

## Original Research Article

# Management of distal tibial nonunion with tibiotalocalcaneal arthrodesis using tarsus nail: a retrospective study

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### ABSTRACT

**Background:** Distal tibial nonunion presents a significant challenge due to poor vascularity, limited soft tissue coverage, and mechanical instability. Conventional fixation methods often fail in complex cases, particularly when accompanied by bone loss, deformity, or infection. Tibiotalocalcaneal (TTC) arthrodesis using a tarsus nail has emerged as an effective strategy, providing stable fixation and supporting limb preservation. This study aims to evaluate the clinical and radiological outcomes of managing distal tibial nonunion with TTC arthrodesis using a tarsus nail.

**Methods:** This retrospective study included 40 patients with distal tibial nonunion who underwent TTC arthrodesis using a tarsus nail at a speciality hospital between 2024 and 2025. Functional outcomes were evaluated using standardized scoring systems, including the American Orthopaedic Foot and Ankle Society (AOFAS) score, pain intensity was analyzed by VAS and complications were recorded at one-year follow-up. Radiographic assessments were performed at regular intervals to evaluate bone union and alignment.

**Results:** A total of 40 patients (26 males, 14 females) with a mean age of  $52.3 \pm 11.6$  years were included. At one-year follow-up, radiographic union was achieved in all the patients, with satisfactory alignment in all cases. The mean AOFAS score improved significantly from  $38.5 \pm 7.2$  preoperatively to  $78.9 \pm 6.8$  postoperatively. Pain levels, as measured by the VAS, decreased from a preoperative mean of  $7.2 \pm 1.1$  to  $2.1 \pm 0.9$ . No complications were reported; no cases of implant failure were reported.

**Conclusions:** TTC arthrodesis using a tarsus nail is an effective and reliable procedure for distal tibial nonunion, providing high rates of bone union, significant improvement in functional outcomes, while maintaining limb alignment and stability.

**Keywords:** Distal tibial nonunion, Tibiotalocalcaneal arthrodesis, Tarsus nail

### INTRODUCTION

Distal tibial nonunion represents a significant clinical challenge in orthopedic surgery due to the unique anatomical and biological characteristics of the distal tibia. The distal third of the tibia has relatively poor vascularity and limited soft tissue coverage, which predisposes it to delayed healing and increases susceptibility to infection, particularly following trauma or multiple surgical interventions.<sup>1,2</sup> These factors, combined with high mechanical demands during weight-bearing, make achieving stable fixation and successful bone union

difficult. Conventional treatment modalities, including plate osteosynthesis, external fixation, and intramedullary nailing, have demonstrated variable success rates in complex distal tibial nonunions, particularly in cases complicated by bone loss, malalignment, or infection.<sup>3</sup> Failures with these methods often result in persistent pain, prolonged immobilization, and functional impairment, underscoring the need for alternative strategies.

Tibiotalocalcaneal (TTC) arthrodesis with intramedullary tarsus nails has emerged as a reliable salvage procedure for managing complex distal tibial nonunion. By spanning the

distal tibia, talus, and calcaneus, TTC arthrodesis provides rigid axial and rotational stability, facilitates union in biologically compromised bone, and preserves limb alignment.<sup>4,5</sup> This approach also allows for simultaneous correction of deformity and management of associated hindfoot pathology, while reducing the risk of implant failure commonly seen with conventional fixation techniques. Early studies have demonstrated promising outcomes, including high rates of radiographic union, improvement in pain and functional scores, and acceptable complication profiles.<sup>6</sup> Despite these encouraging results, the evidence remains limited, with relatively few studies systematically evaluating both clinical and radiological outcomes following TTC arthrodesis for distal tibial nonunion.<sup>7</sup>

The present study aims to evaluate the effectiveness of TTC arthrodesis using a tarsus nail in patients with distal tibial nonunion, focusing on bone union, functional recovery, pain relief, and complication rates. By providing a comprehensive analysis of these outcomes, this study seeks to inform clinical decision-making and optimize management strategies for this challenging condition.

**METHODS**

This retrospective observational study was conducted at a speciality hospital between November 2024 and December 2025. A total of 40 patients diagnosed with distal tibial nonunion were included. Inclusion criteria comprised patients aged ≥18 years with established nonunion of the distal tibia (defined as absence of radiological and clinical signs of healing for at least 6 months), with or without deformity, bone loss, or previous failed fixation. Patients with active uncontrolled infection, severe comorbidities precluding surgery, or incomplete follow-up data were excluded.

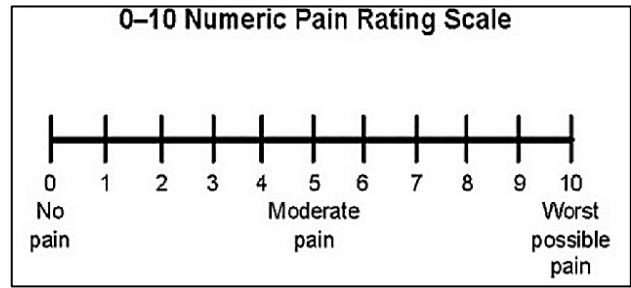
**Surgical technique**

All patients underwent TTC arthrodesis using a auxein medical tarsus nail under spinal or general anesthesia. A standard surgical approach was utilized, with careful debridement of fibrous tissue and preparation of the distal tibia, talus, and calcaneus surfaces to achieve bleeding bone ends. Alignment in the coronal, sagittal, and rotational planes was restored prior to fixation. The tarsus nail was inserted in a retrograde manner through the calcaneus, talus, and into the tibial medullary canal under fluoroscopic guidance. Interlocking screws were applied proximally and distally to enhance stability.

