Outcome of Distal First Metatarsal Osteotomy Shortening in Hallux Rigidus Grades II and III

Paolo Ceccarini, MD1, Alfredo Ceccarini, MD1, Giuseppe Rinonapoli, MD1, and Auro Caraffa, MD1

Abstract

Background: Existing techniques for operative treatment of hallux rigidus commonly combine skeletal and soft tissue interventions to obtain long-lasting relief of pain. To date, operative treatments include implant arthroplasty, cheilectomy, various osteotomies, nonimplant arthroplasty, and arthrodesis. We assessed a technique that respects the anatomy and joint function and used a shortening osteotomy of the head of the first metatarsal.

Methods: We evaluated a series of 40 consecutive patients affected by grade II and III hallux rigidus, aged 32 to 79 years, who had undergone surgery from January 2010 to January 2014. All patients were evaluated clinically and radiographically, preoperatively and postoperatively, and underwent a final follow-up at a mean of 35.4 (range = 12-51) months. For the clinical evaluation, the American Orthopaedic Foot & Ankle Society (AOFAS) clinical rating scale for the hallux metatarsophalangeal-interphalangeal joints was used.

Results: A patient survey revealed excellent and good overall satisfaction in 90% of the sample. Postoperative results included a significant increase (P < .001) in the median global AOFAS score, from 39 (range = 25-60) to 84 (range = 78-94).

Conclusions: The technique of a shortening osteotomy of the first metatarsal head appeared to be useful for the correction of stiffness, pain relief, and an improvement in range of motion. Other advantages were that it preserved the integrity of the metatarsophalangeal joint and led to a rapid functional recovery.

Level of evidence: Level IV, retrospective case series.

Keywords: forefoot surgery, hallux rigidus, metatarsal osteotomy

Introduction

Hallux rigidus is a common affliction of the first metatarsophalangeal joint (MTPJ), defined as degenerative osteoarthritis of the first MTPJ that results in pain and decreased range of motion (ROM), primarily dorsiflexion (DF).1,2,5,9,14,21 The treatment of hallux rigidus with distal first metatarsal osteotomy has been advocated for many years. Many osteotomies have been described in the literature; the procedure that the authors use most often is that by Youngswick.22 Specifically, this type of osteotomy is performed from dorsal-distal to plantar-proximal, with an angle ranging from 70 to 90 degrees in the sagittal plane. A second proximal osteotomy is made dorsal and parallel to the first dorsal cut. The interposing piece of bone is removed, and the head fragment is plantarflexed and fixed with 1 screw.7,13

In 2003, Coughlin and Shurnas published a classification for hallux rigidus based on the ROM as well as radiographic and clinical findings.3,4

In grade 0, DF of the first MTPJ is between 40 and 60 degrees (20% loss of normal motion), and there are normal radiographic results without pain.

In grade I, DF is between 30 and 40 degrees, and there are dorsal osteophytes along with minimal joint space narrowing.

In grade II, DF is between 10 and 30 degrees, there are dorsal, lateral, and/or medial osteophytes, a mild flattening of the MTPJ, and a mild to moderate joint narrowing or sclerosis.

In grade III, DF is less than 10 degrees, whereas plantarflexion (PF) is often less than 10 degrees, and

1Department of Orthopaedics and Traumatology, S.M. Misericordia Hospital, University of Perugia, Perugia, Italy

Corresponding Author:
Paolo Ceccarini, XX, Department of Orthopaedics and Traumatology, S.M. Misericordia Hospital, University of Perugia, Perugia, Italy.
Email: paoloceccarini84@gmail.com
commonly there are severe radiographic changes, with cysts or erosions, hypertrophied or irregular sesamoids, a constant moderate to severe pain, and pain at the extremes of ROM.

