# Extreme Chevron

*José A.V. Sanhudo, PhD*

**Abstract:** Diaphyseal osteotomies have been successfully used in the treatment of moderate to severe hallux valgus owing to their high correction potential without the typical instability of proximal osteotomies. The author describes the extreme chevron technique, which has an excellent correction potential. The technique also provides great intrinsic stability, resulting from the osteotomy shape and extensive contact area between fragments, and extrinsic stability, resulting from the possibility of multiple fixation.

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

**Key Words:** hallux valgus, forefoot malalignment, osteotomy, chevron

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## HISTORICAL PERSPECTIVE

The goals of hallux valgus correction are to remove the medial eminence and to restore joint congruity with minimal shortening of the first ray. Distal chevron osteotomy, described by Austin in 1981, is of great historical importance, as it was the first one that achieved these goals with great intrinsic stability. The technique has been used successfully for correction of mild deformities, but, for correction of major deformities, the literature recommends proximal osteotomies, diaphyseal osteotomies, or cuneometatarsal arthrodesis. Subsequently, many authors have published modifications of the original technique of Austin aimed at increasing the stability of the osteotomy and/or extending its indications. Changing the angle between the arms of the osteotomy allowed osteotomies centered in the metatarsal head to achieve greater correction through a larger displacement of the distal fragment and the use of more robust internal fixation, contradicting the historical concept that major deformities should be treated with proximal osteotomies.[1–4] The change in the distal chevron osteotomy angle from 60 to ~30 degrees, described by the author, allows the upper arm of the osteotomy to reach the proximal metaphyseal region, increasing the contact area between the fragments and the stability of the procedure, due to the possibility of fixation at multiple points. In fact, this modification transforms a distal osteotomy into a distally centered diaphyseal osteotomy.[1,2]

### Indications and Contraindications

The extreme chevron osteotomy is indicated for moderate to severe hallux valgus in the absence of significant metatarsophalangeal osteoarthritis and/or cuneometatarsal instability. Patients with infection, vascular deficiency, and neuropathy are also not candidates for surgery.

### Preoperative Planning

Preoperative planning begins with a thorough clinical examination that includes analyzing the severity and flexibility of the hallux valgus and presence of associated disorders, such as metatarsalgia, toe deformities, and gastrocnemius tightness. Metatarsophalangeal and intermetatarsal angle measurements, despite showing poor interobserver and intraobserver agreement, are still the most commonly used parameters to guide treatment.[5,6] The author prefers distally centered extreme chevron osteotomy for deformities with an intermetatarsal angle of 14 degrees or more; in these cases, performing traditional distal osteotomy alone may not provide sufficient correction.

## TECHNIQUE

The procedure is performed with the patient in the supine position, with the lower extremity rotated externally and the lateral border of the foot in parallel and resting on the operating table (Fig. 1). All surgical procedures are performed under sedation, regional anesthesia, and antibiotic prophylaxis, performed with cefazolin 2 g before surgery, and 1 g every 8 hours for 24 hours. An Esmarch tourniquet is applied above the ankle joint. A 5-cm longitudinal medial incision is made at the junction of the plantar and dorsal skin centered at the first metatarsophalangeal joint. The lateral capsule is released longitudinally through the medial incision under the first metatarsal head to allow it to move over the sesamoids, as described by Sammarco and Russo-Alessi (Fig. 2).[7] Releasing the adductor tendon, however, is avoided to reduce the chance of hallux varus.

Using a Hall micro-saw (blade no. 5023-137), the first metatarsal medial eminence is removed 1 to 2 mm medially to the sagittal groove, and the modified chevron-shaped osteotomy is completed with its apex centered in the metatarsal head and at least 10 mm from the joint. The angle between the arms of the osteotomy is 30 to 40 degrees (Figs. 3A–F). The distal osteotomy fragment is displaced and rotated laterally, to correct the intermetatarsal angle. Rotation is obtained by pushing the head laterally more than the proximal part of the fragment. The osteotomy is provisionally fixed with Kirschner-wires (K-wires) (Fig. 3B). The alignment of the first ray and metatarsophalangeal joint reduction are checked by direct

FIGURE 1. Position of the foot with the lower extremity rotated externally and the lateral border of the foot in parallel and resting on the operating table.

