Total Ankle Replacement Through a Lateral Approach

Jeremy LaMothe, MD, Jonathan Deland, MD, Lew Schon, MD, Charles Saltzman, MD, Steve Herbst, MD, and Scott Ellis, MD

Abstract: Since the first clinical series of total ankle replacements in 1973, implants design has evolved tremendously. Early catastrophic failures associated with first-generation total ankle replacement are now less common with modern prostheses. However, registry data suggest that the 10-year survivorship is still lower than total knee and hip arthroplasty. The anterior surgical approach used in the vast majority of implants lies between 2 angiosomes and can lead to complications including wound breakdown and damage to the peroneal nerves and anterior tibial artery. Furthermore, current anterior approach implants do not allow bony resections to parallel the sagitally curved talar and tibial surfaces; cuts are limited to flat/chamfered cuts which inherently take more bone than curved, matched, bony resections. In 2012, the FDA approved the Zimmer Trabecular Metal Total Ankle Replacement, which is a placed through the lateral approach. This approach theoretically minimizes surgical intrusion on a previously traumatized anterior soft-tissue envelope and allows direct visualization of the curved talus and tibial surfaces. In addition, such an approach allows bone-sparing, curved resections that maximize bony contact and theoretically minimize component subsidence. Furthermore, this implant is based on using a rigid alignment stand to which the lower extremity and milling guides are fixed, allowing for both the correction of deformity and the accurate resection of bone. The aim of this paper is to present the design rationale and useful technical tips for surgeons implanting this prosthesis.

Level of Evidence: Diagnostic Level 4. See Instructions for Authors for a complete description of levels of evidence.

Key Words: total ankle arthroplasty, lateral approach, ankle arthritis, trabecular metal, alignment stand

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HISTORICAL PERSPECTIVE

Total ankle replacement (TAR) has progressed substantially since the first published clinical study in 1973 by Lord and Marotte.[1–3] Prostheses design has paralleled an enhanced understanding of ankle joint kinematics and periprosthetic joint mechanics.[4–13] With this, TAR survivorship drastically improved in second-generation implants.[1–3,14,15] However, with compiled registry and nonregistry data reporting 10-year survivorships of 73% and 89%, respectively, ankle survivorship is still lower than that reported in hip and knee arthroplasty.[3] As implant survivorship has increased, surgical indications have changed. Conversely, the surgical approach and technique has remained relatively unchanged. All of the current-generation TARs, except the prosthesis presented herein, are placed through an anterior approach.

An anterior surgical approach is able to provide excellent visualization of anterior joint pathology, but is limited in other respects. Anterior surgical wounds may be predisposed to wound complications or neurovascular damage, especially when the soft-tissue envelope may have been previously violated with injury and/or surgery.[16–18] Furthermore, bony cuts with an anterior approach have been limited to flat/chamfered cuts of the talus and plafond and have been unable to provide anatomically matched curved resections.

To avoid the shortcomings of the anterior approach, a laterally based TAR has been developed. Specifically, a laterally based surgical approach has potential benefits in that it avoids an anterior wound and allows direct visualization of the center of rotation of the ankle. In addition, visualizing the ankle from a lateral approach allows precise curved cuts of the talus and tibia to be made. These cuts minimize bone resection, maximize implant contact area, and position the implant in better alignment with the talar dome and distal tibia trabeculae. Furthermore, tibial implant–stabilizing rails are inserted perpendicular to the sagittal plane of flexion and extension, which may help improve implant stability. All of these factors may dissipate peri-implant stress concentrations and thereby minimize subsidence, which may ultimately extend implant survivorship.

The lateral approach total ankle (Zimmer Trabecular Metal Total Ankle) is an implant that obtained FDA approval as a semiconstrained cemented replacement in August 2012. Because of its recent inception, there are currently no studies that publish on its outcomes, but close to 300 implants have been placed with encouraging early surgeon feedback. The implant is a 2-component, non–mobile-bearing device with a highly cross-linked polyethylene on metal-bearing surface. One of the key aspects of this design is that it requires an alignment stand (ie, jig or external frame) and milling device for proper insertion. The stand is a powerful tool that facilitates correction of multiplanar deformities and provides a stable, rigid coordinate system to base the bony resections. In turn, this allows for a high degree of accuracy and precision in implant positioning and should reduce variability with implant positioning. The aim of this paper is to describe helpful technical tips for surgeons implanting this prosthesis and is to be used as an adjunct alongside the manufacturer's surgical technique guide.

INDICATIONS AND CONTRAINDICATIONS

Patient Evaluation

A potential patient should be examined for any significant medical comorbidities that may contraindicate surgery (eg, uncontrolled diabetes, active infection). Focused lower extremity examination should pay particular attention to correctable and noncorrectable deformities. Deformity may occur proximal to the ankle as in the case of malunited tibial fractures or distal to the ankle as occurs in patients with a flatfoot or cavovarus foot. Depending on the complexity of the deformity, it can be corrected either concomitantly with the TAR or in a staged manner. The extremity should also be

From the Hospital for Special Surgery, New York City, NY.
J.D., L.S., S.H., C.S.: Implant Design Surgeon/Consultant Zimmer. The remaining authors declare no conflict of interest.
Address correspondence and reprint requests to Jeremy LaMothe, MD, Hospital for Special Surgery, 523 East 72nd Street, 5th Floor, New York, 10021 NY. E-mail: lamothej@hss.edu.

inspected for any soft-tissue compromise from previous trauma, surgery, infection, or neurovascular condition.

Indications

- Primary or revision arthroplasty for posttraumatic, degenerative, or inflammatory arthropathy. If used for revision arthroplasty, the case should be templated preoperatively to ensure that there is sufficient talar bone stock to accept the implant.

Contraindications

- Significant medical comorbidities including uncontrolled diabetes.
- Active history of joint infection.
- Insufficient bone stock or severe osteoporosis.
- Severe peripheral neuropathy.
- Significant lower extremity deformity or instability not potentially corrected by other surgery.
- Previous ankle arthrodesis with lateral malleolar excision.
- Severe and global avascular necrosis of the talus.
- Flat top talus or severe distal tibia bone deficiency in which preoperative templating reveals the rail drill holes are not completely contained within the talus or tibia are relative contraindications.

Preoperative Planning

The patient's lower extremity should be examined for any significant deformities. The leg must be able to fit in the positioning stand. Standing preoperative radiographs should be assessed for any ankle deformities that will need to be corrected before making bony cuts, and should be specified on the preoperative radiographs to help guide intraoperative positioning. Templates can be used to determine the implant size; the talus should be templated so that there is minimal talar overhang, minimal bony resection, and no notching medially into the tibia or laterally into the fibula. If there is a flat top talus, the implants can be used as long as the rail holes are well contained within bone in the talus and tibia. Tibial and talar sizes are not interchangeable and must be the same size (eg, the same number). As with other total replacements, significant foot deformities need to be assessed either in the same surgical setting or as a staged procedure.

