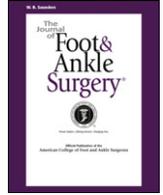




Contents lists available at ScienceDirect

The Journal of Foot & Ankle Surgery

journal homepage: www.jfas.org



Tips, Quips, and Pearls

"*Tips, Quips, and Pearls*" is a special section in The Journal of Foot & Ankle Surgery which is devoted to the sharing of ideas to make the practice of foot and ankle surgery easier. We invite our readers to share ideas with us in the form of special tips regarding diagnostic or surgical procedures, new devices or modifications of devices for making a surgical procedure a little bit easier, or virtually any other "pearl" that the reader believes will assist the foot and ankle surgeon in providing better care. Please address your tips to: D. Scot Malay, DPM, MSCE, FACFAS, Editor, The Journal of Foot & Ankle Surgery, PO Box 590595, San Francisco, CA 94159-0595; E-mail: editorjfas@gmail.com

Tibiototalcaneal Arthrodesis Using a Femoral Locking Plate

Lawrence A. DiDomenico, DPM, FACFAS^{1,2}, Mari Wargo-Dorsey, DPM²¹ Section Chief, Departments of Podiatry and Surgery, St. Elizabeth Health Center, Youngstown, OH² Private Practice, The Ankle and Foot Care Centers, Boardman, OH

ARTICLE INFO

Keywords:

bone
fusion
hybrid technique
inverted condylar plate
surgery

ABSTRACT

The goal of a tibiototalcaneal arthrodesis is to create a pain-free, stable hindfoot and ankle. Although a reserved procedure, it is useful when simultaneous ankle and subtalar joint pathology exists. Numerous complications have been reported after tibiototalcaneal arthrodesis, most importantly nonunion. Locking plates have proved to be a more stable construct than alternative forms of arthrodesis. In the inverted positions, the hybrid plating of the femoral locking plate structurally aligns with the anatomy of the hindfoot. This provides an anatomically sound construct, while allowing for both locking and lag screw insertion. We describe a new technique using a 4.5-mm condylar plate for tibiototalcaneal arthrodesis.

© 2012 by the American College of Foot and Ankle Surgeons. All rights reserved.

Tibiototalcaneal arthrodesis (TTCA) is a procedure reserved for the treatment of arthritides, avascular necrosis, and deformation of the rearfoot and ankle. It is performed when conservative treatment for concurrent ankle and subtalar joint pathology fails. The surgical options for TTCA include screw fixation, external fixation, intramedullary nailing (IM), the use of locking plates, and the use of blade plates (1). Despite application of a wide range of fixation constructs, nonunion remains a common complication associated with efforts to achieve TTCA. Chou (2), in a multicenter study of 56 ankles after TTCA, reported nonunion in 8 (14%). Frey et al (3) reported nonunion in 8 (89%) of 9 patients when performing ankle arthrodesis in the presence of avascular necrosis of the talus. Ahmad et al (1) reported a rate of nonunion of approximately 6% in 18 patients who underwent TTCA using a humeral locking plate. When using retrograde IM nailing, Pelton et al (4) reported a 12% incidence of nonunion in 33 feet, and Niinimäki et al (5) reported a 24% incidence in 34 patients. Malunion is another common complication experienced with efforts to achieve TTCA. Malunion can lead to genu recurvatum if in a position of equinus, lateral column overload if in a varus position, and unnecessary stress of the posterior tibial tendon, knee, and first ray if in valgus misalignment (4). A review of the published data

suggested that the neutral position in terms of ankle joint dorsiflexion and plantarflexion, with 5° valgus, and 5° to 10° of abduction is the ideal (2,6–11).

The development of stress risers is another complication associated with IM nailing. Thordarson and Chang (12) described stress



Fig. 1. Intraoperative lateral radiographic view of surgical reconstruction after partial talarctomy.

Financial Disclosure: None reported.

