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Article

Single-Lateral-Incision Technique for Talar Neck Fractures—A Viable Option

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Abstract: Background: Displaced talar neck fractures are subject to avascular necrosis and degenerative joint disease. A single-lateral-incision approach may avoid damage to the remaining blood supply to the talar body provided by the deltoid artery. The purpose of this paper is to describe the surgical technique for a single approach to talar neck fractures, to evaluate the outcomes in a cohort of patients, and to review the literature on the topic. Method: A retrospective review. Patients were identified at a single medical center and met the following inclusion criteria: closed fracture, type-II talar neck fracture with displacement of the subtalar joint, single lateral operative approach, and radiographic follow-up of at least 6 months. Results: Five patients were identified meeting the inclusion criteria. The mean follow-up was 18 months (12–25). The mean VAS (Visual Analog Score) score at the final follow-up was 1.2 (0–3). Four of five patients returned to running at the final follow-up. The one patient who did not return to running was able to bike and hike. There were no cases of avascular necrosis and no cases of degenerative joint disease. Conclusions: Although a two-incision approach could be considered for all displaced talar neck fractures, there are certain fractures that can be anatomically reduced and stabilized through a single lateral incision which may limit the risk of avascular necrosis.

Keywords: talar neck fracture; sinus tarsi approach; Hawkins Type II; osteonecrosis

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1. Introduction

Fractures of the talus are uncommon and challenging fractures. There is no consensus on surgical techniques for treatment. Various studies approximate the incidence of talar fractures ranging from 0.1–3%, with talar neck fractures accounting for 50% of those cases [1,2]. The surgical approach is based on the level of displacement and the complexity of the fracture. Current standard practice utilizes combined medial and lateral approaches [2–7].

Outcomes of talar fracture fixation remain poor, with osteonecrosis representing a potentially modifiable complication. Early studies documented rates of osteonecrosis as high as 58% [8]. More recent reviews have documented rates between 20% and 45% [7,9]. In a systematic review of the literature, Dodd et al. reviewed factors associated with osteonecrosis in 26 articles. The authors noted that risks factors include open fractures, fracture displacement, and degree of comminution. The use of a surgical approach was not evaluated as a risk factor [9]. The persistent high rate of osteonecrosis indicates that current standards of care that include the use of combined medial and lateral incisions may need to be challenged. Osteonecrosis occurs secondary to damage to the unique blood supply of the talus. The main blood supply to the talus comes from an anastomotic sling inferior to the talar neck. This sling is an anastomosis between the lateral artery of the tarsal sinus (a branch of the perforating peroneal artery) and the artery of the tarsal canal (a terminal artery of the deltoid branches of the posterior tibial artery [1]). Through studies using gadolinium-enhanced MRI, the approximate contribution from the peroneal artery is 17%, from the anterior tibial artery is 36%, and from the posterior tibial artery is 47% [10]. When a fracture occurs through the talar neck, the retrograde blood supply from the anterior tibial artery and peroneal artery can be compromised, leaving the deltoid branches of the posterior tibial artery to supply the remaining talar body. A medial incision compromising the remaining branches of the deltoid artery could potentially increase the risk of osteonecrosis [1].

Talar neck fractures were originally classified by Leland Hawkins, and this classification system is described by initial displacement: Type I is described as a nondisplaced fracture, Type II is a displaced fracture with a subluxed or dislocated subtalar joint, Type III is a displaced talar neck fracture with the associated dislocated tibiotalar joint [8]. In Hawkins Type-II talar neck fractures (Figure 1), the lateral aspect of the fracture is the tension side, while the medial aspect is the compression side. A lateral approach allows for an anatomic reduction of the tension-sided fracture fragments. A single lateral incision minimizes iatrogenic disruption of the medial talar blood supply and can potentially decrease the rate of osteonecrosis. In this paper we describe the surgical technique for a single-lateral-incision approach to the talus and report on outcomes and complications in a retrospective case series utilizing this technique.

