DOI: https://doi.org/10.30795/jfootankle.2024.v18.1856

Special Article

Pediatric hallux valgus

David S. Liu[1], Christopher P. Miller[2], Fernando Cepollina Raduan[3]

1. Boston Children's Hospital, Boston, MA, United States.
2. Brigham and Women's Hospital, Boston, MA, United States.
3. Beth Israel Deaconess Medical Center, Boston, MA, United States.

Abstract

Pediatric hallux valgus is a common condition that may present with various symptoms. In children with underlying neuromuscular diagnoses, treatment strategies can be fairly straightforward: if the deformity is painful and challenging to manage due to hygienic or shoewear problems, first metatarsophalangeal joint arthrodesis is indicated as a safe, reliable, and single surgical procedure. In ambulatory healthy children, skeletal maturity status and the remaining growth should be strongly considered. Surgical treatment options are indicated for patients with recalcitrant pain and symptoms despite a dedicated effort towards activity and shoewear modifications. If possible, surgery should be delayed until the complete closure of the physes. Various procedures exist to correct hallux valgus, and surgeons should critically analyze and select the most appropriate option. Recurrence may be a significant risk, particularly in the pediatric and adolescent population.

Level of evidence V; Therapeutic studies - investigating the results of treatment; Expert opinion.

Keywords: Pediatric; Hallux valgus; Bunion.

Introduction

Pediatric hallux valgus is a relatively common condition, with a reported incidence of up to 36%[1]. Various terminology describes its presentation: juvenile or adolescent bunion, metatarsus primus varus, and metatarsus primus adductus. The etiology of pediatric hallux valgus is unclear; however, several features have been identified as potentially predisposing factors: a positive family history, female sex, pes planus, a relatively long first metatarsal, constrictive footwear, and metatarsus primus varus[2,3]. Patients may complain of a painful, erythematous bunion, dissatisfactory cosmetic deformity, and difficulty or pain with appropriate footwear. Treatment strategies for pediatric hallux valgus mirror those available for their adult counterparts. Non-operative management is initially recommended, starting with footwear modifications or orthotics. However, the literature suggests that these non-operative measures have a limited role in preventing the progression of the deformity[4,5]. Surgical intervention is considered after failed conservative management, with numerous surgical options described in the hallux valgus correction. In the pediatric and adolescent populations, the risk of recurrence after deformity correction is high[6]. Nonetheless, outcomes are generally favorable.

Anatomy

One of the most important functions of the great toe is stabilizing the medial longitudinal arch. When the first metatarsophalangeal (MTP) joint is extended (during the third rocker in the stance phase of the gait), the sesamoids, connected to the base of the proximal phalanx, cause tension on the plantar fascia and improve the forefoot surface area of contact with the ground[2,7]. This biomechanic sequence is called the "windlass" mechanism and is impaired when the great toe has a valgus alignment.

The hallux valgus deformity occurs in steps, either sequentially or in parallel. First, the medial supporting structures of the first MTP joint (medial sesamoid and collateral ligaments) fail. Next, the metatarsal head shifts medially, slipping out of the sesamoid apparatus. The proximal phalanx then moves into a valgus position as it is tethered by the sesamoids, the deep transverse ligament, and the adductor hallucis tendon. Then, the metatarsal head

Study performed at the Beth Israel Deaconess Medical Center, Boston, MA, United States.

Correspondence: Fernando Cepollina Raduan. Beth Israel Deaconess Medical Center, 330 Brookline Ave, Boston, MA 02215, USA. **Email:** fernando@raduan.com.br
Conflicts of interest: None. **Source of funding:** None. **Date received:** November 12, 2024. **Date accepted:** December 06, 2024. **Online:** December 30, 2024.

How to cite this article: Liu DS, Miller CP, Raduan FC. Pediatric hallux valgus. J Foot Ankle. 2024;18(3):292-8.

rests on the medial sesamoid, causing cartilage erosion. This triggers a bursal thickening over the medial eminence. After that, the extensor and flexor hallucis longus tendons appear to bowstring laterally, further increasing the valgus displacement of the proximal phalanx. The metatarsal head pronates after dropping off the sesamoid apparatus, making the flexor tendons potent great toe abductors and worsening the valgus deformity of the great toe (Figure 1). The weaker dorsal MTP joint capsule rotates medially with pronation, thereby losing its inherent stability. Finally, the metatarsal head elevation and medial motion transfer plantar pressure laterally[8].