Conflict of Interest: None reported.

Address correspondence to: Lawrence A. DiDomenico, DPM, FACFAS, Private Practice, The Ankle and Foot Care Centers, 8175 Market Street, Boardman, OH 44512.
E-mail address: ld5353@aol.com (L.A. DiDomenico).



Fig. 2. Intraoperative lateral radiographic view demonstrating the initial insertion of the autogenous cortical cancellous bone graft and 1 of 2 full-threaded 7.3 (positional) cannulated screws.

risers localized to the locking screws in the proximal tibia. In their study of 12 patients who underwent TTCA with use of an IM nail, 2 patients (16.7%) developed stress fractures and 7 (58.3%) experienced cortical hypertrophy ≥ 2 mm (12). Locking plate technology enables a rigid, stable construct, while preserving the biologic principles of bone such as the blood supply that are typically lost with conventional plating. The screwhead threads into and rigidly purchases the plate, which, as does an external fixator, maintains an established distance between the plate and bone. With plate holes that can accommodate both locked and unlocked screws, “hybrid” constructs can be achieved, thereby using lag screws to assist with achieving the reduction and locked screws to aid in maintaining the reduction (13). It is not uncommon for us to initially use lag screws for the initial reduction and then either replace the lag screw or adding a locked screw for stabilization. Performing TTCA with a femoral locking plate takes advantage of the added stability achieved with locking plate technology, and we believe that this adds to stability and diminishes the risk of failed arthrodesis.

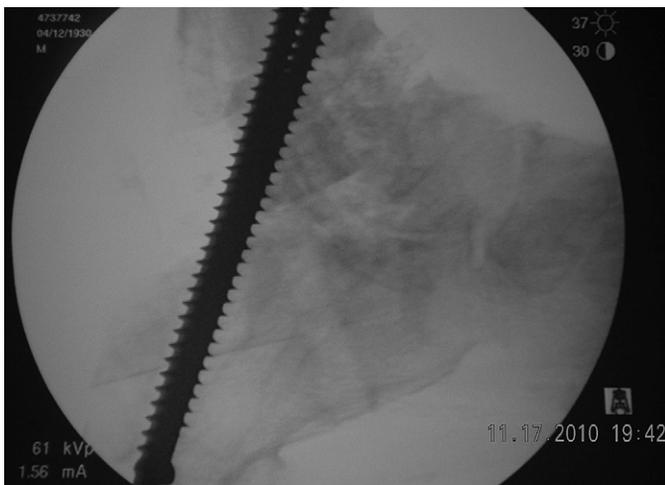


Fig. 3. Intraoperative lateral radiograph after insertion of tricortical cancellous autogenous graft with two 7.3-mm full-threaded positional screws inserted.

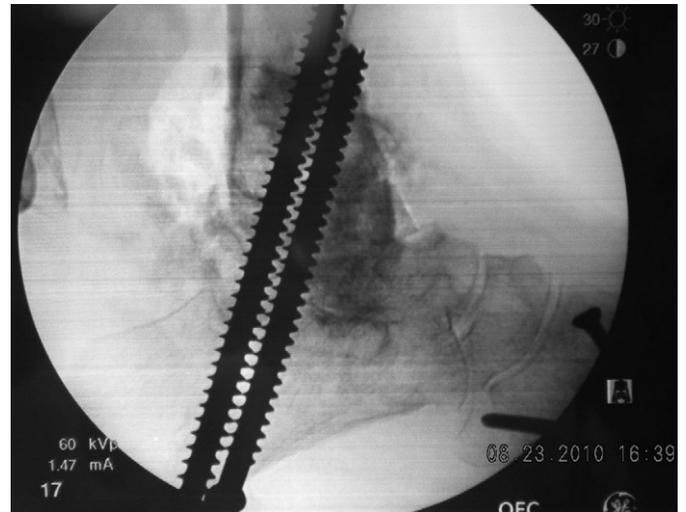


Fig. 4. Intraoperative lateral radiograph after insertion of tricortical cancellous autogenous graft with two 7.3-mm full-threaded positional screws inserted.

