Case Report

Correction of Tibial Malunion in a Patient with Ipsilateral Total Knee and Ankle Prostheses Using External Ring Fixation and the Ilizarov Method

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Abstract

Total ankle replacement (TAR) aims at reestablishing a functional and painless ankle joint while maintaining motion and preventing adjacent joint arthritis. TAR can be complicated by comorbidities such as ipsilateral knee arthritis and deformity with subsequent arthroplasty and/or other lower extremity malalignment issues. We present a case of a 67-year-old female with severe right ankle pain and a history of ipsilateral subtalar and calcaneocuboid fusion, bilateral total knee arthroplasty, and a malunion of a conservatively treated ipsilateral segmental tibial fracture. Following TAR, there was recurrent lateral hindfoot pain due to subtle malalignment from the tibial malunion which resulted in persistent hindfoot valgus. This caused symptomatic subfibular impingement in addition to limb length discrepancy. To address that, a circular external fixator was applied to realign the ankle and lengthen the tibia, eliminating pain and avoiding complications with either implant.

Keywords: *Ilizarov method, subfibular impingement, taylor spatial frame, tibial malunion, total ankle replacement*

Introduction

Bone, joint, and soft-tissue deformities of the lower limb have been shown to influence the integrity of ipsilateral joints.[1-3] For example, increased varus/valgus deformity of an arthritic ankle has been associated with increased arthritis in the ipsilateral knee.[1] One study showed that in patients with varus knee and valgus hindfoot deformities, correction of knee alignment with total knee arthroplasty (TKA) resulted in exaggerated, persistent hindfoot valgus, causing a lateral shift in the normal mechanical weight-bearing axis.[2] A mechanical axis not centered can be problematic for a total ankle replacement (TAR).[4] For this reason, it is crucial that TAR is performed in a well-aligned extremity and foot.[4] We present salvage of a TAR by means of gradual correction of an offending tibial deformity using the Ilizarov method through Taylor spatial frame (TSF) (Smith and Nephew, Memphis, TN, USA) while avoiding an ipsilateral total knee prosthesis.

Case Report

A 67-year-old female presented with chronic right ankle pain that failed conservative treatment and interfered with activities of daily living. Her history included osteoarthritis of multiple lower extremity joints after a full comprehensive workup was negative for inflammatory arthritis in the past, as well as a right segmental tibial fracture conservatively treated by casting over 20 years prior. Surgical history included a right subtalar and calcaneocuboid fusion and bilateral TKAs without complications.

Examination revealed hindfoot valgus malalignment of 10°, painful, restricted dorsiflexion and plantar flexion, and tenderness along the ankle joint line. Weight-bearing ankle radiographs showed a portion of the diaphyseal malunion, ankle end-stage arthritis, concentric talar valgus tilt of 10° [Figure 1a], and distal tibial recurvatum [Figure 1b].

Three months following an uneventful TAR [Figure 2], she continued to have significant ankle and hindfoot pain which hindered full weight bearing. Examination revealed tenderness over the sinus tarsi and lateral gutter. There was persistent ankle valgus, observed clinically [Figure 3] and radiologically [Figure 4a]. Unremarkable

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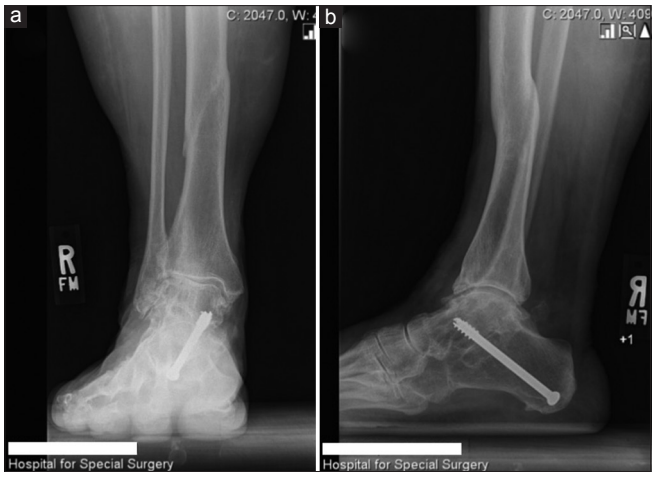

Figure 1: (a) Weight-bearing anteroposterior radiograph (right ankle) showing evidence of talotibial osteoarthritis, talar valgus tilt, and distal portion of the previously healed tibial segmental fracture. (b) Weight-bearing lateral radiograph showing tibial recurvatum deformity and a screw from previous subtalar and calcaneocuboid fusion