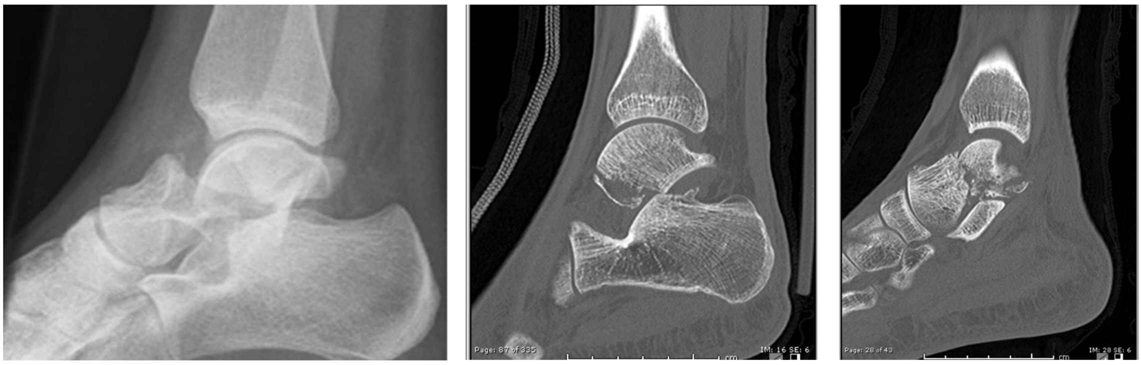

Figure 1. Preop lateral view of Type-II talar neck fracture, with middle picture showing simple lateral line and subtalar dislocation and right showing medial communition of the fracture.

2. Materials and Methods

Ethical review and approval were waived for this study due to it being a retrospective chart review. The electronic medical records for all patients who underwent operative fixation of a talar neck fracture through a single lateral incision over a five-year period were reviewed. All patients were treated by a senior fellowship-trained Foot and Ankle Orthopedic Surgeon with over 15 years of experience. Inclusion criteria included Hawkins Type-II talar neck fractures with at least one year of radiographic follow-up in those aged 18–50. Simple rotational ankle fractures were not excluded if concomitant injuries. Patient records had to include a Visual Analog Pain scale and occupational outcome information. Exclusion criteria included: open fractures; ipsilateral fractures of the distal tibia; hindfoot fractures; fracture extending into the body; frank dislocation of the subtalar joint; age less than 18 or greater than 50; lack of occupational or radiographic follow-up. We excluded the above due to a known increase in surgical complexity, severity, and worse outcomes in polytrauma patients. It would also require additional incisions which could compound or conflict the outcome findings in this study. Fifteen fractures were initially identified. Ten fractures were excluded as they involved the talar body or had associated fractures of the calcaneus or distal tibia. This left 5 fractures for analysis. Computed tomography (CT) was utilized to define fracture patterns for inclusion. All five fractures were displaced greater than 2 mm with an associated subluxation of the subtalar joint and were classified as Type-II fractures utilizing the Hawkins Classification System.

2.1. Surgical Technique

Patients were treated supine on the operative table with a bump under the ipsilateral hip. The operative foot was placed on an elevated foam wedge to allow for lateral radiographs without interference of the non-operative foot. The ipsilateral arm was placed over the top of the chest and secured to prevent traction on the brachial plexus, which can occur with shoulder extension secondary to the hip bump.

The landmarks of the lateral ankle are drawn out to include the distal fibula and the base of the fifth metatarsal. When swelling allows, the sinus tarsi is palpated and marked. A curvilinear incision is created just inferior to the fibula and anterior to the peroneal tendons for a distance of 3 cm. The actual length of the incision may vary depending on patient size and swelling. The incision is brought superior to the sinus tarsi and curves distally toward the fourth metatarsal (Figure 2). The superficial incision is brought down to the fascia of the extensor digitorum brevis (EDB), and a full thickness skin flap is created and elevated down to the attachment of the extensor digitorum fascia on the peroneal sheath. Care should be taken not to injure the peroneal tendons during the approach. The EDB is then separated from the peroneal fascia and elevated from the calcaneus staying on top of the periosteum. The adipose tissue in the sinus tarsi is elevated with the EDB in a single flap which is peeled and brought superiorly. This is continued proximal and distal until the talar neck is well visualized. A Hohman retractor is placed over the dorsal aspect of the talar neck to allow for visualization of the entire fracture.