In the skeletally immature child, consideration for open physes should be emphasized. The great toe distal and proximal phalanx physes are expected to close at age 17-18. The first metatarsal physis is expected to close at the same age. Note that the first metatarsal physis is anatomically proximal to the long axis of the metatarsal, whereas the second through fifth metatarsal physis is located distally (Figure 2 A and B).

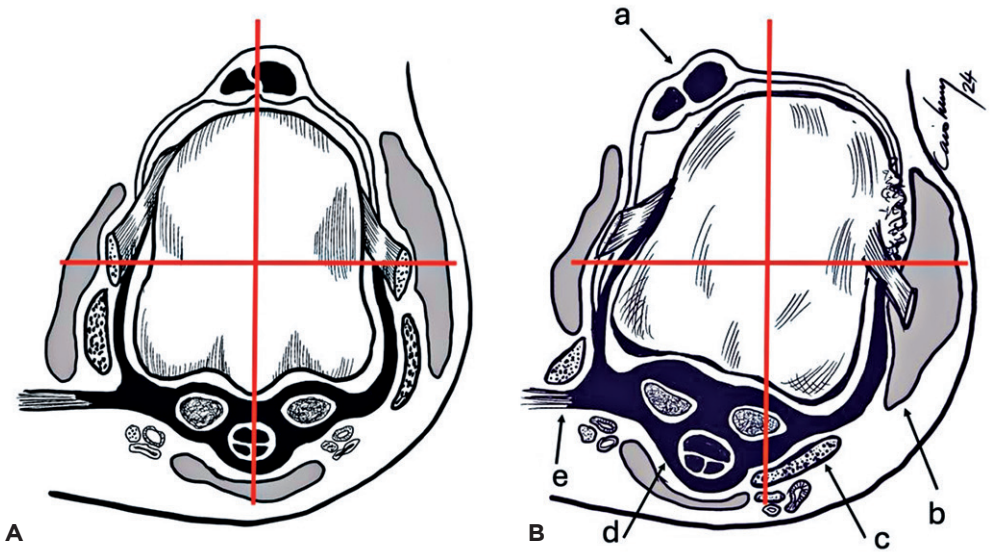


Figure 1. (A) Flexor and extensor tendons on the first metatarsal head at the median plane. (B) Flexor and Extensor tendons shifted laterally, becoming deforming forces and bringing the great toe to valgus position when activated.

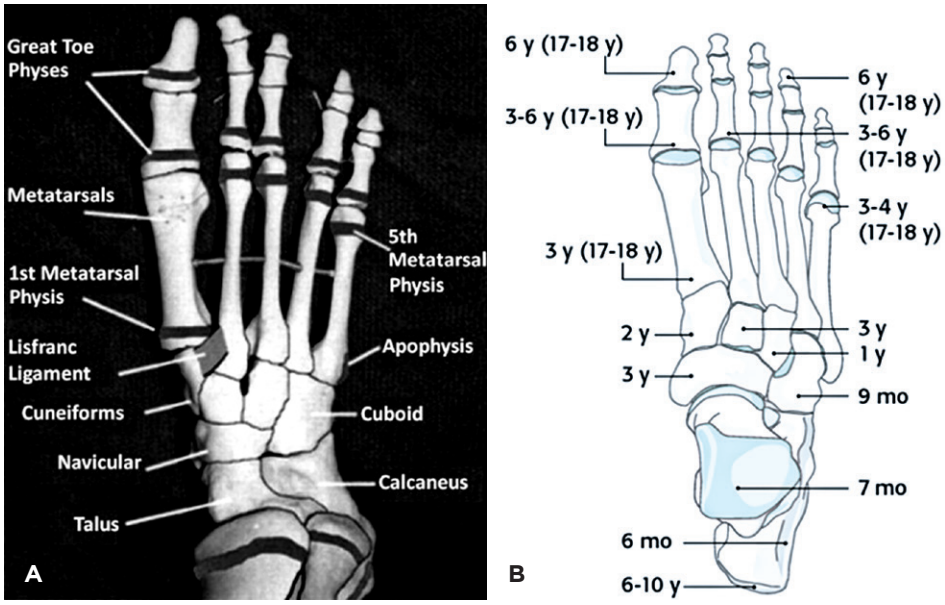


Figure 2. (A) The figure shows where the growth plates are in the bones. (B) Estimate when the growth plates close completely.

