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# Clinical and Functional Outcome of Subtalar Arthrodesis in Post Traumatic Subtalar Arthritis

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**Abstract:** ***Introduction: Fractures resulting from intraarticular malunion of the calcaneus may be associated with chronic pain and functional limitations of the subtalar joint. The purpose of this study is to evaluate the effectiveness of subtalar arthrodesis technique in subtalar arthritis caused due to malunited calcaneum fracture; utilizing double lag screws from the calcaneus to the talus along with autograft from Iliac Crest and assess the functional outcome. Material and Methods: Over the course of July '20 through February '22, we performed 20 isolated subtalar arthrodesis from calcaneus to talus using double lag screw technique and autograft from Iliac crest. A total of 12 males and 8 females participated in the study. Results: In total, 18 of the 20 joints were fused except for 2; out of which one went unfollowed and the other one dies due to some other co-morbidity, resulting in an overall fusion rate over 90%. On average, fusion took 13 weeks. Conclusion: In 90% of the cases, double lag screws 6.5 mm long across the posterior facet of the subtalar joint and Iliac crest autograft resulted in fusion of the joints. Using this technique, pain relief was obtained in 100% of cases. It is an easy and reliable way to achieve fusion of the subtalar joint.***

**Keywords:** Subtalar Arthritis, Subtalar Arthrodesis, Iliac crest autograft, Lag screw

## 1. Introduction

The calcaneus accounts for 2% of all tarsal bone fractures and is the most commonly fractured one. It is debatable how to treat intra-articular calcaneal fractures, which account for about three-quarters of all cases[1]. Options include open reduction internal fixation, primary fusion, and non-operative methods. Due to different classification, treatment, and evaluation techniques for these injuries, it has been challenging to compare the outcomes of surgical and nonsurgical therapies[2,3,4,5]. Unsatisfactory outcomes were associated by Paley and Hall[4] with fracture comminution and persistent calcaneal deformity. Various proponents of open reduction and internal fixation of these calcaneal fractures have released conflicting findings in their publications[6,7,8,9,10,11]. All writers concur that it is challenging to treat substantially comminuted articular fractures, with outcomes getting worse as comminution and displacement rises[4,5,11]. Primary subtalar arthrodesis has been recommended in order to deal with technical challenges of restoring joint congruency and the resulting cartilage degradation [12,13,14]. The emphasis was not placed on restoring the precise structure of the hindfoot, and the outcomes of their treatments varied greatly [12,13,14,15]. In this study, we discuss our experience managing post-traumatic subtalar arthritis related to malunited articular calcaneus fractures using primary subtalar arthrodesis.

Isolated subtalar arthrodesis is now thought to be a successful treatment for diseases of the hindfoot, such as post-traumatic arthritis, talocalcaneal coalition, posterior tibial tendon dysfunction, isolated subtalar joint instability, or inflammatory arthritis[16,17]. Our research is limited to patients who have arthritis of subtalar joint as a result of calcaneus fractures in the past. Due to the intimate connection between the subtalar and midtarsal joints, triple arthrodesis has historically been used. Midtarsal joint preservation, however, results in a more practical outcome since isolated subtalar arthrodesis preserves transverse tarsal joint motion[18,19] and lowers tarsometatarsal joint stress. Additionally, it makes the surgical operation simpler and prevents midtarsal malunion or non-union.

This retrospective study's objectives were to identify the results of isolated subtalar arthrodesis in the management of isolated subtalar disorder, to evaluate the progression of arthritic changes in the surrounding joints, and to identify any clinical or radiological factors that may have an impact on the results.

## 2. Material and Methods

Before starting our study, the Institutional Review Board approved our retrospective review.

**Description of patients**

Twenty persons, 12 men and 8 women, with a median age of 48 years (25-75 percentile: 33-53) at the time of the surgery underwent 20 consecutive isolated subtalar arthrodesis procedures between July 2020 and February 2022. A review of the patient's medical record was conducted with a focus on preoperative diagnoses, concomitant conditions, and postoperative problems that occurred during the first 90 days after the procedure. Out of all, eight patients were smokers. For a follow-up examination, two of the 20 patients were not accessible (one patient had erratic follow-up; the other died from causes unrelated to his injury). The average age of these 18 patients was 40 years (range, 24-68 years). Falls from great heights or car accidents caused their calcaneal fractures (16 on the right and 4 on the left). Nine of the 20 patients had additional injuries in addition to their calcaneal fractures; these additional injuries were treated separately from the calcaneal fractures and included two chest injuries, one ankle sprain, four ankle fractures, one zygoma fracture,

one radial head fracture, one fracture of the zygoma, and one fracture of the radial head. Before having fusion surgery, all patients had tried nonoperative methods to manage their arthritis, such as activity adjustment, shoe modification and/or bracing, and physical therapy.