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**FIGURE 2.** Lateral capsule release performed through medial incision. Adductor tendon release can be performed through the same incision but should be avoided to reduce the chance of hallux varus.

visualization at this moment. When misalignment persists with valgus and joint incongruency, the adductor tendon may be released through the same medial incision. After the lateral capsule is released, with a number 15 scalpel blade near the base of the proximal phalanx, directed distally and superiorly, the hallux is rotated so that the adductor tendon passes through the scalpel blade.

Radiographs are taken if necessary, and the K-wires are replaced one by one by 2 mm cortex screws, placed from plantar to dorsal either using a lag technique or a partially threaded screw (Figs. 3C, D). After the metatarsophalangeal joint is reduced, the interphalangeal joint is examined for valgus or rotational deformity and, if necessary, corrected with a diaphyseal oblique medial wedge resection of the proximal phalanx (modified Akin osteotomy). This additional step has the ability to add angular and rotational correction to the procedure, and the degree of additional correction of the hallux valgus angle depends on the size of the resected wedge. It is very important that the saw blade does not reach the lateral cortex completing the osteotomy, because the instability between the fragments makes it difficult to fix with one 2 mm lag screw.

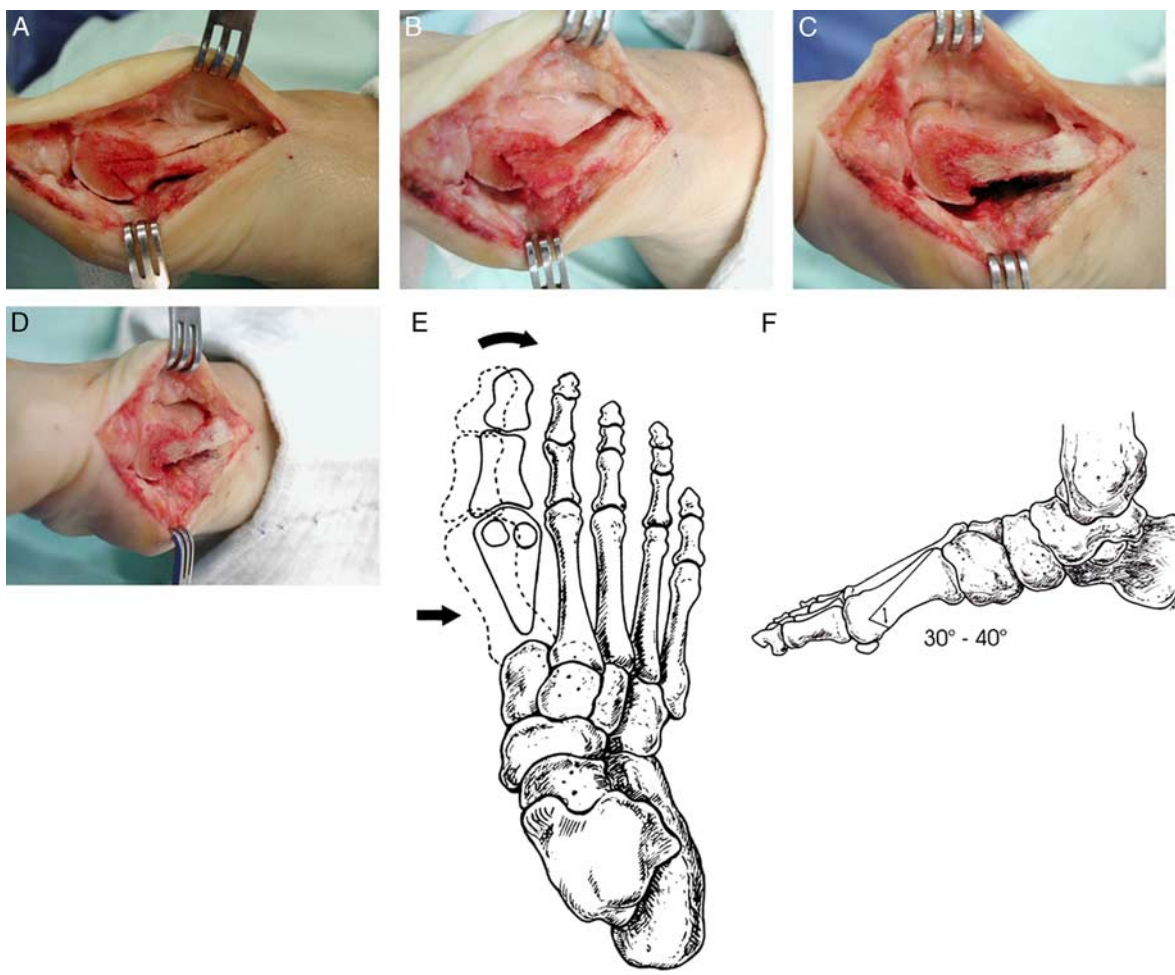


**FIGURE 3.** A, Modified chevron osteotomy with "V" arms forming a 30- to 40-degree angle. B, Significant distal fragment displacement allowed by the great contact area between the fragments. C, Provisional Kirschner-wire fixation. D, Final appearance of the osteotomy after mini-screw fixation. E and F, Schematic representation of the technique, with arrows showing the direction of displacement and rotation.