Finally, in grade IV, there is a stiff joint on radiographs showing loose bodies or osteochondritis dissecans (OCD). Moreover, there is pain throughout the entire ROM.4

Presently, operative treatment for hallux rigidus include implant arthroplasty, cheilectomy, various osteotomies (ie, Hohmann, Regnauld/enclavement, plantarflexory), nonimplant arthroplasty (ie, Keller-Brandes, Mayo-Hueter), and arthrodesis.8,9,17 In particular, several metatarsal osteotomies have been described for the treatment of hallux rigidus.11,20

These procedures allow for decompression and realignment of the joint through axial shortening and plantar translation of the first metatarsal head-neck. Decompression of the joint occurs through shortening of the metatarsal head, thus decreasing stress while restored the motion as much as possible. Nevertheless, the role of the metatarsus primus elevatus in the pathogenesis of hallux rigidus has not been proven, and the surgical correction by distal first metatarsal osteotomy is still questionable.16 The operative treatment depends on the etiology and severity of the deformity. After using the first metatarsal shortening osteotomy for many years, we decided to review a retrospective series of patients. The purpose of this study was to evaluate the effectiveness of the distal triplanar shortening osteotomy of the first metatarsal to correct stage II and III hallux rigidus. Our main aims were to measure the grade of satisfaction of patients and the amount of correction.

Methods

From January 2010 to January 2014, a total of 40 consecutive patients retrospectively evaluated in our clinic and affected by grade II and III hallux rigidus underwent distal osteotomy shortening of the first metatarsal, performed by a senior surgeon.22

Twenty-eight of the 40 patients presented with grade III hallux rigidus but with more than 50% of the remaining articular cartilage, whereas the other 12 patients had grade II. The assessment of cartilage wear was done radiographically preoperatively and can be confirmed only intraoperatively. In this case series, all patients presented more than 50% of articular cartilage viable.

The assessment of cartilage wear was done radiographically and then confirmed intraoperatively. In 11 patients, hallux rigidus was associated with valgus deformity and in 6 of the 40 with a lateral toe deformity, all of which were treated simultaneously. Twenty-nine patients were female and 11 were male, 26 right side and 14 left side, and the mean age was 61 (range = 32-79). The mean follow-up was 35.6 (range = 12-51) months. None of the patients were lost during follow-up.

Clinical evaluation included scoring with the American Orthopaedic Foot & Ankle Society (AOFAS) clinical rating scale for the hallux metatarsophalangeal-interphalangeal joints, the passive DF of the first MTPJ was measured with a goniometer, preoperatively and postoperatively.10,12 At follow-up, a patient satisfaction survey was also performed. Patients were asked to rate their satisfaction according to their ability to wear everyday shoes and practice normal daily activities after surgery on a scale of 0 to 10, with 0 equating complete dissatisfaction and 10 excellent satisfaction (0-5 = poor, 6-7 = fair, 8-9 = good, 10 = excellent).

All patients were radiographically evaluated, preoperatively and postoperatively with anteroposterior and lateral weight-bearing radiographs, according to Coughlin and Shurnas3,4 (Table 1).

Statistical analysis

Nonparametric Wilcoxon test for paired data was used to compare scores before and after surgery. Statistical analysis was performed with IBM-SPSS software, version 22.0. We defined statistical significance at the 5% (P ≤ .05) level.

Operative Technique

After antibiotic prophylaxis and peripheral block anesthesia, patients were positioned supine on the operating table with a 250 mmHg tourniquet at their ankles. The first MTPJ was approached through a longitudinal medial skin incision, and the capsule was incised longitudinally and the dorsal and lateral osteophytes were removed.

Whenever a valgus deformity was present, the medial eminence was excised. Afterwards, a percutaneous incision was made dorsally in the first M1 space, and the lateral release of the adductor hallucis tendon was performed.

Then, an L-type osteotomy was performed in the head of the metatarsal with a distal apex of approximately 90 degrees. Second, a shortening osteotomy, parallel to the first dorsal cut, was carried out. The more severe a deformity, the larger the cut needed (Figure 1). Usually, shortening of about 3 mm was enough to decompress the joint and periarticular soft tissues, plantarflex the first metatarsal head, and avoid transfer metatarsalgia, as Malerba et al13 have reported. The capital fragment was united with full contact at the metatarsal and fixed with a Herbert screw of 3 mm. Regarding the valgus-rigidus deformity, lateral translation of the capital fragment was performed. Capsulorrhaphy was performed whenever needed.

