Longitudinal Epiphyseal Bracket as an Overlooked Etiology of Congenital-Residual Hallux Varus

A Case Report

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Longitudinal epiphyseal bracket is a rare ossification disorder of the short tubular bones. The affected bone becomes deformed as a result of the bracket. The normal growth pattern cannot occur, and when it affects the first metatarsal bone, hallux varus may develop with the abnormal growth pattern. We present such a 6-year-old patient who had undergone surgery at 6 months of age for hallux varus and polydactyly. The deformity had worsened gradually after the initial operation because of the overlooked longitudinal epiphyseal bracket. The patient was treated with surgical excision of the epiphyseal bracket, with corrective medial open wedge osteotomy and split transfer of the extensor hallucis longus tendon. The result was excellent at the 20-month follow-up. At an early age, patients who present with hallux varus must be checked for the epiphyseal bracket, which can be invisible on radiographs because of the chondral structure. Untreated or overlooked patients with epiphyseal bracket will need revision operations for recurrent deformities. (J Am Podiatr Med Assoc 111(2): 1-4, 2021)

Longitudinal epiphyseal bracket (LEB) is a rare ossification disorder affecting the short tubular bones of the hand and foot. The affected bones have a C-shaped, longitudinally oriented growth plate extending distally to the diaphysis. Bones that contain proximal epiphysis and secondary ossification center (ie, phalanges, first metatarsal) are the most commonly involved.[1-4] The incidence of LEB is not clearly known, but 11% of all cases were found in the great toe.[2] When it affects the first metatarsal bone, LEB will lead to a short, broad, trapezoidal metatarsal with hallux varus.[1,2,5-8] The deformity was first described by Jones[9] as "delta phalanx." Light and Ogden[4] used the terminology of LEB, which more accurately addresses the pathoanatomy.

Congenital hallux varus is also a rare condition in which the great toe is angled medially at the metatarsophalangeal (MTP) joint. The potential causes of hallux varus are multifactorial. One of the rare causes of this deformity is LEB. A typical first metatarsal bone has a proximal epiphysis, but with a bracket, this proximal epiphysis extends distally on the medial side of the bone. The metatarsal bone cannot elongate normally because of the abnormal epiphysis bracketing the bone, resulting in the hallux varus deformity.[4,7]

LEB can exist as an isolated deformity at the foot but is commonly associated with polydactyly and hallux varus.[1,2] At an early age, LEB can easily be overlooked because of the invisible chondral structure on radiographs.[2,3,6,10] Therefore, the physician must suspect the deformity to make the correct diagnosis.

In this report, we present a 6-year-old boy, who had undergone surgery for hallux varus and polydactyly—but not LEB—at 6 months of age. This study aims to emphasize the importance of suspecting LEB when diagnosing pediatric foot deformities and the management of untreated LEB patients.

Case Report

A 6-year-old boy was referred to our outpatient clinic with complaints of left foot pain, a deformity at the great toe, and difficulties with wearing shoes.

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The patient's history revealed an operation at 6 months of age for congenital hallux varus and preaxial polydactyly (Venn-Watson type 4) at another institute. The patient underwent medial accessory toe resection and a soft-tissue procedure, including release of the medial joint capsule. The parents stated that, after the surgery, the deformity at the great toe worsened gradually over the years. The physical examination showed a short first ray and hallux varus deformity (Fig. 1A). His neurovascular assessment was normal and there was no family history of musculoskeletal abnormalities. Radiographic examination revealed a short, thick, and trapezoidal first metatarsal bone; slight metatarsus adductus deformity at the other four metatarsals; and varus deformity of 35° at the MTP joint (Fig. 1B).

After informed consent was obtained from the parents, surgery was performed with the patient in the supine position under general anesthesia and tourniquet control. A longitudinal medial skin incision was made on the first metatarsal bone. A firm and fibrous LEB was exposed. The diaphyseal portion of the LEB was resected with a small rongeur and curette until the cortical bone was encountered. The resection was carried proximally and distally where the epiphysis was oriented transversely. Then, proximal transverse osteotomy was performed at the first metatarsal bone to realign the MTP joint and secured with one Kirschner wire in a valgus invaginated position. No interposition graft was used. The extensor hallucis longus (EHL) tendon was split detached from the insertion point at the base of the proximal phalanx and passed under the interosseous ligament between the first and second metatarsal heads. A bone tunnel with a diameter of 2.7 mm was created at the base of the first proximal phalanx in the dorsoplantar direction. The EHL tendon was passed through the tunnel and sutured onto itself. One longitudinally placed Kirschner wire held the reduced MTP joint from the distal to the proximal direction (Fig. 2). The incision was closed with simple absorbable sutures. A short-leg spica cast was applied. At the end of the sixth week, cast and Kirschner wires were removed, and the patient was allowed to walk with full weightbearing. The patient was evaluated at 3, 6, and 12 months postoperatively for clinical and radiographic assessments. Clinical outcome was assessed according to the criteria of Phelps and Grogan.[11] Pain, callus, residual deformity, and scar cosmesis were examined. The clinical result was excellent at the 20-month follow-up (Fig. 3A). Varus angulation of 35° at the MTP joint was improved to 9° of valgus with a slight brachymetatarsia at the final follow-up (Fig. 3B). The patient was able to wear regular shoes and accomplish all activities of daily living, including participating in sports activities.

