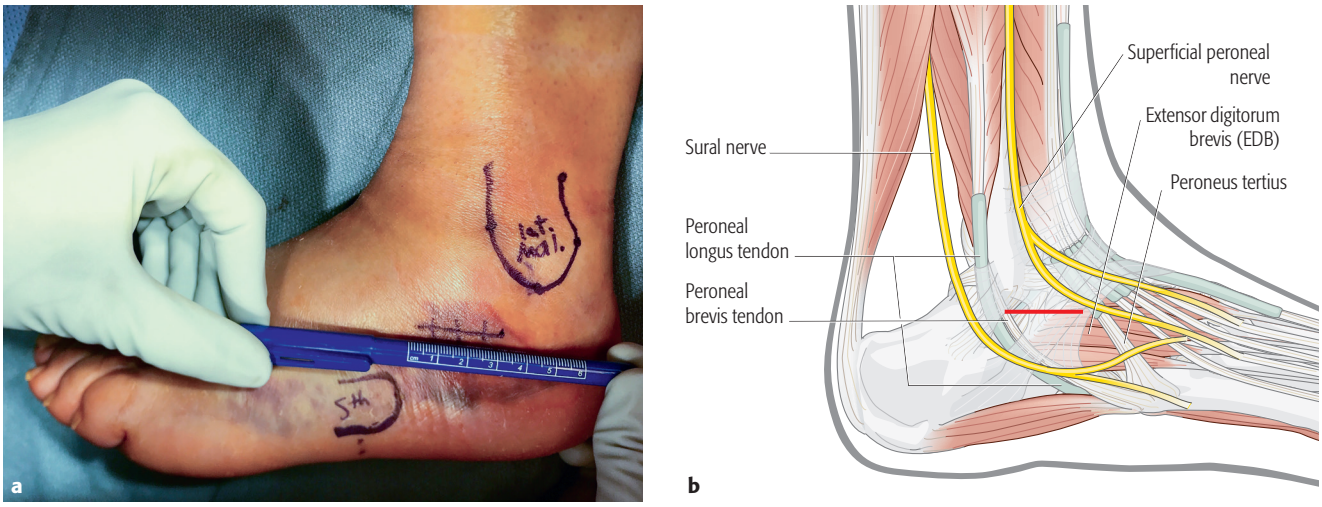

Fig 4.5-5a–b The sinus tarsi approach skin incision (**a**) with underlying anatomy (**b**).

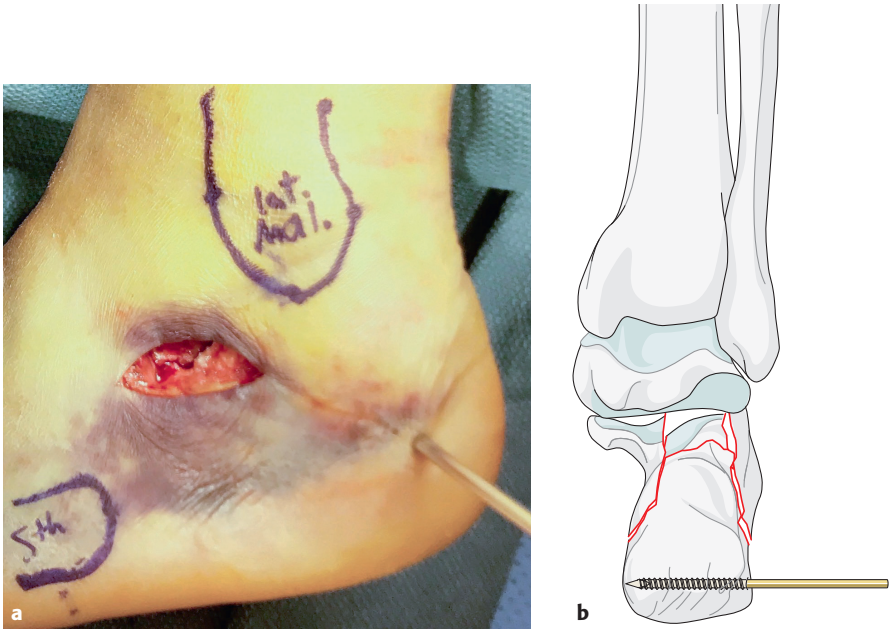

Fig 4.5-6a–b Bicortical placement of the Schanz pin in the tuberosity.

Two small K-wires are placed from the plantar medial tuberosity with one slightly superior to the other and inserted just inside the medial wall, angled dorsally up to the fracture line (**Fig 4.5-7**). An osteotome is then placed under the lateral posterior facet fragment and through the primary fracture line exiting out the medial wall (**Fig 4.5-8**). A T-handle is placed on the Schanz pin. The medial wall is reduced by manipulating the medial joint surface with the osteotome to elevate and disimpact combined with a Schanz pin to rotate and realign the tuberosity. This will restore medial wall height and correct varus.

