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Evaluation of Clinical Outcomes After Cheilectomy and Microfracture in Hallux Rigidus

Halluks Rigidus'ta Çelyektomi ve Mikrokırık Sonrası Klinik Sonuçların Değerlendirilmesi

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Abstract: Hallux rigidus (HR) is a common form of osteoarthritis that affects the first metatarsophalangeal joint, causing pain, stiffness, and functional limitations. Cheilectomy, a joint-preserving surgical method, is often used in early to mid-stage HR. Microfracture is a cartilage repair technique that stimulates fibrocartilage formation. This retrospective study evaluated and compared the clinical outcomes of 62 patients who underwent cheilectomy alone (Group 1, n=32) or cheilectomy combined with microfracture (Group 2, n=30) between January 2019 and September 2023. The mean follow-up duration was 25.8 ± 7.2 months (range, 18–40 months) in Group 1 and 23.1 ± 7.3 months (range, 16–42 months) in Group 2. Functional outcomes were assessed using the American Orthopaedic Foot and Ankle Society (AOFAS) score, Visual Analog Scale (VAS) for pain, and dorsiflexion (DF) angles. Both groups demonstrated statistically significant improvements in all parameters postoperatively ($p<0.001$), while the AOFAS scores were significantly higher in the combined microfracture group ($p=0.0168$). No significant differences were observed in VAS and DF angle values between the groups. These findings suggest that the addition of microfracture to cheilectomy may enhance short- to mid-term functional outcomes without increasing complications. Further prospective, long-term studies are required to confirm its sustained effectiveness and potential benefits in the treatment of hallux rigidus.
Keywords: Hallux rigidus, cheilectomy, microfracture, foot surgery

Özet: Halluks rigidus (HR), birinci metatarsofalangeal eklemi etkileyen ve ağrı, sertlik ile fonksiyonel kısıtlılıklara neden olan yaygın bir osteoartrit formudur. Eklem koruyucu bir cerrahi yöntem olan çelyektomi, erken ve orta evre HR olgularında sıklıkla tercih edilmektedir. Mikrokırık tekniği ise kıkırdak tamirini hedefleyen ve fibrokartilaj oluşumunu uyaran bir yöntemdir. Bu retrospektif çalışmada, Ocak 2019 ile Eylül 2023 tarihleri arasında çelyektomi uygulanan 62 hasta değerlendirildi. Hastalar sadece çelyektomi yapılanlar (Grup 1, n=32) ve çelyektomiye ek mikrokırık uygulananlar (Grup 2, n=30) olarak iki gruba ayrıldı. Ortalama takip süresi Grup 1'de 25,8 ± 7,2 ay (18–40 ay aralığında), Grup 2'de ise 23,1 ± 7,3 ay (16–42 ay aralığında) idi. Fonksiyonel sonuçlar; American Orthopaedic Foot and Ankle Society (AOFAS) skoru, Vizüel Analog Skala (VAS) ağrı skoru ve dorsifleksiyon (DF) açıları kullanılarak değerlendirildi. Her iki grupta postoperatif tüm parametrelerde istatistiksel olarak anlamlı iyileşme izlendi ($p<0.001$); ancak AOFAS skorları mikrokırık uygulanan grupta anlamlı olarak daha yüksekti ($p=0.0168$). Gruplar arasında VAS ve DF açısı açısından anlamlı fark saptanmadı. Bulgular, çelyektomiye ek olarak uygulanan mikrokırık tekniğinin kısa ve orta vadede fonksiyonel sonuçları artırabileceğini göstermektedir. Ancak yöntemin uzun dönem etkinliğinin değerlendirilmesi için ileriye dönük çalışmalara ihtiyaç vardır.
Anahtar Kelimeler: Halluks rigidus, çelyektomi, mikrokırık, ayak cerrahisi

Ethics Committee Approval: The study was approved by Sağlık Bilimleri University Gülhane Clinical Research Ethical Committee (Decision no:2024-249, Date: 28.05.2024)
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1. Introduction

Hallux rigidus (HR), a common form of osteoarthritis affecting the first metatarsophalangeal (MTP) joint, causes stiffness, pain, and functional limitations in patients, especially during activities that require dorsiflexion, such as climbing hills and stairs (1–3). This condition is seen not only in older adults but also in young, active patients after trauma (4). Many etiologic factors have been suggested, including long first metatarsal, trauma, high first metatarsal height, and positive family history, but most cases are probably idiopathic (5,6).