Figure 2. A curvilinear incision is made inferior to the fibula, anterior to the peroneal tendons, and extends superior to the palpated sinus tarsi.

The lateral aspect of the talar neck fracture is the tension side for talar neck fractures, and in Hawkins Type-II fractures the lateral side typically has a simple fracture line that can be reduced and temporarily held with Kirshner wires (k-wires). A four-hole plate can then be contoured to match the concavity of the lateral talus. (Figure 3) Occasionally a Type-II fracture will extend posteriorly into the body as it exits the lateral talus; and in this situation the lateral plate will not have two holes proximal and two holes distal to the fracture line. An attempt to place the plate more posterior will result in lateral impingement and should be avoided. Instead, with the plate in the typical position to avoid impingement, the threads of the two posterior screws will cross the lateral aspect of the fracture line. The plate is intended to maintain reduction. Due to the position of the plate, the screws will generally be directed from an inferior to superior position and should diverge from the fracture site.

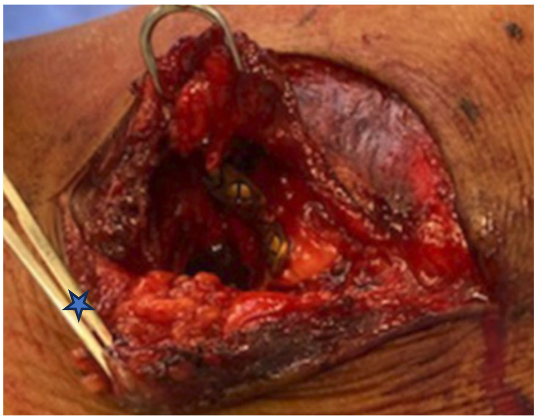

Figure 3. The extensor digitorum brevis (EDB) is elevated in a superior flap after releasing it adjacent to the peroneal sheath inferiorly (double-pronged skin hook). The forceps are holding subcutaneous fat in the full thickness skin flap. The blue star shows a 4-hole plate on the reduced lateral talus.

With the plate in position, the temporary k-wires can be removed. Next, a percutaneous approach to the posterior aspect of the talus is created just lateral to the Achilles tendon. The sural nerve is at risk with a percutaneous approach, and dissection should be performed bluntly in a vertical direction to avoid traction on the nerve. Fluoroscopy should be utilized to ensure correct positioning, but the posterior aspect of the talus is typically at the inferior aspect of the fibula. Once the talus is reached, internal and external oblique radiographs will help ensure that the starting position for the screws is in fact on the talus and not on the posterior fibula (Figure 4). A freer elevator can be utilized to sweep soft tissue from the back of the talus and may be used as a retractor on the lateral aspect of the flexor hallucis tendon (FHL) to protect the medial neurovascular bundle.

When placing the guide wire for cannulated screws, care should be taken to ensure that the start position is safely superior to the subtalar joint, but not so superior that posterior impingement will occur. Ideally, two wires are placed from posterior to anterior. The screws should generally aim inferior to the lateral plate screws and be divergent. A partially threaded screw should be placed laterally to further compress the tension side of the fracture. When possible, the medial screw should be fully threaded or long threads should be selected to prevent compression across the comminuted medial aspect of the talar neck fracture. If it is not possible to place two screws across due to hardware interference, it is generally easier to place the medial screw when the lateral plate screws are blocking the lateral screw. It is not necessary to countersink the lateral screw, but the medial screw may benefit from countersinking as it can cause irritation of the FHL tendon.

Once the hardware is in position, the ankle should be brought through a full range of motion while the fracture is visualized. The subtalar joint should be inspected a second time to ensure there are no loose bodies within the joint. Radiographs should include a lateral ankle view in full flexion and full extension to ensure there is no posterior impingement. In addition, an anterior-posterior (AP) foot view, a Canale view, and an AP ankle view are required. If the posterior screws potentially impinge on the tibiotalar joint, they should be countersunk at this time as there is often not enough bone stock posterior to place the screws in a new position. Any screws that may violate the tibiotalar joint or talonavicular joint with fracture resorption and compression should be shortened during this time as well.