Fig 4.5-7a–c Intraoperative clinical images showing K-wire placement before tuberosity reduction. The wires are placed just inside the medial cortex and directed toward the posterior facet and are driven in just short of the fracture. Two wires are used to prevent rotation (**a–b**). Confirmation of appropriate K-wire position using the image intensifier (**c**).

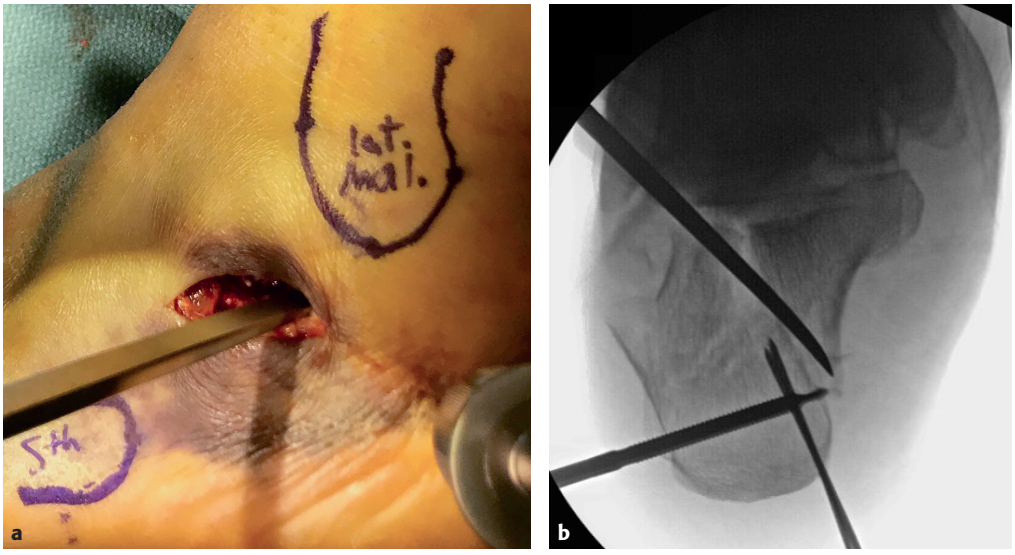

Fig 4.5-8a–b Osteotome placement through the primary fracture line and out the medial wall.

Once reduction is acceptable on the image intensifier, an assistant advances the previously placed K-wires across the fracture while the surgeon holds the reduction (**Fig 4.5-9**). At the surgeon's discretion, a small distractor can be used to aid in reduction.

(See Case 4.4: Simple articular fracture (Sanders 2)—minimally invasive screw fixation for description on how to use a distractor as a reduction aid in calcaneal fracture fixation.)