Cheilectomy (resection of dorsal osteophytes and part of the metatarsal head) is an established joint-sparing surgical procedure for early to mid-stage HR (7). It is a relatively simple procedure that preserves joint motion and allows a more rapid return to daily activities. Microfracture is a bone marrow stimulation technique that entails creating small perforations in the subchondral bone at the site of the cartilage defect (8). This process promotes the migration of pluripotent mesenchymal stem cells to the affected area, encouraging the development of fibrocartilaginous repair tissue. Following the procedure, a bone marrow clot rapidly forms within the defect, offering a supportive microenvironment that facilitates the differentiation of progenitor cells into structurally stable reparative tissue. This clot resembles a fibrous cartilage tissue and fills the defect (8,9). This study hypothesizes that the long-term clinical outcomes of HR patients who underwent microfracture of the damaged articular cartilage area after cheilectomy are better than those who did not.

The aim of this study is to compare the clinical outcomes of HR patients who underwent cheilectomy with microfracture and those who underwent isolated cheilectomy.

2. Materials and Methods

This study was conducted with the approval of the Gülhane Clinical ResearchEthics Committee (no: 2024/249). Preoperative radiographs and clinical and operative notes of patients who underwent cheliectomy surgery between January 2019 and September 2023 were retrospectively analyzed. All patients who underwent cheliectomy surgery without additional procedures were included in this study. Other inclusion criteria included preoperative anteroposterior radiographs, access to clinical scores, and operative notes.

Patients who underwent foot and ankle surgery before or after cheliectomy, those with rheumatological diseases, and those without appropriate images and records in the archive search were excluded. Patients were also invited back to evaluate their postoperative functional outcomes using the first MTP joint dorsiflexion (DF) angle measurement, visual analog scale (VAS) and American Orthopaedic Foot and Ankle Society (AOFAS) scores. The patients' preoperative plain film radiographs were independently analyzed by three authors and graded according to the Coughlin and Shurnas classification system (10). Passive range of motion at the first MTP joint was assessed using a goniometer (11). The degree of dorsiflexion was measured by measuring the angle between the digits in the sagittal plane after the maximum dorsiflexion range of the digit was reached with an applied passive force. Functional outcomes were assessed using AOFAS and VAS scores. The VAS score is represented by a line ranging from one to ten, corresponding to the severity experienced by the patient. A score of one indicates no pain, while a score of 10 indicates the maximum amount of pain. In the AOFAS score, the patient reports the amount of pain and function, and the patient's functional outcomes are calculated together with the stability and alignment noted during the physical examination (12).

2.1. Surgical procedure

All surgical interventions were carried out under spinal anesthesia with the application of a tourniquet. A dorsomedial skin incision was made, and the extensor hallucis longus tendon was gently retracted to allow visualization of the first metatarsophalangeal joint. Approximately one-fourth of the metatarsal head was excised using an oscillating saw. Osteophytes located on the proximal phalanx and any residual spurs on the metatarsal head were carefully removed with a rongeur. The resected surfaces were then refined using a rasp. In cases requiring cartilage repair, microfracture was performed by debriding the damaged dorsal cartilage and creating multiple perforations using 1 mm Kirschner wires spaced at 2–3 mm intervals. Finally, the joint capsule was sutured with interrupted absorbable stitches (Figure 1).

Figure 1. Surgical image of a patient who underwent microfracture after cheilectomy

2.2. Statistical analysis

The statistical evaluation of the data was performed using IBM SPSS Statistics version 22.0 (Armonk, NY, USA). Continuous variables were expressed as mean ± standard deviation (SD), and categorical variables were summarized using numbers and percentages. The Shapiro-Wilk test was conducted to examine the normality of variable distributions.

For within-group comparisons of preoperative and postoperative scores (VAS, AOFAS, and dorsiflexion angle), the paired t-test was used when normal distribution was confirmed; otherwise, the Wilcoxon signed-rank test was applied. For between-group comparisons of postoperative outcomes, the independent samples t-test was used for normally distributed variables, and the Mann-Whitney U test was used for non-normally distributed variables.

The distribution of HR grade (Coughlin and Shurnas classification) was presented as the number and percentage of feet in each group. A significance level of $p < 0.05$ was considered statistically significant.

3. Results

A total of 62 feet from 62 patients were included in the study, with 32 feet in the Cheilectomy group (Group 1) and 30 feet in the Cheilectomy + Microfracture group (Group 2). In Group 1, 40.6% of feet were grade 2, and 59.4% were grade 3. In Group 2, 50% of feet were grade 2 and 50% were grade 3. (Table 1). The demographic profiles of the patients are summarized in Table 2. No statistically significant differences were identified between the two study groups regarding age, body mass index (BMI), or the duration of follow-up. ($p > 0.05$ for all comparisons)

Table 1. Patient grouping

Group	Surgical procedure	HR grade	Number of feet	p-value
1	Cheilectomy	2	13 (40.6%)	
		3	19 (59.4%)	
2	Cheilectomy + Microfracture	2	15 (50.0%)	
		3	15 (50.0%)	
Overal				1.000

