One-stage Metatarsal Lengthening by Allograft Interposition

A Novel Approach for Congenital Brachymetatarsia

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Received: 14 May 2009 / Accepted: 16 December 2009 / Published online: 8 January 2010
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Abstract

Background Congenital brachymetatarsia, a shortened metatarsal bone, can be corrected surgically by callus distraction or one-stage lengthening using bone graft.

Questions/purposes We asked whether one-stage metatarsal lengthening using metatarsal homologous bone graft could improve forefoot function, lead to metatarsal healing, restore metatarsal parabola, and improve cosmetic appearance.

Patients and Methods We retrospectively reviewed 29 patients (41 feet) in whom we lengthened 50 metatarsals. Surgery consisted of a transverse proximal osteotomy of the metatarsal shaft and interposition of a metatarsal homologous bone graft (average, 13 mm long) fixed with an intramedullary Kirschner wire. Minimum followup was 3 years (mean, 5 years; range, 3–11 years).

Results Bone union was achieved in all cases. The mean preoperative American Orthopaedic Foot and Ankle Society score was 37 points (range, 28–53 points) and the mean postoperative score was 88 points (range, 74–96 points), with

an average improvement of 51 points. Radiographically, the mean gain in length was 13 mm (range, 10–15 mm), and the mean percentage increase was 23%.

Conclusions One-stage metatarsal lengthening using interposition of metatarsal homologous bone graft to correct congenital brachymetatarsia has low morbidity for the patient, limited complications, short recovery times, and restores forefoot anatomy.

Level of Evidence Level IV, therapeutic study. See Guidelines for Authors for a complete description of levels of evidence.

Introduction

Brachymetatarsia is defined as an abnormal shortness of a metatarsal bone [2, 15]. It is a rare deformity, the incidence of which is reported as ranging from 0.02% to 0.05% [28, 29], with a clear female preponderance of 25:1 [28]. This deformity can be unilateral or bilateral, and any of the five metatarsals can be affected [23, 25, 27, 33], although the fourth metatarsal is the most frequently involved. The deformity reportedly is caused by premature closure of the epiphyseal plate of the metatarsal [29, 33, 35], although the etiology of the premature closure is not known. There are three types: idiopathic congenital, associated congenital, and acquired; the idiopathic congenital etiology seems to be the most frequent [23]. Some causes of associated congenital brachymetatarsia are Down's, Turner's, Larsen's, and Albright's syndromes and diastrophic dwarfism [15, 23]. The acquired etiology refers to traumas, neurotrophic disorders, poliomyelitis, and surgery during growing age [19, 23, 30, 35]. The deformity is not usually present at birth but becomes clinically manifest usually after 4 years of age [28].

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Patients with brachymetatarsia complain of metatarsalgia, calluses, shoe wear irritation, and soft tissue contractures [1, 3, 28]. In addition, many patients, particularly young women, complain of the appearance [8, 17, 21, 28, 34, 35]. Other toe deformities often are associated: the toes of the normal rays may be deviated to fill the gap formed by the involved toe: the toes placed medially are deformed in valgus, whereas the toes placed laterally are deformed in varus (Fig. 1A).

Surgery reportedly improves function and cosmetic appearance of the forefoot [20, 22, 28, 35]. Distraction osteogenesis using external fixation systems is a widely used technique to correct congenital brachymetatarsia [1, 4, 18, 28, 31]. However, this technique is associated with long duration of treatment, difficulties ensuring maintenance of

alignment during distraction, frequent redressing, and patient cooperation [4, 14]. Other complications are pain during distraction, pin tract infections, joint stiffness, and premature callus consolidation [5, 7, 8, 17, 20, 25, 32, 34, 35, 38, 39]. An alternative method for correcting brachymetatarsia is one-stage metatarsal lengthening using autologous bone graft. Even if this surgical technique minimizes the complications encountered with callus distraction, an autologous graft requires increased operation time and a second incision to harvest the graft and may cause donor site morbidity such as local pain and infection.