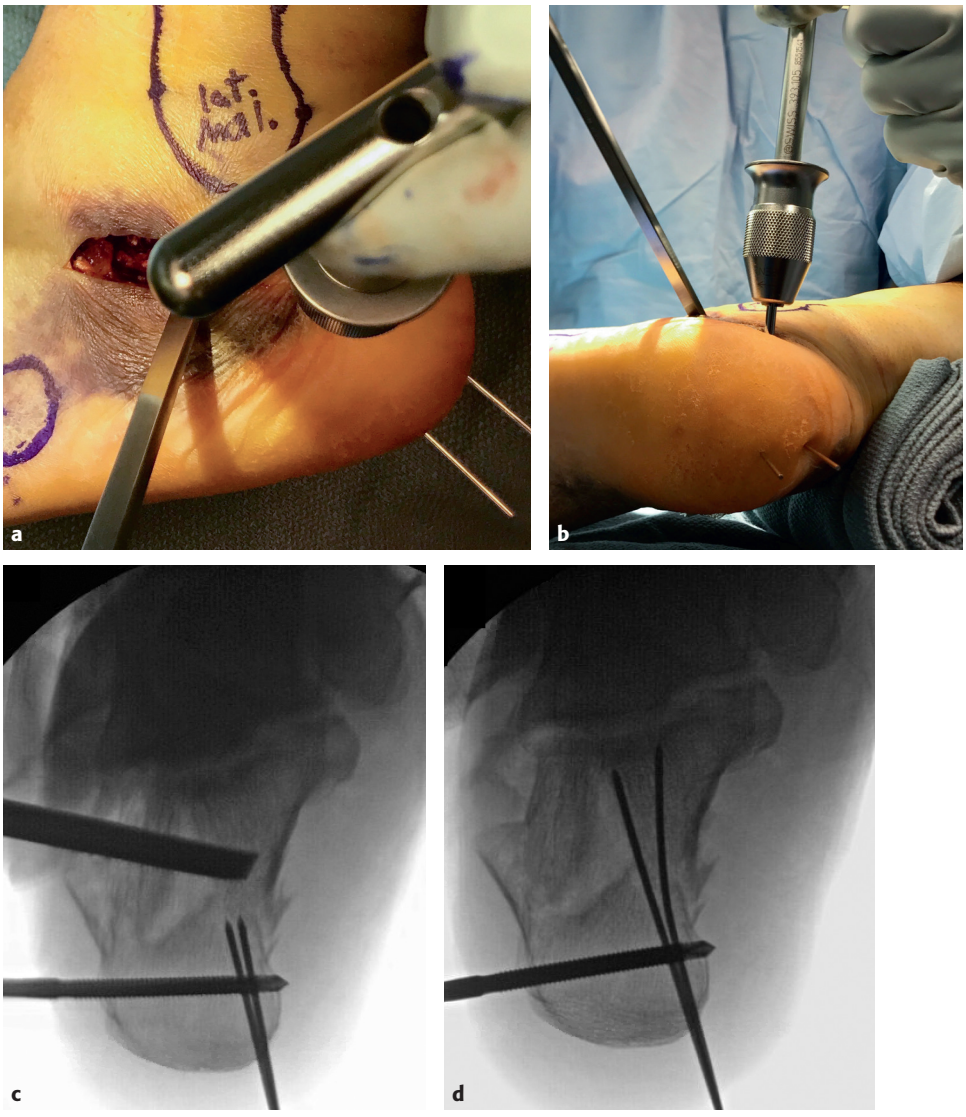

Fig 4.5-9a–d The osteotome is used to elevate the medial articular surface and the Schanz pin is used to align the tuber reducing the medial wall (**a–c**). The K-wires are then advanced across the fracture line (**d**).

Next, the articular surface of the posterior facet reduction can be accomplished by inserting a small K-wire into the lateral posterior facet fragment. This wire is placed just under the articular surface to avoid interfering with plate placement. A drill sleeve is placed over the K-wire and used as a joystick to maneuver the fragment into appropriate position. Often, more than one K-wire is needed. Once the fragment is in appropriate position, the K-wire is advanced to provisionally hold the reduction (**Fig 4.5-10**). Additional K-wires may be used, if necessary, to aid in reduction. A minimum of two provisional K-wires are required to maintain reduction and prevent rotation.

Next the anterior process and critical angle are reduced. Reduction is performed under direct visualization. The anterior process is typically elevated, and a dental instrument/scaler is used to reduce this down to the leading edge of the posterior facet at the critical angle. In this location the bone is dense and the fracture line will have an accurate reduction read. While the reduction is held in place, K-wires are brought through the skin into the anterior process and directed posterior into the calcaneal body for provisional fixation (**Fig 4.5-11**).

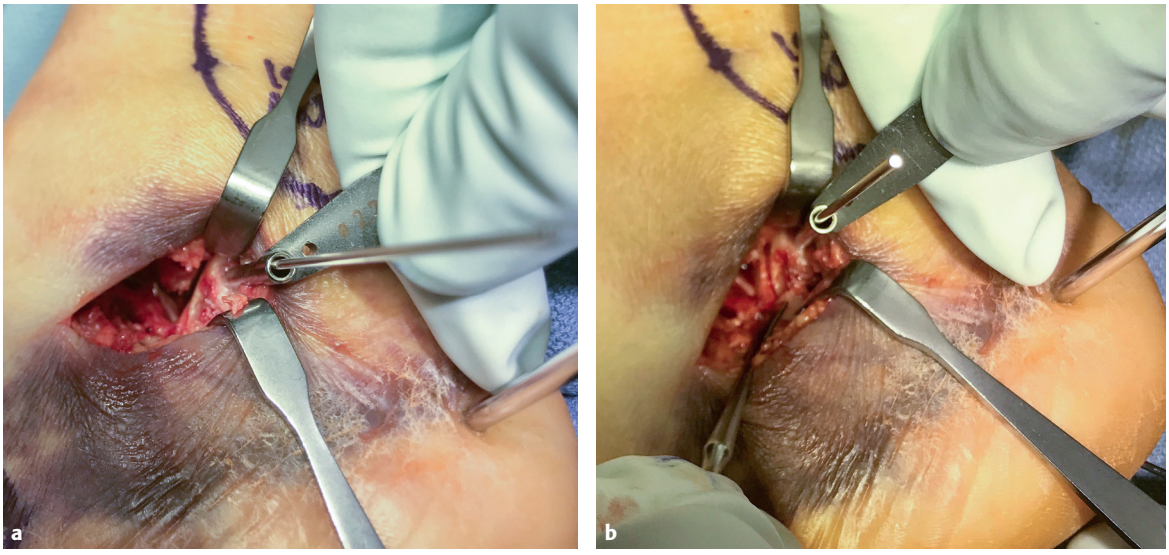

Fig 4.5-10a–b Reduction of the posterior facet.
a The posterior facet before reduction with a K-wire is positioned so that it will not interfere with plate placement. The drill guide is over the K-wire to use as a joy stick to aid in reduction of the articular surface. Often more than one wire will be used.
b The posterior facet after reduction with the K-wire advanced to hold the reduction.

