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Gradual Correction of Traumatic Hallux Varus With Metatarsal Hemicallotasis

Hayato Kobayashi, MD, PhD [1], Yasunori Kageyama, MD, PhD [2], Yoji Shido, MD, PhD [3]

[1] Department of Orthopaedic Surgery, Fujieda Heisei Memorial Hospital, Shizuoka, Japan
[2] Department of Orthopaedic Surgery, Hamamatsu Minami Hospital, Shizuoka, Japan
[3] Department of Orthopaedic Surgery, Hamamatsu University School of Medicine, Shizuoka, Japan

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ABSTRACT

Traumatic hallux varus associated with osseous deformity, especially in the case of a decreased distal metatarsal articular angle, is an extremely challenging, but rewarding, deformity to treat. To the best of our knowledge, no previous reports have referred to surgical correction of traumatic hallux varus using first metatarsal hemicallotasis. We report the case of a 54-year-old male with traumatic hallux varus associated with medial subluxation of the second metatarsophalangeal joint and second metatarsocuneiform joint arthrosis. The patient was successfully treated with metatarsal hemicallotasis with medial soft tissue release, a proximal second metatarsal shortening osteotomy, and second metatarsocuneiform joint arthrodesis. After 1 year and 6 months, the correction had been maintained in a suitable position, no discomfort or pain was present, and the patient was completely satisfied with the surgical results. Metatarsal hemicallotasis can safely determine the angle of correction and minimize the risk of avascular necrosis of the metatarsal head even in deformed halluces with previous traumatic injuries and/or surgical treatment. This technique should be indicated only for hallux varus with a decreased distal metatarsal articular angle, an angular-type metatarsal head, and good metatarsophalangeal joint congruence.

Hallux varus is a deformity, either congenital or acquired, characterized by medial deviation of the great toe at the first metatarsophalangeal (MTP) and/or interphalangeal (IP) joints (1). Hallux varus is usually a postoperative complication after correction of hallux valgus (2,3). Other causes have included congenital (4–7) or idiopathic (2,8) defects, inflammatory arthritis (2,4,9), trauma (2,3,10,11), poliomyelitis (12), Charcot-Marie-Tooth disease (13), avascular necrosis (14), and contractures due to burns (15). Of these etiologies, traumatic hallux varus associated with osseous deformity, especially in the case of a decreased distal metatarsal articular angle (DMAA), is an extremely challenging, but rewarding, deformity to treat.

Hemicallotasis is the continuous, asymmetric callus distraction of the metaphysis and is commonly used to correct proximal tibial deformities for medial gonarthrosis (16–18). This technique has been less commonly applied in the distal femur (16,19), distal radius (20), proximal fifth metacarpal (21), or calcaneus (22). However, to the best of our knowledge, no previous reports have referred to surgical correction of traumatic hallux varus using first metatarsal hemicallotasis.

We report the case of a 54-year-old male with traumatic hallux varus associated with medial subluxation of the second MTP joint and second metatarsocuneiform joint arthrosis. This represents the first report of a debilitating hallux deformity successfully treated with metatarsal hemicallotasis and concomitant procedures.

Case Report

A 54-year-old male presented to our outpatient clinic with a chief complaint of a painful right great toe. He was also experiencing insidious pain on the dorsal aspect of the midfoot when he wore rubber boots. He had had an open type 3b injury of the distal one third of his right first metatarsal in a motor vehicle collision at the age of 23 years, for which the initial treatments had included wound debridement and removal of the fracture fragments by a local physician. Subsequently, he was transferred to a university hospital, where he received cross pin fixation, followed by a full-thickness free-skin graft obtained from the groin. Gradual contraction of the hallux with progressive medial deviation had been noted over a period of time after complete bone healing. Although he had been

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Address correspondence to: Hayato Kobayashi, MD, PhD, Department of Orthopaedic Surgery, Fujieda Heisei Memorial Hospital, 123-1 Mizukami, Fujieda, Shizuoka 426-8662 Japan.
E-mail address: heisei.kobayasi@ny.tokai.or.jp (H. Kobayashi).

