Lesser-Metatarsal Medial Displacement Osteotomy for the Treatment of Digital Transverse Plane Deformities

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We sought to evaluate the clinical and radiographic outcomes in patients treated with a medial displacement transverse osteotomy of the second metatarsal to correct transverse hammer toe deformities. Eighteen patients underwent 20 procedures in 3 years. Each patient had a transverse plane deformity of the second metatarsophalangeal joint. Evaluation consisted of clinical examination, radiographic examination, and self-reported pain and function parameters. Mean ± SD follow-up was 2.5 ± 1.0 years. Radiographic joint congruence improved from 20% before surgery to 95% after surgery. Clinical examination revealed a rectus digit in 85% of cases, a transverse plane deviation in 10%, and a residual hammer toe deformity in 5%. At follow-up, the mean ± SD visual analog scale score for pain with activity was 2.2 ± 2.8 and for pain at rest was 0.6 ± 1.4. Ninety-five percent of the patients said that they would undergo the procedure again. Medial displacement osteotomy for transverse plane deformity of the second metatarsophalangeal joint is a reliable procedure, with substantial improvement in joint congruence and self-reported pain. (J Am Podiatr Med Assoc 95(6): 550-555, 2005)

Transverse plane deformities of the lesser toes are a common clinical entity with a wide array of surgical treatment options. Subluxation and dislocation of the second metatarsophalangeal joint is a relatively common occurrence.[1] Few procedures, however, address the transverse plane component of this deformity. This transverse plane deformity is adduction of the second toe at the metatarsophalangeal joint. This joint is thought to be the most commonly dislocated joint in the foot.[2,3] DuVries[4] noted that nontraumatic dislocation of the second toe is the most common static complete dislocation of the foot. A medial displacement osteotomy of the second metatarsal can reduce such a deformity.

Many surgical procedures have been described to correct deformities of the lesser digits as a result of chronic subluxation at the metatarsophalangeal joint. Osteotomy of the second metatarsal is required when reduction of the deformity at the second metatarsophalangeal joint is unobtainable after stepwise soft-tissue release.[5] Our literature review en-

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countered sparse research on the correction of lesser-digital transverse plane deformities. This deformity most often involves medial deviation of the second toe at the level of the metatarsophalangeal joint, and it has been referred to as *crossover toe deformity*. The clinical entity that precedes this deformity is commonly referred to as *predislocation syndrome* (Fig. 1).[1, 6-10] Similar procedures were described by Bogy et al[11] in 1992 and by Goforth and Urteaga[12] in 1996, but they lack a large enough population and a long enough follow-up period to provide reliable long-term results.

Etiology

Authors who have addressed medial crossover toe deformity agree on several of the contributing factors.[6, 13, 14] A long second ray results in increased pressure on the toe from shoes or stockings. This causes buckling of the toe, and the proximal phalanx rides dorsally on the metatarsal head. The longer the duration of deformity, the more adaptation of the surrounding tissue that occurs with contracture of the dorsal structures. Distention and degeneration of the plantar metatarsophalangeal joint structures also occurs in chronic deformities. During ambulation, all of the forces across the metatarsophalangeal joint tend to hyperextend the joint; this, accompanied by the medial pull of the long flexor tendon, may cause the toe to subluxate in a dorsomedial direction. Marked hallux valgus, causing the hallux to abut the second toe, contributes to the deformity. Most patients with crossover toe deformity exhibit close proximity of the second and third metatarsals, and this crowding may contribute to second toe medial deviation away from the crowded third toe toward the more distant first toe. Inflammatory conditions, such as rheumatoid arthritis, psoriatic arthritis, Reiter's syndrome, and nonspecific synovial disorders, can lead to synovial weakening and eventually to joint instability. Any neuromuscular disorder that results in clawing of the digits, such as diabetic peripheral neuropathy, Charcot-Marie-Tooth disease, poliomyelitis, Friedreich's ataxia, and lumbar disk disease, can cause metatarsophalangeal joint subluxation.



Figure 1. Clinical view of a foot depicting early medial crossover second toe deformity.

Methods

We evaluated a cohort of 18 patients (mean age, 63 years) who underwent 20 surgical procedures. The surgeries were performed between 1997 and 2000. The mean ± SD time from surgery to follow-up examination and radiography was 2.5 ± 1.0 years (range, 9 months to 4.2 years). The right foot was affected in 15 of the 20 procedures. All but two patients were women.