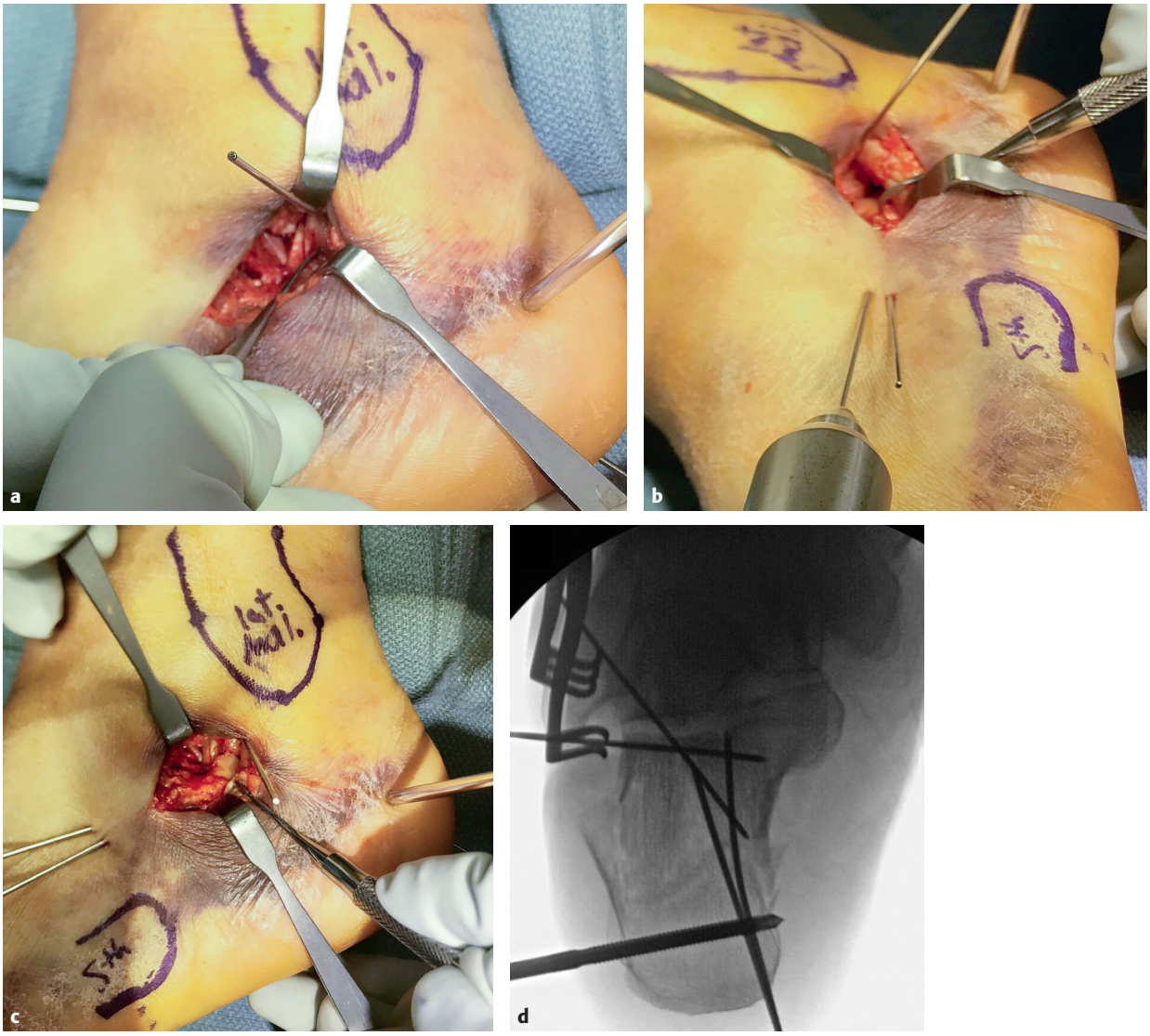

Fig 4.5-11a–d The critical angle and anterior process are before reduction (**a**). Two K-wires are inserted through the anterior process toward the calcaneal body to hold the reduction of the anterior process and critical angle (**b–d**).

Fixation of the posterior facet to the anterior process using a plate

A plate is inserted and placed on the lateral aspect of the calcaneus just plantar to the critical angle with holes in position to connect the posterior facet, critical angle, and anterior process. Care is taken to ensure the plate is not on the peroneal tendons and that the lateral wall fragment is contained under the plate.

A common error is to not release the peroneal tendons off the lateral wall of the calcaneus at the peroneal tubercle. The lateral cortical fragment often referred as the lateral wall blow-out is pulled away by the peroneal tendons. If the tendons are not released the plate may inadvertently be placed between the lateral cortical wall and the body of the calcaneus. After the plate is in the correct position, threaded ball-tipped compression wires can be used to hold the plate in place (**Fig 4.5-12**). Two 2.7 mm cortex lag screws are placed through the plate underneath the posterior facet to stabilize the articular surface. Two screws are placed into the anterior process and then the K-wires in the anterior process are removed.