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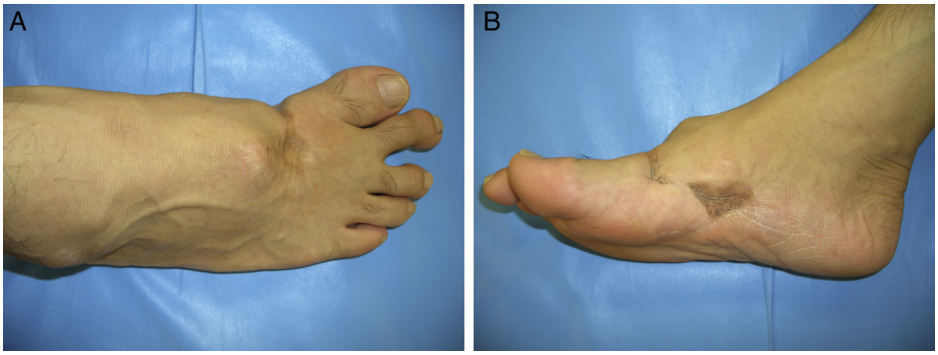

Fig. 1. (*A* and *B*) Preoperative clinical photographs showing medial deviation of the hallux and the second toe. Note the skin graft scars over the dorsomedial aspect of the forefoot.

treated conservatively by several local physicians, his symptoms had not improved.

The physical examination revealed a nonreducible medial deviation of the hallux without adequate purchase (Fig. 1). However, the characteristic "cock-up" deformity—often caused by flexion contracture of the IP joint—was not observed. Skin graft scars were noted over the dorsomedial aspect of the forefoot. He had a painful protuberance over the dorsal aspect of the midfoot that made wearing shoes difficult and painful. However, the patient did not express any discomfort around the second or third metatarsal head, and no plantar callosities were seen. He had no relevant family or other medical history, except for the previous fracture treatment. The blood laboratory results were reported as normal. He mentioned that he had quit smoking cigars 6 years earlier and had been consuming 2 to 3 beers every day for an unknown period.

The anteroposterior right foot radiograph showed a clinically significant deformity and shortening of the first metatarsal. The first metatarsal ended approximately 22 mm proximal to the second metatarsal head. The radiograph also revealed medial subluxation of the second MTP joint. On the lateral weightbearing radiograph, we observed a hyperostotic bone reaction (i.e., degenerative arthritis) on the dorsal aspect of the second metatarsocuneiform joint that had probably been induced by the relatively long second ray (Fig. 2). The left foot did not exhibit any abnormalities.

Surgical correction was indicated for the right foot. The goal of the procedure was to correct the deformity and maintain the first MTP and IP joint motion. If this could not be achieved, arthrodesis would be required at a later date. The initial surgery consisted of medial soft tissue release, distal first metatarsal incomplete osteotomy, a proximal second metatarsal shortening osteotomy, temporary pin fixation of the second ray, and second metatarsocuneiform joint arthrodesis (Fig. 3). For hemicallotasis, the lateral cortex of the first metatarsal was preserved with care to act as a hinge. Next, a short MiniRail™ lengthener (Orthofix, McKinney, TX), accommodating 3-mm shaft diameter bone screws, was applied for hemicallotasis of the first metatarsal. An optional T-clamp was attached for the insertion of the screws close to the joint, in a plane at a right angle to the longitudinal axis. The distal fixator screws were placed parallel to the joint surface to reduce abnormal joint inclination during gradual distraction. The shortened first metatarsal could not accommodate both fixator clamps, even when the fixator was set at its shortest length. Therefore, the proximal fixator screws were placed in both the metatarsal and the medial cuneiform (i.e., joint bridging). The contracted extensor hallucis longus and brevis were left untouched.