Both authors independently reviewed each patient's pre- and post-operative physical examination and weight-bearing radiographs of the affected ankle. Radiographs were examined prior to surgery to determine the severity of osteoarthritis in the subtalar joint. Following surgery, the radiographs were evaluated for subtalar joint fusion. According to Kennedy et al., fusion was defined as the obliteration of the joint space with trabecular continuity and verified clinical loss of mobility at the subtalar joint. We used a cut-off of six months to define a delayed union [20] and a year or more to define a non-union [21]. Patients were called following surgery to respond to a survey on their current degree of function. The American Orthopaedic Foot and Ankle Society (AOFAS) hindfoot scores[22] and the Foot and Ankle Ability Measure (FAAM)[20] were both obtained. 18 of the 20 patients responded to the questionnaire. On the basis of the most recent clinical visit, the clinical section of the AOFAS was finished.

The FAAM has been proven to be a reliable, valid, and responsive outcome measure of physical function in people with foot and ankle dysfunction. It is a clinically validated tool for assessing foot and ankle diseases. A higher score corresponds to a higher level of function in this 100-point rating system. An evaluation of ankle and hindfoot pain and function is done using the 100-point AOFAS hindfoot score. Despite being used more frequently than the FAAM, it has not yet undergone validation. Scores between 90 and 100 indicate exceptional function; 75 and 89 indicate acceptable function; 60 to 74 indicate average function; and 60 indicates subpar function[23]. This was chosen because it was the most often used outcome score in earlier research on ankle arthrodesis[24].

## 3. Surgical Technique

General anaesthesia was used for every surgery. The patients were positioned laterally on the unaffected side, with the tourniquet put around the thigh. Before surgery, each patient received an intravenous antibiotic dose as a preventative measure. Through a horizontal incision that extended from one centimetre behind the fibula's tip to the lateral edge of the extensor digitorum brevis, a lateral approach was adopted. The sural nerve and the peroneal tendons were carefully avoided. The subtalar joint was made visible by the removal of capsular tissue. To enhance visibility of the subtalar joint, a lamina spreader was employed. An osteotome was used to scrape away the remaining cartilage and sclerotic subchondral bone from the talar and calcaneal joint surfaces until a bleeding surface was attained. Two faculty orthopaedic surgeons carried out all operations and made all decisions on method and bone grafting. The posterior tibial neurovascular bundle was carefully avoided. In each case, an autograft from the ipsilateral iliac crest was packed with cancellous bone into the subtalar joint region. Using a flexible chisel, the talus underside was stripped of cartilage, and bleeding bone surfaces were obtained using a high-speed burr. Assessment of the tibiocalcaneal alignment and reduction of the subtalar joint was done. By meticulously denuding the cortical bone in the sinus tarsicorresponding to the neck of the talus and calcaneus, both an extra- and intraarticular arthrodesis were achieved. Then, across the talocalcaneal joint, a 2-mm guide pin was inserted from plantar to dorsal. A cannulated 6.5-mm screw was employed in every patient to hold arthrodesis in place. Since the guidewire might be redirected, if necessary, fluoroscopic imaging proved to be quite beneficial for this step.

A posterior plaster splint and compression dressing were added, along with the closure of the wound in layers over a suction drain. Radiographs were collected following surgery. For 24 hours following the drain removal, prophylactic intravenous cephalosporin antibiotics were continued. The sutures or staples were removed two weeks following the procedure (if the incision was clear and dry), and a posterior splint was put on. The afflicted extremity, which included the foot and ankle, was then subjected to early range-of-motion exercises by the patient. Six weeks later, radiographs were taken. The patients were permitted to start weight bearing in a cast if the radiographs looked good, and after 10 to 12 weeks they could progress to weight bearing as tolerated. At follow-up visits, radiographs are routinely taken progressively and kept up until radiographic union.

## 4. Methodology

The ankle hindfoot grading system developed by the American Orthopaedic Foot and Ankle Society (AOFAS) was used to assess the functional outcomes both pre- and postoperatively[25]. 94 points was the highest possible score at the last follow-up. Excellent was defined as 90 to 94 points, good as 75 to 89, fair as 50 to 74, and poor as less than 50. The physical examination includes a determination of ankle or transverse tarsal joint pain, subtalar stress pain, and hindfoot alignment. Using a goniometer, the ankle's range of motion was measured. Patient satisfaction, activity restrictions, and shoe wear were evaluated. The evaluation was completed with information on conspicuous hardware, walking aid use, and sural nerve complaints.