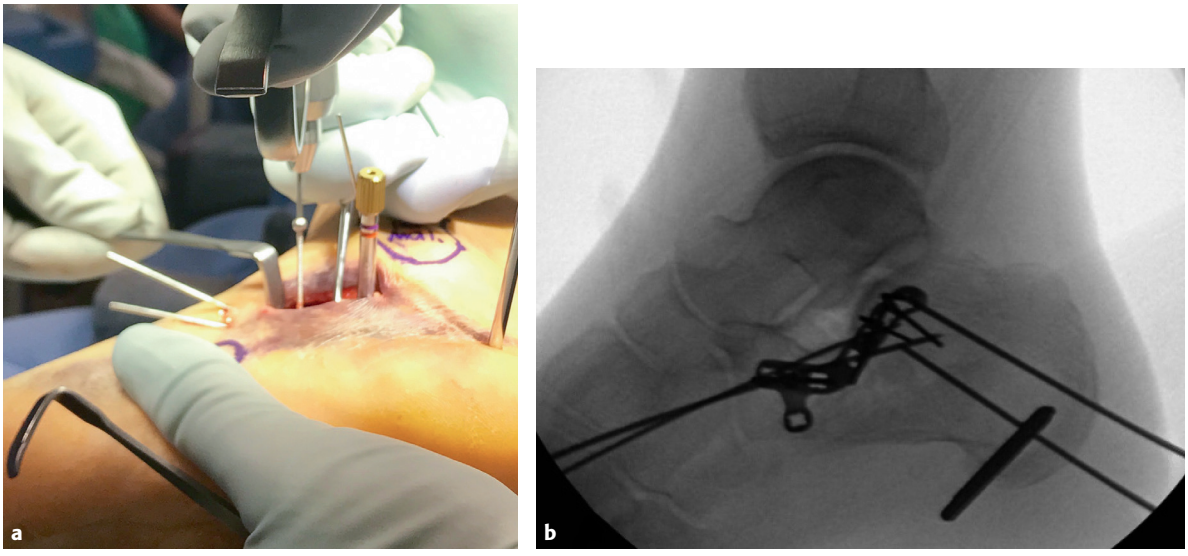

Fig 4.5-12a–b The plate is inserted onto the lateral of the calcaneus and holding in place with threaded ball-tipped compression wires (**a**). Image intensifier showing plate in correct position (**b**).

Fixation of the tuberosity to articular segment with screws

A small incision is made in the posterior tuberosity between the tuberosity K-wires holding the medial wall reduction. The Schanz pin is removed to avoid interfering with hardware insertion. A 4.0 mm cortex screw is inserted just inside the medial wall of the tuberosity in line with the K-wires to stabilize the calcaneal height and alignment. A second 4.0 mm screw is placed along the medial wall of the tuberosity directed toward the posterior facet (**Fig 4.5-13**). Both posterior tuberosity K-wires are removed. Two points of fixation are always necessary to prevent loss of reduction.

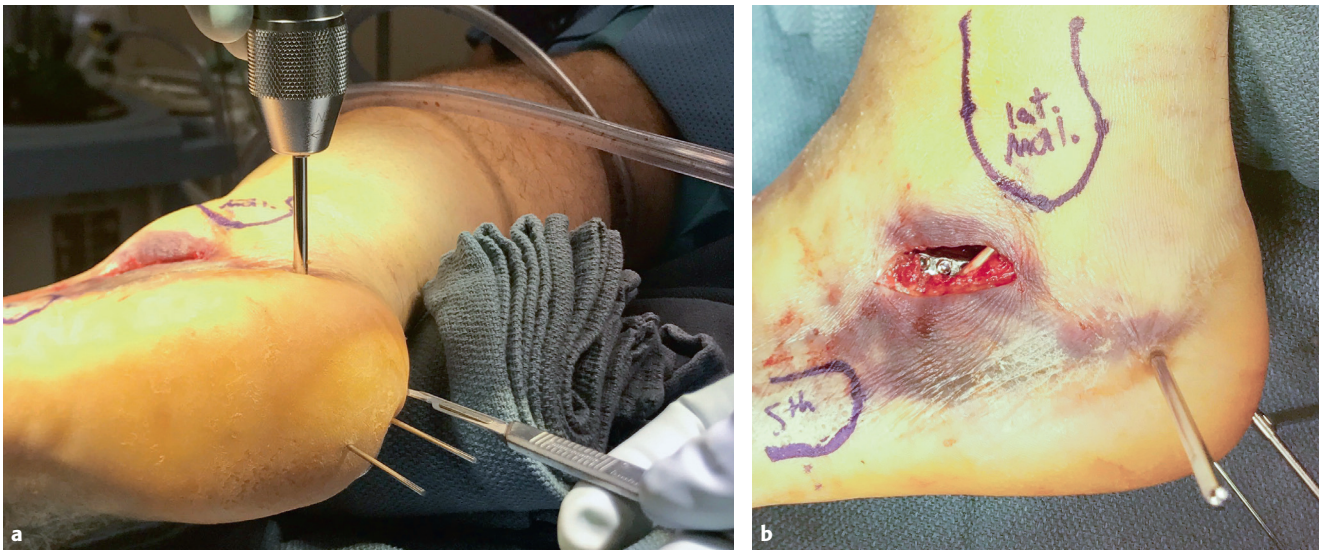

Fig 4.5-13a–b A small incision is made just superior to the K-wires used to maintain the medial wall reduction (**a**) and a 4.0 mm cortex screw is drilled in line with the K-wire and an appropriate length screw is placed (**b**). A second screw will be placed between the two K-wires to complete fixation of the fracture line exiting the medial wall.