Surgical Technique

The patient is placed in a supine position and slightly rolled with a bump under the ipsilateral hip, which provides good exposure of the lateral aspect of the hindfoot and ankle. A 15-cm incision is made posterior and parallel to the long axis of the fibula, to the level of the inferior calcaneus. The incision is carried deep to the dermis, avoiding the neurovascular structures. Once all soft tissues are free from the fibula, a fibular osteotomy is made, and the distal portion of the fibula is resected. The resected fibula is placed in saline (or platelet-rich plasma) and subsequently prepared for use as a corticocancellous bone graft to fill voids. Once satisfactory exposure of the ankle and subtalar joints has been achieved, the diseased joints are resected and positioned into the desired corrected alignment. Next, two 2.8-mm guidewires are inserted from the posteroinferior portion of the calcaneus into the anterodistal tibia, maintaining anatomic alignment (Figs. 1 and 2). Once the desired alignment has been ensured with fluoroscopy, placement of a corticocancellous bone graft is

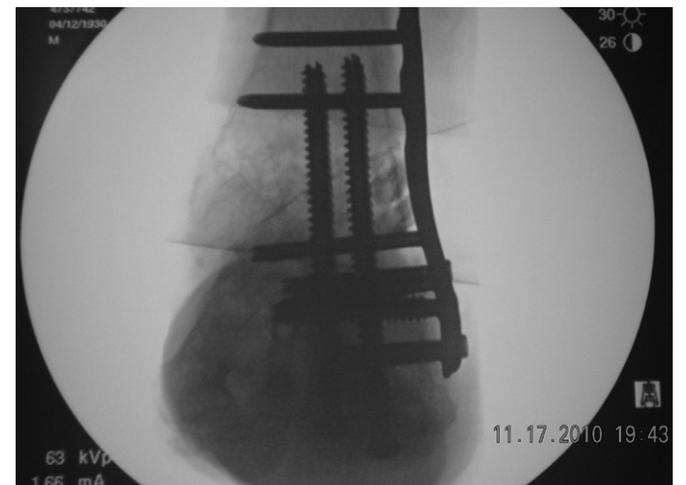


Fig. 5. Anteroposterior intraoperative ankle view with femoral locking plate applied from laterally to medially.

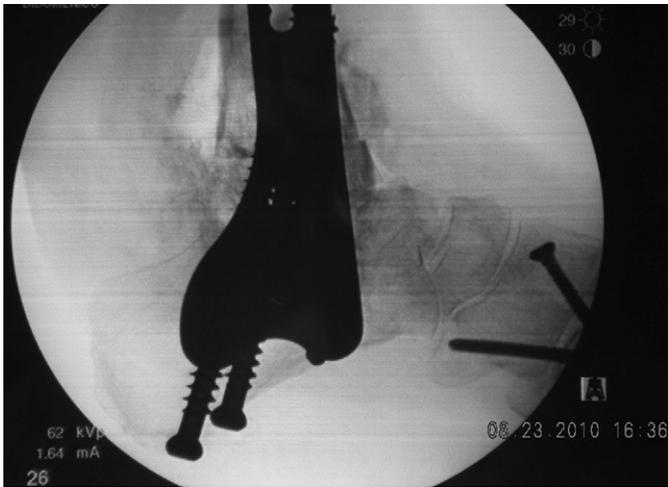


Fig. 6. Intraoperative lateral radiograph demonstrating autogenous tricortical cancellous bone graft well positioned with 7.3-mm fully threaded positional screws and femoral locking plate.