The physical examination covered hindfoot stability and motion, general alignment, and dorsiflexion and plantarflexion range of motion. At the final follow-up, a weight-bearing anteroposterior radiograph of the ankle and weight-bearing lateral and anteroposterior radiographs of the foot were both taken. Prior to surgery, the same radiographs were taken to evaluate the subtalar joint arthritis. The radiographs were evaluated for eight parameters, including talocalcaneal height, cuboid-to-floor distance, navicular-to-floor distance, calcaneal pitch, angle between first metatarsal and talus in anteroposterior and lateral planes, angle between talus and calcaneus, and talar declination angle.

## 5. Results

The presence of related injuries, temperature, and oedema in the foot and ankle, as well as the radiographic appearance, were used to determine the initiation of weight bearing on the operated foot. If there was no warmth or swelling and

bone bridging could be seen across the arthrodesis site, 50 percent protected partial weightbearing could start. Patients were prohibited from bearing weight on the afflicted extremity for an average of 8.6 weeks (range, 5-12 weeks). Patients were urged to walk in a swimming pool when it was safe to do so once partial weightbearing started. By one year following surgery, union had been attained in 18 of 20 participants (90%) with a median time to union of 16.4 weeks. Only two of the 18 healed patients exhibited a delayed union (less than 6 months); one was confirmed by X-ray at 7 months. All patients participated in a structured physical therapy and rehabilitation programme; one patient did these exercises at home. A 9-week average of postoperative care (range, 4-28 weeks). The focus of the physical therapy sessions was on strengthening the lower extremities, improving range of motion in the ankle, midfoot, and forefoot joints, and reducing oedema and rigidity in the soft tissues.

## 6. Examination

The patients were assessed on average 12 months (within a range of 10 to 14 months) after the operation. The American Orthopaedic Foot and Ankle Society's (AOFAS) 100-point hindfoot and ankle scale [26] was used to measure all examinations and measures and to evaluate patients' postoperative activity and mobility. On this scale, alignment receives 10 points, 50 points for function, and 40 points for pain. In this population, the highest attainable score was 94 because no patients had either functional inversions or eversions.

**Clinical Outcomes**

The median AOFAS hindfoot score significantly increased following surgery from 49 (25-75 percentile: 36-61) to 76.5 (25-75 percentile: 67.5-82). Following treatment, the median pain score (maximum 40 points), median function score (maximum 50 points), and median alignment score (maximum 10 points) were all 40, 42, and 10, respectively. The objective outcomes were superb in two cases, good in twelve cases, and average in the rest. Both subjectively and clinically, the hindfoot was stable in every patient. Twelve patients believed their regular activities were not restricted in any way. Four people and two cane users reported some minor daily activity limitations. Eight of the twenty patients also believed that their access to recreational activities was unrestricted. In four cases, residual ankle and hindfoot oedema was visible, Pain relief was obtained in all the cases.

All surgical patients had stable hind feet, normal functional sagittal mobility, and acceptable ankle-hindfoot alignment. Normal sagittal tibiotalar joint mobility was determined for each case to be within 5° of the opposing ankle. For the foot with and without primary subtalar arthrodesis, the mean ankle dorsiflexion was 6° and 12°, and the mean plantarflexion was 50° and 61°, respectively. In order to determine hindfoot stability, the patient's stated "giving way" had to be absent, and there had to be no signs of ankle instability when an anterior drawer or manually administered varus load was applied. Hindfoot alignment was considered to be satisfactory if the calcaneus on the axial hindfoot radiograph was within 5° of the opposite foot; though this measure was not used when bilateral injuries were reported.

**Bony union**

All 18 arthrodesis procedures took a median of 13 weeks (25–75 percentile: 12–14) to achieve bone union. In 16 cases, a complete bone fusion was accomplished. On the final radiographs of the two remaining cases, there were persistent signs of partial fusion rather than clinical non-union (pain or mobility at the site of subtalar arthrodesis). Nearly everyone in the smoking and non-smoking groups had the same median time of union.

## 7. Discussion

Young to middle-aged industrial workers are particularly susceptible to calcaneal fractures [27]. The morbidity and natural history of these injuries are widely documented. 30 The "final outcomes are absolutely awful" for calcaneal fractures, according to Con[28] in 1926, and according to Bankart [29] in 1942, "the results of therapy of crush fractures of the os calcis are rotten." Later, with reference to intra-articular fractures, Barnard and Odegard [30] wrote that "it appears hopeless, as well as technically impossible, to restore properly a normal articular surface to a subtalar joint that has been destroyed." In their work titled "Calcaneal Fracture Controversies: Can We Put Humpty Dumpty Together Again?" Paley and Hall [4] echoed this challenge. Holding the position once reduction is attained can be challenging; Mclaughlin [31] compares it to "nailing a custard pie to the wall."