We asked whether (1) the use of an allograft would lead to reliable healing of metatarsal osteotomies, (2) this method would achieve improvement of forefoot function, and (3) the one-stage metatarsal lengthening would restore the metatarsal parabola.

Fig. 1A–B A 33-year-old woman had bilateral brachymetatarsia of the fourth metatarsal. **(A)** A preoperative clinical dorsoplantar view shows shortening of the fourth metatarsal, valgus deviation of the first, second, and third toes, and varus deviation of the fifth toe. **(B)** At the 4-year followup after bilateral one-stage metatarsal lengthening and bilateral correction of hallux valgus by the SERI technique, the brachymetatarsia is corrected, and the patient is satisfied with the cosmetic outcome.

Patients and Methods

We prospectively followed all 29 patients (41 feet) on whom we operated for brachymetatarsia from 1997 to 2006. The inclusion criteria in the study were congenital brachymetatarsia of one or more metatarsals of one foot or both feet, in patients older than 12 years; patients with brachymetatarsia of the first and fifth toes were excluded from the study. There were 26 females (90%) and three males (10%), with a mean age of 27 years (range, 12–42 years). There was a family history of brachymetatarsia in five patients. Nine patients had brachymetatarsia of the right foot, eight in the left, and 12 in both feet. Of the 41 feet, nine had multiple brachymetatarsia, which involved the third and fourth metatarsals in all cases (Fig. 1). Thus, we treated 50 short metatarsals: the fourth metatarsal was involved in 40 cases (80%) and the third metatarsal in 10 (20%); the first, second, and fifth metatarsals were not involved. The minimum followup was 3 years (mean, 5 years; range, 3–11 years). No patients were lost to followup.

The main symptoms of the patients were pain caused by transfer metatarsalgia and skin irritation caused by shoe wear. The short metatarsal typically causes a deformed position of the corresponding toe, which is placed in a dorsiflexed position atop the web space (Fig. 1A). Pain was sometimes the consequence of associated toe deformities: 18 feet had hallux valgus, 14 had fifth toe varus, and 27 had hammertoes with lateral or medial deviation. All patients complained of the appearance: none felt comfortable wearing open-toed shoes and walking barefoot. Moreover, patients complained of calluses, which frequently were symptomatic, inability to wear tight shoes or high heels, and limitation of metatarsophalangeal joint motion of the corresponding metatarsal.

Preoperative imaging consisted of plain radiography in all patients: dorsoplantar and lateral weightbearing views were performed. On the dorsoplantar view, a curved line passing through the metatarsophalangeal joints can be drawn. The curve of this line has been defined as the metatarsal parabola, and reportedly has functional importance [14]. In brachymetatarsia, the metatarsal parabola is interrupted near the short metatarsal (Fig. 2).

On the dorsoplantar radiography, we measured the length of the affected metatarsal and the length needed to restore the metatarsal parabola; thus, the length of the required bone graft was estimated [14, 38]. On the dorsoplantar view, the level of the osteotomy was determined at the proximal metaphysis to achieve a wide contact surface and adequate stability of the allograft. As second, third, and fourth metatarsal bones have similar diameters,

Fig. 2 A dorsoplantar standing radiograph of a 25-year-old woman with congenital brachymetatarsia shows the discontinued metatarsal parabola.

we chose one randomly from the bone bank. On the dorsoplantar and lateral views, deformities of the toes such as hallux valgus or hammertoes were evaluated.

