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REVIEW

Review of current hallux valgus management options

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Abstract

Hallux valgus is one of the most common forefoot pathologies, with a multifactorial etiology that causes important functional impairment and metatarsalgia. The characteristic deformity originates from a biomechanical imbalance induced by the disruption of first metatarsophalangeal joint alignment and manifests as an abnormal weight transfer on the first ray during walking. Conservative treatment is unable to correct the deformity or stop the evolution of the disease but can distinctly control the symptoms. With time, a myriad of surgical correction techniques have been developed but no definitive surgical treatment algorithm has been generally accepted. Nonetheless, the decision process for choosing the suitable technique must be completed on an individual basis after considering the deformity severity stratification, status of the metatarsophalangeal and tarsometatarsal joints, bone anatomy, and associated comorbidities. In spite of a large variety of surgical options, there are a few main strategies that incorporate these variations: metatarsophalangeal and/ or tarsometatarsal joint fusion, metatarsal osteotomies and soft tissue procedures. Nowadays, the surgical management of hallux valgus is dominated by first metatarsal osteotomies performed through open surgery or minimally invasive techniques. Hallux valgus angle has been found to be the single most important parameter for surgical outcome prognostic.
Keywords: review, hallux valgus, correction, osteotomy, treatment algorithm, surgical technique

Introduction

Hallux valgus is a ubiquitous, complex foot deformity managed worldwide by orthopedics or podiatry specialists. Clinical presentation includes metatarsalgia, mainly under the second metatarsal head and medial eminence enlargement of the first metatarsal, commonly termed bunion. The abnormal weight loading of the second metatarsal and sometimes of the sequential metatarsals during the push-off stage of gait generates pain. The biomechanical imbalance generating the anomalous weight transfer is the manifestation of an altered first metatarsophalangeal joint alignment, with medial shift of the first metatarsal, coupled with lateral displacement of the first phalanx and the sesamoid plate. Furthermore, the enlarged medial aspect of the first metatarsal head can interfere with footwear, generating pain or along with the resulted deformity can elicit aesthetic concerns from the predominantly female patients [1-3].

The current concept regarding the etiology of hallux valgus suggests that a multitude of intrinsic and extrinsic factors can be incriminated. Inadequate footwear has long been considered the main intrinsic precipitating factor but it has been suggested that it is merely an exacerbating component, especially for metatarsalgia. The series of intrinsic factors include genetic and/ or female gender susceptibility, metatarsus primus varus, ligamentous laxity with hypermobility of the first ray, pes planus, metatarsal formula, and bone anatomy [4-6].

Diagnosis

An accurate case history is important because it provides information about the family history of hallux valgus but also identifies the patients' concerns and the characteristic complains: pain over the enlarged medial eminence or subsequent metatarsal heads, local skin or bursa irritation and callus formation. Metatarsalgia and the deformity can sporadically be associated with long standing periods (occupational) and certain types of footwear like those with very high heels [7,8].

Physical examination evaluates the magnitude of the deformity, metatarsal formula, gait alterations, or the presence of static foot deformities. Range of motion must be a part of the assessment for the following joints: first tarsometatarsal and metatarsophalangeal joints, transverse tarsal, subtalar, and ankle joint. Hypermobility of the first tarsometatarsal joint has been incriminated as a major etiologic and risk factor for recurrence after surgical correction. Therefore, its assessment must be performed either manually or using a particular device like the Klaue device, with abnormal results defined as range of motion exceeding 10 millimeters [9,10].

Specific radiographic evaluation consists of lateral and anteroposterior weight-bearing foot X-rays. This way, joints degeneration, static or dynamic deformities can be identified, and specific measurements can be executed for disease severity stratification. The angular measurements performed on the anteroposterior view define four particular angles out of which the hallux valgus angle (HVA) and the intermetatarsal angle (IMA) are mainly used for severity systematization (Table 1).