Technique

Anesthesia

Regional or general anesthesia; our preference is a combined spinal/epidural with a long-acting popliteal block.

Positioning

The patient should be positioned supine on a radiolucent table with a bump underneath the ipsilateral hip to internally rotate the operative leg. Care needs to be taken to ensure that there is enough room laterally and distally on the table for the alignment stand to fit (the foot should be positioned approximately 6 inches from the end of the table). Remove soft pads from the end of the table on the operative side; this helps stabilize the alignment stand when used. A mayo stand or similar metal tray can be used as a hard surface on which to rest the stand. Placing a wide and long 4- to 6-inch high block or stack of blankets under the surgical leg from the distal thigh to the end of the table to elevate it above the nonoperative leg will help facilitate lateral imaging. A standard, full-size image intensifier should be used.

Approach

A standard lateral approach to the distal fibula is performed. A tourniquet may be used during the approach, but should be deflated before placing the leg and foot in the alignment stand. A plate for the fibula is chosen and is provisionally secured with pins before performing a fibular osteotomy. The plate is contoured to match the lateral aspect of the fibula and then the plate position is marked. Our preference is to use locking screws distally. Following marking, the plate is removed. An oblique fibular osteotomy is made so that the fibula can be lengthened, shortened, or angled, if necessary, to balance coronal plane deformities. If fibular lengthening or shortening is performed through the osteotomy at the end of the procedure, the final fibular plate position will be different than originally marked. The distal limb of the osteotomy must end proximal to the highest point on the tibial plafond to allow for adequate tibial bony resection without resecting part of the fibula (Fig. 1). The osteotomy should also be distal enough to leave the syndesmosis intact, so that syndesmotic fixation is not necessary; this is usually 1.5 to 2 cm proximal to the highest point of the tibial plafond.

The syndesmotic soft tissues distal to the osteotomy site and the anterior talofibular ligament (ATFL) are sectioned. A cuff of the ATFL is left for later repair, and the fibula is reflected inferiorly or posteriorly and pinned to the calcaneus thereby allowing visualization of the ankle joint (Fig. 2). Reflecting the fibula inferiorly generally moves the fibula more successfully out of the way of bony resections, but requires more soft-tissue stripping. Removing the soft tissues off the tibial side and leaving them attached on the fibula will preserve them for closure and subsequent healing. Posterior reflection is performed if there is absent or poor ligament tissue at the distal fibula, making it more desirable to maintain the cuff of tissue acting as the posterior hinge. The ankle joint is visualized and an anterior/posterior capsular release is performed as necessary. A thorough posterior capsular release will allow for placement of retractors that will protect the posterior neurovascular bundle when performing bony resections. A medial gutter approach is needed if there are medial exostoses. In cases of poor bone quality, consideration may be given to a prophylactic medial malleolar screw which will minimize the risk of an iatrogenic fracture. However, medial malleolar fractures are uncommon with this procedure, and are usually associated with reaming too far medially on the tibia. If the ankle cannot be brought into a neutral position due to a plantarflexion contracture, a gastrocnemius recession or Achilles lengthening should be considered at this time.

Sizing

After the approach and release, the medial/lateral talar dome is sized with the metal sizing guide as visualized on an intraoperative anteroposterior (AP) radiograph. The goal of sizing is to use the largest talar size possible while avoiding medial or lateral overhang. If the correct implant appears to be between sizes, consider choosing the smaller option to avoid an overhanging talar component.

Alignment Stand

The alignment stand provides a rigid coordinate system that serves 2 functions. First, it grants surgeons a powerful tool to correct multiplanar deformities. Second, because the mill guide is attached to the stand, which is firmly fixed to bone, accurate and precise cuts can be made. The leg is placed in the stand so that the tibia is parallel to the longitudinal bars and the ankle is centered between the longitudinal bars from a lateral

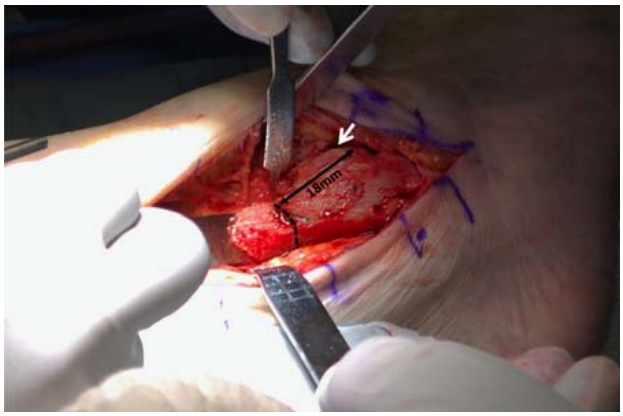

FIGURE 1. Lateral transfibular approach demonstrating the oblique osteotomy. A pin (at the dashed line) represents the distal most extent of the osteotomy and is usually 1.5 to 2 cm proximal to the ankle joint (white arrow) and can serve as an excellent landmark to aim the osteotomy towards.

view (Fig. 3). If the ankle sits too high or low in the stand, rather than centered on the side view, bone milling becomes difficult. The ankle should be rotated internally for a true mortise view, and this should be checked with fluoroscopy. An initial starting point to roughly set rotation is to align the medial border of the foot roughly parallel to the medial border of the footplate on the alignment stand. This can be refined by placing the back wide end of the pointer through the position hole of the cutting guide flush against the lateral anterior articular surface of the talus (Fig. 4). The lateral anterior articular surface of the talus should be flush against the flat end of the pointer if the ankle is appropriately internally rotated. Adjustments are made while the calf and heel cups attached to the stand are supporting the leg, and the foot is then initially secured to the footplate with a canvas strap. Ensure that there are no inadvertent pressure points on the foot from positioning or strapping. After satisfactory alignment is achieved, the foot is rigidly fixed to the footplate with a transcalcaneal pin that is placed, from lateral to medial, parallel to the footplate if there is no ankle deformity.