Patients were placed supine on the operating table, under peripheral or general (for the youngest patients) anesthesia. The affected foot was prepared and draped, and a pneumatic tourniquet was used for hemostasis. Simultaneous to patient preparation, the metatarsal homologous bone graft from the bone bank was defrosted, and a cylindrical bony segment of the proper length was created according to the preoperative measurements performed on the dorsoplantar view. The length varied between 10 and 15 mm according to the deformity; bone defects greater than 15 mm were corrected with a 15-mm bone graft to avoid over tensioning the soft tissues (Fig. 3). A 2-cm-long dorsal longitudinal incision was made over the proximal metaphysis of the affected metatarsal. When two metatarsals were involved, only one median incision was made over the corresponding web space. The extensor tendon was elongated by z-plasty, the interosseous muscles on the medial and lateral sides were released to increase the lengthening and to better prepare the graft site, and the metatarsal shaft was exposed subperiosteally. The flexor tendon of the affected toe was lengthened subcutaneously at the level of the proximal phalanx of the affected toe. A transverse proximal osteotomy of the metatarsal was performed using an oscillating saw. An intramedullary 1.6-mm Kirschner wire was passed through the metatarsal shaft from proximally to distally up to the toe. The distal end of the wire then was grasped and pulled distally until its proximal end was at the level of the osteotomy. The osteotomy then was distracted with a bone spreader in accordance with the soft tissues contracture and the bone lengthened as planned before surgery (Fig. 4A–B). To avoid soft tissue stress, the bone graft, prepared according to the preoperative planning, was never larger than the gap that could be created during distraction. The cylindrical

Fig. 3A–B The homologous graft used for one-stage metatarsal lengthening is a frozen metatarsal bone from the bone bank. (A) It is prepared in the operating theater and (B) a bone graft of the required length is obtained.

metatarsal homologous bone graft was driven into the distracted osteotomy and the Kirschner wire was pushed through it from distally to proximally up to the metatarsal base (Fig. 4C–D). The pneumatic tourniquet was removed before closure to control the peripheral blood flow of the lengthened metatarsal. The extensor tendon was sutured elongated as much as the lengthened metatarsal; 3-0 absorbable sutures were used to close the skin. The distal end of the Kirschner wire was bent just beyond the tip of the toe and cut. We injected 5 cc of local anesthetic (ropivacaine hydrochloride 1%) in the forefoot around the skin incision to minimize postoperative pain. A gauze compression dressing was applied, with the gauze passing around and between the toes to minimize toe movement.

Postoperative dorsoplantar and lateral radiographs were obtained.

Additional surgeries included the SERI (simple, effective, rapid, inexpensive) minimally invasive distal osteotomy of the first metatarsal for correction of hallux valgus [10] in 18 feet: a 1-cm medial incision at the metatarsal neck and a complete linear distal metatarsal oblique osteotomy using an oscillating saw were performed. The metatarsal head was dislocated laterally and temporally stabilized by a 2-mm Kirschner wire. Additional surgeries were fusion of the proximal interphalangeal joint for correction of the fifth toe varus in 14 feet and fusion of the proximal interphalangeal joint for correction of hammertoe in 27 feet.

Fig. 4A–D (A) To correct the congenital brachymetatarsia of the fourth toe, (B) a transversal osteotomy at the proximal metaphysis of the fourth metatarsal is performed, which then is distracted gradually

by a bone spreader. (C) Through a small skin incision, the bone graft is driven into the distracted osteotomy to fill the gap, and (D) a Kirschner wire is passed through the metatarsal shaft up to the toe.

Fig. 5 A talus shoe with a special heel that prevents weightbearing on the forefoot allows patients who undergo one-stage lengthening to walk immediately after surgery.

Postoperatively, we allowed weightbearing immediately only on the hindfoot, using a shoe with a special heel to prevent weightbearing on the forefoot (Fig. 5). Walking without assistance was possible immediately, however, we suggested using one or two crutches for balance and to avoid fatigue. Patients were discharged 1 day after surgery. The first postoperative followup was 5 weeks after surgery; at that time, the initial dressing, suture, and all Kirschner wires were removed, a clinical evaluation was performed, and weightbearing was allowed on the entire foot with the patient wearing comfortable shoes and without using crutches. Patients resumed light sport activity 4 months and competitive sport activity 6 months after surgery.