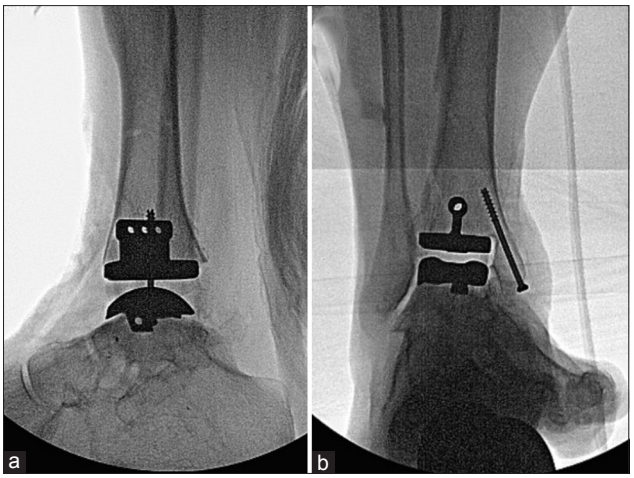

Figure 2: Intraoperative fluoroscopic images during total ankle replacement (right ankle). (a) Lateral image showing tibial tray and talar dome perpendicular to long axis of the distal tibia, satisfactorily aligned. (b) Anteroposterior image demonstrating medial malleolar screw placed prophylactically to prevent intra- and post-operative fractures

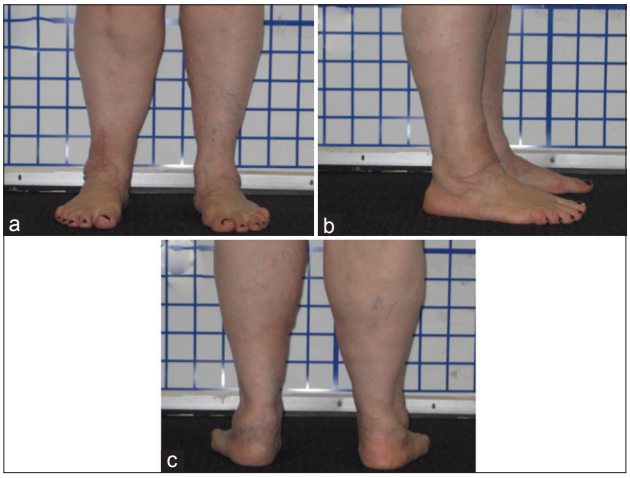

Figure 3: Clinical photographs of both lower extremities (standing) 12 weeks status post right total ankle replacement from (a) anterior, (b) lateral, and (c) posterior views. Slight persistent right ankle valgus is demonstrated

Figure 4: (a) Weight-bearing anteroposterior radiograph 12 weeks status post right total ankle replacement showing valgus malalignment and evidence of subfibular impingement. (b) Right ankle computed tomography 12 weeks following total ankle replacement showing no evidence of fibular stress reaction or joint loosening but showing significant gutter impingement

computed tomography (CT) [Figure 4b] and erythrocyte sedimentation rate and C-reactive protein levels ruled out fibular stress reaction, aseptic loosening and infection.

The patient was eventually referred to the limb lengthening and complex reconstruction service. Long leg X-rays revealed right tibial segmental diaphyseal malunion and limb length discrepancy (LLD), right leg shorter by one inch [Figure 5]. The right ankle was in approximately 10° of valgus with a lateral distal tibial angle (LDTA) of 82°. A preoperative CT before the second planned corrective surgery was performed to rule out hindfoot valgus from malunion of the subtalar arthrodesis and showed normal alignment of the fused subtalar and calcaneocuboid joints.

Tibial diaphyseal malunion was causing persistent right ankle valgus and subfibular impingement, necessitating correction. It was decided that gradual correction with distraction osteogenesis using the Ilizarov method and TSF would be the best intervention despite the risk of infection of the ipsilateral TKA and TAR.

The patient then underwent TSF placement with lateral ankle ligament reconstruction and gutter debridement uneventfully. Postoperatively, the patient was made partial weight bearing [Figure 6], and gradual, full correction of valgus and LLD was achieved after 12 weeks, following the software-generated schedule of the TSF [Figure 7].

At 18 weeks, the TSF was removed, and the patient was placed in appropriate below-knee braces for 6 weeks [Figure 8]. Four months later, the patient had no ankle pain and was able to progress gradually with her activities and remained asymptomatic and fully functional 2 years later.