Preoperative anteroposterior and lateral radiographs (Fig. 2) were compared with postoperative radiographs (Fig. 3) by a radiologist (D.K.M.) to evaluate the following five parameters: the angle of the proximal phalanx to the weightbearing surface on the lateral view, the angle of the proximal phalanx to the bisection of the metatarsal on the anteroposterior view, joint congruence on the anteroposterior view as illustrated by Gerbert et al[15] (Fig. 4), the length of the metatarsal parabola on the anteroposterior view, and the appearance of avascular necrosis. A postoperative clinical examination evaluated the clinical appearance of the toe, the presence of pain with active and passive range of motion, and the ability of the digit to purchase the ground while standing. A patient questionnaire was completed by each patient to assess pain and functional status. Radiographic results were assessed statistically using the McNemar test for correlated proportions, and the changes in measurements were assessed using the paired *t*-test. Physical examination findings and patient questionnaire results were summarized using standard descriptive statistics. A statistically significant difference is indicated by $P < .05$.

The procedure as currently performed begins with a resection arthroplasty at the proximal interphalangeal joint of the second toe through a longitudinal dorsal sigmoid incision. When this did not adequately reduce the deformity, the long extensor tendon and hood apparatus were released. If further reduction was required, the metatarsophalangeal joint capsule was transected dorsally, and a McGlamry elevator was used to free the capsule from the metatarsal





Figure 2. A, Preoperative anteroposterior radiograph depicting transverse plane second toe deformity; B, preoperative lateral radiograph depicting sagittal plane second toe deformity.

head circumferentially. At this point, the foot was loaded plantarly to simulate weightbearing to assess reduction in deformity. If the sagittal plane deformity was corrected but a transverse plane adduction deformity was still present, a medial displacement osteotomy at the second metatarsal head was then performed. A bone saw was used to initiate the cut dorsally at the proximal edge and parallel to the cartilaginous margin, progressing downward and proximally through the metatarsal head to exit just proximal to the plantar condyle at the head and neck junction. Fixation was accomplished after medial displacement of the head by using single 2-mm screw fixation from dorsal proximal lateral to plantar distal medial. In cases in which a Kirschner wire was used for stabilization, it was not driven across the metatarsophalangeal joint. The long extensor tendon was reattached, and deep tissues were closed with absorbable sutures. The skin was closed with intradermal absorbable sutures and was dressed with compressive dressings. Patients were allowed to walk in a postoperative shoe as required for self-care. Only





Figure 3. A, Postoperative anteroposterior radiograph showing reduced transverse plane second toe deformity; B, postoperative lateral radiograph showing reduced sagittal plane second toe deformity.

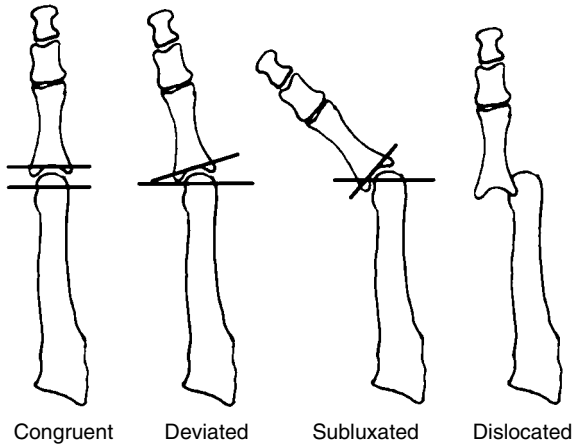


Figure 4. Four levels of joint integrity. Congruent is defined as parallel articular cartilages of the phalangeal base and the metatarsal head; deviated, the lines of cartilage of the second metatarsophalangeal joint intersect but outside of the joint space; subluxated, the lines of cartilage of the second metatarsophalangeal joint intersect within the joint space; and dislocated, complete dissociation of the articular surface.

feet that required all of these surgical steps were included in this study.

Results

Clinical evaluation revealed that 85% of the feet had a rectus digit, 10% had a transverse plane deviation, and 5% had a residual hammer toe deformity. Ninety-five percent of the cases had pain-free active and passive range of motion. In 65% of the cases, patients could purchase the ground with enough resistance to hold a small piece of paper beneath the toe while standing (Table 1).

Table 1. Clinical Outcomes

Outcome	Cases (No. [%]) (N = 20)
Clinical appearance of the toe	
Transverse deviation of lesser digit	2 (10)
Hammer toe	1 (5)
Rectus toe	17 (85)
Pain-free ROM of the metatarsophalangeal joint after surgery	
Passive ROM[a]	19 (95)
Active ROM[a]	19 (95)
Purchase of the lesser digit while standing in the neutral position	13 (65)

Abbreviation: ROM, range of motion.
[a]One patient had pain with plantarflexion.