Discussion

Congenital hallux varus deformity and LEB are both rare conditions. Although LEB can exist as an isolated deformity at the foot, it is commonly associated with polydactyly and hallux varus.[1,2] If the patient with hallux varus is presented at an early age, the diagnosis of LEB should be considered. The early stages of LEB (preossified) could be overlooked very easily because the epiphyseal bracket is cartilaginous and not yet visible until 2 years of age. Only a short or wide metatarsal bone on radiographs could be a sign for the physician to suspect LEB.[2,6,12] Magnetic resonance imaging and ultraso-

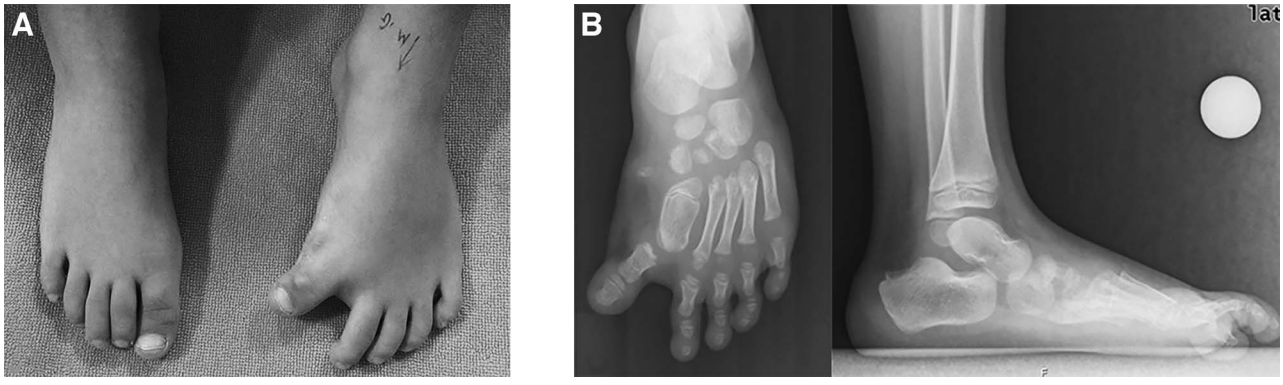


Figure 1. A, Preoperative clinical appearance of both feet. B, Preoperative radiographic examination shows marked hallux varus deformity of 35° with widening of the first web space and a trapezoidal, short, broad first metatarsal.

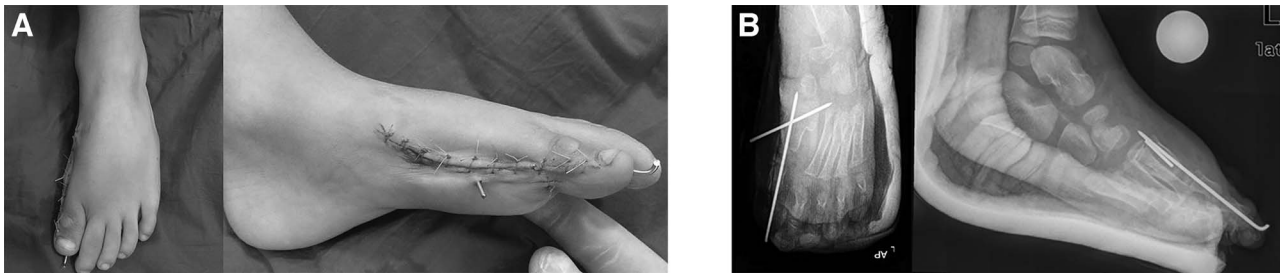


Figure 2. Early postoperative clinical (A) and radiographic (B) appearance of the left foot. Longitudinal epiphyseal bracket has been resected and proximal transverse osteotomy has been fixed with Kirschner wires.

nography can help diagnose the entity if any suspicion occurs.[3,6,12] Early detection and adequate excision of LEB can reduce the risk of residual deformity and the need for revision surgery. Untreated or unconsidered LEB cases may present with severe deformities, including varus deformity, and short first ray in the following years.[1-3,6-8,10]