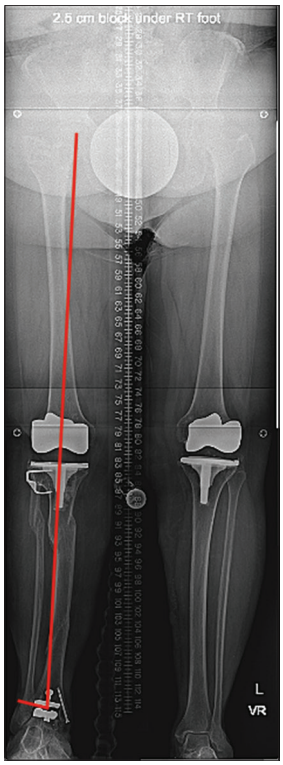

Figure 5: Standing 52-inch long leg radiograph 30 weeks status post right total ankle replacement with mechanical axis drawn to highlight the ankle valgus tilt, evidenced by an abnormal lateral distal tibial angle measuring 82°. Also apparent is the tibial diaphyseal malunion

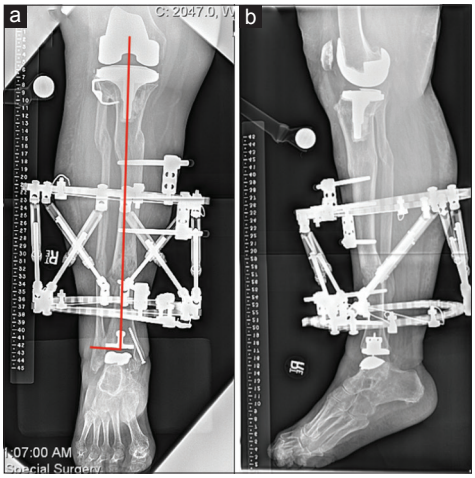

Figure 7: (a) Anteroposterior and (b) lateral radiographs of the right leg at end-distraction before removal of the Taylor Spatial Frame. Drawn in red is the mechanical axis showing the corrected lateral distal tibial angle measuring 88°

Discussion

To maximize long-term results of TAR, attention is warranted to preoperative factors - including ipsilateral limb deformities - that could compromise this goal. Previously, significant preoperative hindfoot deformity was considered a relative contraindication to TAR.[5] A subsequent study showed no significant difference in failure risk, complications, or adverse clinical outcomes among

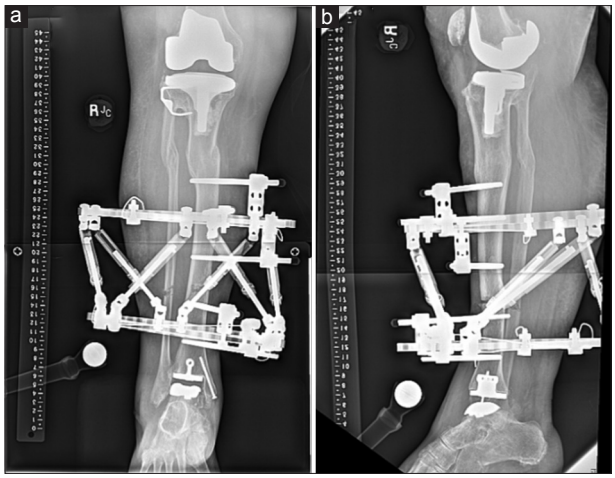

Figure 6: (a) Anteroposterior and (b) lateral radiographs 2 weeks following Taylor Spatial Frame placement. The proximal ring was 91.4 mm from the distal edge of the knee prosthesis; proximal pin 52.2 mm. Distal ring was 22.3 mm from proximal edge of ankle prosthesis; distal pin 15 mm

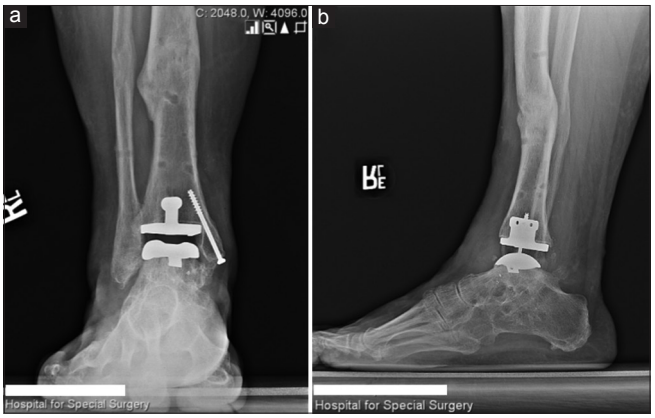

Figure 8: Weight-bearing (a) anteroposterior and (b) lateral radiographs 7 weeks following removal of the Taylor Spatial Frame. The healing tibial and fibular osteotomy sites are seen with normalized alignment of the total ankle replacement and complete resolution of subfibular impingement

patients with up to 30° of hindfoot deformity, which supports our efforts in correction of this patient's 10° of hindfoot valgus.[5,6]

It is important to distinguish that the preoperative deformities in the above study were intra-articular, thus completely correctable during TAR.

