Treatment of Grade 3 Hallux Rigidus Cases: Distal Metatarsal Dorsiflexion Osteotomy Combined with Cheilectomy Short-Term Period Radiological and Clinical Outcomes

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Abstract

Aim: The aim of the study was to analyze the short-term radiological and clinical results of the distal metatarsal dorsiflexion osteotomy method, a technique used to preserve the joint in grade 3 hallux rigidus cases.

Methods: The retrospective study was conducted at Adana City Training and Research Hospital between January 2018 and January 2023. The analysis included adult cases with hallux rigidus grade 3, in whom at least six months of conservative treatment was unsuccessful and treated by distal metatarsal osteotomy combined with cheilectomy surgery. Age, gender, preoperative Coughlin and Shurnas grading scores, the functional clinical assessments were performed using the American Orthopaedic Foot and Ankle Society (AOFAS) Hallux score and Foot and Ankle Ability Measurement (FAAM) scores were assessed, the method of surgery, and complications were noted.

Results: The mean age of the study group (n=12) was 54.2±8.7, with ages varying between 44 and 68 years. The final assessments of the angle of the motion of the big toe showed that dorsiflexion, plantar flexion, and total motion values were significantly increased compared to the preoperative measurements, but between the sixth and the twelfth month, all three angles were decreased ($p<0.001$). Among all cases, mean AOFAS Hallux and FAAM Daily scores were significantly improved ($p <0.001$). The radiological assessment results of the first MTP joint showed that the final mean width was significantly increased compared to the preoperative measurement; however, the value was decreased compared to the sixth month ($p <0.001$).

Conclusions: In the surgical treatment of grade 3 hallux rigidus, distal metatarsal dorsiflexion osteotomy combined with cheilectomy increases the range of motion of the first MTP and provides clinical and radiological improvement. However, careful assessment is required before planning distal metatarsal dorsiflexion osteotomy based on the results of the studies conducted on hallux rigidus patients graded other than 3. Also, an intraoperative finding of a 50% intact cartilage rate or more should be considered as a motivating indicator for the surgeon.

Keywords: *Hallux, Rigidus, distal metatarsal osteotomy, first metatarsophalangeal joint, cheilectomy*

1. Introduction

Hallux rigidus is a frequently occurring joint inflammation pathology of the foot. The degenerative osteoarthritic changes in the first metatarsophalangeal (MTP) joint are characterized by dorsal and peripheral osteophyte formation, levelling of the metatarsal head, and lessened articular gap, causing widespread pain, dorsal tenderness, and joint stiffness with markedly reduced dorsiflexion[1,2]. Although the etiology of hallux rigidus remains unclear, it is linked to female gender, genealogical presence, hallux valgus interphalangeus, and particularly in cases with unilateral involvement with trauma history[3,4]. It is more common in middle-aged and older people, with an increased incidence in women around the age of 40 years[5,6].

Early classifications based on the radiological findings included three grades; later, Coughlin and Shurnas added symptoms and range of motion and developed the classification commonly used today[4,7].

In the initial stages of the disease, conservative methods and shoe modifications are mostly preferred in the treatment, but surgery is

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required for advanced cases, and many methods have already been described. Commonly used surgical treatment methods include cheilectomy, distal metatarsal osteotomy, proximal phalanx osteotomy, arthroplasty without or with implants, and arthrodesis.

Cheilectomy is one of the more commonly used surgical techniques that can also be used in the early stages. Sidon et al.[8] claimed in 2019 that cheilectomy was successful in grades 1-3. In patients with grade 3 and more than 50% intact cartilage in the distal metatarsal, osteotomies of the distal metatarsal or proximal phalanx are recommended[9,10]. Metatarsal osteotomy technique aims to conserve the first MTP joint and are recommended for light to average hallux rigidus deformities. The design aims to depressurize the joint by lessening the metatars bone or revolving the plantar cartilage of the first metatarsal head more caudally to articulate with the hallux[11].

Recently, several reports highlighted satisfactory clinical results in curing hallux rigidus using joint decompression techniques combined with osteotomy of the distal metatarsal and cheilectomy[12,13]. In advanced stages of hallux rigidus, such as in Grade 4 cases which lack articular cartilage, arthrodesis or arthroplasty is an option, but as many articles have shown, arthrodesis is considered the gold standard[4,14].

There are many studies in which all of these surgical treatment options have been successfully demonstrated. In this study, we aimed to compare the radiological and functional results of patients with stage 3 hallux rigidus who underwent joint decompression surgery with distal metatarsal osteotomy combined with cheilectomy in our clinic.