undertaken, and 2 fully threaded 7.3-mm screws are inserted over the guidewires as positional screws (Figs. 3 and 4). The femoral condylar locking plate is then applied in an inverted position. Thus, if the repair is on the left ankle, the surgeon will need to select an appropriately sized right femoral condylar locking plate. Once the appropriate plate position is determined, it is secured to the lateral wall of the calcaneus with 3 guidewires, which are advanced until they reach the medial wall of the calcaneus. The central hole is measured for screw length, and a fully threaded 7.3-mm cannulated conical screw is inserted into the far cortex, thereby lagging the plate to the lateral wall of the calcaneus. Up to 5 additional lagging or locked screws can then be used to further stabilize the plate to the calcaneus (Figs. 5 and 6). We have found this technique to be advantageous in regard to securely purchasing the thin cortex and cancellous bone of the calcaneus. The ability to have multiple points of fixation and locked screws in the calcaneus provides excellent stability. The most proximal portion of the plate is reduced against the lateral wall of the tibia and a lag screw is inserted to bring the plate to the bone. Thereafter, a combination of lag and/or locking screws can be inserted to fill the remaining plate holes (Figs. 7 and 8).

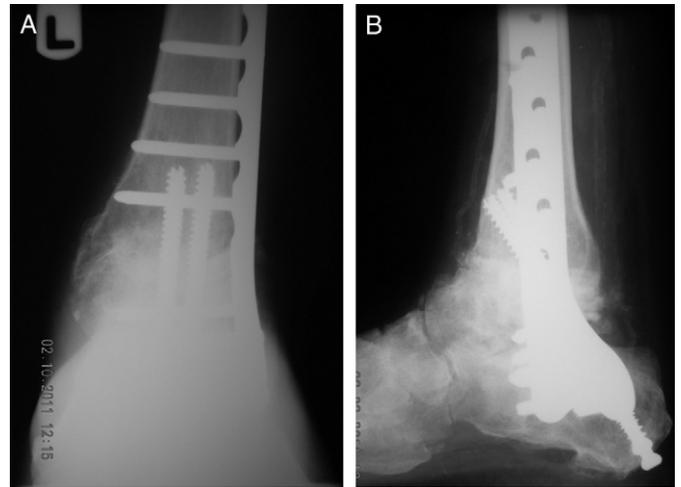


Fig. 7. Postoperative anteroposterior (A) and lateral (B) radiograph demonstrating good bony union and rigid internal fixation.

In cases in which there is a varus deformity (Fig. 9), the calcaneus can be fixated initially, as described above. Because of the strong fixation of the calcaneus, the proximal lag hole and plate becomes a reduction tool as the plate becomes more parallel with the tibia. This reduces the ankle and subtalar joint while correcting the varus deformity and achieving the desired axial alignment (Figs. 10 and 11). Two additional 7.3-mm screws can then be inserted as described above (Fig. 12).

Discussion

The ultimate goal of TTCA is to provide maximum stability of the realigned rearfoot and ankle. Numerous studies have been undertaken to determine the surgical treatment that elicits the most stable construct (14–18). In 2008, Chodos et al (14) performed a TTCA using both a locking plate and a blade plate on 9 pairs of below-the-knee fresh frozen cadaver specimens. Their results suggested that the locking plate was a better option than the blade plate because it was superior in initial stiffness and load to failure and displayed less deformation. IM nailing and the use of blade plates were comparable