Table 1. Hallux valgus severity stratification based on radiological angular measurements

	Intermetatarsal Angle (IMA) °	Hallux Valgus Angle (HVA)°
Normal	<9°	<15°
Mild	10-13°	16-19°
Moderate	14-20°	20-39°
Severe	>20°	>40°

The hallux valgus angle (HVA) can be calculated between the diaphyseal axes of the first metatarsal bone and its corresponding proximal phalanx. The intermetatarsal angle (IMA) can be determined in reference to the axes of the first and second metatarsals. A hallux valgus interphalangeus angle (HVI) has been defined by the proximal metaphyseal and diaphyseal axes of the first proximal phalanx, with a suggested normal range up to 10°. The center line of the first metatarsal diaphysis and the limits of the distal articular surface of the same bone designate the distal metatarsal articular angle (DMAA) with a similar upper limit of 10° (Fig. 1). Nevertheless, there is no solid consensus on these conventionally fixed values of radiographic measurements used for severity grading and the process may require more variables [11-14].

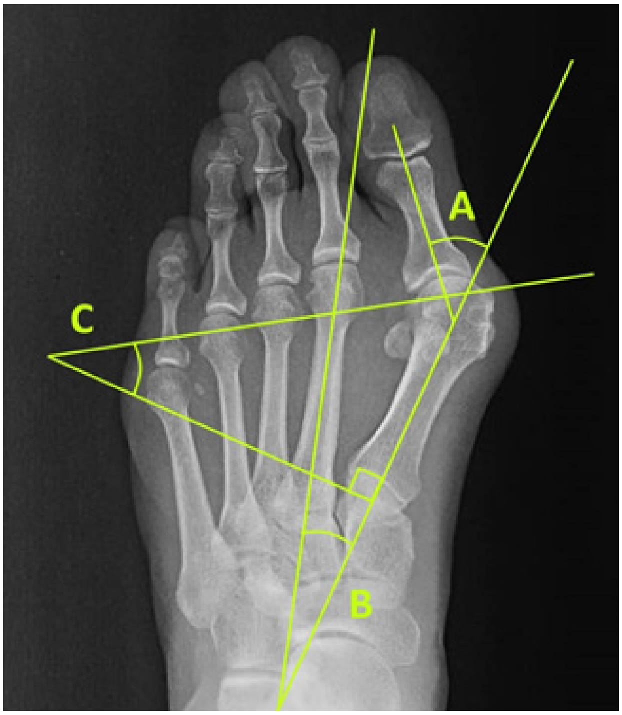


Fig. 1 Hallux valgus radiological assessment;
(a) hallux valgus angle – HVA;
(b) intermetatarsal angle – IMA; (c) distal metatarsal articular angle - DMAA

Conservative treatment

Pain, aesthetic considerations, and shoe type restrictions are the main reasons that prompt the patients to seek medical help. Sometimes, they can be controlled for a variable period of time using nonoperative means but these are incapable of stopping the deformity progression or correct it. By the time of presentation, most of the patients have already switched to more adaptable and comfortable footwear, with wider toe-box and/ or softer insoles. Special padding, spacers, insoles or night splints can be used to alleviate the symptoms but with limited effects on the disease progression. Conservative treatment is preferred when absolute or relative surgery contraindications exist like uncontrolled diabetes mellitus, heavy smoking, manifested peripheral vascular disease, or neuromuscular disorders. A special consideration must be given to patients with general ligamentous hyperlaxity or hypermobility of the first tarsometatarsal joint because data suggest a strong correlation with high recurrence rates after surgical correction. Nevertheless, the overall patient satisfaction and functional results have been shown to be superior after surgical treatment compared to the nonoperative management [15,16].

Surgical treatment

Surgical management of hallux valgus encompasses a myriad of correction techniques developed during the last few decades but with no strong consensus on the ideal procedure or operative treatment algorithm. In choosing the appropriate correction technique, every case must be individually assessed, with concern to the following crucial parameters: degree of deformity (HVA and IMA), first tarsometatarsal hypermobility, first metatarsal anatomy, metatarsophalangeal joint congruency, and degenerative changes. There is a great variability in the management algorithms used worldwide, the majority being established mainly on empirical experience and not on comprehensive research and data resulted from controlled clinical studies. A fundamental surgical treatment algorithm has not been implemented and widely accepted because evidence of clear superiority for any given technique, in correlation with the type of hallux valgus and numerous associated variables, lacks [17]. Nevertheless, the main goal for every technique remains the same, of reinstating the normal foot architecture and achieving good functional results and patient satisfaction. The main procedures used for surgical correction of hallux valgus can be systematized and combined on individual base.