Fixation of the tuberosity to the anterior process with screws

Another small incision is made just medial to the previous two (centered medial to lateral). A small incision is then made centrally on the tuberosity and a 4.0 mm screw is drilled from the posterior tuberosity to the anterior process, measured and placed (**Fig 4.5-14**). Additional 4.0 mm cortex screws may be placed as needed based on the fracture pattern.

The joint is inspected under direct visualization, palpitation with a freer elevator and an image intensifier to assess anatomical reduction (**Fig 4.5-15**). The wound is thoroughly irrigated. The tourniquet is deflated, and hemostasis is confirmed. Skin tension is relieved by placing a small towel bump distal to the malleoli everting the foot, assisting in wound closure (**Fig 4.5-16**). The sinus tarsi incision is closed with 2-0 braided absorbable for subcutaneous tissue and 3-0 nylon in a tension-relieving fashion for the skin. The small incisions are closed with simple sutures (**Fig 4.5-17**). A sterile dressing is applied consisting of adaptic, gauze, and Webril. The patient is placed in a well-padded, posterior sugar-tong splint.

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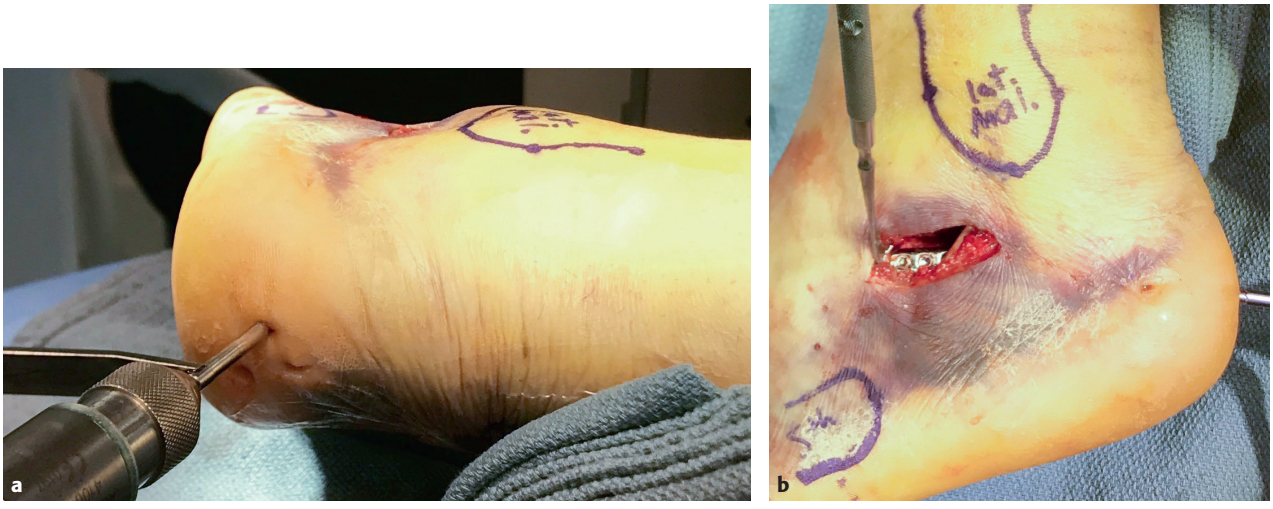

Fig 4.5-14a–b A final 4.0 mm cortex screw is drilled starting just lateral to the previous two screws (**a**) and directed toward the anterior process. Ideally, the screw will be placed just inferior and distal to the plate as indicated by the small elevator (**b**).