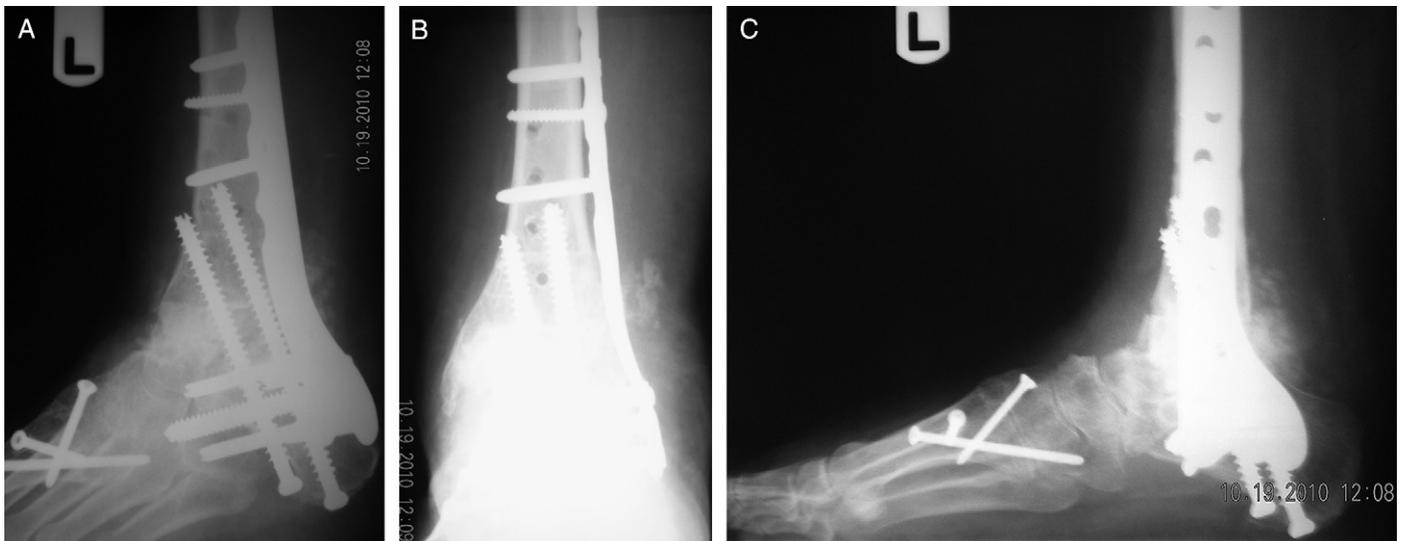


Fig. 8. Postoperative radiographs demonstrating well-healed hindfoot and ankle with rigid internal fixation. (A) Oblique, (B) anteroposterior, and (C) lateral.



Fig. 9. Anteroposterior radiograph demonstrating Charcot hindfoot and ankle.

in terms of stability (15,16), and the IM nailing method was also considered inferior to the locking plate construct. The femoral locking plate that we have described in the present report has holes that can accommodate both locking and nonlocking screw fixation. When orienting the plate with the condylar portion placed distally (inverted), the contour of the plate suitably matches the natural alignment of the topographic anatomy of the surgical site. The plate has 8 screw holes in the condylar segment, enabling plenty of purchase of the cancellous bone of the calcaneus. Three of these holes are non-threaded (standard) and allow for lagging, and 5 are monoaxial locking holes that can be used to provide axial stability. The condylar plate accepts standard 6.5-mm cancellous screws, 4.5-mm standard cortical screws, and 5.0-mm locking screws.



Fig. 10. Anteroposterior radiograph demonstrating well-fixed calcaneus and proximal portion of locking plate reducing varus deformity.

