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Original Article

Arthrodesis of the first metatarsophalangeal joint by locking plate in patients with hallux rigidus

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Abstract

Background: The aim of this study was to evaluate the clinical and radiological results of first metatarsophalangeal (MTP) joint arthrodesis surgery performed with a plate in patients diagnosed with hallux rigidus (HR). **Methods:** Nineteen patients who underwent first MTP joint arthrodesis with a diagnosis of HR between 2018 and 2024 were retrospectively analyzed. Patient gender, surgical site, complication status, preoperative and postoperative hallux valgus angles (HVA), union and follow-up times, and staging according to the Coughlin-Shurnas classification were evaluated. Statistical analysis was performed using the Wilcoxon test, with $p < 0.05$ considered significant. **Results:** A total of 19 patients (15 females, 4 males) were included in the study. The mean age was 55.3 ± 8.1 years, and the follow-up period was 9.16 ± 1.95 months. Hallux rigidus was detected as stage 2 in one patient and stage 3 in 18 patients. The preoperative HVA decreased from 18.9° ± 5.4 to 14.6° ± 6.1 postoperatively; the difference was not statistically significant ($p = 0.129$). Complications occurred in six patients (31.6%). The mean time to union was 8.39 ± 2.4 weeks, and one patient experienced nonunion. **Conclusion:** We consider arthrodesis using plates as an appropriate surgical technique in the treatment of HR due to its high union rate.

Keywords: Hallux rigidus, metatarsophalangeal arthrodesis, fusion, plate fixation

Introduction

Hallux rigidus (HR) is a painful, degenerative disease affecting the first metatarsophalangeal (MTP) joint and is characterized by progressive osteophyte formation and limited range of motion [1]. The prevalence is 2.5% in people over 50 years of age. Bilateral involvement is present in 80% of patients, and familial transmission is common [1].

The etiology of HR is multifactorial, and the only factor that can establish a cause-and-effect relationship is trauma [1-3]. Unilateral cases often present with trauma such as an intra-articular fracture [1-3]. Other factors besides trauma include osteochondritis dissecans of the first metatarsal head, paralytic deformities, metabolic diseases, inflammatory diseases, and pes equinovarus deformity [2]. As degeneration of the first MTP joint increases in hallux rigidus, synovial hypertrophy and osteophytes develop around the joint [1-3]. Consequently, osteophytes cause pain during dorsiflexion and limited range of motion. This condition leads to difficulty wearing shoes and performing daily activities [3,4].

The staging proposed by Couglin and Shurnas has become the most widely accepted classification because it also aids in surgical treatment selection [5]. This staging considers both clinical and radiographic parameters [4,5]. Erosion of more than the dorsal half of the joint surface and pain during early range of motion are significant poor prognostic factors [5,6].

Treatment of hallux rigidus varies depending on the degree and stage of osteoarthritis. Conservative treatment is preferred in the early stages [7]. Conservative treatment includes foot orthoses, shoe modifications, cold compresses, and corticosteroid or sodium hyaluronate injections [7]. Surgical treatment is reserved for advanced-stage cases accompanied by pain and limited mobility. Numerous procedures have been described for surgical treatment, including cheilectomy, interposition arthroplasty, resection arthroplasty, and first MTP joint arthrodesis [8]. Among these options, first MTP joint arthrodesis is considered the gold standard for the treatment of advanced-stage HR. Arthrodesis with interfragmentary compression screws or dorsal plates has been associated with high union rates (94%-98%) and patient satisfaction [8].

Figure 1. a, b) Intraoperative images of the arthrodesis procedure with a locking double plate in a patient with hallux rigidus in the left foot.

The aim of the present study was to evaluate the clinical and radiological outcomes in patients with hallux rigidus who underwent first MTP joint arthrodesis.