In the early 1900s, subtalar arthrodesis was used as the sole method of treatment for intraarticular calcaneal fractures [32,33]. Even though the heel varus was not addressed, Gallie's [34] posterior approach technique provided satisfactory outcomes. In order to avoid the development of "pain patterns" that might impede later healing, Dick [12] promoted primary fusion posteriorly and made an effort to decrease the fracture. Pennal and Yadav [35] added a sense of urgency to the decision-making process by noting that whereas more than 75 percent of first subtalar fusions had positive outcomes, less than 50 percent of patients who underwent a secondary subtalar arthrodesis had positive outcomes. Noble and McQuilla [36] used a comparable posterior approach without attempting to minimise the fracture and reported good outcomes (90 percent of patients returned to work in 6 months).

The long-term outcomes of in situ subtalar arthrodesis are described in this retrospective study. Even though it often went unnoticed, arthritis often progressed in nearby joints. In order to achieve bony fusion, bone grafting seems to be beneficial. The most crucial clinical variables appear to be tibiocalcaneal alignment and bony union. All patients in this study experienced bony union. A clinical and radiographic assessment is required because estimation of the bony union following a single subtalar arthrodesis is not always clear.

It appears to be debatable how bone grafting affects the union rate. While Kitaoka et al. and Tasto demonstrated 100% union without bone grafting and believed that graft is not necessary [37,38], Scranton advised bone graft to prevent

non-union [39]. According to our opinion, bone grafting is crucial for union.

Smoking appears to be a risk factor for non-union in the literature. Bony union was evaluated by Easley et al. at 92 percent for non-smokers and 73 percent for smokers (p 0.01) [40]. According to Ishikawa et al. [41], smokers have a non-union risk increase of around 2.7. In our research, we did not discover such strong relationships.

A calcaneal fracture has a significant impact on the talocalcaneal relationship; the hindfoot alignment is altered, the talus is horizontalized, and the height of the talocalcaneal joint is diminished. The majority of scientists concur that these anatomical changes have biomechanical repercussions and must be fixed during subtalar arthrodesis.

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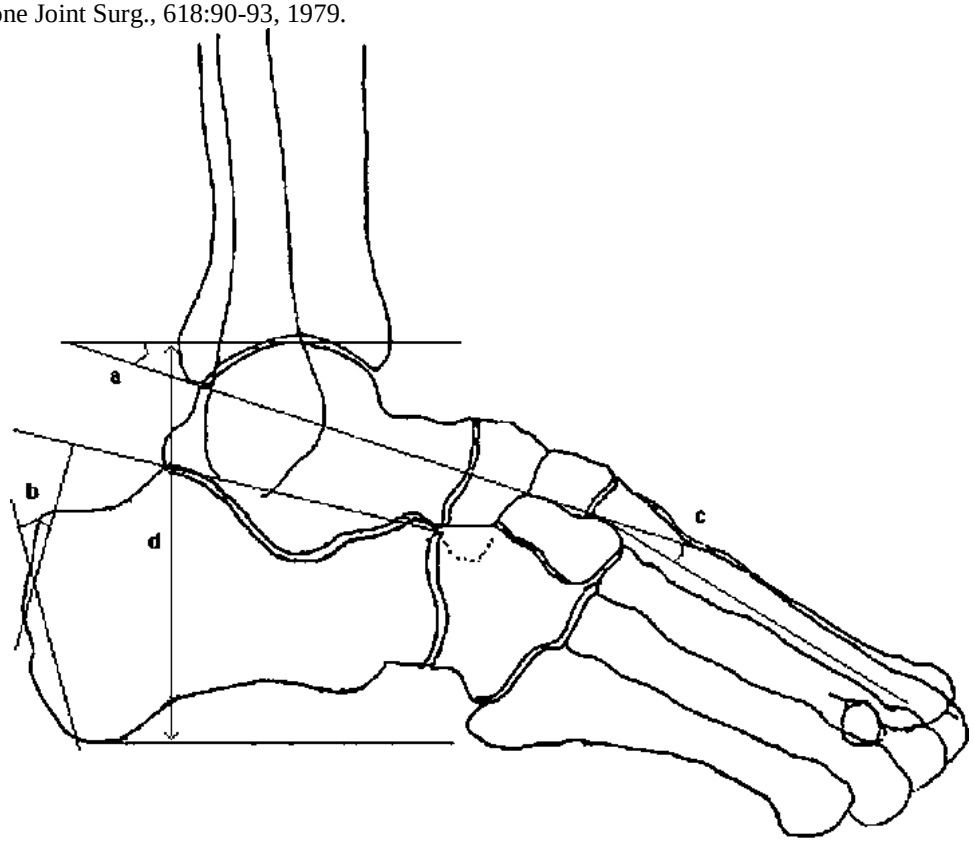


a: talus inclination angle
b: talocalcaneal angle
c: talus - first metatarsal angle
d: talocalcaneal height

**Patient 1**



**Patient 2**