Pathophysiology

The pathogenesis of pediatric hallux valgus is complex. Over 80% of patients are female, and approximately half of these patients present before the age of 10. Maternal transmission may be common, particularly in young patients[9].

Various theories on the anatomic etiology of pediatric hallux valgus have been suggested. Metatarsus primus varus, which may be detected in infancy, is commonly suggested as an etiologic basis. However, other anatomic variations, such as an oblique first metatarsal-cuneiform articulation, a laterally deviated distal metatarsal articular angle, or a flat or conical first MTP joint have been suggested as possible causes or associations[10,11].

Additionally, flexible pes planus and ligamentous laxity have been associated with hallux valgus; however, given its common presentation, the relationship between these deformities has not been confirmed. Hallux interphalangeus and metatarsus adductus are commonly associated with hallux valgus[9].

Hallux valgus in patients with neuromuscular pathologies results from malalignment in various foot and ankle segments and is not a congenital finding. The imbalance between intrinsic and extrinsic muscles and the abnormal biomechanics on the forefoot, especially in the third phase of the stance, will cause deformity with time[9]. Initially, the abductor halluces muscle is hyperactive, bringing the toe to valgus deformity, starting this cascade of events affecting other anatomic structures of the forefoot, particularly on the first ray. In patients with flatfoot deformity because of cerebral palsy, the hyperactivity of the peroneus longus can negatively affect the toe alignment. Since the oblique head of the abductor halluces muscles originates from the peroneal longus tendon, the great toe will have forces applied to its lateral aspect, bringing the toe to the valgus position[12-14]. Neuromuscular pathologies can also lead to arch collapse, pronating the forefoot and the first metatarsal[2-15], changing the axis of the great toe flexion/extension movement, also resulting in apparent great toe valgus deformity[11]

Physical examination

A thorough examination is imperative for any pediatric or adolescent patient who presents with hallux valgus. The first determination should be whether the deformity is rigid or flexible. If passively correctable, the examiner should note the foot position and width while the great toe is in the corrected position. A concomitant flatfoot deformity should be noted, and whether it is rigid or flexible. Calluses should be assessed—a medial callus suggests poor shoe fitting, whereas a plantar callus suggests transfer metatarsalgia. Other associated deformities should be recognized, including hallux interphalangeus and metatarsus adductus. As flatfoot develops, the peroneal longus, instead of coming from lower down (bottom of the cuboid) to plantarflex the first metatarsal, makes a loop on the plantar cuboid and runs parallel to the floor. As it inserts on the plantar aspect of the first metatarsal base, in addition to plantarflexing the first metatarsal, it additionally creates pronation.

The range of motion of the first interphalangeal and MTP should be documented. The stability of the first tarsometatarsal (TMT) joint should be assessed and documented.

Patients in this age population frequently only see one orthopedic provider; a thorough examination of the bilateral lower extremities should be performed. Any additional abnormalities, such as leg length discrepancy, genu varum, genu valgum, and ankle and hindfoot alignment, should be noted and addressed as indicated. Gastrocnemius tightness, tested with the Silfverskiold test, has been reported to contribute to the pathogenesis of juvenile hallux valgus and thus should be tested[16].

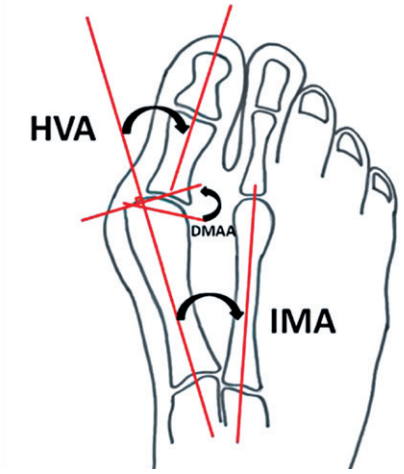
In patients with cerebral palsy or similar neuromuscular syndromes, a key presentation feature is when the great toe is over- or underlapping the second toe, which may cause pain, poor hygiene, difficulty with shoe or orthotic wear, and disruption of gait.