2. Materials and methods

2.1. Patients and Methods

The retrospectively designed study was carried out at Adana City Training and Research Hospital between January 2018 and January 2023. The analysis included adult cases with hallux Rigidus stage 3, in whom at least six months of conservative treatment was unsuccessful and treated by distal metatarsal osteotomy combined with cheilectomy surgery. Age, gender, preoperative Coughlin and Shurnas grading scores, the functional clinical assessments were performed using the American Orthopaedic Foot and Ankle Society (AOFAS) Hallux score and Foot and Ankle Ability Measurement (FAAM) scores were assessed, the method of surgery, and complications were noted. The measurements of the first metatarsophalangeal joint distance in the weight-bearing anteroposterior x-rays of the foot were performed preoperatively during the early postoperative period and at 6 and 12 months after surgery. The assessment of the range of motion, the AOFAS, and the FAAM scores were noted preoperatively and at 6 and 12 months after surgery. The early postoperative period was defined as the time between the second week and the third week following the surgery.

Patients with hallux rigidus developed due to rheumatoid arthritis, gout, fracture sequelae, or septic arthritis, patients with previous hallux valgus surgery, and patients not having a follow-up records of one year or more were excluded from the analysis.

2.2. Ethics

The ethical approval was provided by the Clinical Research Ethics Committee of the Adana City Training and Research Hospital on November 23, 2023, with decision number 2960.

2.3. Operative Technique

The surgical technique in distal metatarsal osteotomy combined with cheilectomy surgery patients was performed as follows: A 4 cm linear incision was cut starting from the dorsal side of the first MTP joint, continuing proximally from the joint border to the metatarsal neck, and a cheilectomy was performed. A 5 mm wide dorsal closed wedge dorsiflexion osteotomy was applied, beginning approximately 10 mm proximally from the top of the metatarsal head. The first osteotomy was made beginning from the dorsal to the plantar vertically (crossways to the axis of the first metatarsal), and the second cut was performed at a 60-degree angle to the metatarsal axis (practically dorsal-proximal to plantar-distal). The dorsal wedge was then removed, and the osteotomy topsides were closed. Since the distal part that included the joint surface was revolved dorsally and proximally, the undamaged cartilage surface in the plantar region of the metatarsal head touched the base of the proximal phalanx. After temporary fixation using two K-wires, the movement ability of the MTP joint and the stability of the osteotomy site were evaluated by using intraoperative fluoroscopy. Then, two headless titanium cannulated screws were placed retrogradely from the dorsal face in the direction of the plantar cortex vertical to the osteotomy surface. The entry points of the screws were positioned on the chondral surface of the dorsal side of the metatarsal head. The insertion depth was carefully measured preventing piercing the articular surface. Finally, the K-wires were disconnected, and the dorsal capsule was closed with an absorbable suture.

2.4. Postoperative Management

Patients were allowed to walk weight-bearing with a hard-soled shoe on the third postoperative day. Active and passive toe movement exercises were started at two weeks, and full weight-bearing walking and wearing casual or regular shoes were allowed at six weeks.

2.5. Radiologic and Clinical Evaluation

In the radiological evaluation of the patients, the first MTP joint distance was measured and recorded according to the method defined by Coughlin and Shurnas[4] as the distance from the articular surfaces of the base of the proximal phalanx to the apex of the metatarsal head. The first MTP joint space width measurements on weight-bearing anteroposterior foot radiographs were recorded preoperatively, in the early postoperative period, and at six months and 12 months postoperatively. All measurements were repeated three times by two orthopaedic surgeons, and the mean measurements were recorded.

AOFAS is a scale ranging from 0 to 100, with 100 points indicating the possibility of a patient feeling zero pain, complete sagittal and hindfoot movement capability, total ankle or hindfoot stability, no poor adjustment, able to ambulate more than six blocks and on various walking surfaces, not having perceptible limp, not having any restrictions of daily or recreational activities, and not requiring aids or appliances for walking. The score distribution of subdomains of function, pain, and alignment were 50, 40, and 10, respectively[15].

FAAM is a self-reported scale scoring from zero to 100 that assesses activities of daily life with 21 questions and sports with eight questions.[16]

The angle of motion of the big toe was quantized using a goniometer as defined by Ronconi et al.[13] preoperatively and six and 12 months postoperatively.

2.6. Statistical Analysis

The statistical analysis was performed using the statistical package SPSS software (Version 25.0, SPSS Inc., Chicago, IL, USA). In assessing normal continuous variables, mean±standard deviation ($p>0.05$ in Shapiro-Wilk ($n<30$)), and for the abnormal continuous variables median were used for description. Data commands were used to calculate prevalence. Pre-post measures data were analyzed by the Friedman test and Wilcoxson test. The level of statistical significance was set as $p < 0.05$.