After surgery, the patient's leg was kept non-weightbearing using crutches. Continuous callus distraction began after a latency period of 15 days at a rate of 0.125 mm every 12 hours (i.e., 0.25 mm/day). At 3 weeks, the temporary pin was removed, and heel walking was initiated as tolerated. At 7 weeks, the radiographs indicated that an approximately 9-mm asymmetric distraction had been accomplished; therefore, the lengthening was stopped. It was thought that additional distraction would increase the risk of iatrogenic avascular necrosis of the metatarsal head and subsequent nonunion. Because of poor callus formation in the distraction gap, supplemental internal fixation, which had not been initially planned, was administered at 9 weeks postoperatively to avoid correction loss or fracture (Fig. 4). The patient underwent physiotherapy and low-intensity pulsed ultrasound to accelerate callus maturation 13 weeks after the intervention until full weightbearing of the hallux was permitted. At 15 weeks, consolidation of the hemicallotasis site was confirmed, and the external fixator was

Fig. 2. Preoperative (*A*) anteroposterior and (*B*) lateral weightbearing radiographs of the foot. Note the decreased distal metatarsal articular angle, angular-type metatarsal head, and good first metatarsophalangeal joint congruence. The hyperostotic bone reaction protruding from the second metatarsocuneiform joint made wearing shoes difficult and painful.

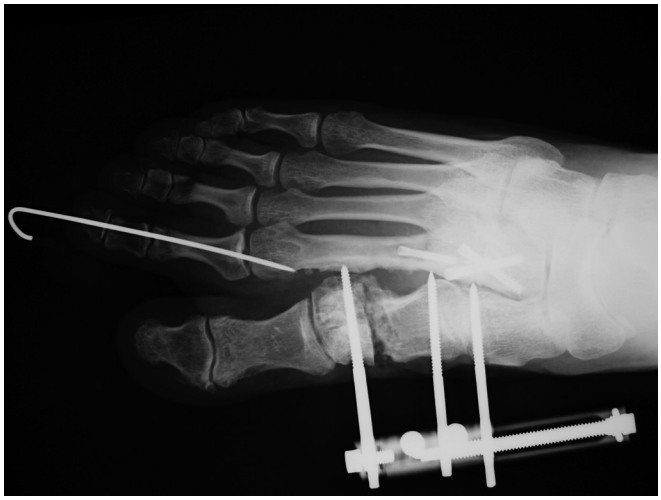

Fig. 3. Anteroposterior radiograph taken immediately after surgery showing distal first metatarsal incomplete osteotomy concomitant with medial soft tissue release, proximal second metatarsal shortening osteotomy, temporary pin fixation of the second ray, and second metatarsocuneiform joint arthrodesis.

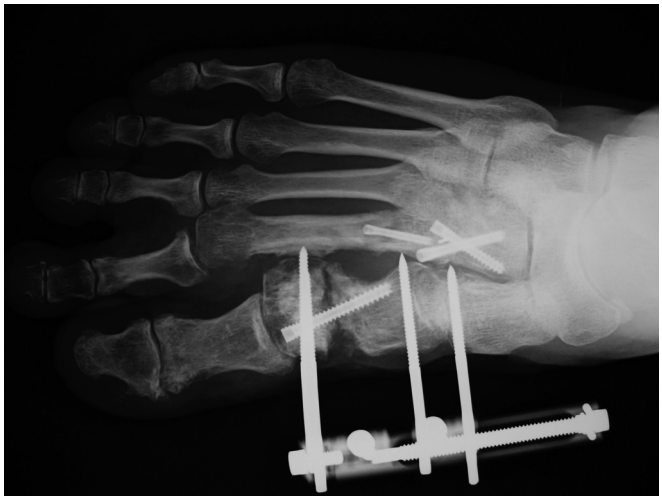

Fig. 4. Anteroposterior radiograph taken 9 weeks after the surgery. Note the poor callus formation of the hemicallotasis site and supplemental internal fixation.

removed. Lateral translation of the distal osteotomy fragment had not occurred during hemicallotasis. His recovery was uneventful, and the patient was able to return to his farm work soon after hardware removal.

Contracture of the first MTP and IP joint did not worsen throughout the treatment period. The preoperative plantar flexion and dorsiflexion angles of the first MTP joint were both 5°, and at the most recent follow-up examination, the corresponding values were 5° and 10°. Similarly, the preoperative plantar flexion and dorsiflexion angle of the first IP joint was 10° and 15°, respectively, and both were 10° postoperatively. Radiographic measurements revealed that the preoperative hallux valgus angle and DMAA was −18° and 61°, respectively. The corresponding postoperative values were −9° and 78°.