Clinical evaluations were performed at 5 weeks and 3 months after surgery and in a subsequent followup conducted for the purpose of this study. We evaluated functional outcomes preoperatively and postoperatively using the American Orthopaedic Foot and Ankle Society (AOFAS) lesser toe metatarsophalangeal-interphalangeal scale, considered an accepted validated tool for forefoot clinical outcome. It evaluates pain, limitation of activities, footwear requirements, metatarsophalangeal and interphalangeal joint motion, presence of calluses, and alignment of lesser toes [16].

Radiographic evaluation was performed 3 months after surgery and in a subsequent followup conducted for the purpose of this study. (We did not obtain radiographs at the 5-week followup as there would be little evidence of healing.) Two of us (SG, CF) assessed the standard standing dorsoplantar and lateral radiographic views. The healing status was assessed by two independent surgeons (SP, MTM) not involved with either surgery or postoperative care. The bone segment was considered radiographically healed in the proximal and distal osteotomy sites if there was bridging bone formation on at least two cortical projections and no radiolucency between the

graft and the metatarsal osteotomy. Restoration of the metatarsal length was assessed in millimeters of length and in metatarsal parabola percentage increase (Fig. 2). Moreover, the metatarsal axis was evaluated in lateral/medial and frontal/dorsal deviation.

All continuous data were expressed as mean and SD of the mean. The paired *t* test was performed to compare AOFAS results preoperatively, 3 months postoperatively, and at the last available followup. Tau-b Kendall ordinal correlation was performed to compare lengthening preoperatively, 3 months postoperatively, and at the last available followup. Analysis was performed using SPSS[®] software (Version 9.0; SPSS Inc, Chicago, IL).

Results

Radiographically, at the 3-month followup, bone union was achieved in the proximal and distal osteotomy sites in 47 cases according to one evaluating surgeon and in 49 cases according to the other evaluator, with an agreement of 96%; at the last followup, agreement for bone healing between the two surgeons was 100%.

The mean AOFAS lesser toe metatarsophalangeal-interphalangeal score was 37 points (SD, 7.3 points; range, 28–53 points) preoperatively and 88 points (SD, 4.8 points; range, 74–96 points) at the last available followup, with a percentage improvement of 76%; the single domains of the AOFAS score had similar percentage improvements. The postoperative AOFAS score was lower in patients affected by serious brachymetatarsia. Clinically, transfer metatarsalgia pain and calluses almost disappeared in all cases (Fig. 1B). In 34 feet, in the dorsoplantar view, a physiologic metatarsal axis was restored without deviation of the lengthened metatarsal in the proximal and distal osteotomy sites, and in the lateral view, no deviations were seen in projection of the metatarsals; five feet had slight lateral or medial deviation of the metatarsal and two had plantar deviation of the metatarsal. No differences in axis were seen between the 3-month and last followups for this study (Fig. 6).

The mean postoperative gain in length was 13 mm (SD, 1.1 mm; range, 10–15 mm), and the mean percentage increase was 23%. The mean gain in length at the 3-month and last followups was 13 mm (SD, 1.0 mm), and the mean percentage increase was 23%. In 36 cases, the metatarsal parabola was restored: the metatarsophalangeal joint of the affected metatarsal achieved the parabola and completed it. In five cases, the affected metatarsal was excessively short. Despite the 27% lengthening achieved, the metatarsal heads remained 4 mm (SD, 0.3 mm) shorter; the metatarsal parabola was not completely restored to avoid over

Fig. 6A–B (A) A preoperative dorsoplantar standing radiograph shows shortening of the fourth metatarsal and valgus deviation of the hallux of the left foot; the metatarsal parabola is interrupted. (B) Five years after surgery, the bone graft is completely fused, the metatarsal parabola is restored, and there is no axial deviation.

tensioning the soft tissues. The surgical scar was small and had almost disappeared within a few years.