Following irrigation, the EDB is reapproximated to the peroneal tendon sheath with absorbable sutures. Care should be taken not to rejoin the EDB to the tendons themselves. The skin/fat flap is then brought up and over the EDB and repaired in layers. Sterile dressings are applied, followed by a splint for 10–14 days. The splint is only utilized to allow for soft tissue rest. Once the sutures are removed, the patient should begin early motion without restrictions. Weight bearing should be restricted for 6–8 weeks to allow for fracture consolidation.

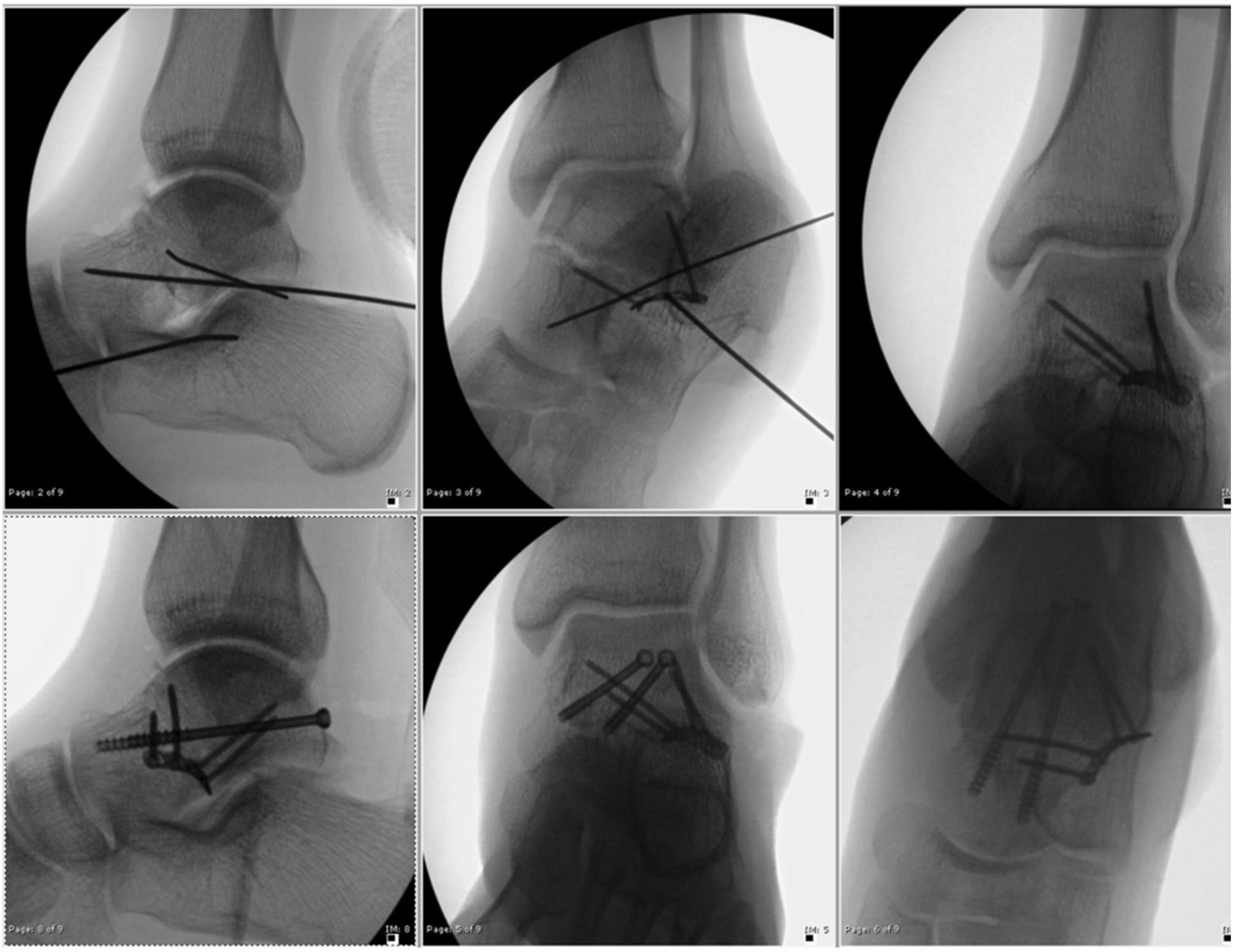

Figure 4. (Top Row) Temporary k-wires are utilized to hold the reduction until a lateral plate is in position. Lateral plate and screw fixation is placed. (Bottom Row) Posterior-to-anterior screws are then placed in a divergent fashion and final views obtained.

2.2. Post-operative Protocol

All patients were placed in a well-padded splint postoperatively. They remained non-weight-bearing in the splint for 2 weeks (Figure 5). A wound check was performed at two weeks, and if swelling allowed, the patient was placed in a CAM boot (controlled ankle motion boot). Early motion was initiated, but the patients remained non-weight-bearing. At the 6 week mark, following an x-ray to ensure the fracture demonstrated early healing, patients began guided physical therapy. Progressive weight bearing was initiated such that patients were 30% weight-bearing for 2 weeks, 50% for 2 weeks, and then full-weight-bearing in the boot for an additional 2 weeks. At the 12 week mark, patients could transition to normal shoe wear and restrictions were removed. All patients then underwent a walk-to-run program guided by the therapist once restrictions were lifted. All patients followed up in the clinic at the 2, 6, 12, 24 week marks and then yearly.

Figure 5. (Top Row) Initial injury XR and selected CT scan slices. (Bottom Row) Follow-up CT at 2 weeks showing the reduction and hardware placement, with no displacement of the fracture reduction.

3. Results

Among the five fractures included in the final analysis, the mean age was 25.6 years old, with a range of 21–32 years. Four of the five patients were male. The mean follow-up was 18 months (range 12–25). At final follow-up, four of the five patients had resumed running for fitness. There were no post-operative complications such as infections, wound breakdown, neuropraxias, or reoperations. The one patient who did not return to running had early arthritic changes in the subtalar joint. The mean VAS was 1.2 (range 0–3). No cases of avascular necrosis were noted at final follow-up.