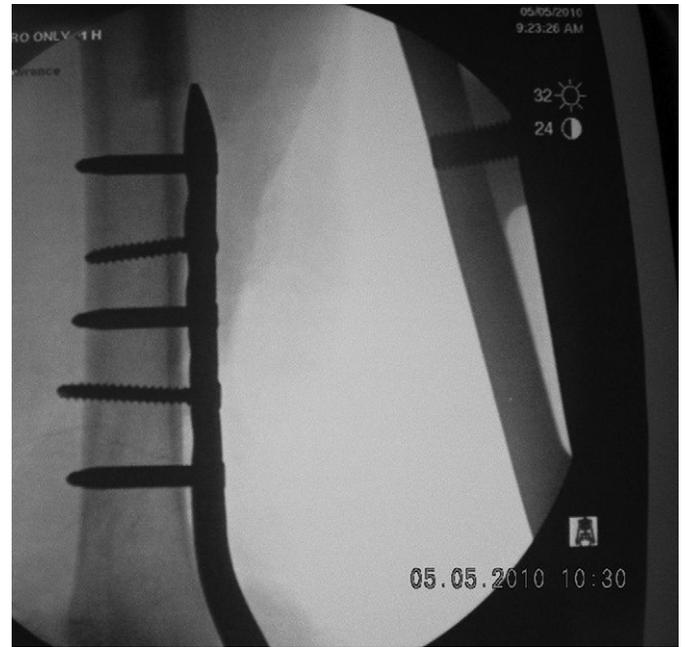


Fig. 11. Anteroposterior radiograph demonstrating reduced proximal portion of femoral locking plate maintaining anatomic alignment.

With locking plates becoming increasingly popular, technological advancements, including contoured plates and a “hybrid” technique of application, have been introduced. The “hybrid” technique uses both locking and lagging screw applications. Previous research has indicated that concurrent use of locking and lagging screws for plating applications can decrease the cost of the procedure, as well as produce greater torsional strength without compromising the axial load strength (13). Doornink et al (17) examined hybrid plating in osteoporotic bone and compared it with an all-locked construct and found that hybrid plating demonstrated 42% greater torsional strength compared with the all-locked plating, although it was 7% lower in axial strength.

Ahmad et al (1) used a humeral locking plate for TTCA in 18 limbs in 17 patients, and all but 1 (5.6%) went on to successful fusion. That study demonstrated a high fusion rate and their

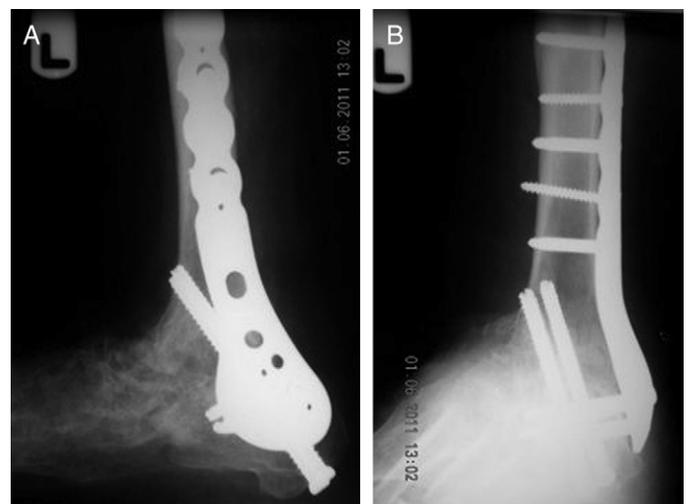


Fig. 12. Postoperative radiographs demonstrating good anatomic alignment, bony union, and rigid internal fixation. (A) Lateral and (B) oblique.

technique was recommended for patients with osteoporotic bone, arthritides, and a fixed deformity. They reported that multiplanar fixation and the plate acting as a fixed angled device were advantages over other methods of fixation skeletal (1). With the application of an inverted humeral locking plate, 4 to 6 locking screws can be placed in the calcaneus, and a combination of cortical and locking screws can then be placed in the distal portion of the plate (3 in the talus and 3 or 4 in the tibia) (18). In contrast, the contour of the Synthes LCP Condylar 4.5/5.0 Femoral Locking Plate® (Synthes USA, Paoli, PA), when placed with the condylar portion applied against the lateral aspect of the calcaneus, mimics the anatomy of the surgical site. The 8 screw sites in the anatomic region of the calcaneus allow the femoral locking plate to produce an anatomically sound construct while providing surgical options for optimal screw placement. Although the talus is often removed owing to avascular necrosis or trauma, the plate can also accommodate up to 2 screws in the talus, if present. In addition, with the femoral locking plate matching the natural contour of the anatomy, we believe the procedure is technically easier for the surgeon compared with alternative techniques.