The treatment was well tolerated by all patients. No intraoperative complications were encountered in the series. There were no superficial or deep infections or wire tract infections. None of the grafts resorbed and there were no late stress fractures, toe deformities, muscular complications about the interosseous release, neurovascular complications, and no obvious instances of excessive stretching of the soft tissues.

Discussion

Brachymetatarsia is a rare deformity that causes forefoot functional impairment and cosmetic problems, particularly in young women. Even if brachymetatarsia is manifest clinically from 4 years old, surgery is not performed in patients younger than 12 years because of the frequent absence of symptoms, to wait until bone growth is completed, and the difficulty with child management after surgery. Patients with brachymetatarsia who present with pain can be treated nonoperatively with medical insoles and drugs, such as antiinflammatories. When nonoperative treatment fails or patients request correction for aesthetic reasons, surgery is indicated. The most frequently used surgical techniques are gradual callus distraction by external fixator (callotaxis) and one-stage lengthening using autologous graft, although various disadvantages noted earlier have been reported. We questioned whether one-stage metatarsal lengthening by metatarsal homologous bone graft could lead to metatarsal healing, improve forefoot function, and restore metatarsal parabola.

We acknowledge several limitations of this study. The first is the absence of control subjects using other techniques, but we compared results of our technique with those reported in the literature. Second, we assessed healing on radiographs; CT and MRI are more reliable examinations but also are expensive. However, the healing status was assessed by two independent surgeons and agreement was 96%; the functional status of the patients suggested all grafts healed clinically. Finally, although not a limitation of the study per se, to perform the lengthening by homologous graft, a bone bank and patient agreement are necessary because of the risk of transmission of infection.

Our data suggest one-stage metatarsal lengthening using metatarsal homologous bone graft is a reliable technique to correct congenital brachymetatarsia (Table 1). Metatarsal gain in length may be less compared with that achieved by callotaxis [28], but it is enough to avoid graft site morbidity or axis deformities. Moreover, in our experience, neurovascular impairment and excessive stretching of the soft tissue can be avoided while obtaining a lengthening of 23% using a bone spreader that distracts the metatarsal osteotomy during the surgical procedure. One-stage metatarsal lengthening by bone interposition was first reported in 1969 by McGlamry and Cooper [22]; many authors treat brachymetatarsia by this method, but the current literature deals only with small series. The use of autologous metatarsal [3, 11, 14, 15, 24, 26], calcaneal [13, 30], tibial [1], and iliac crest [2, 6, 31] bone graft has been reported, and the major advantages are the short time needed to achieve bone union and the small surgical scar [6, 12, 14, 17, 20, 32, 38]. Despite these advantages, donor site morbidity

Table 1. Comparison of metatarsal lengthening between the literature and our study

