Evaluation of Therapeutic Effects of Weil Osteotomy in Patients with Hallux Rigidus

Abstract

Background: The purpose of this study is to investigate the results of surgical treatment for hallux rigidus using the Weil osteotomy method in grade III patients with this disease.

Methods: This quasi-experimental study involved a single-group intervention "before and after" the surgery. The research population consisted of patients with grade 3 hallux rigidus. The data collection tool used in this study was a checklist based on clinical examinations that evaluated joint movement in both plantar and lateral directions, as well as the Visual Analog Scale (VAS) to measure pain. The range of motion and pain level of the metatarsophalangeal (MTP) join were investigated and recorded before the operation and 1, 3, and 6 months after the operation. All this information was entered into SPSS software version 26.

Results: The study groups included 8 (22.9%) male and 27 (77.1%) female patients, with an average age of 77.1 ± 12.17 years. The amount of pain decreased significantly (P=0.00) at the one-month and three-month follow-ups after the intervention, and the amount of passive movement of the joint in the plantar directions significantly increased from one month to three months after the intervention (P=0.00). 17 patients (48.6%) took up to two weeks after surgery, 10 patients (28.6%) between two to four weeks, and 8 patients (22.9%) more than one month to recover the mobility. The average joint space of the patients after the operation in plain radiography was 3.6 ± 0.46.

Conclusion: : The Weil osteotomy surgery in hallux rigidus patients showed a significant decrease in pain level, and also a significant increase in joint motion and improvement in the average joint space in short term.

Keywords: Osteotomy, Hallux rigidus, Pain, Treatment outcome

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Introduction

Hallux rigidus, also known as stiffness of the big toe, is one of the most common forms of arthritis in the foot. This condition is characterized by formation of osteophyte in the first joint of the big toe or the metatarsophalangeal joint (MTP), which can cause stiffness and pain for the patient. The MTP joint is crucial in walking as it bends with every step taken, and if it becomes stiff, walking can become painful and difficult [1, 2]. In the MTP joint, similar to other joints, the ends of the bones are covered by articular cartilage. If the articular cartilage is damaged, the ends of the bones rub against each other, resulting in the formation of extra bones or bone spurs. These additional bony structures hinder the joint's full flexion when walking, causing stiffness in the big toe or hallux rigidus [3, 4]. Other symptoms that develop in people after suffering from hallux rigidus include inflammation and swelling of the MTP area of the big toe, as well as weakness and pain when performing certain movements such as running, bending the toes, squatting, and standing. Hallux rigidus often affects adults between the ages of 30 and 60. The etiology of this disease is not yet fully understood, but injuries that damage joint cartilage, multiple traumas to the joint area, or anatomical differences in the foot that increase pressure on the joint can contribute to the development of this disorder [5].

Coughlin and Shurnas proposed a classification system based on clinical and radiographic findings for Hallux Rigidus. The Coughlin and Shurnas clinical

radiographic grading system is as follows: Grade 0: dorsiflexion is 40 to 60 degrees and/or 10 to 20% less than the normal leg, and radiographic findings are normal. Also, the patient has no pain, only stiffness and loss of movement in the physical examination. Grade 1: Dorsiflexion is 30 to 40 degrees and/or 20 to 50% less compared to the normal leg. In radiography, osteophyte is the main finding, as well as the narrowing of the joint space, peri-articular sclerosis, and flattening of the metatarsal head. Clinical features include mild pain and stiffness, as well as severe pain on dorsiflexion and/or plantar flexion during examination. Grade 2: Dorsiflexion is 10 to 30 degrees and/or a 50 to 75% reduction compared to the normal foot, and radiographs show dorsal, lateral, and possibly medial osteophytes that give a smooth appearance to the metatarsal head, mild to moderate joint space narrowing, and sclerosis. There is moderate to severe pain and stiffness that may be constant. Pain occurs just before maximal dorsiflexion and maximal plantar flexion on examination. Grade 3: Dorsiflexion is 10 degrees or less and/or there is a 75% to 100% joint space reduction compared to the normal side. There is also a significant decrease in plantar flexion. Radiographs show significant narrowing, peri-articular cystic changes, and involvement of more than 1/4 of the joint space in lateral radiographs, and sesamoid size and/or cystic and/or irregularity. The patient experiences almost constant pain and considerable stiffness when in bed and at the maximum range of motion, but not in the average range. Grade 4: Dorsiflexion of the radiographic findings is the same as grade 3. Clinical findings are the same as grade 3 criteria, but there is definite pain in passive range of motion [6].