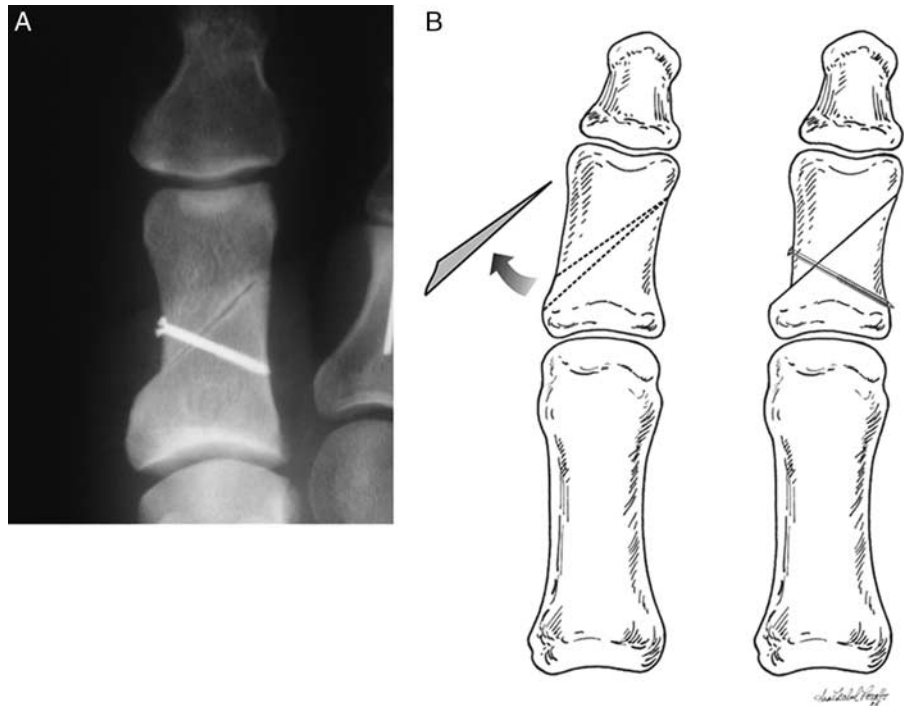


FIGURE 4. A and B, Modified Akin osteotomy. More obliquely positioned cuts increase the area of the osteotomy, allowing almost perpendicular screw fixation and possibly accelerating bone healing. The arrow represents the wedge removed.

On the basis of the author's experience, more obliquely positioned cuts from medial-proximal to lateral-distal increase the area of the osteotomy, facilitating fixation by allowing the screw to almost perpendicularly transfix the cut and theoretically accelerating bone healing. Because the osteotomy involves a larger portion of the proximal phalanx, correction of the deformity occurs over a larger surface area and is less likely to be cosmetically noticeable (Fig. 4).[8] The Akin osteotomy is performed at a higher or lower rate among authors, but its usefulness in providing additional correction is unquestionable.

In cases where shortening of the first ray is indicated, such as in the presence of incipient osteoarthritis of the metatarsophalangeal joint or index plus, the lower arm of the osteotomy is performed with 2 parallel cuts, removing a 2- to 3-mm-thick slice. In the presence of congruent hallux valgus, with an increased distal articular angle, the distal fragment can be


FIGURE 5. A and B, Severe hallux valgus deformity corrected by the modified chevron technique. The apex is distal, but the upper arm of the osteotomy reaches the proximal metaphysis, crossing the entire shaft.



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FIGURE 6. A and B, Severe hallux valgus deformity corrected by the modified chevron technique. Supplementary longitudinal Kirschner-wire fixation adds rigidity to fixation, reducing the chance of metatarsal fracture.

rotated medially, pushing more the proximal end than the distal end laterally, correcting the orientation of the articular facet.

The wound is closed by planes with 2-0, 3-0, and 4-0 Vicryl rapid sutures for joint capsule, subcutaneous tissue, and skin, respectively.