4. Discussion

The two most common complications of talar neck fractures include avascular necrosis and post-traumatic arthritis. The largest series of talar neck fractures published thus far is a retrospective review of 102 talar neck fractures treated at a level I trauma center. Twenty-three of the patients were classified as Hawkins Type-II fractures. Osteonecrosis was found in nine (39%) of the patients with a Type-II fracture in this study, and post-traumatic arthritis was found in six (26%) of the twenty-three patients with a Type-II fracture. The authors in this study did include patients with open wounds, and many of the patients had ipsilateral hindfoot and ankle fractures. The majority of fractures in the study group (91 of 102) were treated with dual incisions, but the specific approach for the 23 Hawkins Type-II fractures was not noted. In addition, the authors did not specify which single approach was utilized or whether a single-lateral-incision approach was performed. Although not specific to Type-II fractures, the authors found that open and/or comminuted fractures were more likely to develop osteonecrosis. No correlation was noted between the timing of surgery and the development of osteonecrosis. The authors did not correlate surgical approach with osteonecrosis [7].

A systematic review and meta-analysis were performed which evaluated outcomes of talar neck fractures in regard to both the approach and fixation strategy [3]. Utilizing PRISMA guidelines, the authors were able to identify eight high-quality studies. All eight studies were level IV. A total of 154 fractures were included. After review, the authors found that patient outcomes were related to the quality of the reduction, and they found no correlation between outcomes and the Hawkins classification, surgical approach, or fixation strategy. The authors did not specify which single-incision approach was utilized. With that said, the authors did point out that open fractures and higher-energy fractures that were treated with dual incisions had higher rates of avascular necrosis and osteoarthritis.