Study	Number of patients/number of feet	Surgical technique	Functional and cosmetic results	Complications (treatment)
Marcinko et al. [19] (1984)	1/1	One-stage lengthening with bone Z-osteotomy	Good	No complications
Chairman et al. [5] (1985)	3/3	One-stage lengthening with autologous MTT bone graft	Good	Limitations in plantar and dorsiflexion
Tabak et al. [33] (1986)	1/1	One-stage lengthening with Z osteotomy and fixation with phalangeal forceps and K wire	Good	No complications
Nuzzo and Mueller [24] (1987)	1/1	One-stage lengthening with autologous MTT bone graft	Good	No complications
Hosokawa and Susuki [11] (1987)	1/2	One-stage lengthening with autologous MTT bone graft	Good	Restriction in ROM
Wakisaka et al. [37] (1988)	1/2	Callus distraction by unilateral external fixator	Good	No complications
Kashuk et al. [13] (1991)	3/3	One-stage lengthening with bone graft taken from calcaneus and from others MTT	Good	No complications
Frankel and Fleishman [9] (1991)	1/1	One-stage lengthening with autologous MTT bone graft	Good	No complications
Sinclair et al. [30] (1991)	1/1	Lengthening by Z-osteotomy using autogenous calcaneal bone graft and internal fixation.	Good	No complications
Beaupied et al. [3] (1991)	1/1	One-stage lengthening with autologous MTT bone graft	Good	Edema for 2 weeks, rotation of the second digit (derotational skinplasty 5 weeks later)
Rock et al. [26] (1993)	1/2	One-stage lengthening with autologous MTT bone graft	Good	No complications
Boike et al. [4] (1993)	1/1	Callus distraction by uniplanar external fixator	Good	No complications
Ferrandez et al. [7] (1993)	3/4	Callus distraction by uniplanar external fixator	Good	2 premature consolidations of the callus, 1 delay of skin healing, 2 episodes of osteoporosis
Magnan et al. [18] (1995)	7/19	1 metaphyseal osteotomy with gradual distraction, 1 one-stage lengthening with autologous iliac bone graft, 7 callus distraction by uniplanar external fixator	70% good	1 superficial pin tract infection, 1 irreducible MTF joint dislocation, 1 early fusion of the callus (osteotomy)
Alter et al. [1] (1995)	1/1	One-stage lengthening with a corticocancellaneus bone graft taken from the tibia	Good	No complications
Levine et al. [17] (1995)	3/6	Callus distraction by uniplanar external fixator	83.4% good	2 transfer metatarsalgias for a few months, 1 pain and stiffness of the MTF joint, 5 pin tract infections, 2 early healing (osteotomy), 1 nondisplaced stress fracture after removal of the fixator that healed with difficulties
Solomon and Blackledge [31] (1995)	1/1	One-stage lengthening with Z-osteotomy and screw fixation, and corticocancellaneus iliac bone graft, with soft tissue stretching with “finger-trap” technique 1 month before surgery	Good	No complications

Table 1. continued

Study	Number of patients/number of feet	Surgical technique	Functional and cosmetic results	Complications (treatment)
Fox [8] (1998)	6/6	Callus distraction by uniplanar external fixator	Good functional, poor cosmetic	1 malunion of the callus, 5 big scars, 2 pin tract infections
Robinson and Ouzounian [25] (1998)	1/2	Callus distraction by uniplanar external fixator	Good	Severe pain during distraction
Baek and Chung [2] (1998)	21/34	19 one-stage lengthening using iliac bone graft in 17 cases, and others MTT in 2 cases	Good, but 2 cases of pain	4 stiffness of MTF joint, 2 fractures of the bony union, 1 loss of fixation, 1 delayed union, 1 nonunion.
Masada et al. [20] (1999)	4/6	Callus distraction by uniplanar external fixator	Good cosmetic; decrease in movement in MTF joint	3 superficial pin tract infections, 6 restriction of MTF movements, 2 medial angulations
Choi et al. [6] (1999)	(1) 10/15	One-stage lengthening with autologous iliac bone graft;	Good	2 stiffnesses of MTF joint; 1 stiffness of MTF joint, 1 pin tract infection
	(2) 5/9	Callus distraction by uniplanar external fixator		
Houshian et al. [12] (2002)	2/3	Callus distraction by uniplanar external fixator	Good	No complications
Song et al. [32] (2003)	16/22	Callus distraction by uniplanar external fixator	59.1% excellent, 36.4% good, 4.54% poor	5 partial or total stiffnesses of MTF joint (especially in lengthening more than 40%), 3 angular deformities, 2 pin tract infections
Kim et al. [14] (2003)	12/35	7 one-stage lengthening with autologous MTT bone graft	10 excellent (5 one-stage, 3 callus, 2 shortening), 6 good (1 one-stage, 5 callus), 2 fair (callus)	One-stage group: cartilage erosion of a metatarsal head, 1 pseudarthrosis (second graft) Callus group: 1 fracture of the callus (immobilization)
		20 callus distraction		
		8 MTT shortening		
Kim et al. [15] (2004)	5/12	One-stage lengthening with autologous MTT bone graft.	Good	No complications
Yamada et al. [39] (2005)	1/2	Callus distraction by internal fixator on the MTT bones	Good	Fracture of the callus 6 month after surgery
Shim and Park [29] (2006)	17/39	Callus distraction by uniplanar external fixator	94% good; 1 no satisfactory lengthening	23% MTF joint subluxation or stiffness (plantar capsulotomy), 1 pin tract infection, 1 intraoperative callus fracture (graft from fibula)
Wilusz et al. [38] (2007)	4/5	Callus distraction by uniplanar external fixator; percutaneous osteotomy performed in the proximal metaphyseal bone and placement of two pins into the cuboid	3/4 good	Joint stiffness, 1 dislocation of MTF joint (correction), 3 flexion deformities (flexor tenotomy), 3 callus fractures (immobilization), 4 angulations, 2 reoperations
Current study	29/50	One-stage lengthening with homologous MTT bone graft	Good function, excellent radiography and cosmesis	No complications