After surgery, the patient questionnaires revealed that mean ± SD self-reported patient satisfaction was 8.4 ± 2.7 (0 = very unsatisfied and 10 = very satisfied). Mean ± SD pain at the surgical site with activity and at rest using a visual analog scale was 2.2 ± 2.8 and 0.6 ± 1.4, respectively. In 95% of cases, the patients would have the same procedure performed again (Table 2).

Radiographic evaluations revealed a statistically significant improvement in the angle formed by the proximal phalanx and the weightbearing surface on the lateral view and in the angle formed by the proximal phalanx and the bisection of the lesser metatarsal on the anteroposterior view (Table 3). The dorsiflexion angle of the second toe proximal phalanx was reduced by a statistically significant amount. There was a statistically significant improvement in the proportion of cases with a congruent metatarsophalangeal joint at follow-up compared with before surgery (20% before surgery *versus* 95% after surgery; $P < .0001$). After surgery, 19 of the 20 joints that underwent surgery were congruent. Second metatarsal

Table 2. Patient Questionnaire

VAS score for satisfaction with digital surgery (mean ± SD)	8.4 ± 2.7
0–2 (very unsatisfied)	1 (5)
3–4	1 (5)
5–6	1 (5)
7–8	4 (20)
9–10 (very satisfied)	13 (65)
VAS score for pain with activity since surgery (mean ± SD)	2.2 ± 2.8
0–2 (no pain)	13 (65)
3–4	2 (10)
5–6	2 (10)
7–8	3 (15)
9–10 (severe pain)	0
VAS score for pain at rest since surgery (mean ± SD)	0.6 ± 1.4
0–2 (no pain)	18 (90)
3–4	1 (5)
5–6	1 (5)
7–8	0
9–10 (severe pain)	0
Would you have the same procedure again?	19 (95)
Does the surgical procedure limit daily activities?	2 (10)
Painful toes	0
Shoes do not fit correctly	0
Other	2 (10)

Abbreviation: VAS, visual analog scale.
Note: Data are given as number (percentage) of procedures, except where indicated otherwise.

Table 3. Radiographic Outcomes

Outcome	Preoperative	Postoperative	*P* Value
Angle of ≤10° between the proximal phalanx of the second toe and the floor on the lateral weightbearing radiograph (No. [%])	6 (30)	14 (70)	<.01
Angle formed by the bisection of the proximal phalanx of the second toe and the bisection of the second metatarsal in an anteroposterior weightbearing radiograph (mean ± SD) (°)	10.9 ± 6.8	7.7 ± 5.5	<.01
Joint congruence (No. [%])			
Congruence	4 (20)	19 (95)	<.0001
Subluxation	16 (80)	1 (5)	
Dislocation	0	0	
Protrusion of the second metatarsal beyond the first on the weightbearing anteroposterior radiograph (mean ± SD) (mm)	5.5 ± 3.7	4.6 ± 3.1	.10

protrusion showed no statistically significant changes (Table 3). No evidence of avascular necrosis was identified.

Discussion

Johnson and Price[16] reported excellent results in a case report of a patient who had a displacement osteotomy for the correction of medial crossover second toe without mention of length of follow-up. The results of this case series demonstrate good long-term correction of deformity and pain relief with a transverse plane metatarsal osteotomy. Previous cohort studies have included small groups with short follow-up periods. For example, Bogy et al[11] reported a series of eight procedures on overlapping second toes with an average follow-up of 3 years. Although six of the seven patients were interviewed by telephone, only four feet were examined after surgery. All of the patients had been treated using Kirschner wire fixation after osteotomy using a rongeur. Only two of the four digits that were examined after surgery had normal range of motion. Abnormal juxtaposition of the lesser-metatarsal heads in the transverse plane was identified as a possible contributing factor to this deformity. This entity has not been well described in the literature, and we believe that it plays a role in the development of the deformity, much in the same manner that medial deviation of the first metatarsal is seen in hallux abducto valgus. Goforth and Urteaga[12] reported ten procedures with an average follow-up of 1.7 years (20.3 months). Only nine of these procedures involved the second metatarsal, and five were fixated using Kirschner wires, leaving only five with screw fixation as described here. Examination of the ten feet revealed that the three toes without good purchase power had not had aggressive postoperative range-of-motion exercises like the others.

Because the dorsal skin and corrective tissue scar tend to contract, it is believed that teaching the patient to perform plantarflexion stretching exercises is important in obtaining appropriate purchase of the weightbearing surface. The one dissatisfied patient seemed to represent this failure and did not have adequate purchase at recall. The long-term results of the lesser-metatarsal medial displacement osteotomy with screw fixation indicate that it is a reliable surgical procedure with favorable outcomes in the treatment of transverse plane deformities.

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