Table 2. Patient demographic data

		Group 1	**Group 2**	**p-value**
Number of patients		32	30	
Sex	Female (n, %)	28 (87.5%)	25 (83.3%)	1.000
	Male (n, %)	4 (12.5%)	5 (16.7%)	
Side	Right foot (n, %)	22 (68.8%)	18 (60.0%)	0.371
	Left foot (n, %)	10 (31.2%)	12 (40.0%)	
Age (years)	(Mean ± SS)(range)	56.84 ± 8.37(40-73)	54.03 ± 8.11(42-69)	0.185
BMI (kg/m^2)	(Mean ± SS)	28.89 ± 3.52	28.54 ± 3.43	0.691
Time to follow up (months)	(Mean ± SS)(range)	25.81 ± 7.21(18-40)	23.13 ± 7.34(16-42)	0.153

In both groups, postoperative VAS scores significantly decreased compared to preoperative values (Group 1: $p < 0.001$; Group 2: $p < 0.001$) (Figure 2).

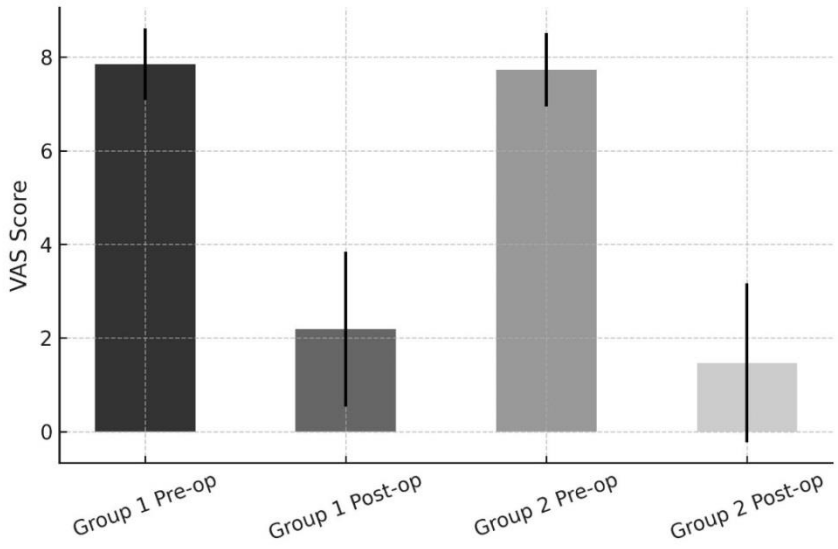
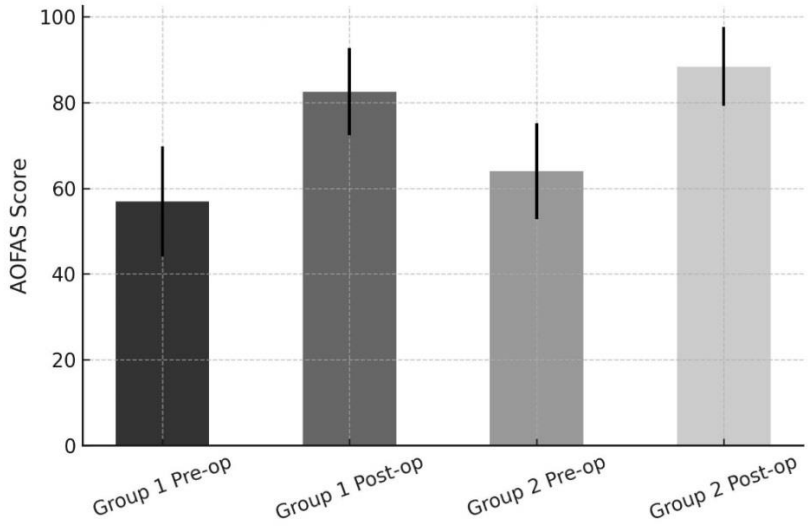


Figure 2. Pre-op vs. post-op. VAS scores (Group 1: cheilectomy; Group 2: cheilectomy and microfracture)

Similarly, AOFAS scores significantly increased postoperatively in both groups (Group 1: $p < 0.001$; Group 2: $p < 0.001$) (Figure 3).

Figure 3.Pre-op vs. post-op. AOFAS scores (Group 1: cheilectomy; Group 2: cheilectomy and microfracture)



Postoperative dorsiflexion angles also significantly improved in both groups (Group 1: $p < 0.001$; Group 2: $p < 0.001$) (Figure 4).

