As recently as a decade ago, it was demonstrated that anatomic reduction of Lisfranc joint injuries resulted in less arthritis and led to the best long-term outcome.\(^1\) Although there have been some reports\(^2,3\) favoring arthrodesis instead of open reduction and screw fixation, the majority of reports, including one quite recently,\(^4\) focus on transarticular screw fixation as the traditional technique.

However, the current authors have no real knowledge of what further damage is done to already traumatized joints, and this has led to plate-spanning techniques. The objective of this study was to describe the method of dorsal multiple plating without the routine use of transarticular screws, and to report on the ability of plate fixation to maintain alignment comparable to that of transarticular screw fixation in 15 patients. [Orthopedics. 2014; 37(12):815-819.]

Abstract: Following a Lisfranc joint injury, stable fixation of the tarsometatarsal joints is crucial to avoid deformity and posttraumatic osteoarthritis, but the ideal method of fixation remains controversial. Kirschner wire (K-wire) fixation of all involved joints with cast immobilization resulted in loss of position, and was replaced by open reduction with improved fixation using transarticular screws. However, it seems intuitive that transarticular screws will result in further damage to already traumatized joints, and this has led to plate-spanning techniques. The objective of this study was to describe the method of dorsal multiple plating without the routine use of transarticular screws, and to report on the ability of plate fixation to maintain alignment comparable to that of transarticular screw fixation in 15 patients. [Orthopedics. 2014; 37(12):815-819.]
The objective of this study was to outline the steps in this technique and to determine if plate fixation (as with screws, plates are routinely removed at 4 months postoperatively) was as satisfactory as transarticular screws in maintaining joint reduction.

The patient is placed supine. Doppler ultrasound is used to locate the neurovascular bundle (dorsalis pedis artery and deep peroneal nerve) to avoid injury during the procedure. After induction of general anesthesia, the limb is exsanguinated and the tourniquet inflated. A single dorsomedial approach, used to address the first and second TMT joints, is made between the first and the second metatarsals (Figure 1A). The dissection is made with great care as it is continued into the deeper layers. The extensor hallucis longus is identified and retracted medially (Figure 1B). Further dissection is made proximally to the base of the first metatarsal to expose the first and second cuneometatarsal joints (Figure 2A).

At this point, the authors test for instability of the joints between the first cuneiform and first metatarsal, the first and second cuneiforms, the first cuneiform and second metatarsal (the so-called Lisfranc joint), and the second cuneiform and second metatarsal. The first step is to reduce the unstable joints, and the authors begin with the first TMT joint. The reduction is maintained with a pointed reduction forceps followed by a smooth Kirschner wire (Figure 2B). Additional K-wires are placed across the Lisfranc joint and from the base of the second metatarsal into the second cuneiform. In cases of displacement at the third TMT joint, a second approach is made between the third and the fourth metatarsals. Gentle dissection is carried down to the base of the third metatarsal, and the joint is reduced and secured with another provisional K-wire. Additional fixation is with 2 K-wires, 1 from the base of the fourth metatarsal and 1 from the base of the fifth metatarsal into the cuboid. These wires are left in for definitive fixation and thus should be cut short, bent, and hammered down to bone. Attention is then turned back to the medial side. A variable-angle plate (LCP 2.4/2.7 mm; Synthes, Solothurn, Switzerland) is applied dorsally across the first cuneometatarsal joint without compression (Figure 3A). The shape of the plate is designed so as to allow for 3 screws on the short cuneiform and 3 screws in the first metatarsal. It is important to ensure that the cuneometatarsal joint has its native degree of flexion and adduction, as it is a joint with limited congruency and landmarks of reduction may be difficult to assess. One should look carefully to see that the edges of the joint match both visually and with fluoroscopy using anteroposterior and lateral views. Then the authors apply the same type of plate (but shorter) from the second metatarsal to the second cuneiform (Figure 3B). If there is no instability between the first and the second columns do the authors use a single-position screw between the first cuneiform and the second metatarsal.

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cuneometatarsal joint, a dorsal bridge plate is applied with 3 screws on each side of the joint. The wounds are now closed in routine fashion. No attempt is made to repair the joint capsule or ligaments.

Postoperative immobilization is by means of an ankle foot orthosis that is maintained for 2 months. Limited weight bearing of approximately 10 kg is prescribed for the same period. The ankle foot orthosis is removed for range of motion exercises for the foot and ankle. At 2 months, patients start to increase weight bearing; by the third month, they are generally full weight bearing. This is done with a shoe with a stiffened sole. Plates are routinely removed during the fourth month and patients are permitted to fully bear weight on the limb.

**RESULTS**

**Patients**

The authors have performed this technique on 15 patients, and report on those with a minimum follow-up of at least 1 year. The authors evaluated radiographs immediately postoperatively, again at 4 months postoperatively at the time of planned plate removal, and at the latest evaluation. The authors assessed the quality of the reduction as anatomic or non-anatomic, based on clear radiographic parameters—the relationship of the medial border of the second metatarsal to the medial border of the second cuneiform; the relationship of the lateral border of the third metatarsal to the lateral border of the third cuneiform; and the relationship between the medial border of the second cuneiform and the medial border of the cuboid—and assessed the sagittal plane deformity using the talometatarsal angle.