The osteotomy procedure requires the following:

1. The width of the shortening osteotomy needs to be based on the degree of the deformity.
Postoperative Care

Walking was allowed immediately after surgery. We recommend using a postoperative shoe with a hard insole for 3 weeks. Sutures were removed after 2 weeks. Active and passive ROM exercises started on the first postoperative day. We performed this technique only if there was more than 50% of the articular cartilage remaining.

Results

Preoperatively, the mean AOFAS score was 39.6 points (range = 25-60). All patients reported pain at the first MTPJ as a result of friction between the hallux and the shoe, leading to considerable reduction in the mobility of the MTPJ. Joints were stable in most cases, and the presence of symptomatic plantar hyperkeratoses at the level of the heads of the first metatarsals was observed. In 11 patients, symptomatic hallux valgus was present. According to Coughlin and Shurnas classification for hallux rigidus, 28 of 40 patients were grade III, and the remaining 12 were grade II (Figure 2). Postoperative radiographs showed that all the joint spaces had improved and at the final follow-up, the improvements were maintained (Figure 3).

Postoperative results included a significant increase ($P < .0001$) in the median global AOFAS score from 39 (range = 25-60) to 84 (range = 78-94). Patients were asked to rate their satisfaction on their ability to wear everyday shoes and practice their regular daily activities

Table 1.

<table>
<thead>
<tr>
<th>Age (y)</th>
<th>Preoperative</th>
<th>Postoperative</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>61.8 (range = 32-79)</td>
<td>32 (80%)</td>
<td>4 (10%)</td>
<td></td>
</tr>
</tbody>
</table>

Abbreviations: AOFAS, American Orthopaedic Foot & Ankle Society clinical rating scale; ROM, range of motion.

2. Osteotomy surfaces need to be opposed precisely.

3. The screw needs to be inserted from the proximal to the distal fragment of the osteotomy, from dorsal to plantar, with an adequate length.

Figure 1. Osteotomy shortening.
after surgery on a scale of 0–10, with 0 equaling complete dissatisfaction and 10 excellent satisfaction. Overall, 36 of 40 (90%) patients expressed good (8-9) or excellent satisfaction.

The mean ROM in DF at the first MTPJ was 13.8 degrees (range = 5-30) preoperatively. The ROM of the first MTPJ showed an improvement in most cases, with a median value of 56 degrees postoperatively (range = 35-70) \( (P < .0001) \) (Figure 4).

We also compared the AOFAS and ROM results of patients with grades II and III. There was no significant difference in the mean AOFAS scores between the 2 groups \( (P > 0.05) \), whereas there was a significant difference for ROM at the final follow-up \( (P < 0.0001) \). Patients were able to return to daily activities and work in 3 to 4 weeks. The average time to bony union was 4.4 (range = 4-6) weeks (Table 2).

Observed complications included 2 cases of mild transfer metatarsalgia and 1 case of dissatisfaction as a result of screw intolerance. Regarding calluses, we observed 2 cases on the second metatarsal head without pain. No infections occurred.
### Table 2.

<table>
<thead>
<tr>
<th></th>
<th>Grade II (n = 12)</th>
<th>Grade III (n = 28)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>AOFAS preoperation</td>
<td>48.33 ± 2.638</td>
<td>36.14 ± 1.267</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>ROM pre operation</td>
<td>17.48 ± 1.678</td>
<td>10.18 ± 0.915</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>AOFAS postoperation</td>
<td>86.50 ± 1.373</td>
<td>83.75 ± 0.6893</td>
<td>&gt;.05</td>
</tr>
<tr>
<td>ROM postoperation</td>
<td>62.50 ± 1.686</td>
<td>52.86 ± 1.190</td>
<td>&lt;.0001</td>
</tr>
</tbody>
</table>

Abbreviations: AOFAS, American Orthopaedic Foot & Ankle Society clinical rating scale; ROM, range of motion.