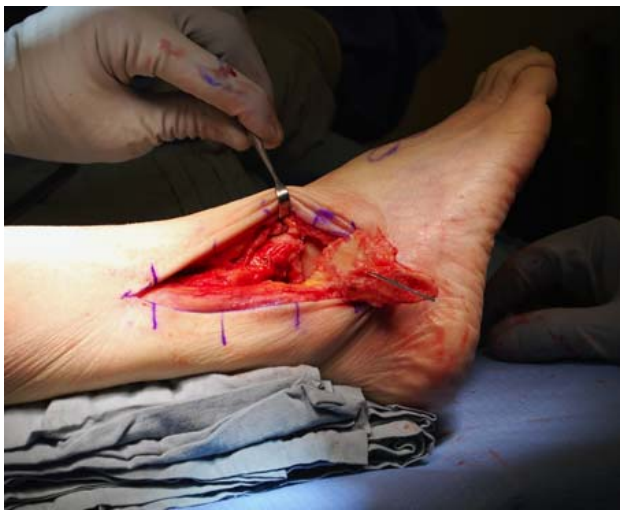

FIGURE 2. A smooth wire is used to pin the reflected fibula to the calcaneus, and allows excellent visualization of the lateral aspect of the ankle joint.

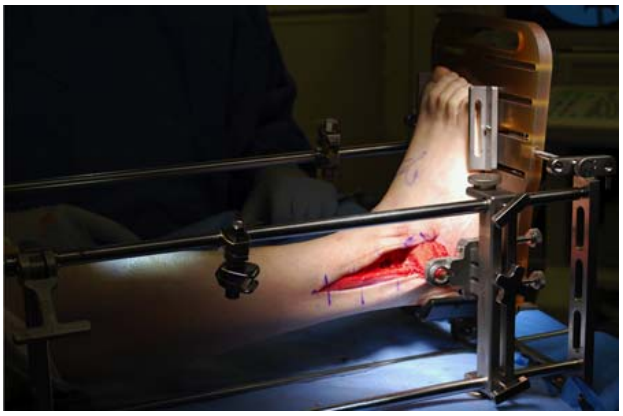

FIGURE 3. The leg is placed in the alignment stand so that the tibia is parallel to the alignment stand bars in the anteroposterior and lateral planes.

The alignment stand can be used to help correct deformity. In general, the deformity should be assessed for angular/translational deformities in the coronal and sagittal plane. Care should also be taken to note bone loss and rotational deformities. In cases of deformity, the calcaneal pin can be used to correct deformity and should be placed parallel to the angle of the deformity as described below. When applying the calcaneal pin to significant deformities, traction may help the correction and can be obtained by leaving the fat pad of the heel slightly distanced from the footplate before the tension is applied to the calcaneal pins to secure the foot to the plate. With the calcaneal pin secure on both sides, remove the heel cup. The talar neck pin can further correct any remaining deformity by placing it parallel with the talar articular surface (in the absence of significant talar bony deformity). Place the talar pin distally in the talar neck and advance it directly across (from medial to lateral and posterior to anterior) so that it does not interfere with later lateral fluoroscopic images of the ankle and is away from talar cut (Fig. 5).

Fluoroscopic imaging is used to assess the tibial alignment. The lateral tibial shaft should be parallel with the tibial alignment rod, and this should be viewed with fluoroscopy along the entire length of the tibia to minimize the artifact that can be associated with fluoroscopic imaging. The pointer placed through the position hole of the cutting guide resting on the anterior aspect of the ankle should be parallel to the non-deformed tibial and talar articular surfaces and perpendicular to the shaft of the tibia (Fig. 6). Once good position is confirmed, the tibial pins can be placed. During placement of the pins, look at the ankle from the lateral view to check that the tibia is not sagging posteriorly. The first pin is placed 3 to 5 cm proximal to the joint line. Once final position of the tibia is verified to be correct in the AP and lateral planes, the second tibial pin is placed 20 cm proximal from the joint line and the alignments are rechecked. Obtaining a proper alignment in the alignment stand is the most critical aspect of this procedure, and future progress cannot be made until this is correct. It is beneficial to recheck that all points of attachment are secure and that the projected cut is not in varus or valgus. An additional stabilizing bar to minimize cantilever bending can be placed between the talar pin or rod to the tibial pin or rod (Fig. 7). This insures a stiff and secure construct for milling.

Using the Stand to Correct Varus Deformities

The alignment stand can be used to correct varus deformities with the aid of the calcaneal and talar pins (Table 1). It is best

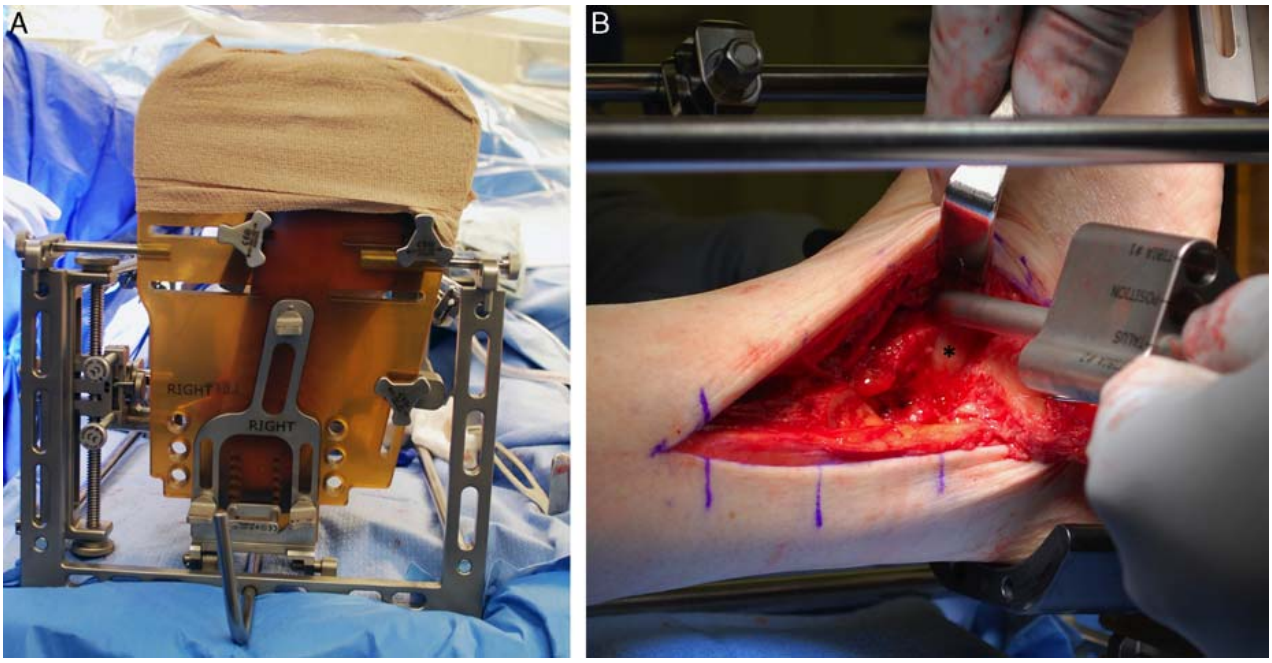

FIGURE 4. A, The medial border of the foot is roughly aligned with the medial border of the footplate. B, Final rotation can be established so that the blunt end of the pointer is parallel/flush with the lateral articular facet of the talus (*).