### Postoperative Protocol

In the operating room, the wound area is covered with an Adaptic dressing, 4 to 5 layers of gauze, and immobilization with a 15 cm crepe bandage, which remains for 7 to 10 days. Surgery can be performed as a day case procedure, but, due to ankle block that may last for hours and inability to safely bear weight on the operated foot, hospitalization for at least 1 day is recommended in our unit. On the first postoperative day, patients are allowed to weight bear as tolerated in a firm sole shoe that is worn for 6 weeks. Before discharge, a radiograph is obtained in cases where no radiologic control has been performed in the operating room. Patients are advised to move their toe actively when they are discharged and to elevate their foot as much as possible until the first return visit to reduce bleeding and swelling. In the first postoperative visit, the wound is examined, and the bandage is replaced by a 10-cm coban elastic wrap bandage. As the skin is closed with Vicryl rapid suture, there is no need to remove the stitches. A control radiograph is obtained 6 weeks from the date of surgery to check first ray alignment and internal fixation conditions. One last radiograph is taken 6 to 10 weeks later. For patients with a different postoperative recovery course than expected, that is, with pain, swelling, or joint stiffness, additional tests may be requested later.

## RESULTS

In our first case series, using the modified distal chevron technique (extreme chevron) in 50 feet, the author obtained a correction of 22.7 degrees of the hallux valgus angle and of 10.4 degrees of the intermetatarsal angle, with a high rate of patient satisfaction (Fig. 5).[2] Angles were measured by the index surgeon following the recommendations of the Ad Hoc Committee of the American Orthopedic Foot & Ankle Society on Angular Measurements.[5]

No cases of radiographic avascular necrosis (AVN) of the metatarsal head or deep venous thrombosis were observed in this initial series. Currently, after operating upon about 2000 cases, we have seen 3 cases of AVN (2 in the same patient) and 1 case of deep venous thrombosis (in a patient who performed a homolateral gastrocnemius release on the same day).

In older patients, patients with low bone density, and/or very active patients, the use of a 1.5 mm K-wire inserted longitudinally in the first ray, from medial-proximal to lateral-distal, increases the strength of the metatarsal. In these patients, the loss of correction occurs due to fracture of the metatarsal shaft, which is divided into 2 halves, and not due to loss of fixation. Given the resilience of K-wires, the alignment of the first ray is maintained even in cases where fracture occurs at the level of the diaphysis resulting from excessive postoperative loading (Fig. 6). The usefulness of this supplementary fixation has already been demonstrated previously.[9]

## COMPLICATIONS

The most common complication in our initial series was hallux varus (2 feet; 4%). Only 1 patient with hallux varus, however, remained symptomatic and required extensor hallucis brevis transfer to the