Materials and methods

Study included 19 patients diagnosed with HR who underwent plate arthrodesis of the first MTP joint between 2018 and 2024. Data including gender, age, side of the affected extremity, follow-up period, time to union, preoperative and postoperative hallux valgus angle (HVA), developing complications were recorded. This retrospective study was approval from the University of Health Sciences Kayseri City Training and Research Hospital Clinical Research Ethics Committee under decision number 635/04.11.25 and was conducted in accordance with the Declaration of Helsinki. Clinical and radiographic diagnosis of HR, arthrodesis with a dorsal plate, and a follow-up period of at least 6 months were included in the study. Patients who underwent screw or Kirschner wire fixation, cheilectomy, resection arthroplasty, or those with a follow-up period of less than 6 months were excluded from the study.

Surgically, the first MTP joint surface was opened with a long incision dorsal to the extensor tendon. The joint capsule was retracted, and osteophytes were removed from the joint surface. The first MTP joint surface was osteotomized. Then, plates and locking screws were placed dorsal to the joint under fluoroscopic guidance. The arthrodesis was performed with the hallux in approximately 15° dorsiflexion relative to the ground plane and in approximately 5°-10° valgus position compared to the first metatarsal bone (Figure 1).

Statistical analysis

All data analyses were performed using IBM Statistical Package for Social Sciences v. 25.0 (IBM Corp., Armonk, NY, USA). Continuous variables were presented as mean and standard deviation values within the scope of descriptive statistics. Categorical data were measured as frequency and percentage. Preoperative and postoperative HVA measurements were analyzed using the Wilcoxon signed-rank test due to the limited number of patients and inappropriate distribution. $P< 0.05$ was considered significant.

Results

A total of 19 patients, 15 female and 4 male, were included in the study. The mean age of the patients was 55.3 ± 8.1 years, and the mean follow-up period was 9.16 ± 1.95 months. According to the Coughlin–Shurnas classification [5], one patient was stage 2 and 18 patients were stage 3. The mean preoperative HVA was 18.9° ± 5.4, and the mean postoperative HVA was 14.6° ± 6.1. A mean improvement of 4.3° was achieved, but this difference was not significant ($p = 0.129$). Complications occurred in 6 of the 19 patients (31.6%). Implant irritation occurred in 3 patients (15.7%), wound opening occurred in 1 patient (5.3%), and superficial skin infection occurred in 1 patient (5.3%). The implants of patients with implant irritation were removed in the third postoperative month. Primary suturing was performed in the patient with wound opening. The patient with superficial skin infection was treated with antibiotics. Nonunion occurred in 1 patient (5.3%). This patient's implant was removed and revised, and union was achieved in the fourth week. No permanent complications developed in any patient. The mean time to union was determined to be 8.39 ± 2.4 weeks (range, 4–14 weeks) (Table 1) (Figure 2).

Discussion

In this study, satisfactory radiological and clinical results were obtained with minimal complications in patients diagnosed with HR who underwent 1st MTP joint arthrodesis with a plate. In the study conducted by Yurteri et al. on 14 patients, the male/female ratio was 2/12 (14.3% / 85.7%), the mean age was 55.71 (38-74) years, and the mean follow-up period was 8.42 months [9]. In our study on 19 patients, the male/female ratio was 4/15 (26.6% / 73.4%), the mean age was 55.3 years, and the mean follow-up period was 9.16 months. Similar results were obtained with the literature in terms of gender distribution, mean age, and follow-up period [9].

In our study, 1 of 19 patients was found to be stage 2 (5.2%) and 18 patients were found to be stage 3 (94.8%). In a study by Akdemir et al., who performed surgery on 34 feet of 18 patients, 13 feet were found to be stage 3 (38.2%) and 21 feet were found to be stage 4 (61.8%), and the results differed between our study and the literature [10]. In our study, patients were not classified as stage 3 or stage 4 due to the lack of clinical data, and the patients were evaluated as stage 3 [10]. In our study, 94.7% of the 19 patients achieved union, and the mean time to union was 8.39 weeks. Nonunion was present in only 5.3%. The patient with nonunion was observed to have union within 4 weeks after plate removal and a different fixation method. Our findings are largely consistent with union rates in the literature [11]. A comprehensive review of the literature reported a nonunion rate of 5.1% (66) and a union rate of 94.9% (1232) in 1298 feet of 1175 patients treated with a dorsal plate [11]. Furthermore, the mean time to union was reported as 69.1 days (9.87 weeks) [11]. The reason for our earlier

Table 1. Patients' demographic and clinical characteristics.