to confirm that the deformity is correctable before placing the ankle in the alignment stand. This is performed by placing a lamina spreader, pin distraction device, wires, or a chisel blade into the joint medially until intra-articular alignment is corrected. Severe deformities may require distraction and a more substantial capsular release. Once the leg is resting in the stand, the calcaneal pin is placed parallel to the plane of remaining deformity (ie, parallel to the talar articular surface, which approximates the deformity; in varus deformities the medial side of the pin will be more proximal than the lateral side). The pins are pulled so that they are then positioned parallel to the footplate and are secured with the provided hooks. A laminar spreader, pin distraction device, or chisel blade can be used to distract the medial tibiotalar joint as needed, and this is typically done through a separate anteromedial incision. Once the calcaneal pin is placed, if there is further deformity the talar pin should be placed parallel to the residual deformity as represented by the talar articular surface. Once the deformity is corrected, the pins are secured to the alignment stand, the laminar spreader can be removed, and an additional talar/tibial stabilizing bar should be placed. Even with contracted medial soft tissues, a deltoid release is very rarely needed. For residual calcaneal varus, a lateral translational closing wedge can be performed after the implant is installed.

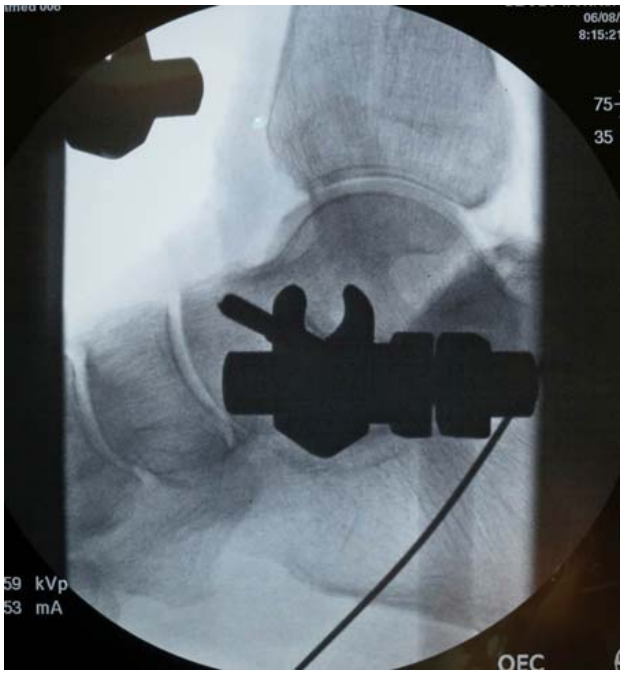

FIGURE 5. Lateral fluoroscopic view with the talar pin placed. Note that the talar pin is distal in the talar neck and does not interfere with the full lateral view of the ankle.

Using the Stand to Correct Valgus Deformities

As noted above, it is best to confirm that the deformity can be corrected before placing the ankle in the alignment stand. This is performed by placing a lamina spreader, pin distraction device, wires, or chisel blade into the joint laterally until intra-articular alignment is corrected. In addition, the calcaneal and talar pins are placed parallel to the deformity (ie, the lateral side of the pin is more proximal than the medial side). The pins are pushed so that they are then positioned parallel to the footplate. Often the fibular osteotomy is all that is required to correct the deformity. Lamina spreaders, or the aforementioned tools, may be applied laterally and a medial stabilizing bar is placed between the talar and tibial pins. In severe, chronic deformities, the fibula may remodel and result in a widened lateral gutter or shortened fibula once the ankle is replaced in a neutral position. A corrective fibular osteotomy to close the widened lateral gutter may be used to help provide varus/valgus stability to the implant. A medializing calcaneal osteotomy may also be needed if there is residual valgus heel deformity.

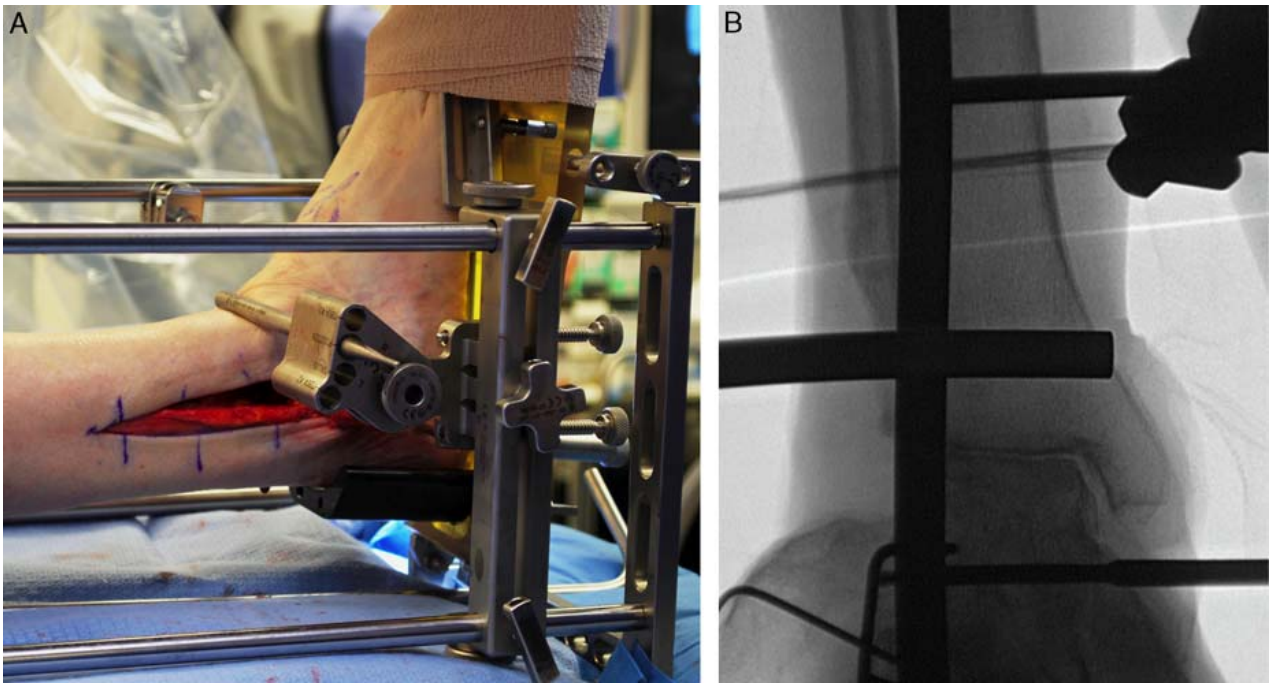

FIGURE 6. A, Before securing the tibia to the alignment stand, the pointer is placed on the anterior aspect of the ankle. Radiographically, the pointer should be parallel to the undeformed tibial articular surface, and the tibial alignment rod should be parallel to the lateral aspect of the tibial shaft. B, Once the desired alignment is achieved, the tibia is secured to the stand and the alignment is rechecked radiographically.