Imaging

Complete radiographs of the bilateral feet are necessary for evaluation and planning. Formal weight-bearing anteroposterior and lateral views and non-weight-bearing oblique views are imperative. These images allow for accurate measurement of the hallux valgus angle, the intermetatarsal angle (IMA), the inclination of the metatarsal-cuneiform articulation, and the distal metatarsal articular angle.

Mild deformity is defined by IMA greater than 9º and hallux valgus angles (HVA) greater than 15º. Moderate deformities are IMA between 12 and 16º and HVA between 20 and 40º. Severe deformities include patients with IMA greater than 16º and HVA greater than 40º.

The distal metaphyseal articular angle (DMAA) should also be evaluated since values above 11º should be corrected, usually with biplanar distal osteotomies (Figure 3).



HVA: Hallux valgus angle. IMA: Intermetatarsal angle. DMAA: Distal metatarsal articular angle.

Figure 3. Radiographic parameters

Several notable details on radiographs should be appreciated. Detailed inspection should assess the presence of an articular facet at the TMT joint between the first and second metatarsals, which may restrict deformity correction at that level, such as in the case of TMT arthrodesis. The unity of the first MTP joint should be appreciated, as congruent joints are considered stable and amenable for motion-preserving deformity correction, while incongruent joints may suggest degenerative changes or instability, for which arthrodesis may be more strongly considered.

Open physes should be noted for several reasons. Surgical techniques that involve growth modulation depend on the presence of an open physis[6]. A high recurrence rate has been reported in patients with growth remaining[17,18]. As such, postponing surgical correction by osteotomy and/or soft tissue balancing until skeletal maturity has been achieved has been advocated by some surgeons to minimize the risk of recurrence[9,18].

If any concern for leg length discrepancy or alignment is suggested by physical examination, a standing scanography, including bilateral legs from hips to ankles, should be obtained to investigate further.

Advanced imaging, such as computed tomography (CT) or magnetic resonance imaging (MRI), is rarely indicated. However, recent studies have shown some efficacy in weight-bearing CT in evaluating the pronation of the first metatarsal and better assessment of the DMAA[16,19].

Treatment

Conservative management

In the growing child with open physes, conservative treatment is the gold standard. The use of orthoses and shoewear modifications should be recommended to allow time for completion of growth and prevent overcorrection or recurrence. Additionally, non-operative treatment provides for the maturation of soft tissues and the natural improvement of ligamentous laxity, which may result in the resolution of any associated flexible pes planus. By allowing the patient to progress to skeletal maturity before surgery, any risk for secondary sequelae due to premature physeal closure is mitigated.

In cases where pediatric hallux valgus deformity is asymptomatic, no intervention is required. Patients and their parents should be advised to monitor for any onset of symptoms and deformity progression. If symptoms arise, the first recommended treatment is activity and shoewear modification.

Orthosis has been a mainstay in the treatment of flexible pes planus and is often helpful for hallux valgus with concomitant pes planus. Stabilization of the flatfoot deformity may improve the pain and symptoms of the great toe[3,4].

Bracing has not been shown to prevent deformity progression. In a study by Kilmartin et al.[4], children who presented with unilateral hallux valgus eventually developed hallux valgus on the initially unaffected side despite using bilateral braces[4].

Groiso[3] published a study on the efficacy of night-time thermoplastic splinting and passive and active exercises. In this study, the authors found improvement in the MTP joint angle and/or the IMA in approximately half of the feet. No recurrences were detected among patients who demonstrated improvement. It should be noted that this study has not been replicated and serves as a historical source advocating for bracing. Nery et al.[5] published their series where IMA and HVA were measured before and after the same customized orthoses were used at night. Besides the fact that 44% of the patients had to be excluded due to discomfort using the orthosis and giving up on the treatment, they found no difference in the radiographs of patients who did use the orthosis for a long time[5].

In the neuromuscular child, the treatment objective is to achieve hygiene and reduce pain, rather than cosmesis and conventional footwear. As such, conservative management goals focus on the ability to provide hygiene to the first web space and to monitor for any pain responses due to the hallux valgus deformity.