After 1 year and 6 months, the correction had been maintained in a suitable position (Figs. 5 and 6), no discomfort or pain was present, and the patient was completely satisfied with the surgical results.

Discussion

Hallux varus, either congenital or acquired, has been reported extensively in podiatric and orthopedic studies. Vanore et al (1) published a clinical practice guideline for the diagnosis and treatment of hallux varus. This guideline is very inclusive and also provides a classification schema. Three types of deformities were proposed, based on which various treatment strategies were discussed. More recently, Devos Bevernage and Leemrijse (23) proposed a treatment algorithm that focused on iatrogenic hallux varus occurring after bunion surgery. The first elements to consider are the mobility and flexibility of the first MTP joint, followed by evaluation of the IP joint and radiographic evaluation. They stated that the treatment should be aimed at the initial deforming force, the abductor hallucis (23).

Although acquired hallux varus is most often seen after bunion surgery, trauma can also be a cause (2,3,10,11). Traumatic injuries that disrupt the lateral stabilizing structure (e.g., adductor hallucis or lateral head of the flexor hallucis brevis) can lead to MTP joint instability, resulting in medial deviation of the hallux. Skalley and Myerson (2) reported 3 cases of traumatic hallux varus, with 1 progressing to degenerative arthritis. Myerson and Komenda (3) devised an extensor hallucis brevis tenodesis procedure and obtained good results for hallux varus that developed after bunion surgery and for traumatic dislocation. Hunter and Wasiak (10) described a split-width extensor tenodesis technique to treat traumatic hallux varus that developed 3 months after a McBride bunionectomy. Labovitz and Kaczander (11) reported a case of traumatic hallux varus secondary to rupture of the adductor tendon. They used a Mitek suture anchor to tighten the lateral aspect of the first MTP joint capsule. With respect to post-traumatic causes, Saraiya (15) reported a unique case of post-burn hallux varus that was successfully treated with medial soft tissue release, MTP joint arthrodesis, MTP joint capsulorrhaphy, and

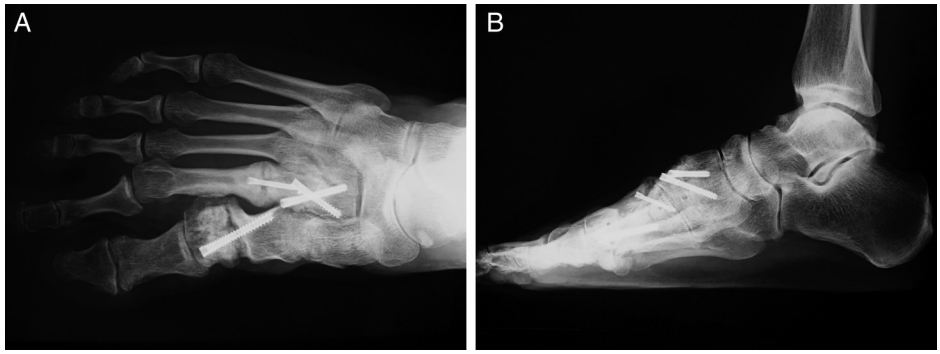

Fig. 5. (*A*) Anteroposterior and (*B*) lateral weightbearing radiographs taken 1 year and 6 months after surgery showing consolidation of both the hemicallotasis and the arthrodesis sites. Note that the hallux and the second metatarsophalangeal joint are realigned in a more suitable position.