Variable	
Number of patients	19
Female / Male	15 / 4
Age, years, mean ± SD	55.3 ± 8.1
Follow-up, months, mean ± SD	9.16 ± 1.95
Preoperative HVA (°) ± SD	16.9 ± 4.2
Postoperative HVA (°) ± SD	11.5 ± 3.9
Average bone union (weeks) ± SD	8.39 ± 2.4
Mean correction, (°)	5.4
Union rate, (%)	94.7
Nonunion, (%)	5.3
Complication rate, (%)	31.6
Complications	Superficial infection implant irritation

Abbreviations: HVA, hallux valgus angle; SD, standard deviation.

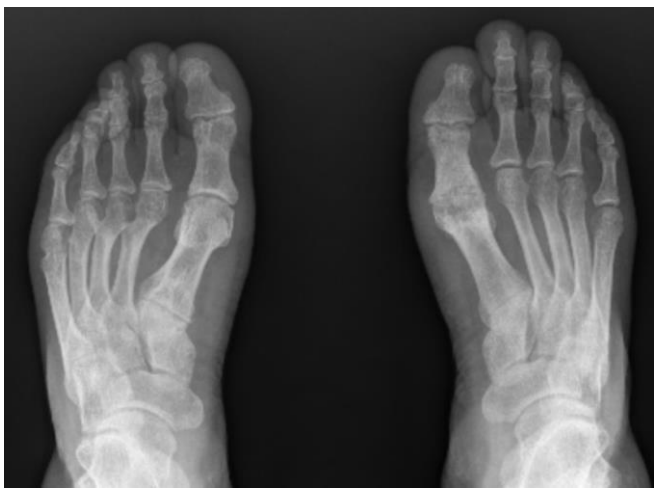

Figure 2. Radiographic image of a patient with hallux rigidus whose plate was removed after arthrodesis of the 1st metatarsophalangeal joint of the right foot.

union time is that it includes revision cases found in the literature study [11].

The mean preoperative HVA was 18.9 degrees, and the mean postoperative HVA was 14.6 degrees. A mean improvement of 4.3 degrees was achieved. Although the preoperative HVA were similar to those in the literature and our study, the rate of postoperative HVA correction was inconsistent and is inconsistent with the literature [9].

In our study, implant irritation occurred in 3 patients (15.9%); in a similar study by Yurteri et al. with 14 patients, this rate was found to be 35.7% [9]. According to the literature, implant irritation complications were less common in our study [9].

Our study has several limitations. These include not being performed by a single surgeon, the small patient series, no comparison group, unequal distribution of gender and side, and the retrospective nature of the study, which prevented the evaluation of functional scores. Despite these limitations, the current data clearly demonstrate the effectiveness of plate arthrodesis in patients with advanced HR.

Conclusions

Plate arthrodesis in patients diagnosed with HR has demonstrated satisfactory results, both radiologically and clinically. The union rate was 94.8%, with only one patient experiencing nonunion. This rate is similar to union rates reported in the literature, and plate arthrodesis has yielded satisfactory results. Among the advantages of this surgery are that most complications are superficial and manageable. In conclusion, first-line MTP arthrodesis with a dorsal plate system is a safe and effective surgical method for the treatment of advanced-stage HR, with a high rate of union and an acceptable complication rate.

Author contributions

All authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by FD, SB, MI˙ and H Ö . The first draft of the manuscript was written by FD, SB, MI˙ and H Ö and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

Statements and declarations

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Conflict of Interest

The authors declare that they have no conflict of interest.

Ethical statement

The University of Health Sciences Kayseri City Training and Research Hospital Clinical Research Ethics Committee approved the study protocol (Approval No.635/04.11.25), informed consent was obtained from each patient, and the study was conducted in accordance with the principles of the Declaration of Helsinki.

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