Surgical management

The primary indication for surgical deformity correction is pain. Symptom severity may not reflect the degree of clinical or radiographic deformity, and as such, the degree of deformity in the absence of symptoms should not be used as an indication for surgery.

Over 130 different procedures have been described for the management of this condition. A description of each technique is outside the scope of this review paper. Generally, procedures can be classified into four major categories: soft-tissue procedures, proximal metatarsal osteotomy, distal metatarsal osteotomy, and combined techniques.

In the skeletally immature child, surgical treatment options are limited, as damage and premature physeal closure may lead to secondary deformity and poor outcomes. As the metatarsal physis of the first metatarsal is located proximally, proximal metatarsal osteotomies are generally contraindicated. Distal metatarsal osteotomies may be more favored if surgery is indicated; however, its correction power may be limited since shifting the head of the first metatarsal more than 50% of its width is generally avoided. If significant growth remains, the first metatarsal with metatarsus primus varus will continue to grow with pathologic alignment, leading to poor long-term outcomes. Similarly, given the high recurrence rate associated with soft tissue-only procedures, these techniques are not recommended in patients with significant growth remaining. Thus, in the skeletally immature child, alternative techniques should be considered.

Davids et al.[6] reported positive results in a small patient series utilizing a lateral hemiepiphysiodesis technique. By arresting the lateral aspect of the physis using a small drill and curette, the remaining active area of the first metatarsal physis is allowed to continue longitudinal growth, resulting in angular correction of the IMA (Figure 4 A, B, and C). The

authors suggest this procedure in symptomatic children with pediatric hallux valgus and two or more years of growth remaining who have failed a trial of shoewear modification and/or have a documented progression of deformity over time[6].

In skeletally mature patients, procedures may be used to address hallux valgus deformity in adults. The degree of deformity measured on radiographs should be utilized to select the appropriate surgical procedure. For example, a Chevron osteotomy or a modified McBride procedure is sufficient to treat mild deformities. A distal soft tissue correction and a proximal osteotomy may be indicated for deformities with MTP subluxation, and proximal and distal osteotomies should be considered for severe deformities with increased DMAA. This algorithm, suggested by Coughlin, offered good or excellent results in 92% of the reported cases[9].

Simple bunionectomy has fallen out of favor, as recurrence of symptoms and progression of deformity have shifted management strategies. While bunionectomy may still be performed to address localized pain due to pressure over the medial eminence, patients and families must understand that the procedure alone will not address the underlying pathoanatomy.

The modified McBride, a combination of bunionectomy and extensive soft-tissue procedures, including adductor hallucis release or transfer, lateral capsular release, and medial capsular plication, has been reported with success. Especially in younger patients, a notable complication from extensive lateral release is secondary hallux varus[20,21].

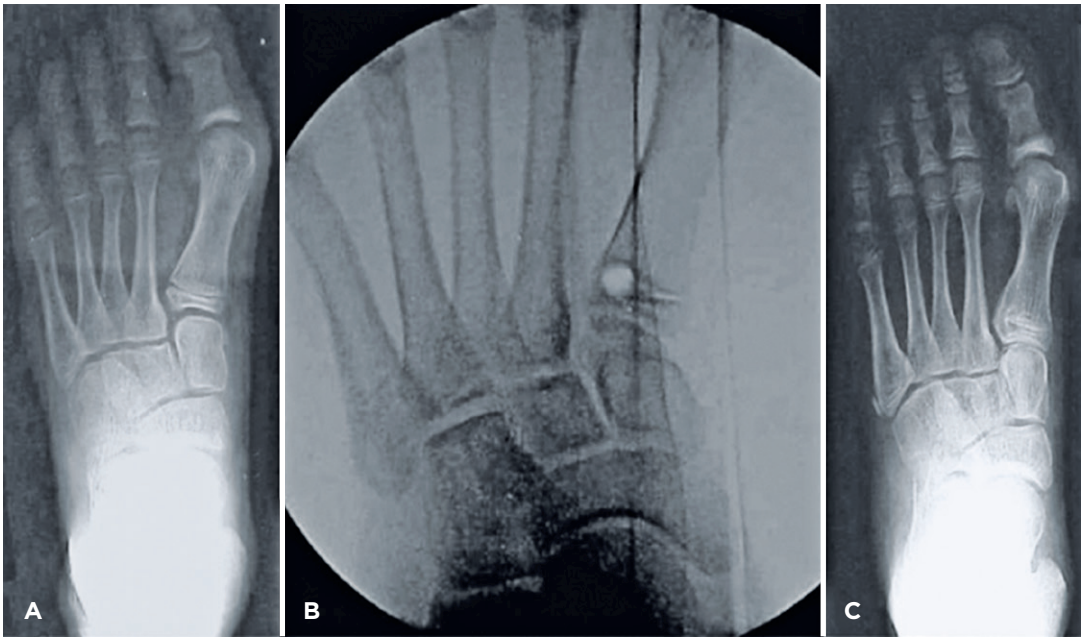
Various distal metatarsal osteotomies have been reported, with improved results associated with internal fixation or stable osteotomy configuration (i.e., Chevron osteotomy) [22,23]. Inherently, distal osteotomies create some metatarsal shortening and may be especially useful in patients with a long first metatarsal. Surgeons should be aware that transfer metatarsalgia may result if the second metatarsal becomes relatively too long after shortening of the first metatarsal.

