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Screw Versus Plate Fixation for Chevron Osteotomy: A Retrospective Study

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ABSTRACT

The chevron osteotomy is a popular procedure used for the correction of moderate hallux abducto valgus deformity. Fixation is typically accomplished with Kirschner wires or bone screws; however, in cystic or osteoporotic bone, these could be inadequate, resulting in displacement of the capital fragment. We propose using a locking plate and interfragmental screw for fixation of the chevron osteotomy that could reduce the healing time and decrease the incidence of displacement. We performed a retrospective cohort study for chevron osteotomies on 75 feet (73 patients). The control groups underwent fixation with 1 screw in 30 feet (40%) and 2 screws in 30 feet (40%). A total of 15 feet (20%) were included in the locking plate and interfragmental screw group. The patients were followed up until bone healing was achieved at a median of 7 (range 6 to 14) weeks. Our hypothesis was that those treated with the locking plate and interfragmental screw would have a faster healing time and fewer incidents of capital fragment displacement compared with the 1- or 2-screw groups. The corresponding mean intervals to healing for the 1-screw group was 7.71 ± 1.28 (range 6 to 10) weeks, for the 2-screw group was 7.27 ± 1.57 (range 6 to 14) weeks, and for the locking plate and interfragmental screw group was 7.01 ± 1.00 (range 6 to 9) weeks. One case of capital fragment displacement occurred in the single screw group and one in the 2-screw group. No displacement occurred in the locking plate and interfragmental screw group. Neither finding was statistically significant. However, we believe the locking plate and interfragmental screw could be a viable option in patients with osteoporotic and cystic bone changes for correction of hallux abducto valgus.

The Austin bunionectomy is accepted as a common procedure by foot and ankle surgeons for treatment of hallux valgus deformity. The most widely used osteotomy is the Austin procedure published in 1981. Originally, it was determined that the orientation of the osteotomy was stable enough that no fixation was required and would allow for early ambulation (1,2). The horizontal V osteotomy offers stability, with ground reactive forces maintaining impaction of the surgical site. The osteotomy performed in the metaphyseal bone minimizes the postoperative healing time and formation of callus (3). Since then, incidents have been reported of displacement of the capital fragment (4,5). Knecht and Van Pelt (6) described using a 0.045-in. Kirschner wire (K-wire) for fixation of the Austin osteotomy. This technique minimizes capital fragment displacement and has been successfully used for many years. However, complications have included pin tract infections, delayed or nonunion, and postoperative stiffness (3,7). Since then, other fixation types have been used, including monofilament wires, bone screws, absorbable pins or screws, and plates (3,7–14). Variation in the orientation of the chevron osteotomy has also been suggested to allow for more stability and added fixation (7,8,15,16). Cortical screws have been used most frequently. Whether to use 1 or 2 screws and the orientation of those screws has been studied to determine which will provide a more stable construct (17,18).

In a recent study by Murphy et al (18), a unique orientation of the second screw was placed, termed the axial loading screw (ALS). This screw is inserted from dorsally proximally to distally plantarly across the osteotomy site. They determined that the patients with the ALS had a statistically significant faster bone healing time and a lower incidence of capital fragment displacement compared with single-screw fixation (18).

We hypothesized that insertion of a locking plate and interfragmental screw might provide a faster healing time and lower incidence of capital fragment displacement. This alternative procedure will allow patients to perform earlier and more aggressive range of motion exercises and a faster return to normal shoe gear and

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Table 1
Patient demographics (N = 75 procedures in 73 patients)

Group	Value [n (%)]	Procedure Total [n (%)]
One screw		30 (40)
Gender		
Female	28 (93.3%)	
Male	2 (6.7%)	
Foot		
Right	18 (60%)	
Left	12 (40%)	
Two screw*		30 (40)
Gender		
Female	25 (89.3%)	
Male	3 (10.7%)	
Foot		
Right	15 (50%)	
Left	15 (50%)	
Locking plate		15 (20)
Gender		
Female	13 (86.7%)	
Male	2 (13.3%)	
Foot		
Right	7 (46.7%)	
Left	8 (53.3%)	

* Two females underwent a procedure with 2-screw fixation on both feet.

activity. This could be especially beneficial for patients with osteoporosis and cystic bone for which traditional fixation might not be adequate.