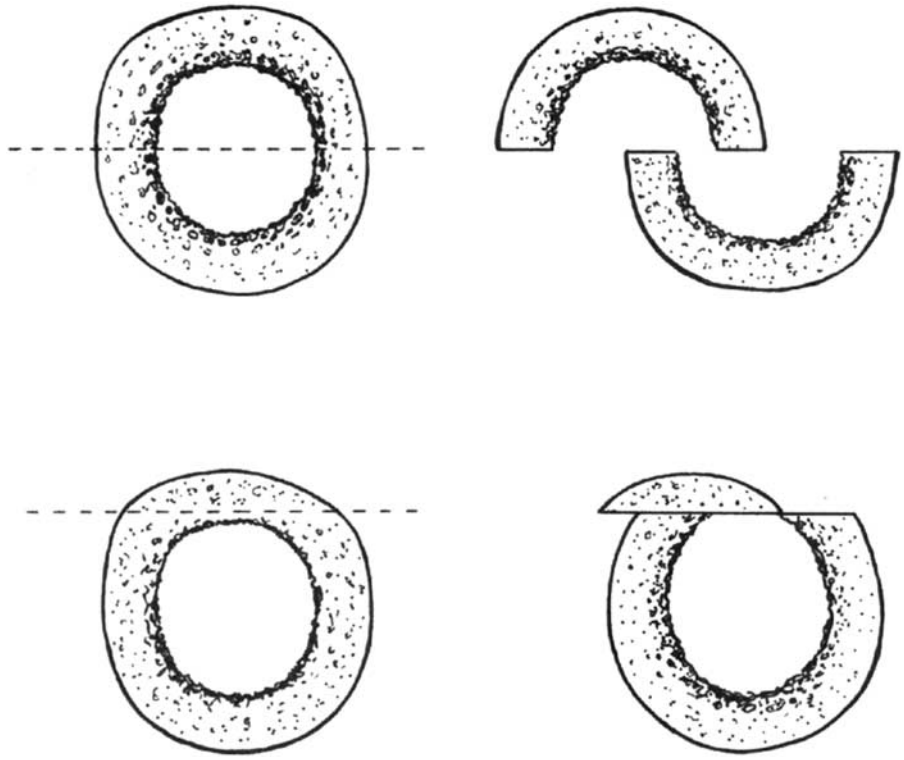

FIGURE 7. Schematic representation of a metatarsal axial section after deformity correction, comparing the classic scarf osteotomy with the modified chevron osteotomy. Note that cortical contact is lost in the case of scarf osteotomy, a predisposing factor for troughing.

neck of the first metatarsal. Because of this complication in our initial series, the author started avoiding adductor tendon release with the procedure, and the incidence of this complication decreased substantially. The author believes that the occurrence of hallux varus was due to the association of adductor tendon release and excessive correction of the intermetatarsal angle.

One patient had recurrent hallux valgus deformity, but, in this case, no further procedure was necessary because symptoms were not severe.

Another patient needed intervention because of loss of fixation; the incident occurred 8 weeks after surgery, when this complication was no longer expected, and was caused by an exaggerated effort placed on the operated lower limb. It was successfully treated by screw implant exchange and fixation of the osteotomy. Nowadays, we are using an additional longitudinal 1.5 mm K-wire fixation in cases of osteopenia and older patients to avoid this complication (Fig. 6).

No patient in this series had either a superficial or deep infection.

## Possible Concerns, Future of the Technique

Hallux valgus is an extremely common and often disabling deformity. Alignment of the first ray is essential for a long-lasting correction of hallux valgus deformity. Despite the recent interest in less invasive correction techniques, experts agree that the arsenal for the treatment of this disorder should include a collection of techniques, all of which aim to correct all components of the deformity to achieve adequate, long-lasting results.

Basal osteotomies have great correction capacity, but, due to the relative osteopenia of the region and the restricted internal fixation area, compared with diaphyseal osteotomies, they are more prone to loss of fixation, recurrence, shortening, delayed union, malunion, dorsiflexion, transfer metatarsalgia, and development of metatarsophalangeal joint osteoarthritis.[10–14]

An inherently stable osteotomy associated with a robust fixation allows prompt mobilization and early weight-bearing.[3,15–18] Diaphyseal osteotomies such as Mitchel, Wu, Mau, and Ludloff have great correction capacity, but less intrinsic stability due to the shape of the osteotomy.[19–21] The scarf osteotomy is the most popular diaphyseal procedure, due to its high correction capacity and versatility.[22] Compared with the scarf osteotomy, the extreme chevron is simpler, only 2 cuts are performed instead of 3, and provides greater stability after correction, as there is no loss of cortical contact after correction, which prevents troughing, a typical complication of the scarf osteotomy (Fig. 7).[22–26] In addition, the plantar cortical area is preserved to a more distal region in the extreme chevron than in the scarf osteotomy, as the osteotomy plantar arm is performed in a more distal region, which in theory provides better biomechanical stability and resistance to loss of fixation. Our complication rate was lower than that described for scarf osteotomy.[17,23–28] Using a technique similar to the extreme chevron in 62 patients, after a mean follow-up of 34 months, Murawski and Beskin[3] obtained hallux valgus and intermetatarsal angle mean correction of 22.2 and 7.9 degrees, respectively. No cases of radiographic AVN were noted.

AVN of the first metatarsal head is a rare complication in our experience, as blood is supplied from the lateral dorsal region through the first dorsal metatarsal artery and its branches, and they are not injured by the osteotomy or adductor release. Technical flaws associated with AVN include extensive capsular stripping, cutting of the first dorsal metatarsal artery by overpenetration of the saw blade, and incorrect placement of the

proximal arms of the osteotomy inside the joint capsule.[29,30] The extreme chevron does not incur these technical flaws.

As demonstrated by other authors, the modified chevron osteotomy, due to the greater contact area between the fragments and the greater possibility of displacement, has a high correction capacity for moderate to severe deformities, and, given its ease of execution, stability, and versatility, it should be considered an option in selected cases. The technique has the ability to correct moderate to severe deformities with stability comparable to that of distal and diaphyseal osteotomies.

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