Table 1

Mean Passive Range of Motion of the First MTP Joint

	Preoperative		Postoperative six months		Postoperative one year		
	Mean±SD	Min-Max	Mean±SD	Min-Max	Mean±SD	Min-Max	*p*
Dorsiflexion	15.5˚±1.9˚	12˚-19˚	37.7˚±5.3˚	24˚-44˚	34.7˚±5.8˚	21˚-42˚	0.001
Plantar Flexion	20.9˚±1.9˚	18˚-25˚	23.3˚±2.4˚	20˚-28˚	21.3˚±1.7˚	18˚-24˚	0.001
Total Motion	36.0˚±2.7˚	30˚-40˚	60.7˚±6.9˚	44˚-70˚	56.2˚±7.4˚	39˚-65˚	0.002

Table 2

Evaluation of Clinical Outcomes Based on the American Orthopaedic Foot and Ankle Society Scale and Functional Outcomes Based on the Foot and Ankle Ability Measure

	Preoperative		Postoperative six months		Postoperative one year		
	Mean±SD	Min-Max	Mean±SD	Min-Max	Mean±SD	Min-Max	*p*
AOFAS Hallux Score	56.2±3.0	52-60	87.9±3.6	85-95	89.2±5.1	85-95	0.002
FAAM Daily Activity Score	66.3±5.2	58.3-75	84.2±3.9	79.8-91.6	90.6±2.4	86.9-94.1	0.001

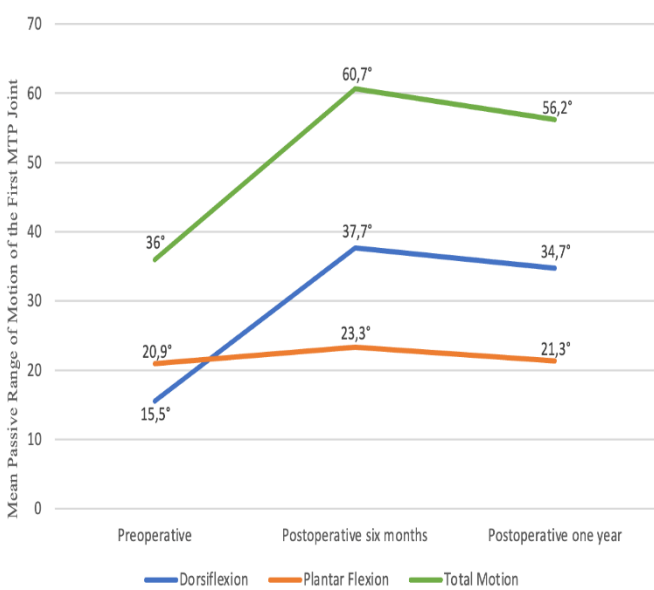
Table 3

The Changes in Width of the First MTP Joint Space

	Preoperative		Early Postoperative		Postoperative six months		Postoperative one year		
	Mean±SD	Min-Max	Mean±SD	Min-Max	Mean±SD	Min-Max	Mean±SD	Min-Max	*p*
Width of the First MTP (mm)	0.76±0.1	0.55-0.96	1.48±0.1	1.29-1.78	1.29±0.1	1.02-1.46	1.15±0.1	0.88-1.33	0.001

Figure 1

The changes of mean passive range of motion of the first MTP joint in one year follow-up period



3. Results

The mean age of the study group (*n*=12) was 54.2±8.7, with ages varying between 44 and 68 years. There were eight females and four males. All cases were grade 3 based on the Coughlin and Shurnas clinical and radiographical grading system.

The final assessments of the angle of the motion of the big toe showed that dorsiflexion, plantar flexion, and total motion values were significantly increased compared to the preoperative measurements, but between the sixth and the twelfth month, all three angles were decreased (p<0.001). (Table 1) (Figure1)

Among all cases, mean AOFAS Hallux and FAAM Daily scores were significantly improved (p <0.001). (Table 2)

The radiological assessment results of the first MTP joint showed that the final mean width was significantly increased compared to the preoperative measurement; however, the value was decreased compared to the sixth month (p <0.001). (Table 3)

Postoperatively, transverse metatarsalgia was seen in two cases in the sixth month of follow-up control (16.7%). Metatarsal silicone pad and non-steroid analgesic treatment were applied. The findings were resolved at the final follow-up.

Additional complications, including non-union, loss of sensation due to digital nerve damage, implant failure, local wound infection, and irritation, were not observed.