In cases where the DMAA is increased, techniques such as biplanar Chevron or Scarf osteotomy may produce better correction and maintain metatarsal length if desired. Rotational correction should be achieved to fully correct the DMAA within the normal range (Figure 5 A and B).

Particularly in children and adolescents with ligamentous laxity, the surgeon must assess the stability of the TMT joint. If there is evidence of instability or hypermobility of the first TMT joint, distal procedures alone should be avoided, and TMT arthrodesis (Lapidus procedure) should be considered. It should be noted that the first TMT instability remains controversial, as objective measurement for instability is limited, particularly regarding axial plane instability[24].

This procedure allows both correction of the deformity and improvement of the IMA, as well as eliminating joint instability. Given the proximity of the physis and its proximal location along the first metatarsal, this procedure should be reserved for skeletally mature patients.

Arthrodesis of the first MTP joint is usually reserved for patients with significant degenerative changes, an extremely rare finding in pediatric patients. One important exception would be patients with neuromuscular pathologies who



Figures 4. (A) Preoperative radiographa of a juvenile hallux valgus with abnormal intermetatarsal angle. (B) Intraoperative fluoroscopy of lateral physes drilling to perform hemiepiphysiodesis. (C) Long-term postoperative with gradual intermetatarsal angle correction.

need procedures to facilitate hygiene or avoid skin ulceration between the great and second toe.

As minimally invasive techniques have gained popularity, choosing an osteotomy at the correct level should rely on the earlier principles[25]. Over the last two decades, from the first generation, which had used poor fixation, to the current fourth generation, which uses specific screws designed for minimally invasive procedures, outcomes have shown to be consistently better. Additional benefits are using minimally invasive techniques: immediate weight-bearing status, improved cosmesis, a notable decrease in immediate postoperative pain, and possibly less stiffness compared with open procedures as the osteotomy is an extra-articular, therefore avoiding capsulotomies[26] (Figure 6 A and B).

In syndromic patients with cerebral palsy or other neuromuscular disease, the main aim of treatment is to provide a painless, stable, comfortable position of the great toe. This is best achieved with a single safe and reliable surgery, the first MTP joint arthrodesis. This option offers the greatest degree of correction and best outcomes compared to other techniques[27]. Given the inherent muscle imbalance due to spasticity or paresis, soft tissue or joint realignment procedures are not recommended.

Outcomes

Outcomes after surgical treatment of pediatric hallux valgus are generally favorable. Recurrence of deformity is a risk for any hallux valgus procedure at any age and is especially a concern in younger patients.

In one long-term study, Schwillate et al.[20] report on the outcomes of 17 feet after the modified McBride procedure. Outcomes were good in 10, satisfactory in 2, and dissatisfying in 5, with a mean of 14-year follow-up[20]. Recurrence rates after distal metatarsal osteotomies such as the Mitchell osteotomy have been reported to be up to 61% in one study by Ball and Sullivan.[28]. However, in a study by Geissele and Stanton[1], a successful correction was reported up to 95%[1].