Distal soft tissue procedure

This technique is routinely used as an accessory procedure to an osteotomy or arthrodesis with adequate results or as a singular procedure for mild deformities. Its limitations as a sole procedure come from the significant postoperative recurrence rates and risk for induced hallux varus, especially when the IMA exceeds 15°. It can be accomplished through a first dorsal web space incision, a minimally invasive dorsal incision or a medial dissection with a transarticular approach but with added risks of joint injury or a deficient lateral soft tissue release. The modified McBride procedure associates medial eminence excision of the first metatarsal head, capsulotomy followed by capsular plication, releases of the lateral capsule, sesamoid plate, and adductor hallucis tendon phalangeal attachment [18-20].

Distal metatarsal osteotomies (Wilson, Mitchell, chevron)

For good results, these types of osteotomies can be used for correction of mild to moderate hallux valgus deformities with an IMA upper limit of 15°. The Wilson and Mitchell osteotomies are two variants with decreasing popularity due to modest functional results and patient satisfaction. The Wilson type implies an oblique metaphyseal cut that allows a lateral and proximal translation of the metatarsal head. This causes first metatarsal shortening and dorsal angulation with subsequent transfer metatarsalgia and callosities under the lesser metatarsal heads. A Mitchell osteotomy involves a stepped, double-cut of the metatarsal neck, which permits a lateral and plantward displacement of the head fragment, secured with transosseous suture wires. Complications like transfer metatarsalgia due to excessive shortening, malunion, or loss of correction advocate against it [21-23].

Probably the most popular and successful type is the chevron (V-shaped) osteotomy that has the advantage of inherent stability and minimal metatarsal shortening. Along with lateral translation of the distal MTS head, an associated medial closing-wedge osteotomy can be used for amending an abnormal DMAA. This variation has changed the name of the procedure to biplanar chevron osteotomy. An improvement of the original technique has been supported by lengthening one arm of the V cut and adding internal fixation with compression screws. A special concern regarding distal osteotomies is the risk for avascular necrosis of the metatarsal head as a result of damaging the particular blood supply of the area [24-27].

Diaphyseal metatarsal osteotomies (modified Ludloff, scarf)

This group of procedures have an adaptable correction potential and are extensively used for treating moderate to severe hallux valgus deformities (IMA<20° and HVA<40°). The prototype is the modified Ludloff technique that uses a long, oblique cut, starting from the proximal, dorsal cortex and going to the plantar, distal diaphysis. The result is a distal fragment that can be externally rotated and sometimes plantarly displaced with good clinical effect on the transfer metatarsalgia [28].

Derived from a carpentry technique, the scarf osteotomy is a very versatile procedure that uses a Z-shaped cut with the longitudinal arm running the length of the diaphysis and two step-cuts through the distal, dorsal and proximal, plantar cortex (Fig. 3). Although they have a good intrinsic stability due to high contact surface and cut geometry, the resulting fragments are held together with two compression screws. The technique allows a variety of corrections by combining the lateral translation of the distal fragment with rotational or longitudinal displacement resulting in added metatarsal shortening or adjustment of an anomalous DMAA. All this has made it a very popular technique, especially used in conjunction with a distal soft tissue procedure. The main limiting factor is a long learning curve due to its higher technical difficulty, which predisposes to complications like malunion, nonunion or loss of fixation [29-32].