**Outcome assessment**

Patients were followed up at regular intervals (6 weeks, 3 months, 6 months, and 12 months). Functional outcomes were assessed using the AOFAS score. Pain intensity was evaluated using the visual analog scale (VAS) Figure 1. Radiological assessment was performed using standard anteroposterior and lateral radiographs to evaluate bone

union, defined as the presence of bridging trabeculae across the fusion site.



**Figure 1: VAS scoring.**

**Statistical analysis**

Primary outcomes were measured using VAS with mean. VAS from baseline to each visit was analysed.

**RESULTS**

A total of 40 patients with distal tibial nonunion were included in the study, comprising 26 males and 14 females, with a mean age of 52.3±11.6 years (range: 31-74 years). All patients completed a minimum follow-up duration of 12 months and were available for both clinical and radiological evaluation. Radiographic union was successfully achieved in all the patients within the follow-up period, with a mean time to union of 5.8±1.2 months Table 1. The progressive healing was observed over time, and none required secondary surgical intervention. Additionally, satisfactory alignment in the coronal, sagittal, and rotational planes was achieved and maintained in all patients at final follow-up, with no cases of malalignment or loss of fixation.

**Table 1: Demographic data.**

Parameters	Value
<b>Total patients</b>	40
<b>Gender</b>	26 males (65%) 14 females (35%)
<b>Mean age (in years)</b>	52.3±11.6 (range 31-74)
<b>Mean duration of nonunion (months)</b>	11.2±3.5
<b>Minimum follow-up (months)</b>	12 (range 12-18)

Functional outcomes demonstrated a statistically significant improvement following surgery. The mean AOFAS score increased from a preoperative value of 38.5±7.2, indicative of poor function, to 78.9±6.8 at one-year follow-up, reflecting good functional recovery. Patients reported improved ability in weight-bearing, ambulation, and daily activities. Pain assessment using the VAS revealed a marked and statistically significant reduction in pain levels, with mean scores decreasing from 7.2±1.1 preoperatively to 2.1±0.9 at final follow-up,

indicating effective pain relief following arthrodesis Table 2.

No postoperative complications were reported. Importantly, there were no cases of deep infection, implant failure, hardware-related complications, or need for revision surgery during the follow-up period. Overall, the TTC arthrodesis using the Auxein's Tarsus nail provides reliable union rates, significant functional improvement, effective pain relief in the treatment of distal tibial nonunion Table 2.

**Table 2: Functional outcomes.**

Outcome measure	Pre-op	Post-op (1-year)	Change
<b>AOFAS score (mean±SD)</b>	38.5±7.2	78.9±6.8	Significant improvement in function
<b>VAS pain score (mean±SD)</b>	7.2±1.1	2.1±0.9	Significant pain reduction
<b>Radiographic union</b>	–	36/40 (90%)	Achieved in most patients
<b>Implant failure/revision surgery</b>	–	0	None reported

**DISCUSSION**

Distal tibial nonunion remains a challenging clinical condition due to compromised vascularity, limited soft tissue envelope, and the frequent presence of deformity, bone loss, or prior surgical failure. Achieving both mechanical stability and biological healing in such cases is difficult with conventional fixation methods. The present study demonstrates that TTC arthrodesis using a tarsus nail system by Auxein Medical is an effective limb procedure, providing high union rates, significant functional improvement.

The stable intramedullary fixation achieved with the tarsus nail allows for optimal load sharing and axial compression across the fusion site, which are critical factors for successful union, particularly in cases with poor bone quality or previous failed fixation.<sup>8,9</sup> Additionally, the ability to restore and maintain alignment in all planes in our cohort highlights the mechanical reliability of the construct.

This improvement reflects enhanced pain relief, stability, and ambulatory capacity following TTC arthrodesis. Although arthrodesis sacrifices ankle and subtalar joint motion, the trade-off is often justified in complex nonunion cases where pain relief and limb stability are prioritized over joint mobility. The significant reduction in VAS scores further supports the effectiveness of this technique in alleviating chronic pain associated with nonunion.<sup>10,11</sup>

TTC arthrodesis with a tarsus nail offers several advantages over alternative methods such as plate fixation or external fixation. These include a load-sharing construct, minimal soft tissue disruption, better biomechanical stability, and the potential for earlier mobilization. It is particularly beneficial in elderly patients, those with osteoporotic bone, or cases with significant bone loss and deformity, where traditional fixation methods may be less reliable.

**CONCLUSION**

TTC arthrodesis using a tarsus nail system represents a reliable and effective treatment option for distal tibial nonunion, offering high rates of union, significant functional improvement, and no complications, thereby supporting its role as a valuable limb procedure in complex cases.

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