Anatomical reconstruction of the fourth brachymetatarsia with one-stage iliac bone and cartilage cap grafting

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Summary  Background: We present a one-stage procedure for lengthening the fourth brachymetatarsia with autogenous iliac bone and cartilage cap grafting for the anatomical reconstruction of the metatarsophalangeal (MTP) joint.

Methods: During the last 8 years, 56 feet in 41 patients with congenital brachymetatarsia of the fourth toe were corrected with a one-stage operation to reposition the articular cartilage cap to the distal part of interpositional iliac bone graft at the metatarsal epiphysis.

Results: The length of the harvested iliac bone graft was 22.9 mm on average. The mean fixation period was 58.5 days, and the mean gain in length and percentage increase was 20.9 mm and 39%, respectively. MRI showed a stable MTP joint over viable cartilage cap in 83.3% of the cases. Mean postoperative American Orthopedic Foot and Ankle Society lesser MTP-interphalangeal score was 82.0. Neither neurovascular impairment nor recurrence of brachymetatarsia occurred in the mean follow-up period of 43.6 months. All patients were satisfied with the postoperative cosmetic results. Thirteen patients (23.2%) complained of limited active dorsiflexion of the fourth toe, and extensor adhesion was released by extensor tenolysis in only one patient. In a single case of nonunion at the bone graft site, additional surgery was not necessary.

Conclusions: Anatomical reconstruction of the fourth brachymetatarsia with one-stage interpositional iliac bone and cartilage cap grafting resulted in excellent cosmetic results and a...
Congenital brachymetatarsia is a shortening of the toe that is usually due to a short metatarsal, but not a short phalanx. The deformity is not seen at birth. It usually becomes evident when the child is between 4 and 15 years old. The deformity is usually involved in the fourth ray and sometimes bilaterally. It is found 25 times more often in females than in males. Almost all patients with congenital brachymetatarsia have neither gait-related nor other functional problems. Some patients complain of problems with hygiene at the recessed web, dorsal or plantar keratosis; toe pain caused by the cockup deformity; or metatarsalgia following prolonged walking, but most patients seek solutions for cosmetic concerns because they cannot wear open-toed shoes. The deformity may be notable, especially in Asian countries where people do not wear shoes indoors and expose their feet in public.

Several operative options have been suggested to correct brachymetatarsia. One-stage lengthening of the fourth brachymetatarsia with or without autogenous or homogenous bone grafting is a procedure that only requires a single main procedure, which is less restrictive on patients’ daily lives. The main disadvantages are the limited extent of lengthening (because of neurovascular compromise and soft tissue tension) and donor site morbidity. Shortening of adjacent metatarsals could be another option in conjunction with lengthening procedures to restore the parabolic arc of the metatarsal heads. Gradual lengthening by distraction osteogenesis can achieve simultaneous bone and soft tissue lengthening. There is no donor site morbidity and fewer neurovascular complications. A lengthening gain of over 15 mm can be achieved, and the possibility of stopping the lengthening whenever the metatarsal regains the proper length could be another advantage. Even though distraction osteogenesis has become popular, it requires multiple operations, patient cooperation, and a sizable amount of time and money. The risk of joint stiffness or subluxation and complications such as pin-tract infection, nonunion, fracture, or angulation deformity must not be underestimated.

The cause of brachymetatarsia is believed to be premature closure of the distal epiphyseal growth plate; it is theoretically ideal that a graft be placed at the site of the deficiency. We presented a one-stage lengthening of the fourth brachymetatarsia with interpositional autogenous iliac bone grafting with the preservation of articular movement using anatomical repositioning of articular cartilage. We hypothesized that physiologic articulation could be performed between a viable cartilage cap and the proximal phalanx.

Patients and methods

This study was performed after approval from the Institutional Ethics Committee. We retrospectively reviewed 56 feet in 41 patients with congenital brachymetatarsia of the fourth toe who received treatment with one-stage autogenous iliac bone grafting between 2008 and 2015. There were 39 females (95%) and 2 males (5%), with a mean age of 33.2 years (range, 18–54 years). Fifteen patients (37%) underwent simultaneous operations for bilateral brachymetatarsia, and four patients (12%) had familial histories. Before operation, 10 patients suffered mild pain following prolonged walking, five patients complained of pain at the dorsum of the toe while wearing shoes, and three complained of pain due to callus. However, the primary objective of the treatment for all patients was purely cosmetic improvement, not functional.

Operative technique

Under spinal anesthesia, the patient assumed the supine position on the operating table with the contralateral iliac crest exposed. A pneumatic tourniquet was applied on the upper thigh. Skin incision of 1.5–2 cm was made along the Z-plasty over the dorsal surface of the fourth MTP joint of each limb (Figure 1). The extensor digitorum longus tendon at the MTP joint level was lengthened with a stepladder pattern. The MTP joint was exposed, and dorsal capsulotomy was performed. The dorsal capsule was excised to prevent impingement into the joint, where the graft would be interposed. The dorsal midline was marked with a marking pen on the cartilage of the metatarsal head for later orientation of the bone graft. The lateral capsule and fascia of the interossei were opened without any dissection or damage to the neurovascular bundles at all. The flexor tendon was identified and preserved. The exposed plantar plate was excised distally as not to impinge into the newly formed joint space (Figure 2A). Osteotomy was conducted at the ephysis level; the cartilaginous head of the metatarsal became the new distal cartilaginous cap. Autogenous iliac bone was harvested from the iliac crest in the usual manner. Care must be taken to include a large cortical portion to minimize resorption and resist compressive force.

First, a 1.2-mm K-wire was inserted longitudinally into the prefabricated cartilage cap and tri-cortical iliac bone graft on the scrub table (Figure 2B). Next, the inserted K-wire was advanced distally through the fourth phalanx with the MTP joint in the flexed position. The distal K-wire was grasped and pulled distally until its proximal end was at the...
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