Using the Stand to Correct Anterior/Posterior Talar Translation

Sagittal deformity may be very difficult to manage with anterior surgical approaches. The alignment stand used with this lateral approach, however, makes this challenge more manageable. Significant deformities will require a thorough capsular release, distraction, and possible bony resection (posterior distal tibia for anterior talar translation, and anterior distal tibia for posterior talar translation). Once it is verified that the deformity is correctible, the foot is secured to the footplate with a calcaneal pin as described above, and the talar neck pin is placed. A unicortical, anterior to posterior tibial pin is placed and can impart an anteriorly (in anterior talar translation) or posteriorly (in posterior talar translation) directed force to the tibia to reduce the deformity. With longstanding posterior translation, plantarflexing the ankle 5 to 10 degrees may help relax the posterior soft tissues. Once reduced, the tibial pin is locked in place with a pin-bar connector. Essentially, when correcting translational deformities, the focus is on reducing the tibia to the talus, which is rigidly secured to the alignment stand.

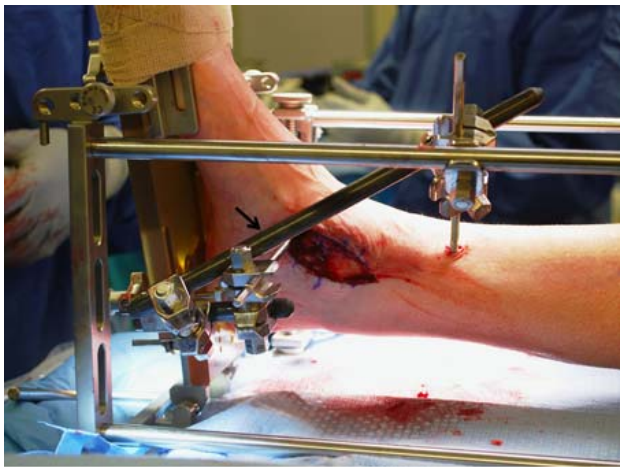

FIGURE 7. Alignment stand demonstrating the accessory tibiotalar stabilizing bar (arrow). Occasionally, the pin-bar connector that connects the talar pin to the stabilizing bar may interfere with lateral imaging, and needs to be connected to the talar carbon fiber post, as pictured here.

Using the Stand to Correct Rotational Deformities

The foot should be positioned as noted above using all parameters to ensure proper internal rotation. These include keeping the foot parallel to the medial border of the footplate, placement of the flat end of the pointer against the anterior aspect of the lateral side of the talus and finally checking radiographs. On the "AP view" shot, perpendicular to the frame with the rotation corrected a mortise view should be seen. On the lateral view with the rotation properly corrected, a perfect lateral silhouette of the talus should be achieved without double opacities. Now place the transcalcaneal and

TABLE 1. Deformity Correction Using Vectors on the Alignment Stand Pins With Respect to a Fixed Tibial Pin

Deformity	Talar Pin Vector Inserting Lateral to Medial	Calcaneal Pin Vector	Lamina Spreader Location
Varus	Distal	Proximal	Medial ankle joint
Valgus	Proximal	Distal	Lateral ankle joint

Obtaining correct alignment in the stand is of paramount importance to achieve a reliable surgical result.

talar pins. To correct intra-articular rotational deformity that remains at the tibial level, a laminar spreader or distractor is inserted into any defect and/or the anterior to posterior distal tibia pin option is placed. With this half pin, which is attached to an anterior transverse carbon bar, the tibia can be maneuvered to facilitate rotational correction. Once achieved, the pin is locked to the bar and AP and lateral images are obtained. Make fine-tuning adjustments and then place the more proximal tibial pin. Finally, attach another carbon bar from the talar to the distal tibial pins to minimize cantilever bend and ensure stability of the construct.

Sizing

This is done by selecting the same size anterior-posterior sizer based on the previous medial-lateral measurement made at the beginning of the case. One should assess the talar bony resection that would be made by aligning the sizer on the lateral aspect of the talus; coverage of the bone by the implant should be maximized (while avoiding overhang) and bony resection should be minimized. Once an appropriate sizer is selected, the same sized cutting guide should be selected and attached to the lateral cutting guide assembly. The cutting guide should be positioned so that the "position" hole probe is placed at the zenith of the joint line. To minimize talar resection, one can place it 1 to 2 mm above the joint line at the center of the talar dome. The exact dimensions of the cut can be visualized by placing the milling tool into the guide and then sweeping the tool anterior and posterior to demonstrate the talar and tibial cuts. Ensure the arc of curvature of the probe is concentric and parallel with the talar articular surface. The talar and tibial sizes must be the same. If in between sizes, choose the smaller size to avoid overhang. Once the position is satisfactory, secure the cutting guide in place.

Bone Resection

Establish the depth of the resection using a contralateral talar trial component of the correct size and a drill fitted with a Jacob's chuck (Fig. 8). Predrill the bony surface through the drill guide to allow later, smoother milling with the burr. In sclerotic bone, the drill bit may deviate toward the joint. If this is the case, use a peck drilling technique to help avoid this deviation or consider using a box wrench provided in the set to help "push" the drill bit into the sclerotic bone (Fig. 9). Verify the drilling depth with fluoroscopy. After drilling, prepare for the burr to finish the bony resection. Use the burr guard stop in a similar manner to the Jacob's chuck to establish the burr penetration depth. Use the stop screws to avoid burr penetration into the anterior or posterior soft tissues. Use fluoroscopy to avoid overburring medially (Fig. 10). Irrigation should be used continually during milling. Use a posterior soft-tissue retractor to protect the flexor hallucis longus, medial tendons, and neurovascular bundle. Mill the talus first, then the tibia. The tibia usually requires 2 to 3 mm less medial resection than the talus; milling the same distance for the talus and tibia risks milling too far medially and iatrogenically weakening or fracturing the medial malleolus. It may be helpful to mill the posterior talus and tibia last. This allows extra attention to be focused on posterior soft-tissue protection. Once cutting is complete, visualize and palpate the surfaces to detect any ridges that may require additional contouring with the burr.