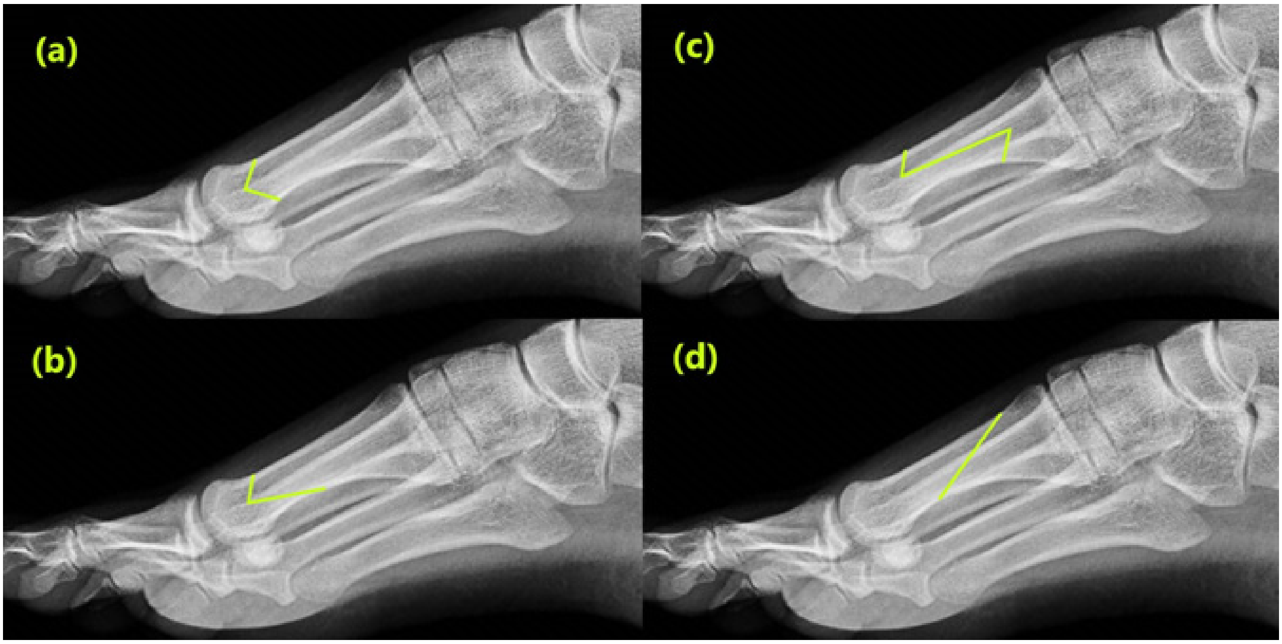


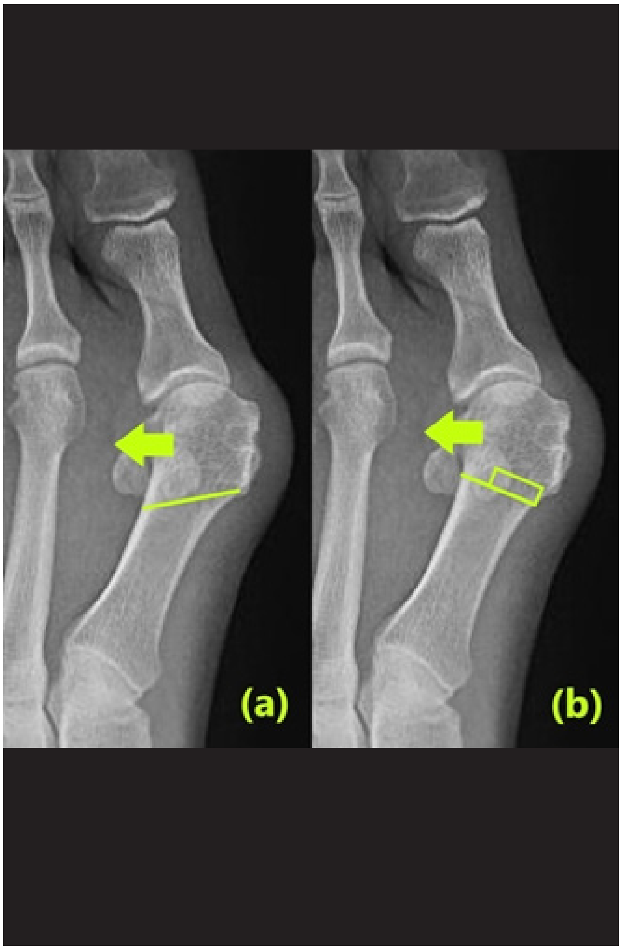
Fig. 3 (a) distal chevron osteotomy; (b) modified chevron osteotomy; (c) scarf osteotomy; (d) Ludloff osteotomy

Proximal metatarsal osteotomies (wedge, crescentic, chevron)

The corrective potential of this category of procedures is very high, which makes them suitable for treating moderate and severe hallux valgus deformities. They are typically combined with a distal soft tissue procedure and sometimes with one or two distal osteotomies creating the double and triple osteotomies techniques. Unfortunately, they are associated with a high incidence of serious complications like DMAA exaggeration, excessive elevation, or shortening of the first metatarsal, nonunion or fixation failure. The group of proximal osteotomies includes opening or closing wedge, chevron, and crescentic (curved) osteotomy. Better results have been reported for the crescentic and chevron types with minimal metatarsal shortening and higher inherent stability for the V-shaped cuts [33-35].