The Scarf osteotomy has demonstrated positive results. John et al.[29] reported on seven patients with a mean age of 14 years, with only one recurrence after 14 years[29]. Farrar et al. reported that 39 feet were submitted to Scarf osteotomy at a mean age of 14, and 93% of the results were satisfactory at 3 years[30]. One study cautioned against Scarf osteotomy, as they found a high recurrence rate in a series of 19 feet with a mean age of 14[31]. The Lapidus procedure has been reported to have favorable outcomes. In a series of 30 feet, good or excellent results were reported in 90% (27 feet) by Grace et al.[32].

Figure 5. (A) Preoperative juvenile hallux valgus with abnormal intermetatarsal angle and distal metaphyseal articular angle. (B) Intermetatarsal angle and distal metaphyseal articular angle correction after biplanar Chevron osteotomy.

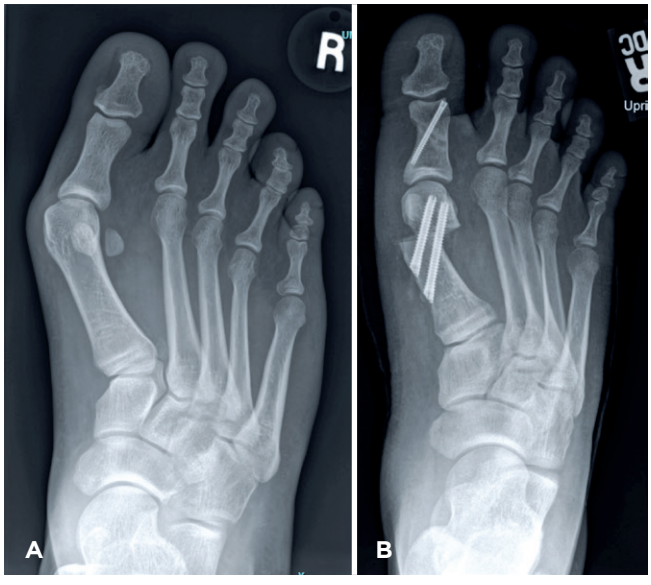


Figure 6. (A) Preoperative juvenile hallux valgus. (B) Correction with minimally invasive technique (Distal first metatarsal Osteotomy + Akin)

Authors' contributions: Each author contributed individually and significantly to the development of this article: DSL, and CPM, and FCR *Conceived and planned the activities that led to the study, data collection, wrote the article, approved the final version. All authors read and approved the final manuscript. *ORCID (Open Researcher and Contributor ID) .