Another article published by Vallier et al. [11]. looked at factors that contribute to osteonecrosis after talar neck fractures. This was a retrospective review in a large level 1 trauma center where surgery was performed by one of five fellowship-trained traumatologists. In their review, they had a total of 81 fractures with a mean age of 36.7 years old and a 30.3-month average follow-up period. They found that subtalar dislocation, not subluxation, was a statistically significant risk factor for developing avascular necrosis of the talus. Type-III fractures as well as those with associated talar body extension also had increased risk of osteonecrosis and development of post-traumatic arthritis. Their conclusion is that possibly separating Hawkins Type II into IIa and IIb types, where IIa is a subtalar subluxation and IIb is a subtalar dislocation, can possibly help predict rates of osteonecrosis of the talus [11]. We had a much smaller patient population, so statistical analysis would have a Type I error. None of our five patients had evidence of avascular necrosis at our follow-up.

A recent review article discussed single versus dual approaches for talar neck fractures [2]. In this review article the authors stated that the anteromedial approach was the most common single incision. The alternative single approach recommended was a straight anterior approach. The authors noted that neither the anteromedial nor anterior approach would allow for visualization of the major fracture fragments on the lateral side. It was noted that a dual approach does risk damaging the remaining vascularity to the talus and that surgical insult could contribute to the rate of osteonecrosis [2].

A more recent study by Parmeshwar et al. [12] published in 2023 looked to compare three different approaches to talar neck fractures (anteromedial, anterolateral, and combined). They had a total of 30 patients, 10 in each group, with a mean follow-up of 20.85 months, and they included the American Orthopedic Foot and Ankle society hindfoot score (AOFAS). They found that the dual approach increased post-operative complications and time of surgery (75 min vs. 112 min). The dual approach was the only one to have two deep infections and one superficial infection. AOFAS at 18 months was between 75–78 for all groups (not statistically significant). Though this study compared surgical approaches and AOFAS outcomes and complications, it is a long anterolateral incision > 15 cm in length [12]. This is different than our surgical technique, where the average length is 4 cm and the incision is centered over the sinus tarsi. Therefore, the study cannot be used in direct comparison to our cohort as the incisions are different.

In our series we performed a single lateral incision. Fracture fixation was performed with a lateral plate and percutaneous posterior-to-anterior screws for all patients. Biomechanical studies have demonstrated that posterior-to-anterior screws have a higher resistance to shear forces than anterior-to-posterior screws [13,14]. Posterior screws alone are stronger than lateral plates combined with anterior screws [14]. A lateral plate, however, can prevent the fracture from falling into varus with compression and can be placed on the tension side of the fracture where the fracture reduction can be more readily achieved.

This paper has strengths and weaknesses. One of the main weaknesses of our paper is inherent to retrospective case series in that the amount of information that can be collected is limited. The sample size is small, which does not allow for statistical analysis. The mean follow-up time of 18 months may not have allowed for late complications to be recognized. A comparative cohort was not included, and therefore statistical comparison regarding rates of osteonecrosis could not be correlated with approaches. While the series is small, this is the first description of a single-lateral-incision approach for Hawkins Type-II talar neck fractures. The surgical technique described resulted in no wound complications or cases of avascular necrosis.

5. Conclusions

This paper describes a single lateral incision centered over the sinus tarsi for surgical fixation of Hawkins Type-II talus fractures. Our study had a short-term outcome of 12–25 months with a mean of 18 months; however, we did not experience any surgical complications to include surgical site infections, the need for reoperations, or loss of reduction. None of the patients developed avascular necrosis of the talus, which is a concern for all talus neck fractures. This approach limits iatrogenic risks to the deltoid branches of the posterior tibial artery which supply the talar body, thus reducing the risk for avascular necrosis of the talus. We describe a small incision which does not cross the ankle joint and therefore could limit post-operative wound complications. Although the surgical template for every fracture should be fracture-pattern-specific, a single lateral incision should be considered for Type-II talar neck fractures and may help reduce overall complications.

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Informed Consent Statement: Patient consent was waived due to the use of an electronic chart review.

Data Availability Statement: The data presented in this study are available on request from the corresponding author.

Conflicts of Interest: The authors declare no conflict of interest.

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