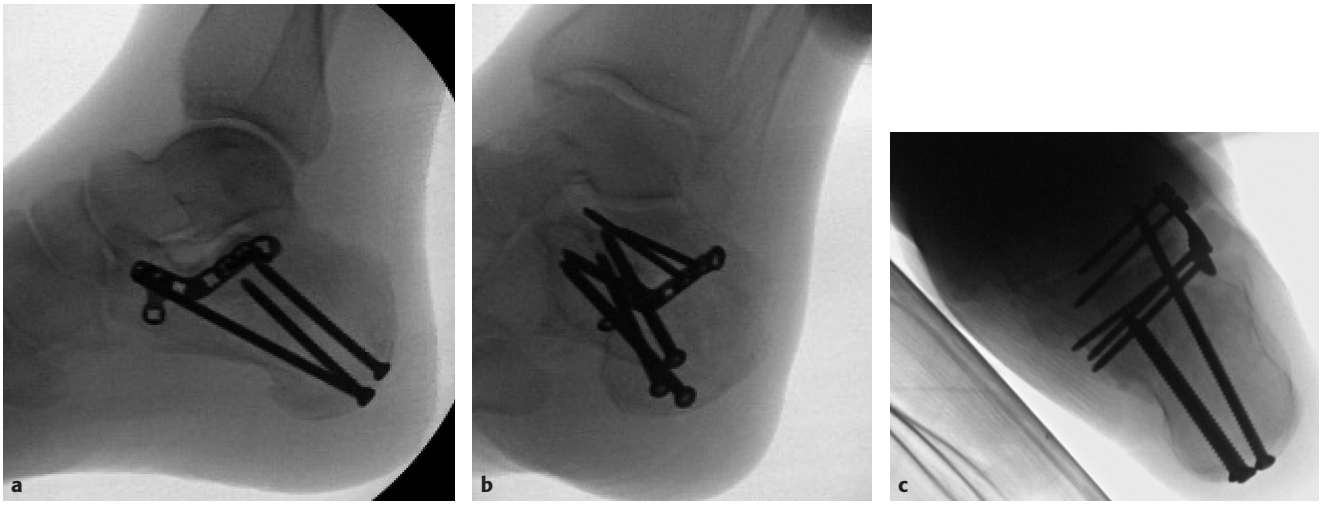

Fig 4.5-15a–c Final intraoperative images of the definitive fixation with anatomical reduction.
a Lateral view.
b Axial view.
c Brodén view.

Fig 4.5-16a–d Final fixation and a small portion of the peroneal tendons are visible through the sinus tarsi incision (**a**). A towel bump is proximal to the malleoli improving visualization by allowing the subtalar joint to invert. The small incisions are used to insert the independent screws from the tuberosity (**b**). To decrease skin tension at the sinus tarsi incision the towel bump may be placed under the foot distal to the malleoli causing eversion aiding in wound closure with less tension (**c–d**).

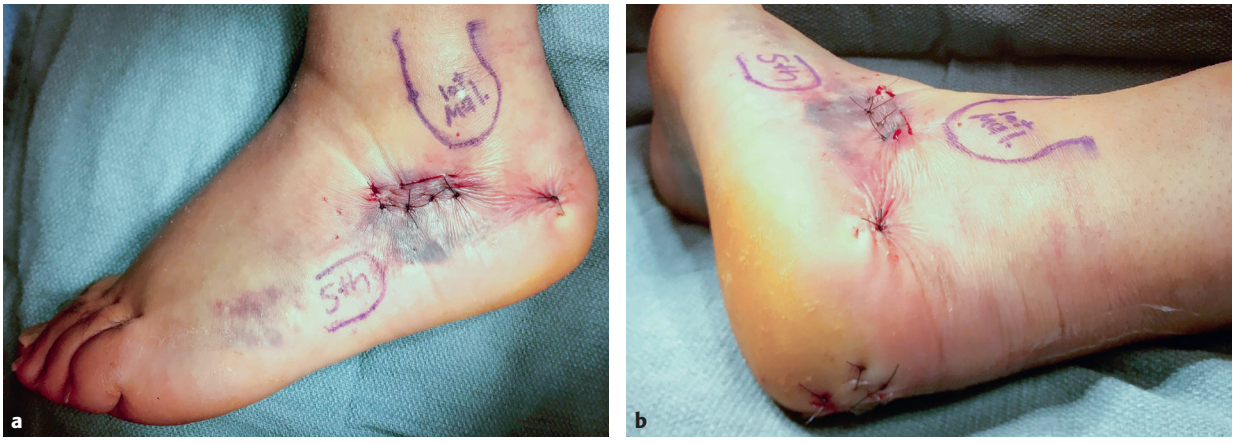

Fig 4.5-17a–b Closure of all incisions with 2-0 vicryl for subcutaneous tissue and 3-0 nylon for skin.

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"...elongating the incision, thus creating a larger mobile window can help improve visualization."

5 Pitfalls and complications

Pitfalls

Inadequate reduction of the posterior facet

The sinus tarsi approach allows for direct visualization of the posterior facet. However, in severely displaced injuries, anatomical landmarks are distorted which may result in the incision being placed too inferior or superior. It is challenging to visualize the posterior facet but may be compensated by elongating the incision, thus creating a larger mobile window.

Surgeon experience is essential. The surgeon must be familiar with the 3-D geometry of the calcaneus, fracture patterns and reduction techniques required to reduce these difficult fractures. This knowledge increases the likelihood of successful reconstruction of the entire shape of the calcaneus. Surgeons unfamiliar with this technique are encouraged to begin with simpler fracture patterns.

Inadequate reduction and fixation of the varus malalignment

The varus malalignment is indirectly reduced. To verify correct reduction and placement of fixation, perfect intraoperative images must be obtained. If the C-arm is not set up correctly, or the person operating the C-arm is inexperienced, this can be difficult. It is important to take time at the beginning of the case to set up the C-arm properly and discuss with the appropriate staff member how to obtain the necessary images, particularly the heel view of the calcaneus.