However, in our case, the persistent ankle valgus and subfibular impingement were caused by extra-articular, supramalleolar causes. It was unlikely that this was due to the patient's previously fused subtalar and calcaneocuboid joints, given the presence of both tibial malunion and an abnormal LDTA that accounted for the whole 7° of valgus encountered on clinical examination. Furthermore, the subtalar and calcaneocuboid joints appeared clinically and radiographically aligned. Moreover, a preoperative CT scan was obtained before the second planned corrective surgery to rule out hindfoot valgus from malunion of the subtalar arthrodesis and showed normal alignment of the fused

subtalar and calcaneocuboid joints. The 7° of hindfoot valgus evident on clinical examination was consistent with the 7° of valgus originating from the tibial malunion. It was, therefore, determined that the tibial deformity accounted for the whole deformity encountered on clinical examination, rendering the deformity solely of tibial origin, causing persistent valgus and pain. Revising neither the ankle prosthesis nor the previous fusions would, therefore, correct the problem. Moreover, on a postoperative follow-up visit, a Saltzman view was obtained. The measurement showed calcaneotibial angle of 2° varus on the right and 0° on the left. Since this angle was not affected by the tibial realignment surgery, it can, therefore, be confidently assumed that it was the same preoperatively, and hence not the cause of the deformity.

While lateral gutter debridement alone could temporarily relieve the patient's pain, it was determined that to avoid recurrence of her symptoms, the tibial deformity had to be corrected.

Continued varus/valgus tilt of the ankle following TAR can induce contact pressures on the polyethylene insert that approach or even exceed the insert's yield stress.[7] Failing to correct that may lead to premature implant failure.[8] However, correction between ipsilateral TKA and TAR posed a significant infection risk to both prostheses. It was carefully decided that TSF would gradually correct the tibia while trying to maximize the distance between TSF hardware and the prostheses.

The tibial abnormality's effect on limb alignment was not appreciated before TAR since no long-leg weight-bearing radiographs were obtained (not typically part of TAR preoperative evaluation). This report shows, however, that a history of ipsilateral tibial/femoral malunion, knee/hip pathology/replacement and muscle imbalance, all should prompt a more thorough clinical and radiological assessment of the entire lower extremity before surgery. This may avoid complications and need for ancillary procedures.

Ancillary procedures are often necessary to improve the longevity of a TAR.[9] This case highlights that when ancillary procedures are needed before, during, or after TAR, it is best to perform them in proximal-to-distal approach. A prior study demonstrated that if TAR is performed in alignment with a valgus knee, subsequent knee axis neutralization with TKA will result in ankle varus and uneven contact pressures on the TAR.[8] In this case, performing a TAR before correcting the tibial deformity led to an initially unsuccessful TAR. While a fibular lengthening osteotomy was cited in a previous study as an option to correct valgus malalignment following TAR,[10] this was not an option in this case as it would increase subfibular abutment and lateral impingement symptoms, which were the main incapacitating pathology in the patient.

Finally, the authors acknowledge that there is a higher risk of infection of the surrounding prostheses with this technique compared to an acute osteotomy and plate fixation. Indeed, the risk of pin tract infection is much more common with this technique, yet it is more commonly superficial infection, which is usually controlled with oral antibiotic therapy, as opposed to deep infection encountered with plate fixation, which mostly requires intravenous antibiotic treatment. In addition, the risk of spread of infection to the prostheses could be minimized by widely spacing the pin sites from the tip of the prostheses as demonstrated in this case. However, the choice of this technique was not based on a smaller incidence of infection as compared to acute correction and plating, but rather due to its ability to restore both angular alignment and leg length discrepancy, which is not achievable with acute osteotomy and plating.

Conclusion

This case shows the importance of thorough assessment of the entire lower extremity before TAR. When a history of ipsilateral tibial malunion is present, more detailed clinical and radiological exams are highly encouraged to elucidate abnormalities that may require correction to ensure the success of the operation. Necessary ancillary procedures should be done in a proximal-to-distal fashion. Moreover, this case highlights that salvage of a malaligned TAR due to proximally-based ipsilateral limb deformity can be successfully managed using the Ilizarov method, despite the risk of infection to the prosthesis. This can be prevented by judicious placement of pins/wires at sufficient distances from prostheses.

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Nil.

Conflicts of interest

Austin T Fragomen, MD has the following Conflict of Interests: Consultant for Smith and Nephew, Synthes, NuVasive, and royalties from Stryker.

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