Various surgical methods are indicated for some patients who have severe radiographic changes (Grade III) of hallux rigidus, namely arthrodesis or joint fusion [4], and arthroplasty. Another surgical method is removal of disturbing osteophytes Weil osteotomy [7]. These different surgical methods have their own advantages and disadvantages and varying outcomes have been observed from them. The objective of this study is to examine the outcomes of surgical treatment for hallux rigidus using the Weil osteotomy grade III hallux rigidus.

Surgical technique Weil's osteotomy is performed through a dorsal incision, dorsal capsulotomy of the MTP joint, and plantar flexion of the proximal phalanx to expose the metatarsal head. The osteotomy starts from the dorsal part of the metatarsal head and is performed along the shaft parallel to the floor (Figure 1). The key point is to make a long osteotomy incision to provide a large surface area for healing, avoid lowering the head by making the incision parallel to the ground. As the head naturally moves proximally, most authors recommend 5 to 10 mm of shortening. The osteotomy is then fixed using screws. Factors that affect fixation include screw placement angle, screw size, and number of screws. Fixation in relatively porous bone is improved by using two screws [8] (Figure 2). All patients who underwent Weil osteotomy surgery were placed under a short leg splint or boot and were advised not to bear full weight for two weeks.

Methods

This study was conducted as a quasi-experimental single-group intervention before and after the intervention. The research population consisted of patients suffering from grade 3 hallux rigidus who were referred to Baqiyatullah Hospital for surgical treatment. The sample size was estimated using G Power software, and considering an error level of 5%, a test power of 80%, and an effect size of 0.25%, 28 patients were required. Finally, 35 patients were examined in this study. The inclusion criteria for the study were: 1) chronic pain in the MTP joint of the first foot, 2) matching the type of pain and clinical diagnosis with the diagnosis of third-degree hallux rigidus, and 3) the patient's

willingness to participate in the study. Exclusion criteria included:
1) non-cooperation of the patient for follow-up after treatment, 2) a history of diabetes and vascular collagen diseases, and 3) a history of taking immunosuppressive drugs or any disorder in the weakness of the body's immune system. The data collection tool in this study included a checklist based on clinical examinations that evaluated the amount of joint movement in both plantar and dorsal directions, as well as the measurement of patients' pain using the VAS pain scale, which ranges from 0 to 10 to determine the severity of pain. This study was conducted in accordance with the code of ethics received from the Research Vice-Chancellor of Baqiyat Elah Azam University of Medical Sciences. The researcher began by sampling and explaining the research objectives to the patients. Informed consent was obtained from the patients and their demographic information was recorded. The range of motion and pain level of MPT joints were then checked and recorded before the operation, as well as 1, 3, and 6 months after the operation. The duration of immobility was also documented. All information was registered in a checklist and entered into SPSS software version 26 for comparison. A significance level of 0.05 was considered for all tests.

Figure2: Weil osteotomy post-op xray, improved by using two screws

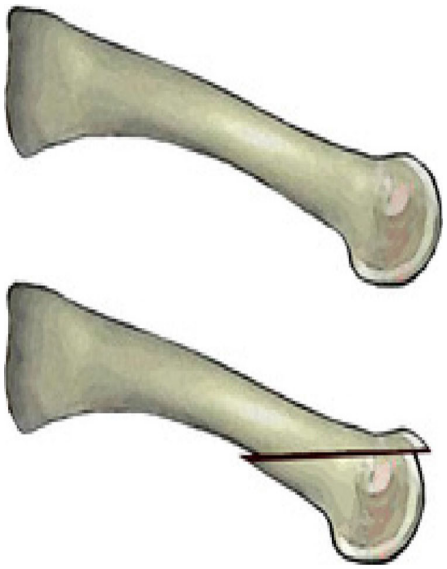

Figure 1: Schematic figure of oblique

Discussion

In this study, 8 male (22.9%) and 27 female patients (77.1%) were examined. The average age of these patients was 77.1 ± 12.17 years. The amount of pain in the patients decreased significantly (P=0.00) (Table 1).
The amount of passive movement of the joint in the plantar and dorsal flexion significantly increased from one month, three months, to six months after the intervention (P=0.00) (Table 2).