References

- Ahmad J, Pour AE, Raikin SM. The modified use of a proximal humeral locking plate for tibiotalocalcaneal arthrodesis. *Foot Ankle Int* 28:977–983, 2007.
- Chou LB. Tibiotalocalcaneal arthrodesis. *Foot Ankle Int* 21:804–808, 2000.
- Frey C, Halikus N, Vu-Rose T, Ebramzadeh E. A review of ankle arthrodesis: predisposing factors to nonunion. *Foot Ankle Int* 15:581–584, 1994.
- Pelton K, Hofer JK, Thordarson DB. Tibiotalocalcaneal arthrodesis using a dynamically locked retrograde intramedullary nail. *Foot Ankle Int* 27:759–763, 2006.
- Niinimäki TT, Klemola TM, Leppilahti JI. Tibiotalocalcaneal arthrodesis with a compressive retrograde intramedullary nail: a report of 34 consecutive patients. *Foot Ankle Int* 28:431–434, 2007.
- Cooper PS. Complications of ankle and tibiotalocalcaneal arthrodesis. *Clin Orthop Related Res* 391:33–44, 2001.
- Buck P, Morrey B, Chao E. The optimum position of arthrodesis of the ankle: a gait study of the knee and ankle. *J Bone Joint Surg Am* 69-A1052–1062, 1987.
- Bennett GL, Cameron B, Njus G, Saunders M, Kay DB. Tibiotalocalcaneal arthrodesis: a biomechanical assessment of stability. *Foot Ankle Int* 26:530–536, 2005.
- Berend ME, Glisson RR, Nunley JA. A biomechanical comparison of intramedullary nail and crossed lag screw fixation for tibiotalocalcaneal arthrodesis. *Foot Ankle Int* 18:639–643, 1997.
- Maurer RC, Cimino WR, Cox CV, Satow GK. Transarticular cross screw fixation: a technique of ankle arthrodesis. *Clin Orthop Related Res* 268:56–64, 1991.
- Scranton PE Jr. An overview of ankle arthrodesis. *Clin Orthop Related Res* 268:96–101, 1991.
- Thordarson DB, Chang D. Stress fractures and tibial cortical hypertrophy after tibiotalocalcaneal arthrodesis with an intramedullary nail. *Foot Ankle Int* 20:497–500, 1999.
- Gardner MJ, Griffith MH, Demetrakopoulos D, Brophy RH, Grose A, Helfet DL, Lorch DG. Hybrid locked plating of osteoporotic fractures of the humerus. *J Bone Joint Surg Am* 88:1962–1967, 2006.
- Chodos MD, Parks BG, Schon LC, Guyton GP, Campbell JT. Blade plate compared with locking plate for tibiotalocalcaneal arthrodesis: a cadaver study. *Foot Ankle Int* 29:219–224, 2008.
- Alfahd U, Roth SE, Stephen D, Whyne CM. Biomechanical comparison of intramedullary nail and blade plate fixation for tibiotalocalcaneal arthrodesis. *J Orthop Trauma* 19:703–708, 2005.
- Chiodo CP, Acevedo J, Sammarco VJ, Parks BG, Boucher HR, Myerson MS, Schon LC. Intramedullary rod fixation compared with blade-plate-and-screw fixation for tibiotalocalcaneal arthrodesis: a biomechanical investigation. *J Bone Joint Surg Am* 85:2425–2428, 2003.
- Doornink J, Fitzpatrick D, Boldhaus S, Madey S, Bottland M. Effects of hybrid plating with locked and nonlocked screws on the strength of locked plating constructs in the osteoporotic diaphysis. *J Trauma* 69:411–417, 2010.
- Lowery N, Joseph A, Burns P. Tibiotalocalcaneal arthrodesis with the use of a humeral locking plate. *Clin Podiatr Med Surg* 26:485–492, 2009.