MTT = metatarsal; MTF = metatarsophalangeal.

should be considered. In addition, when a metatarsal autograft is used, it is difficult to regain the metatarsal parabola owing to the limited length of the graft. Also, when corticocancellous bone is used, there is a risk of graft collapse or implant instability. Gradual metatarsal lengthening with an external fixator is a widely used method with many reported advantages, such as simultaneous bone and soft tissue lengthening to minimize the stress of the soft tissues, especially the neurovascular ones, and the possibility of stopping the lengthening when the metatarsal regains the proper length [4, 8, 9, 12, 17, 18, 21, 25, 29, 32, 36–39]. The need to control the distraction and pin tract dressings requires several checks during treatment [12, 32]. The implant can be removed 1 month after bone healing is radiographically evident and this may take as much as 3 months [28]. The presence of the external fixator, management of the distraction, and frequent redressing can create emotional and psychological problems for the patients [6]. The long time for bone healing, hypertrophic surgical scar, pin tract infections in as much as 21% of cases, premature consolidation of the callus, pain during distraction, callus fracture, stiffness of the metatarsophalangeal joint with decrease in movement, dislocation and subluxation of the metatarsophalangeal joint, toe flexion deformity, and angular and medial deviation of the treated metatarsal have been reported [7, 8, 17, 20, 25, 32, 35, 38, 39]. In correcting brachymetatarsia, young women want to avoid inconvenience and emotional and psychological problems concerning the duration of the treatment, management, limitations, justification to other people, and surgical scar. One-stage metatarsal lengthening is a procedure that is well tolerated, especially by young women, because during the treatment they are not limited in their everyday lives (walking, the presence of a bulky dressing), they do not have to manage pins as they would with external fixators, and the treatment is rapid. After this technique, patients can wear any kind of shoe and walk normally in only 5 weeks, and the surgical scar is tolerable because it is a single, small scar that almost disappears within a few years.

The foot function was restored, as suggested by the AOFAS score. We recommend correction of other toe deformities because regaining correct alignment of the other rays facilitates alignment of the involved toe. Redistribution of the pressure of the metatarsal heads after surgery was observed clinically with the reduction or disappearance of the transfer metatarsalgia pain and the plantar calluses. The metatarsal parabola can be restored using this technique although the parabola was not completely restored in patients with a very short affected metatarsal who had substantial intraoperative lengthening of the metatarsal. One-stage metatarsal lengthening using interposition of homologous bone graft corrected the

congenital brachymetatarsia, with low morbidity, limited complications, short recovery times, restored forefoot anatomy, and high functional scores.

Acknowledgments We thank Graham Baxendale for revising the manuscript.

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