The treatment of LEB has been primarily surgical. Initial surgical procedures included mostly osteotomies to correct the deformities. In 1964, Jones[9] described the osteotomy for delta phalanx. Numerous techniques have been reported over the years. In 1981, Light and Ogden[4] described the pathoanatomy and coined the term LEB. They performed an open wedge chondro-osteotomy with fat interposition in the hands of three children younger than 4 years. Vickers[13] reported the results of 12 cases of clinodactyly of the little fingers in which he resected a limited part of the isthmic region of the bracket. He used free fat graft harvested from the medial forearm. After understanding pathologic anatomy, Mubarak et al[3] developed a technique called "central physiolysis." They stated that the method is a simple, effective procedure that allows correction of the angular deformity and longitudinal growth of the metatarsal bone. In their study, polymethyl methacrylate was used as an interposition graft to prevent new subsequent physeal bar formation that they had observed in a previous patient operated on with fat interposition. Also, osteotomies fixed with external fixators were reported.[8,14]

Several studies have reported surgical outcomes for congenital hallux varus, using various surgical procedures.[15,16] Because of the rarity of the condition, and lack of an established, clear definition of the deformity, there is no one universally accepted method. General guidelines recommend the correction of the soft-tissue tether on the medial side and the enlarged webspace, correction of the MTP incongruity, and correction of a metatarsal or bracket epiphyseal deformity.[6]

In our case, the patient was operated on for polydactyly and hallux varus as the initial operation, but LEB was overlooked. By the bracketing effect of LEB, hallux varus deformity was worsened over the years, and longitudinal growth was restricted. After diagnosing the overlooked LEB, we performed a revision operation to correct the varus deformity. The patient underwent central LEB bar resection and medial wedge osteotomy. Split transfer of the EHL tendon was also applied. The tendon transfer procedure as treatment of hallux varus is reserved for cases of flexible deformity with a functioning

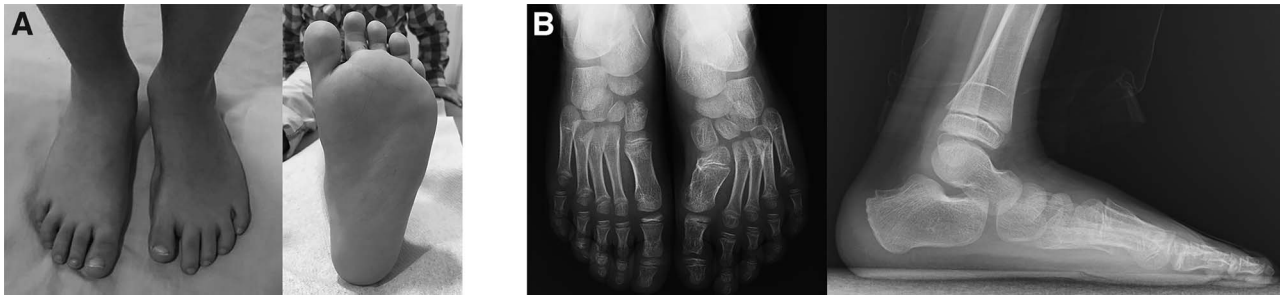


Figure 3. Clinical (A) and radiographic (B) views at the final follow-up (20 months postoperatively) with a valgus angle of 9° at the metatarsophalangeal joint and slight brachymetatarsia.

and painless first MTP joint. Numerous techniques, including extensor hallucis longus, abductor hallucis, and split extensor hallucis longus tendon transfers have been described.[17,18] Split EHL tendon transfer procedures are dynamic tendon transfers, in which the function of the remaining part of the extensor hallucis tendon is not affected, so a more reliable correction of the hallux varus deformity can be managed.[19]

In the literature, there are a few such LEB cases reported that discuss the initial treatment choices. To the best of our knowledge, there is no published study regarding the treatment of overlooked LEB cases seen years after the initial operation. We believe that a tendon transfer procedure combined with metatarsal osteotomy may be an efficient technique for such patients seen after the initial surgery with congenital hallux varus deformity.

Conclusions

Congenital hallux varus deformity or the recurrence of the deformity should be an alerting sign for LEB. We believe that suspicion of LEB is the cornerstone of the diagnosis, especially at an early age. Appropriate surgical procedures after diagnosis will maintain the normal growth pattern and prevent recurrent deformities. However, correcting the varus deformity may not avoid some other deformities such as metatarsus primus varus, metatarsus adductus, and brachymetatarsia. Parents must be informed about such conditions and possible future interventions.

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