Akin phalangeal osteotomy

This type is usually used in addition to other procedures, when the hallux valgus interphalangeus angle (HVI) exceeds 10°. The original technique describes a medial closing wedge osteotomy of the proximal phalanx followed by fixation using suture wires, screws, or staples [36,37]. Also, this procedure can be a constituent of a complex, double or triple osteotomy correction technique (Fig. 4).



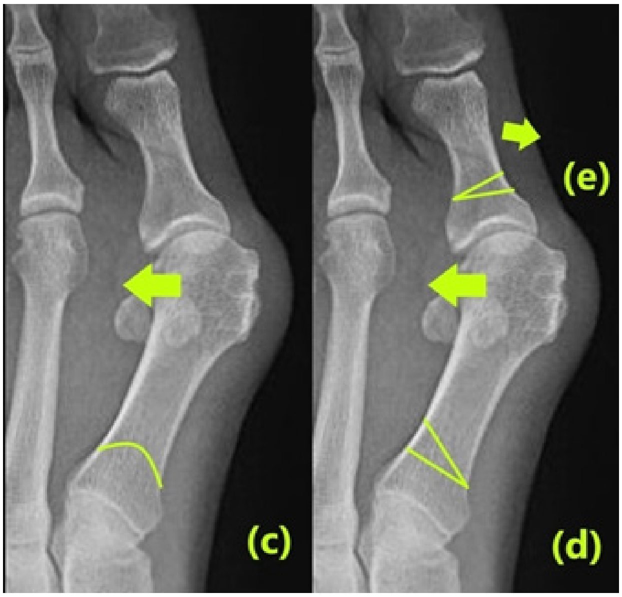


Fig. 4 (a) distal Wilson osteotomy; (b) distal Mitchell osteotomy; (c) proximal crescentic osteotomy;
(d) proximal closing wedge osteotomy; (e) Akin phalangeal osteotomy

First tarsometatarsal joint arthrodesis (Lapidus procedure)

The main indication for this procedure is hallux valgus associated with hypermobility of the first tarsometatarsal joint coupled with a distal soft tissue procedure. Sometimes it can be a treatment option for severe cases with an IMA>20° and subluxation, degeneration of the first tarsometatarsal joint or recurrent hallux valgus. Its use can be restricted by the risk of excessive metatarsal shortening, arthritic changes in the corresponding metatarsophalangeal joint, technical challenges and difficult rehabilitation. A modified Lapidus procedure involves the surgical arthrodesis of the first tarsometatarsal joint and a lateral and plantar closing wedge osteotomy of the medial cuneiform, with a great variety of fixation options available nowadays: screws, external fixator, different configuration plates, or staples. As a determinant factor, the theory of first ray hypermobility has been challenged by the idea that the stability of the first tarsometatarsal joint is not an innate joint characteristic but it is dependent on a competent biomechanical alignment of the ray. This may dispute the use of this technique for managing hallux valgus deformities associated with first ray hypermobility [38-40].

First metatarsophalangeal joint arthrodesis

This technique is indicated for a series of particular conditions like severe degeneration of the metatarsophalangeal joint due to aging or rheumatoid arthritis, as a salvage procedure after primary surgery or severe deformities. It can be implemented in combination with a metatarsal correction osteotomy and it provides good functional results in properly selected cases by securing a stable and pain-free joint. There are two different techniques for joint preparation (ball and socket or flat surfaces) and numerous fixation options using plates, screws, wires, or staples. An important component for achieving walking biomechanical conditions is fusion of the joint with a slight valgus (up to 15°) and minimal dorsal flexion (20°-25°) [41,42].