### Discussion

Numerous operative techniques have been described for the correction of hallux rigidus, each with its advantages and disadvantages. The goal of treatment is to relieve pain and improve ROM and function. The choice of surgery depends on the degree of the hallux rigidus, as the most recent systematic reviews report. Specifically, for cheilectomy, approximately 30% of the dorsal metatarsal head articular surface is removed.6,15,18,20

Most patients with hallux rigidus of lower grade (I-II) have good postoperative results with cheilectomies. In fact, Coughlin and Shurnas have reported that 92% of 93 cheilectomies lead to significant improvements in both postoperative pain and AOFAS scores.4

Distal metatarsal osteotomies with conservation of the head are used in many cases, especially for grades II and III, but these can predispose to transfer metatarsalgia. However, with a balanced proximal and plantar displacement, according to the length of the second and third metatarsals, this risk can be reduced.13 Regarding other techniques, Kilmartin11 prospectively compared a group of 49 patients treated with a phalangeal osteotomy with a group of 59 patients treated with first metatarsal decompression osteotomy.13 In both groups, the osteotomies improved the outcome significantly from a mean preoperative AOFAS score of 43 to a postoperative score of 88, with higher patient satisfaction revealed in the phalangeal osteotomy group; however, this was not statistically significant (P > .05).15 Roukis20 examined a periarticular osteotomy group of 16 patients (Austin-Youngswick osteotomy or Green-Watermann osteotomy), finding no significant difference between preoperative and postoperative modified AOFAS scores for the 2 study groups; the periarticular osteotomy group improved from 54.4 to 84.6 postoperatively. However, P values for this comparison were not given.15 The authors did not indicate how many osteotomies were Austin-Youngwick and how many were Green-Watermann, and follow-up was only of 12 months.

Malerba et al13 reviewed 20 patients with grade III hallux rigidus who were treated with a Weil-type osteotomy to shorten and displace the metatarsal head plantarly. At an average follow-up of 11.1 years, the forefoot AOFAS score was 82, and 95% of patients reported good or excellent satisfaction. Dorsiflexion increased from 8 to 44 degrees, and only 1 patient reported metatarsalgia. This has been the only study with a long-term follow-up (>10 years). Ronconi et al19 evaluated the effect of adding a decompressive metatarsal osteotomy to the proximal phalangeal hemiarthroplasty in 21 patients, reporting a mean AOFAS score improvement from 47.5 ± 11.5 preoperatively to 76.0 ± 15.5 postoperatively (P < .001). The same author reported that 5 patients (23.8%) were not satisfied: 3 patients with metatarsalgia and 2 with persistent pain, stiffness, and subluxation of the prosthesis.

Systematic reviews assert that arthrodesis is the most effective treatment for grades III and IV with <50% of the articular surface.6,15,20 Mc Neil et al15 reported that there are no reliable findings from comparative studies that are properly powered with validated and appropriate outcome measures to permit any definitive conclusions on which procedure is best. As demonstrated by these studies, the results ranged from an AOFAS score of 76 to 88.11,19 Our postoperative results are in line with those above: a significant increase (P < .0001) in the median global AOFAS score from 39 to 84 (range = 78–94).

Moreover, regarding the osteotomy shortening technique, it produced similar mean postoperative AOFAS (84.6) scores as other osteotomy techniques. By using this technique, our main goals were joint preservation and decompression; resolution of pain; increase in mobility, stability, and consolidation of the osteotomy; and return to daily activities and work in 3 to 4 weeks. The authors recommend treating hallux rigidus in the early stages to avoid advance of the disease as well as the preservation and correction of any valgus deformity.

The present study has some limitations. First, it lacks a comparison between the proposed technique and other techniques. Moreover, the length of follow-up was not adequate to determine whether the study technique led to a lower incidence of stiffness and recurrence, compared to other techniques.

### Conclusions

This technique has been shown to be easy to perform and has good to excellent corrective capacity. Moreover, it permits the preservation of joint mobility. Ninety percent of patients expressed good or excellent satisfaction at a
median follow-up of 24 months. Specifically, this technique of a shortening osteotomy of the metatarsal head relieved stiffness and pain and also improved the ROM of the first MTPJ in patients with grades II and III hallux rigidus.

Declaration of Conflicting Interests
The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding
The author(s) received no financial support for the research, authorship, and/or publication of this article.

References