Although the authors’ primary outcome was radiographic (ie, the ability of plate fixation to maintain reduction and alignment as securely as achieved with screw fixation), the authors did evaluate all of their patients using the American Orthopaedic Foot and Ankle Society (AOFAS) Midfoot Score.

Among the 15 patients, there were 10 men and 5 women with a mean age of 34 years (range, 24-58 years). In all cases, the postoperative radiographs revealed an anatomic reduction. Radiographs at 4 months postoperatively just prior to hardware removal revealed satisfactory maintenance of reduction in all patients. All 15 patients returned for the 1-year follow-up. They underwent a clinical examination and were evaluated with the AOFAS Midfoot Score. The mean score was 85, with a range from 78 to 92. There were no instances of screw or plate breakage. There were 2 patients with delayed healing of the lateral incision, in both cases noted at 3 weeks postoperatively. There was no evidence of infection, but simply wounds that healed secondarily following dressing changes. Of note is that both patients were smokers. Radiographs routinely demonstrated some degree of early posttraumatic osteoarthritis, usually of a mild nature consisting of joint space narrowing at the TMT joint line with small osteophyte formation.

**Case Example**

A representative case is that of a 38-year-old man who sustained a midfoot injury in a motorbike accident. Injury radiographs and computed tomography (CT) scans (Figure 4) revealed a complex fracture-dislocation of the TMT joints. There was an enlargement of the space between metatarsals I and II, specifically loss of alignment of the medial cortex of the second metatarsal in relation to the medial border of the second cuneiform. Additionally, there is a fracture of the metaphysis and base of the third metatarsal and dislocations of the fourth and fifth tarsometatarsal joints.

Because of moderately severe swelling, his initial treatment was immobilization and elevation of the limb. Eight days after injury, he was operated on through the approach described above. Tarsometatarsal joints I through III were stabilized with dorsal plates, while TMT joints IV and V (the lateral column) were stabilized with 3 K-wires. Postoperative radiographs (Figure 5) revealed restoration of alignment and stabilization across the TMT complex. Radiographs at 4 months postoperatively (Figure 6) just prior to hardware removal revealed good maintenance of the reduction, satisfactory alignment of the foot, and healing of the fracture.

The patient was last seen at 2.5 years postoperatively. He was minimally symptom-
atic with morning stiffness but without pain. He had returned to his regular activities, including sports. He was running 3 to 4 marathons per year and training for the Ironman Triathlon. He was not taking medication. Weight-bearing radiographs at 2.5 years postoperatively (Figure 7) revealed minimal TMT joint space narrowing with postrauematic fusion between the bases of the second and third metatarsals. The alignment was good. On the lateral view, a small dorsal osteophyte was noted at the TMT joint margin.

**Discussion**

In the authors’ limited clinical series, they have demonstrated that dorsal plating of Lisfranc joint injuries maintained the initial reduction without loss of position in their patients. This is consistent with a biomechanical study that used 10 matched pairs of fresh-frozen cadaver lower extremities in which an unstable Lisfranc joint injury was created after sectioning the Lisfranc and TMT joint ligaments. The first and second TMT joints of the right foot were reduced and stabilized with transarticular 3.5-mm cortical screws, while those of the left foot were fixed with dorsal 2.7-mm one-quarter tubular plates. The 2 fixation techniques showed equal ability to hold the involved joints reduced with application of a weight-bearing load. It is not possible for the authors to state that their joint-preserving technique will result in fewer degenerative changes in the involved joints and perhaps decrease the likelihood of postrauematic osteoarthritis. It is doubtful that even a prospective randomized study comparing plate fixation with transarticular screws could provide insight into these points, since the very nature of the injury predisposes to degenerative changes in the joints. However, if there is concern about crossing these damaged joints with screws, joint-spanning plate fixation provides equal ability to maintain reduction and overall alignment. The authors’ plate placement has been directly dorsal because they feel it offers the best soft-tissue coverage. Interestingly, in a recent review of fractures and dislocations of the midfoot, Benirschke et al. do not mention extra-articular plating.
of Lisfranc injuries, remaining with the standard approach of transarticular screw fixation. Watson et al⁴ state that they consider plate fixation in cases of comminuted fractures with bone fragments in the joint or total ligamentous injuries, estimating this comprises approximately 10% of their cases. It is unclear why they use such a limited amount of plate stabilization, since they state that “the concern for joint damage resulting from screw fixation across the TMT joints is eliminated.”

**CONCLUSION**

The primary limitation of the current study is that it is not an outcome study from the patient point of view. To evaluate the effect of these substantial injuries to important weight-bearing joints would require a longer follow-up. All of the patients demonstrated mild degenerative changes at follow-up, but this did not appear to compromise their function. This has been noted by others.⁵ An additional limitation is the use of a transarticular screw in cases of instability between the first and the second cuneiforms. However, after plate fixation of the medial 2 columns, there is no room for a small plate. Perhaps this will eventually be possible with newer implants.

**REFERENCES**