Keller arthroplasty-resection

The primary objectives for this surgical technique are the decompression of the first metatarsophalangeal joint by resection of approximately one third of the proximal phalanx and realignment of the first ray through release of the lateral joint structures and the sesamoid plate and medial retensioning of the capsule. An unacceptable rate of complications like first metatarsal shortening with transfer metatarsalgia, reduced joint mobility and a very challenging revision have restricted the indication only to elderly patients with modest functional demands. Furthermore, the procedure has no corrective power for a deviant intermetatarsal angle [43].

Metatarsophalangeal arthroplasty

Replacement of the first metatarsophalangeal joint has been promoted for managing advanced degenerative changes of the first metatarsophalangeal joint associated with hallux valgus or specific treatment of hallux rigidus. When used for HV management, it is usually associated with a metatarsal osteotomy for IMA correction. Unfortunately, the results show undesirable high complication rates, which frequently require demanding revision surgery [44,45]. A considerable variety of implants and arthroplasty techniques are under research and development.

Minimally invasive and novel procedures

These procedures are based on the principle of minimal skin incisions (millimeters in length) and soft tissue dissection using small blades along with subdermal bone cuts performed with special power burrs. All this is accomplished under fluoroscopic guidance. Suggested advantages for this group of techniques are faster rehabilitation and fewer complications due to limited soft tissue violation.

The beginning of the percutaneous procedures is based on the Isham-Reverdin osteotomy, promoted by Mariano de Prado. It consists of an intracapsular, but extra-articular closing wedge osteotomy of the first metatarsal head, associated with bunionectomy, lateral release and sometimes an Akin procedure. Despite the concerns regarding the possible complications caused by the lack of internal fixation and variable metatarsal shortening, the results have been promising but without large-scale validation. Another revisited technique is the Bosch vertical neck osteotomy, which was modified into the SERI procedure (Simple, Rapid, Rapid, and Inexpensive) with one or two K-wire fixation. The published results are inconsistent and the technique needs more long-term evaluation. A promising procedure that combines the advantages of a minimally invasive surgery with the corrective power of metatarsal osteotomies is the Minimally Invasive Chevron-Akin (MICA) technique. It consists of a distal soft tissue release, an Akin phalangeal osteotomy and an extracapsular, distal, chevron osteotomy of the first metatarsal fixed with compression screws [46,47].

In the intricate and multistep pathogenesis of the deformity, an important element that has long been considered an initial event is the varisation of the first metatarsal due to impaired static and dynamic stabilizers of the metatarsophalangeal joint. The extent on which tarsometatarsal hypermobility promotes the varisation process and the recurrence of the disease, especially after surgical correction, is more and more under scrutiny. Because the osteotomy techniques fail to address this aspect, attention has been given to the development of soft tissue approaches, which would achieve correction, stabilization and avoid recurrence, without the added complications and invasiveness of the osteotomy procedures. The initial technique relying on this philosophy is the syndesmosis procedure, which creates an intermetatarsal osteodesis for correction and stabilization of the IMA, augmented with cerclages. A modern wave of techniques has reintroduced this concept by applying a dynamic, flexible fixation of a corrected IMA using high-strength suture wires secured on bone with metallic buttons or anchors (metallic or biodegradable). Also, variations of these procedures can be used for tarsometatarsal stabilization in conjunction with osteotomies for bone correction [48-50]. The results seem promising but a longer follow-up and biomechanical testing are needed for a comprehensive recognition as a reliable treatment strategy.

Conclusion

Hallux valgus management must be a personalized process that takes into account a series of factors. Among them the single most significant component for the outcome seems to be the severity of hallux valgus angle alteration. Surgical treatment offers good clinical results and patient satisfaction for the overwhelming majority of cases and it relies on realignment of the first ray and stabilization the soft tissues surrounding the metatarsophalageal joint.

The main operative techniques entail soft tissue procedures, metatarsal osteostomies or joint fusion. Current surgical treatment strategy is dominated by metatarsal chevron or scarf osteotomies performed through open surgery or minimally invasive techniques. New reliable data derived from prospective studies is necessary for further improvement or standardization of treatment algorithms and conventional or novel correction techniques.

Conflict of Interest statements

Authors state no conflict of interest.

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