Drill Rail Holes

The rail hole drill guides are then placed and must be positioned flush against the talus and tibia before drilling. Ensure the correct size guide is used, as the implants are not interchangeable. Fluoroscopy and direct visualization must confirm that the guides are flush all along the talar and tibial cuts once the tightest spreader pin is in place between them (Fig. 11). If there is space between the rail hole guide and the talus or tibia, remove the guides and reuse the milling device to ensure the cuts are smooth with no bumps or impinging bone medially. Reset the posterior tissue protector before remilling. Often, correction is achieved by remilling the anterior or posterior most aspects of the talus and tibia. Fix the guides with the tibia and talar components well centered in the medial/later and anterior/posterior planes. The rail holes must be drilled to the full depth and ensure that the drill holes are

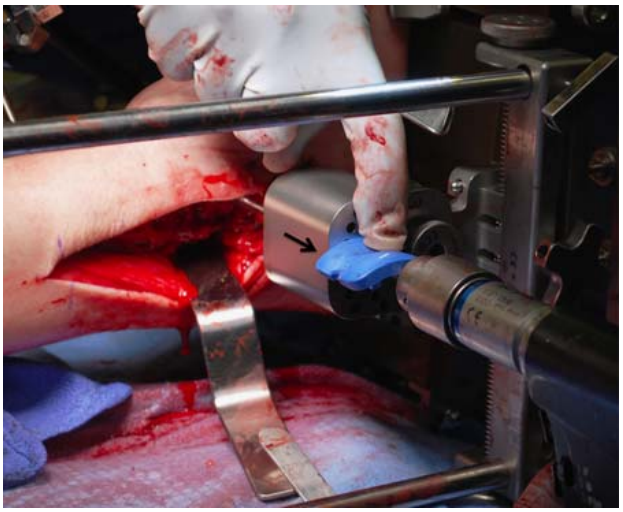

FIGURE 8. A trial talar component (arrow) is used to establish drilling penetration depth. The drill bit is advanced to the lateral talus and once the tip of the bit contacts the talus, the Jacob's chuck is advanced to the appropriately sized trial talar component and tightened. It is recommended to use the contralateral trial component in case the component is inadvertently dropped from the surgical field.

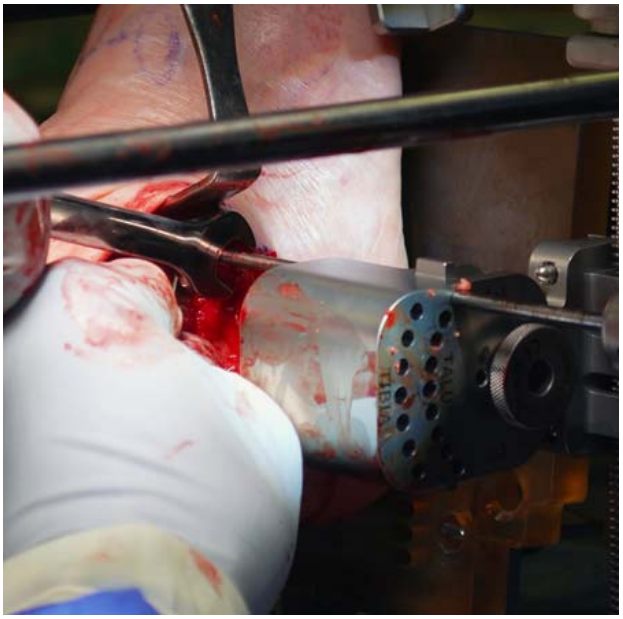

FIGURE 9. A wrench can be used to help guide the drill bit away from the joint space in the sclerotic bone.

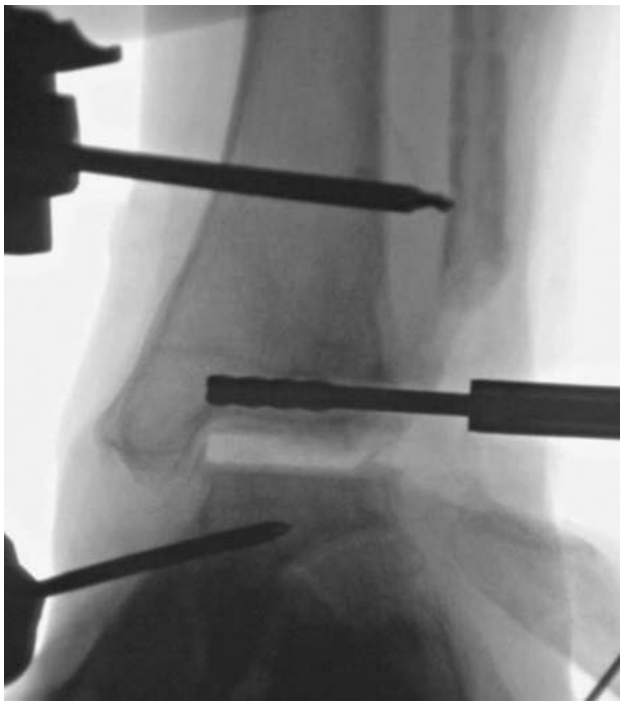

FIGURE 10. An anteroposterior view of the ankle shows the medial limit of the tibial milling, which should be confirmed under fluoroscopy during the milling process.

cleanly drilled. Use fluoroscopy to ensure that the drilling does not occur medial to the medial extent of the milling.

Trial Components

The trial components are inserted to verify that an appropriate, smooth, bony resection was performed and to assess soft-tissue tension. Determine the thickness of the poly based on the thickness required to minimize medial gapping with a valgus stress and minimizing laxity with longitudinal foot traction. The trial components should sit flush or slightly medial to the lateral tibia and talus, but should not leave substantial medial bone uncovered. Release the footplate from the stand and perform a trial range of motion and check the deltoid tightness with the ankle at neutral. With fluoroscopic stress tests, the deltoid should allow <2 mm of medial component surface gapping with the ankle in neutral and the component should permit >10 degrees of dorsiflexion. If not, consider changing the polyethylene size. If the size is optimal to valgus stress testing, but dorsiflexion is limited, perform a gastrocnemius recession or Achilles lengthening (usually after the leg is removed from the stand).

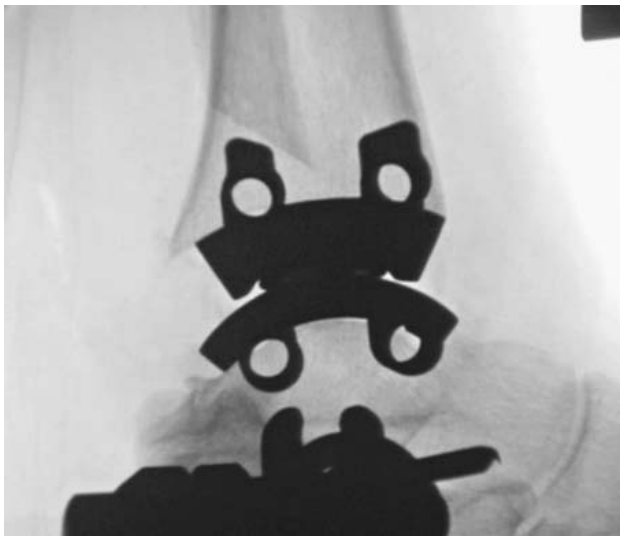

FIGURE 11. A lateral fluoroscopic image demonstrates the position of the rail hole guides (with the spreader in place) as well as the close apposition of the curved surfaces of the rail guides against the tibial and talar cuts. No gaps should be seen between the rail hold guides and the cuts on a direct lateral fluoroscopic view of the guides.