References

1. Geissele AE, Stanton RP. Surgical treatment of adolescent hallux valgus. J Pediatr Orthop. 1990;10(5):642–8.
2. Inman VT. Hallux valgus: a review of etiologic factors. Orthop Clin North Am.1974;5(1):59–66.
3. Groiso JÁ. Juvenile hallux valgus. A conservative approach to treatment. J Bone Joint Surg Am. 1992;74(9):1367–74.
4. Kilmartin TE, Barrington RL, Wallace WA. A controlled prospective trial of a foot orthosis for juvenile hallux valgus. J Bone Joint Surg Br. 1994;76(2):210–4.
5. Nery CAS, Mizusaki JM, Magalhaes AAC, Macedo BD, Camilo AC. Tratamiento conservador del hallux valgus juvenil mediante ortesis nocturnas. Rev Esp Cir Osteoart. 1997;32(187):32–7.
6. Davids JR, McBrayer D, Blackhurst DW. Juvenile hallux valgus deformity: surgical management by lateral hemiepiphyseodesis of the great toe metatarsal. J Pediatr Orthop. 2007;27(7):826–30.
7. Mann RA. The great toe. Orthop Clin North Am 1989;20(4):519–33.
8. Perera AM, Mason L, Stephens MM. The pathogenesis of hallux valgus. J Bone Joint Surg Am. 2011;93(17):1650–61.
9. Coughlin MJ. Roger A. Mann Award. Juvenile hallux valgus: etiology and treatment. Foot Ankle Int. 1995;16(11):682–97.
10. Herring A. Tachdjian's pediatric orthopaedics. 3rd ed. Philadelphia: WB Saunders; 2002.
11. Tachdjian MO. Clinical pediatric orthopaedics: the art of diagnosis and the principles of management. Stamford (CT): Appleton & Lange; 1997.
12. Goldner JL. Hallux valgus and hallux flexus associated with cerebral palsy: analysis and treatment. Clin Orthop. 1981;(157):98–104.
13. Jenter M, Lipton GE, Miller F. Operative treatment for hallux valgus in children with cerebral palsy. Foot Ankle Int. 1998;19(12): 830–5.
14. Renshaw TS, Sirkin RB, Drennan JC. The management of hallux valgus in cerebral palsy. Dev Med Child Neurol. 1979;21(2): 202–8.
15. Weiner BK, Weiner DS, Mirkopulos N. Mitchell osteotomy for adolescent hallux valgus. J Pediatr Orthop. 1997;17(6):781–4.
16. Barouk LS. The effect of gastrocnemius tightness on the pathogenesis of juvenile hallux valgus: a preliminary study. Foot Ankle Clin. 2014;19(4):807–22.
17. McHale K, McKay D. Bunions in a child: conservative versus surgical management. J Musculoskel Med. 1986;3:56–62.
18. Scranton PE Jr, Zuckerman JD. Bunion surgery in adolescents: results of surgical treatment. J Pediatr Orthop. 1984;4(1):39–43.
19. Lalevée M, Barbachan Mansur NS, Lee HY, Maly CJ, Iehl CJ, Nery C, et al. Distal Metatarsal Articular Angle in Hallux Valgus Deformity. Fact or Fiction? A 3-Dimensional Weightbearing CT Assessment. Foot Ankle Int. 2022;43(4):495–503.
20. Schwillate M, Karbowski A, Eckhardt A. Hallux valgus in young patients: longterm results after McBride operation. Arch Orthop Trauma Surg. 1997;116(6–7): 412–4.
21. Luba R, Rosman M. Bunions in children: treatment with a modified Mitchell osteotomy. J Pediatr Orthop. 1984;4(1):44–7.
22. Zimmer TJ, Johnson KA, Klassen RA. Treatment of hallux valgus in adolescents by Chevron osteotomy. Foot Ankle. 1989;9(4):190–3.
23. Das De S. Distal metatarsal osteotomy for adolescent hallux valgus. J Pediatr Orthop. 1984;4(1):32–8.
24. Doty JF, Coughlin MJ. Hallux valgus and hypermobility of the first ray: facts and fiction. Int Orthop. 2013;37(9):1655–60.
25. Lausé GE, Miller CP, Smith JT. Minimally Invasive Foot and Ankle Surgery: A Primer for Orthopaedic Surgeons. J Am Acad Orthop Surg. 2023;31(3):122–31.
26. Lai MC, Rikhraj IS, Woo YL, Yeo W, Ng YCS, Koo K. Clinical and radiological outcomes comparing percutaneous chevron-akin osteotomies vs open scarf-akin osteotomies for hallux valgus. Foot Ankle Int. 2018;39(3):311–7.
27. Jenter M, Lipton GE, Miller F. Operative treatment for hallux valgus in children with cerebral palsy. Foot Ankle Int 1998;19(12):830–5.
28. Ball J, Sullivan J. Treatment of juvenile bunion by the Mitchell osteotomy. Orthopedics. 1985;8(10):1249–52.
29. John S, Weil L Jr, Weil LS Sr, Chase K. Scarf osteotomy for the correction of adolescent hallux valgus. Foot Ankle Spec. 2010;3(1):10–4.
30. Farrar NG, Duncan N, Ahmed N, Rajan RA. Scarf osteotomy in the management of symptomatic adolescent hallux valgus. J Child Orthop. 2012;6(2):153–7.
31. George HL, Casaletto J, Unnikrishnan PN, Shivratri D, James LA, Bass A, et al. Outcome of the scarf osteotomy in adolescent hallux valgus. J Child Orthop. 2009;3(3):185–90.
32. Grace D, Delmonte R, Catanzariti AR, Hofbauer M. Modified Lapidus arthrodesis for adolescent hallux abducto valgus. J Foot Ankle Surg 1999;38(1):8–13.