4. Discussion

The aim of the study was to analyze the short-term clinical results of the distal metatarsal dorsiflexion osteotomy method, a technique used to preserve the joint in advanced hallux rigidus cases.

The literature findings suggest that the application of arthrodesis in hallux rigidus cases is more widely accepted compared to cheilectomy, osteotomy, implant arthroplasty, interposition arthroplasty, and resection arthroplasty[17].

There are numerous reports highlighting the effectiveness of the first MTP joint decompression osteotomy surgery in grade II and III hallux Rigidus cases[12,13,18]. The fact that the most important condition for the procedure is the preservation of the cartilage over 50% is commonly suggested in the literature[4,19]. All cases in the study group were assessed intraoperatively, and it was seen that the ratio of intact cartilage in the study group was over 50%.

In order to avoid the progression of the degenerative arthritis of the first MTP joint in advanced hallux rigidus patients, the dorsal closed wedge osteotomy, which was modified by Cho et al.[9] and considered as an alternative among numerous techniques that exist in the literature, was preferred aiming to increase the joint range of motion by rotating the intact cartilage on the plantar side of the metatarsal head and widening the joint width. Although the technique seems to offer upsides regarding providing adequate joint congruency along the range of motion in the first MTP joint and the facilitation of the excision of the pathological dorsal part of the joint, might increase the risk of an impairment in the adaptability of the sesamoids to the joint due to the rotation of the plantar side of the joint to the anterior.

A systemic review of the distal metatarsal periarticular osteotomy series showed that metatarsalgia was seen in 30.5% of the cases[20]. A lower rate was observed in our study group (n=2, 16.7%). The low rate seen in our study might be attributed to more detailed preoperative planning, including the consideration of the length of the metatarsal regarding the preservation of the metatarsal arcus, which is highly associated with decreased metatarsalgia following distal metatarsal osteotomy.

In a study presenting the long-term results of combined surgery methods, including cheilectomy and the proximal phalangeal osteotomy, which the latter is known to be one of the joint-preserving osteotomies preferred in hallux rigidus patients, and conducted on 60 cases with an average follow-up of 96 months, Waizy et al.[21] proposed that none of the cases required revision surgery.

Furthermore, in a review, Roukis[20] stated that in hallux rigidus patients the incidence of revision surgery following cheilectomy is relatively low (8.8%), and the leading cause of the revision surgery was the progressive arthritis of the first MTP joint. Besides, in the studies focused on long-term follow-ups after cheilectomy, the clinical impact of the recurrence of the dorsal osteophytes, chondrolysis, narrowing of the joint space, and the progression of the radiological grading of the condition was not proven on the function of the first MTP joint[22].

Yet again, according to Roukis[20] the main reasons for the revision surgery following periarticular osteotomy were persistent metatarsalgia, implant failures or irritations, and the progression of the degenerative arthritis on the first MTP joint. Adding that, based on high rates of revision, periarticular osteotomy shall be excluded from consideration as a first-line method regardless of the stage of the condition. The contradicting results on the complication rates of periarticular osteotomy in hallux rigidus surgery existing in the literature indicate the need for further studies with long-term follow-up.

Similar to the reports in hallux rigidus cases showing the lack of an association between a decrease in the dorsiflexion function and the radiologic findings, in our study, there was no relation[4]. Moreover, Coughlin and Shurnas[4] suggested that cheilectomy was not associated with the natural progress of the condition, and yet the patients have expressed satisfaction after the procedure. In another study, the authors stated that following a cheilectomy, there was no link between the AOFAS scores and the poor radiologic progress of the first MTP joint[23].

Limitations

A small sample size, having been conducted in a single center, and the lack of a control group are the major limitations of the study. Prospective randomized studies with longer follow-up periods comparing the most commonly used periarticular osteotomy procedures surely will help determine the most effective operation methods in patients with hallux rigidus grade 3.

5. Conclusion

In the surgical treatment of grade 3 hallux rigidus, distal metatarsal dorsiflexion osteotomy combined with cheilectomy increases the range of motion of the first MTP and provides clinical and radiological improvement. However, careful assessment is required before planning distal metatarsal dorsiflexion osteotomy based on the results of the studies conducted on hallux rigidus patients graded other than 3. Also, an intraoperative finding of a 50% intact cartilage rate or more should be considered as a motivating indicator for the surgeon.

Statement of ethics

The ethical approval was provided by the Clinical Research Ethics Committee of the Adana City Training and Research Hospital on November 23, 2023, with decision number 2960.

Conflict of interest statement

The authors declare that they have no financial conflict of interest with regard to the content of this report.

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