Patients and Methods

The present study retrospectively examined 75 feet (73 patients), including 68 feet (91%) in females and 7 feet (9%) in males. The median patient age was 47 (range 14 to 73) years. All consecutive patients were treated in a private office by 1 of us (L.M.F) and had been diagnosed with symptomatic hallux valgus deformity. Only patients suitable for chevron osteotomy were included in the present study. Each patient underwent fixation with single-screw fixation, 2-screw fixation with an ALS, or locking plate and interfragmental screw fixation from 2011 to 2014 at Oakwood Wayne Hospital. An initial study proposal was reviewed by the Oakwood hospital research committee and submitted to the Wayne State institutional review board, which approved the study. The patients were followed up postoperatively from 2011 to 2014 by 1 of us (L.M.F) until radiographic healing had occurred. The inclusion criteria were a diagnosis of hallux abducto valgus, surgical treatment for hallux abducto valgus using chevron osteotomy with 1 screw or 2 screws with an ALS or locking plate and interfragmental screw, and the availability of sequential radiographs until bone healing had occurred. The exclusion criteria were the absence of sequential postoperative radiographs. The group with 1-screw fixation included 30 feet (40%), the 2-screw ALS group included 30 feet (40%), and the locking plate and interfragmental screw group included 15 feet (20%; Table 1). The subjective and clinical findings were reviewed for all patients by medical record review.

Radiographs were taken at each follow-up visit and reviewed by the primary author (B.J.A) to determine whether capital displacement had occurred. This was determined by a change in the position of the capital fragment compared with immediate postoperative radiographs. If displacement had occurred, the angle was measured between the capital fragment and the first metatarsal shaft. The primary author (B.J.A.) also evaluated the healing time of the capital fragment, which was considered to have occurred when bone consolidation was visualized on the dorsal aspect of the cortex on the lateral radiograph.

Fig. 1. Lateral radiograph showing 1-screw fixation of distal chevron osteotomy.

Fig. 2. Lateral radiograph showing 2-screw (axial loading screw) fixation of distal chevron osteotomy.

Statistical significance was defined as $p \leq .05$. The statistical significance among the 3 groups for healing time and capital fragment displacement was performed by 1 of us (J.P.K) using analysis of variance.

Surgical Technique

A 6-cm linear incision was made at the dorsal medial aspect of the first metatarsophalangeal joint medial and parallel to the extensor hallucis longus. The incision was deepened through the subcutaneous tissue using sharp and blunt dissection down to the capsule. Next, an L-shaped incision was made and the capsule reflected off the head of the first metatarsal. The bone was exposed at the medial eminence and removed. A chevron osteotomy was then made at the medial aspect of the metatarsal with a long dorsal arm. The apex of the osteotomy was located just distal to the articular cartilage of the head of the first metatarsal. The capital fragment was translated laterally and impacted on the first metatarsal. One K-wire was used for temporary fixation from the dorsal aspect of the capital fragment across the osteotomy site. Intraoperative fluoroscopy was used to determine the correct length of the K-wire. The site was then countersunk and measured. A 2.0-mm cannulated drill bit was used to underdrill. A Depuy Synthes™ stainless steel 3.0-mm headless compression screw (Depuy Synthes, West Chester, PA) was inserted until a 2-finger tightness was achieved and no prominence of the screw head was present dorsally (Fig. 1).

For the 2-screw ALS group, a second K-wire was placed from dorsally and proximally across the osteotomy site into the plantar aspect of the capital fragment. This was confirmed using intraoperative fluoroscopy to confirm that the K-wire had not penetrated the sesamoid apparatus. The screw site was countersunk, measured, and drilled over the K-wire. Next, another Depuy Synthes stainless steel 3.0-mm headless screw was placed until the head was flush with the dorsal aspect of the metatarsal head (Fig. 2).

In the locking plate and interfragmental screw group, after the osteotomy was performed, the capital fragment was shifted laterally, and a K-wire was driven across the osteotomy site from dorsally to plantarly for temporary fixation. Next, the medial shelf of bone was removed using an oscillating bone saw. A titanium alloy Tornier® Mini MaxLock Extreme™ 4-hole T-plate (Tornier, Amsterdam, The Netherlands) was then fitted onto the medial aspect of the first metatarsal head across the osteotomy site. The plate was temporarily fixated with an olive wire. The correct position of the plate was confirmed by intraoperative fluoroscopy. Next, a locking tower was applied to the 2 distal screw holes on the plate distal to the osteotomy; using a 1.9-mm drill bit, the screw sites were drilled. Next, 2 titanium 2.7-mm locking screws were inserted at the distal end of the plate. The 2 most proximal holes, which were proximal to the osteotomy, were prepared with a 2-0 drill bit. The holes were measured, and 2 titanium 2.7-mm nonlocking cortical screws were inserted. For added interfragmentary compression, 1 final screw was inserted from distally and dorsally to plantarly and proximally across the osteotomy site using a Depuy Synthes stainless steel 3.0-mm headless compression screw in a fashion similar to that described previously (Figs. 3 and 4). The screw was advanced until no prominence of the screw head was present dorsally. In all groups, the redundant capsule was removed and a capsulorrhaphy performed. The tissues layers were then closed according to the surgeon's preference.

Postoperatively, all the patients were placed in a slipper cast and instructed to be non-weightbearing. The patients followed up with the surgeon 1 week after the

Fig. 3. Lateral radiograph demonstrating locking plate with interfragmental screw for distal chevron osteotomy.