Irreducible fragments

Remove small intercalary fragments that cannot be stabilized with direct or indirect stabilization. These fragments can displace into the joint as a loose joint body.

Complications

- Wound-healing complications
- Injury or irritation of the peroneal tendons
- Irritation of the posterior heel with screw placement
- Loss of fixation
- Malunion
- Nonunion
- Subtalar posttraumatic arthritis

6 Alternative techniques

Alternative approaches include:

- Percutaneous techniques, see Case 4.4: Simple articular fracture (Sanders 2): minimally invasive screw fixation and Case 4.6: Complex articular fracture (Sanders 3/4): extensile approach
- Lateral extensile approach, see Case 4.6: Complex articular fracture (Sanders 3/4): extensile approach.

Plate options include 2.4 plates, both locking (different case: **Fig 4.5-18**) and non-locking in addition to VA locking plates 2.7.

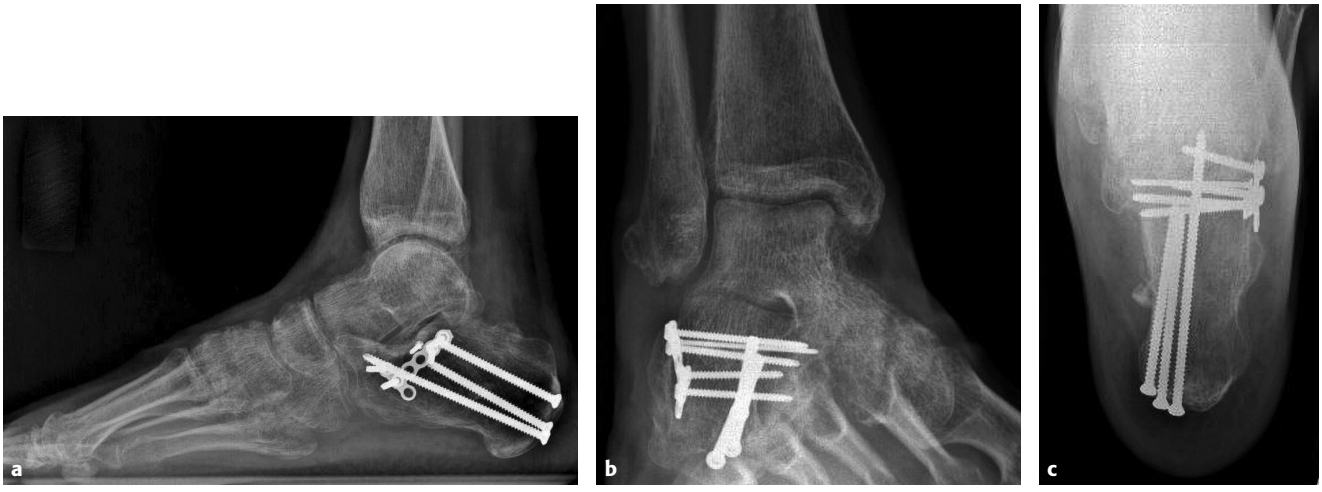

Fig 4.5-18a–c Different case: A 77-year-old man treated with a locking plate 2.4.
a Lateral view.
b Brodén view.
c Axial view.

7 Postoperative management and rehabilitation

Postoperatively, the foot is immobilized in a bulky Jones splint and be careful not to put any pressure over the heel. The patient is administered postoperative antibiotics for 24 hours. Patients are given instructions on non-weight bearing and elevation with specific counseling on the importance of maintaining these recommendations for wound healing.

The first follow-up is at 2 weeks postoperatively when the splint is removed, incisions inspected, and sutures removed. The foot is then placed in a posterior splint orthosis and the patient is instructed to maintain a non-weight bearing status. At this point, the patient can start active range of motion exercises.

At 6 weeks, the patient is seen in the outpatient office and an x-ray of the fracture is taken (**Fig 4.5-19**). The images are scrutinized for anatomical reduction and healing. If the fracture is healed, the patient may increase weight bearing. Progression to full weight bearing typically occurs over a 2- to 4-week period. If the fracture is not healed, the patient must maintain the non-weight bearing status and is reevaluated within another 2–4 weeks. If there are any concerns regarding healing, perform a CT scan.

Implant removal

Some patients experience hardware irritation. The implants causing the irritation may be removed. Hardware removal is typically not performed until at least 1 year after surgery. An arthrolysis of the subtalar joint is performed at the same time as hardware removal.

Fig 4.5-19a–c Postoperative x-rays at 6 weeks.
a Lateral view.
b Axial view
c Brodén view

8 Recommended reading

Basile A, Albo F, Via AG. Comparison between sinus tarsi approach and extensile lateral approach for treatment of closed displaced intraarticular calcaneal fractures: a multicenter prospective study. *J Foot Ankle Surg.* 2016 May–Jun;55(3):513–521.

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