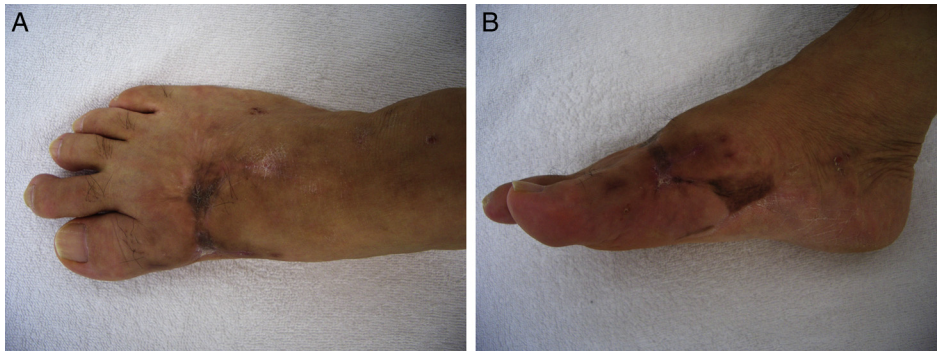

Fig. 6. (*A* and *B*) Clinical photographs taken 1 year and 6 months after surgery revealing a better aligned forefoot.

coverage of the skin defect with Z-plasty and a split-thickness skin graft.

For osseous correction of hallux varus, reverse Reverdin-type procedures can be used to correct an abnormal DMAA; other osseous deformities of the proximal phalanx can be addressed by an Akin or a reverse Akin osteotomy (24,25). However, these closing wedge osteotomies, which inevitably shorten the bone length, are contraindicated for congenital hallux varus with brachymetatarsia (6,7).

The hemicallotasis technique was established by Pennig et al (20), Pennig and Baranowski (26), and O'Dwyer et al (27) for gradual correction of genu recurvatum and genu varum. This technique has been well discussed for high tibial osteotomy (16–18), which corrects varus deformities, to relieve the abnormal mechanical stress exerted on the articular cartilage (28). However, because of the long-term application and the limited indication for the external fixator, few reports have discussed this technique, except for proximally at the tibial region (16,19–22). Hankemeier et al (19) described femoral hemicallotasis with a half segment for the reconstruction of a 6-cm partial cortical defect that had resulted from post-traumatic osteitis. Pennig et al (20) devised a new external fixator with a double-ball joint and distraction module to correct malunited distal radius fractures. According to their report, 8 patients with distal radius malunion were treated with single-stage correction (all 3-dimensional) combined with a corticocancellous bone graft and 6 with gradual correction using hemicallotasis at the rate of 2 mm/day. Kawabata et al (21) reported a case of congenital synostosis of the fourth and fifth metacarpals. Lengthening and correction of the metacarpal were achieved simultaneously by way of fifth metacarpal hemicallotasis at the rate of 0.5 mm/day. Magnan et al (22) performed a subtalar osteotomy-callotasis in the case of malunion of a calcaneus fracture with horizontal collapse. They succeeded in elevating and correcting the varus deformity of the intact articular surface with distraction using an external minifixator without apposition of bone grafts.

The optimum distraction rates for better regeneration in metatarsal lengthening have been reported to be 0.35 to 1 mm/day (7,29,30). Gilbody and Nayagam (30) recommended restricting the distraction rate to no more than 0.5 mm/day in pediatric cases. In contrast, our patient was 54 years old with previous traumatic and surgical insults. Thus, we chose a distraction rate of 0.25 mm/day (2×0.125 mm/day) for metatarsal hemicallotasis, which we believed to be the minimum distraction rate, as described in published studies (7,29,30), and the application of low-intensity pulsed ultrasound to promote consolidation. Thus, the duration of external fixation for our patient was 102 days, and the external fixation index was 113 days/cm. One of the major demerits of this lower distraction rate is a longer period of application of the external fixator. However, the method we have described can safely determine the angle of correction and minimizes the risk of avascular necrosis of the metatarsal head, even in deformed halluces with previous traumatic injuries and/or surgical treatment. Most importantly, metatarsal hemicallotasis should be indicated only for hallux varus with a decreased DMAA, an angular-type metatarsal head, and good first MTP joint congruence. This technique is not recommended for 2- or 3-dimensional correction of deformities.

In conclusion, we have reported a rare case of traumatic hallux varus that was associated with medial subluxation of the second MTP joint and second metatarsocuneiform joint arthrosis. Our patient was successfully treated with metatarsal hemicallotasis and concomitant procedures. Our hemicallotasis technique eliminated the need for additional soft tissue procedures and promised excellent results after surgical intervention of his debilitating hallux varus deformities.

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