In the 6-month examination and follow-up, none of the patients experienced sensory or neurological complications, and movement, non-union, malunion, or metatarsalgia were not observed. Full weight-bearing was obtained after 2 weeks in 17 patients, 2-4 weeks in 10 and over 1 month in 8 cases.
The average joint space of the patients after surgery was 3.6 ± 0.46 mm based on radiographic criteria.

Table 1. Examination and comparison of the pain score, before and 1, 3 and 6 months after surgery				
Variable	**Course**	**Mean ± SD**	**Z**	**P value**
Pain	Pain score before intervention	9.4 ± 0.77	- 5.191	0.00
	Pain score one month after the intervention	3.08± 1.29	- 5.207	0.00
	Pain score three months after the intervention	1.91 ± 0.95	- 5.207	0.00
	Pain score six months after the intervention	1.91 ± 0.95	- 5.207	0.00

Table 2: Passive range of motion of the joints at both plantar and lateral levels one year before and 1, 3 and 6 months after surgery				
Variable	**Course**	**Mean ± SD**	**Z**	**P value**
Passive ROM dorsl flexion	before intervention	33.1 ± 3.9	-5.163	0.00
	one month after the intervention	70.1± 7.9	-5.163	0.00
	three months after the intervention	72.5± 7.1	-5.162	0.00
	six months after the intervention	71.1±3.2	-5.162	0.00
Passive ROM plantar flexion	before intervention	14.7 ± 3.6	-4.880	0.00
	one month after the intervention	22.3±4.1	-4.880	0.00
	three months after the intervention	23.1± 2.8	-5.080	0.00
	six months after the intervention	21.6 ±2.8	-5.080	0.00

Discussion

The pathogenesis of hallux rigidus is unclear, but has a progressive-destructive course, such that even non-surgical treatment is not very effective. Many studies have investigated the advantages and disadvantages of surgical treatment for this pathology. In a study conducted by Kilmartin and colleagues, the usefulness of two different surgical methods in patients with moderate involvement was compared. Patients who underwent phalanx surgery were compared with those who underwent metatarsal bone decompression osteotomy surgery. The results showed that 65% of patients in the first group were fully satisfied with the results of the operation, while 54% in the second group were completely satisfied. Also, in this study, it was found that the average range of joint movement in patients who underwent metatarsal osteotomy surgery was significantly higher than the first group. However, the rate of postoperative complications and the persistence of pain in the patients of the second group were higher [9].

The results of our study showed that the level of satisfaction, the amount of joint movement, and the persistence of pain in grade 3 patients with this pathology significantly improved after surgery. In another study, Lamar and his colleagues [10] investigated three methods of Weil osteotomy for the treatment of hallux rigidus disorder. In this study, bone models were subjected to Weil osteotomy on "saw-bones" in laboratory conditions using the Youngswick, Sagittal V, and Modified methods. Variables such as maximum bearing capacity, energy loss rate, joint stiffness, and bone fracture pattern were tested. The results of this study showed that the joints operated on with the Sagittal V method had less endurance and stiffness after the operation compared to the other methods. In fact, it can be said that the Modified method used in our study is a modified version of the Sagittal V method. In 2020, Cassinelli and his colleagues [3] investigated the use of the Weil osteotomy in patients with grade 3 hallux rigidus during a case series study. In that study, patients were examined in terms of their satisfaction, range of motion of the big toe joint, and length and

width of the joint space at various intervals following surgery, including one-year and two-year follow-ups. It was shown that all patients were fully satisfied with the treatment during the follow-up period. After two years, the average range of motion of the big toe joint in patients increased from 35.1 degrees to 80.3 degrees during the one-year follow-up. Additionally, the average degree of dorsiflexion increased from 5 degrees in previous studies to 15 degrees during the one-year follow-up. The results of this study were similar to those obtained in our study, indicating the superior efficacy of the Weil osteotomy method compared to cheilectomy alone. The major limitation of this study is the short follow-up time and lack of comparative group such as debridement only.

Conclusion

In this study, the results of Weil osteotomy surgery on patients with hallux rigidus were observed at one month, three months, and six months after the operation. The findings showed a significant decrease in pain levels, as well as an increase in joint range of motion and a decrease in patient setup duration. Additionally, there was an improvement in the average joint space of the patients.

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