Final Components

Once satisfied with the trial components, insert the final components. These should be gently impacted in place. Remove the angle locking pin, as this will allow an assistant to place compression across the ankle while the implants are driven across. With the tibial trial in place, use the inserter to place the rails of the implant into the talar rail holes under direct visualization. Gently impact the talar component across without angling proximally or distally (stay perpendicular to the lateral talus and alignment stand). An assistant puts compression across the ankle joint by pushing on the footplate so that that the rails on the implant remain fully seated into the rail holes as the implant is driven across. Under fluoroscopic control, tap the implant into a well-centered position on the talus. Use a similar technique to insert the tibial component. Cement is now injected in a liquid state under minimal pressure with a syringe along the 4 rail protrusions at the bone/rail interface.

Repair the Fibula

With the components inserted, reduce the fibula and ensure there is no gutter impingement; debride the gutters where necessary. The fibula can be repaired in a standard manner with a lag screw and the preselected plate. If the fibula was moved to tension the soft tissue, the fibular plate position will be different than the originally marked position (Fig. 12). Repair the ATFL by direct suture to the bone or a suture anchor. Assess the syndesmosis for stability. If unstable, place fixation across the syndesmosis with a screw.

Adjunctive Procedures

It is important that no gutter impingement is present. If talar osteophytes or varus deformity is present, it is best to check for medial exostoses and remove them through a medial incision. Lateral osteophytes can be removed from the lateral exposure. It is critical to assess the alignment of the foot to determine if other procedures need to be performed to balance the foot; the heel must be in a neutral position at the end of the case (Fig. 13). Similarly, attention should be paid to dorsiflexion. If the foot is unable to be brought into 10 degrees of dorsiflexion, a gastrocnemius recession or Achilles lengthening should be performed as noted above.

RESULTS

Given the recent FDA approval of this implant, no published series exist that report on the results or complications with this prosthesis. However, close to 300 cases have been implanted worldwide, with encouraging early results. Early results from the developing surgeons include 108 ankles performed by 4 surgeons. The deformities were as follows: neutral (n = 27),

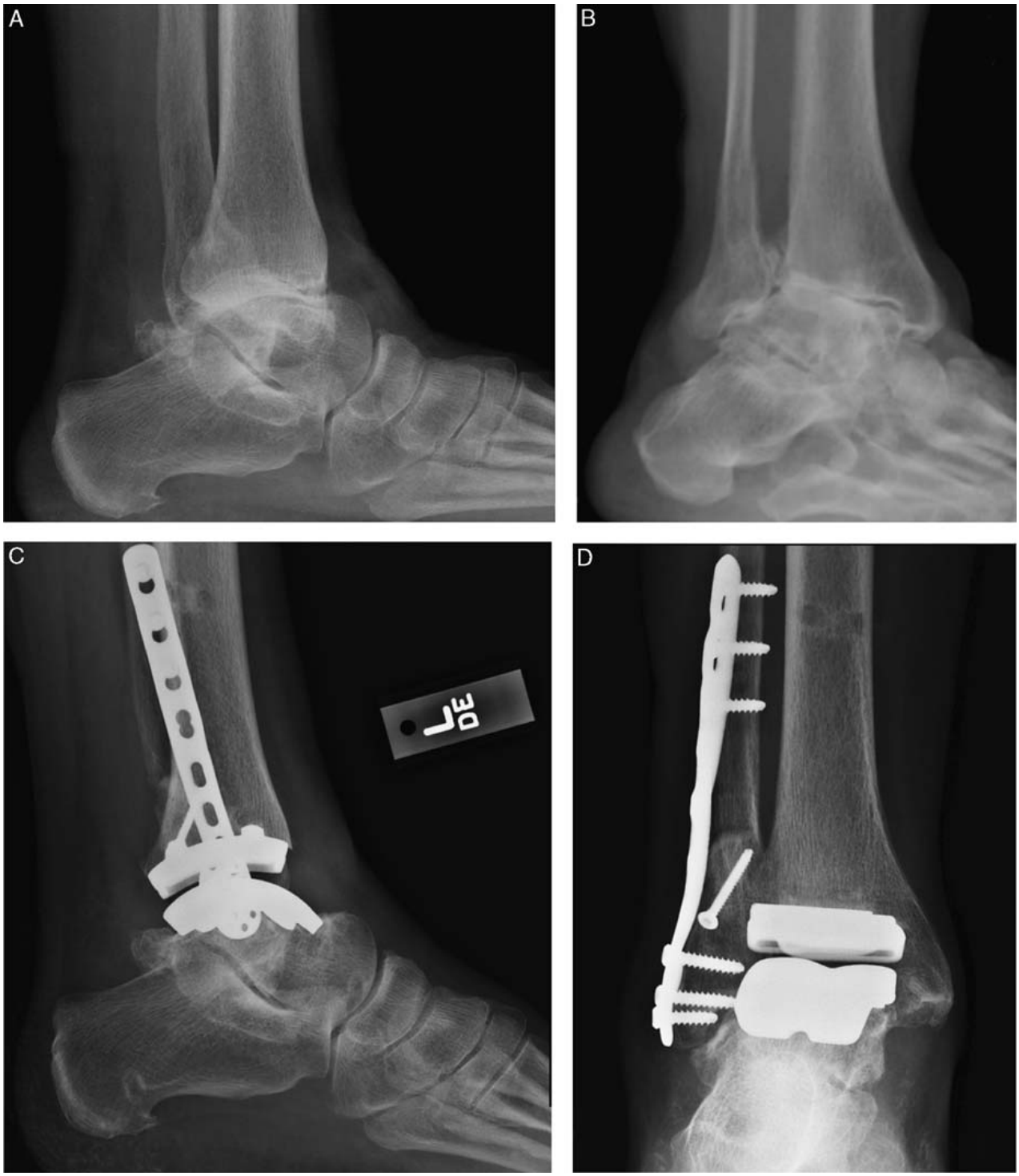

FIGURE 12. A, Lateral and (B) Mortise radiograph of an arthritic ankle with a significant valgus deformity. Immediate postoperative lateral (C) and mortise (D) images showing correction of the valgus deformity. With significant valgus deformities, the fibula may need to be lengthened through the oblique osteotomy.

valgus (n = 28), varus (n = 27), anterior subluxation (n = 14), posterior subluxation (n = 6), major rotational (n = 1), and combined (n = 5). Adjunctive concomitant procedures included: Achilles lengthening/gastrocnemius recession (n = 15), fibula realignments (n = 15), syndesmotic stabilizations (n = 8), calcaneal osteotomies (n = 6), subtalar fusions (n = 2), talonavicular resection of osteophytes (n = 1), and subtalar arthroereisis (n = 1).

There were no returns for loosening/subsidence or malpositioning. There were 3 irrigation and debridements with implant retention, 2 with poly exchange and 1 without. There has been 1 postoperative tibial osteotomy, 1 capsular release for postoperative stiffness, and 4 hardware removals (3 syndesmosis fixation, 1 fibular plate). In general, pain relief and function improved dramatically and range of motion has improved in nearly all cases.

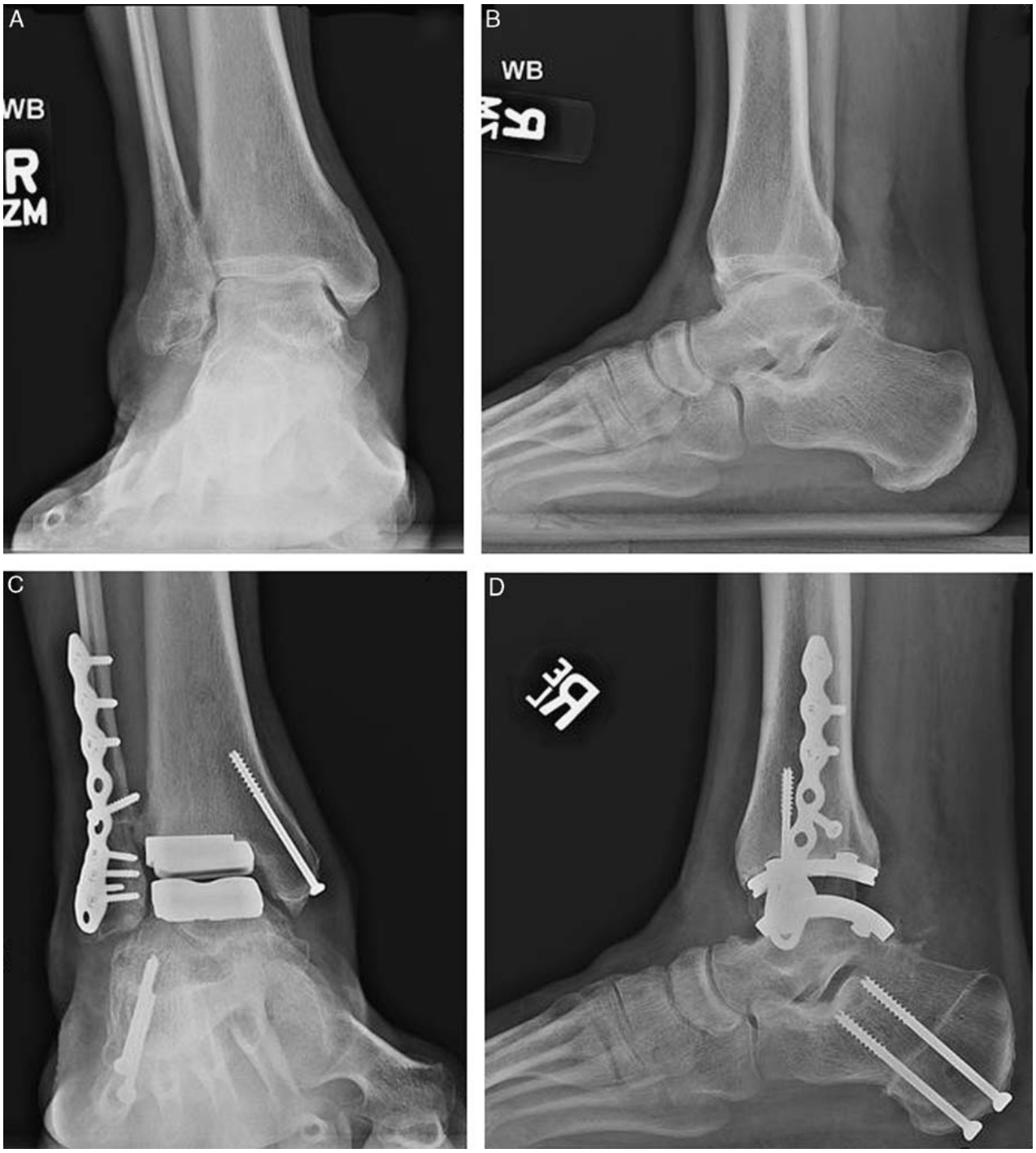

FIGURE 13. Preoperative anteroposterior (AP) (A) and lateral (B) radiographs of a patient with ankle arthritis with posterior translation of the talus and valgus heel deformity. Postoperative AP (C) and lateral (D) radiographs showing a well-positioned total ankle prosthesis with the use of an adjunctive prophylactic medial malleolar screw and corrective medial heel slide osteotomy.

Complications (Based on Surgical Approach and Other Published Total Ankle Series)

- Superficial peroneal nerve injury
- Wound complications
- Implant subsidence
- Osteolysis and late implant loosening
- Postoperative infection
- Fibula nonunion or malunion
- Gutter impingement

Postoperative Management

The patient is kept non–weight-bearing in a well-padded splint in neutral position for the first 2 weeks. Sutures are removed at this point if the wound permits and the patient is placed in a CAM walker boot. At the 2-week visit, the patients are instructed to begin deep knee bends out of the boot to achieve ankle dorsiflexion for 20 minutes at a time for 5 sessions during the course of the day. If there is concern about the wound, the sutures are kept in and a cast is placed for 2 more

weeks. Progressive weight-bearing usually begins at 6 weeks in the boot. Gentle early range of motion is encouraged when the wound allows.

Possible Concerns and Future of the Technique

One of the main concerns of any TAR is long-term implant survivorship, which needs to be followed. Furthermore, future techniques should consider revision strategies to manage bone loss. However, the presented prosthesis resects less bone than other implants by the nature of its lateral approach, and has a highly cross-linked poly insert, which should reduce wear rates. Preoperative templating is of paramount importance to determine if bone stock would allow a revision lateral approach total ankle to be performed. If templating suggests it is not possible to revise the implant to another lateral approach total ankle due to bone loss, consideration may be given to an anterior approach TAR with more aggressive bony resections.

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