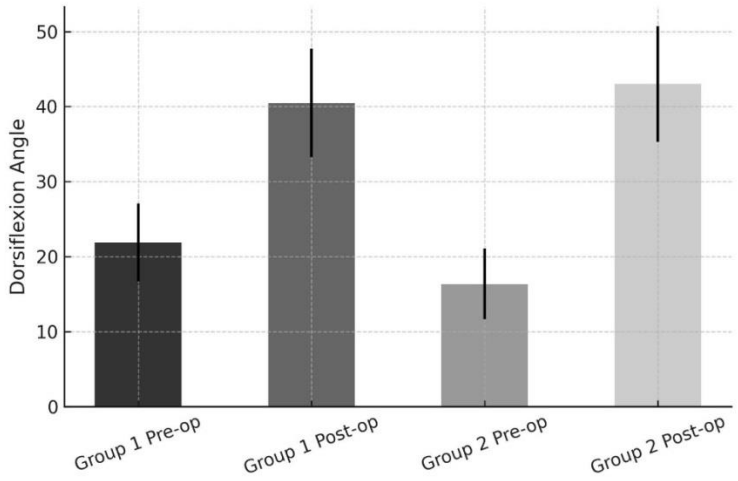


Figure 4. Pre-op vs. post-op. MTP dorsiflexion angle (Group 1: cheilectomy; Group 2: cheilectomy and microfracture)

In the postoperative outcome comparison between the two groups, postoperative AOFAS scores were significantly higher in Group 2 compared to Group 1 ($p = 0.0168$) (Table 3). No significant differences were found between the groups in terms of postoperative VAS ($p = 0.1593$) or dorsiflexion angle ($p = 0.1593$).

Table 3. Comparison of postoperative VAS score, AOFAS score and dorsiflexion angle between groups

	Group 1 (Ort ± SS)	**Group 2 (Ort ± SS)**	**p-value**
VAS scores	2.19 ± 1.65	1.47 ± 1.70	0.1593
AOFAS scores	82.53 ± 10.18	88.43 ± 9.22	**0.0168**
DF degrees	40.47 ± 7.22	43.00 ± 7.72	0.1593

4. Discussion

Our study demonstrated significant improvements in pain, function, and dorsiflexion in both groups after surgery. Importantly, patients treated with cheilectomy combined with microfracture achieved better functional outcomes, as reflected by significantly higher postoperative AOFAS scores compared with the isolated cheilectomy group. This suggests that the addition of microfracture may provide clinical benefits by enhancing joint function. Furthermore, this approach could potentially delay the need for joint-sacrificing procedures such as arthrodesis, although longer-term follow-up studies are required to confirm this benefit.

Many studies have reported that cheilectomy has good results in patients with low HR stages (stages 1,2) (7,10). Our study showed good results in the short and medium-term follow-ups after cheilectomy for HR, which is consistent with the current literature. In patients with higher stage HR (stages 3,4), it may be necessary to prefer joint-sacrificing surgeries such as arthrodesis (13,14). Our study reports good improvement in AOFAS and VAS scores even in patients with higher HR degrees (stage 3), supporting the claim that cheilectomy is a viable option (7,15).

Cheilectomy preserves the joint structure and provides a suitable basis for the transition to revision interventions or procedures that eliminate the joint, such as arthrodesis or arthroplasty when undesirable surgical results occur. In addition, this method can prevent possible complications such as union problems and irritation caused by the implant after osteotomy or arthrodesis (16,17). However, concerns about losing range of motion in the joint lead many patients to avoid fusion surgery. For all these reasons, cheilectomy is an important first-line surgical approach for treating hallux rigidus. Additional procedures have been investigated to improve outcomes. Microfracture has been reported to be beneficial in both experimental and clinical studies, contributing to the alleviation of degeneration (9,18,19). Microfracture aims to stimulate fibrocartilage formation by penetrating the subchondral bone, and early studies combining cheilectomy with microfracture (and sometimes with other techniques) have shown significant improvements in pain and function. A 2005 prospective study (41 patients, 46 feet) reported significant improvements in VAS and AOFAS scores after cheilectomy + microfracture (20). More recently, a 12-month follow-up of a novel combination procedure (cheilectomy + microfracture + scaffolds) reported significant improvements across NPR, EFAS, and SF 36 domains (21). In support of these techniques, AOFAS scores were significantly higher in the cheilectomy and microfracture group in our study. Many authors have reported that joint degeneration progresses after cheilectomy (7,10,15). Microfracture after cheilectomy may offer an opportunity to repair the remaining cartilage damage between the first metatarsal and proximal phalanx in lower-stage cases. In our study, we directly evaluated standard cheilectomy and cheilectomy reinforced with microfracture as a comparison, and we did not find a similar study when we reviewed the literature. This study has several limitations. First, it was retrospective in design and conducted in a single center with a relatively small sample size, which may limit the generalizability of the findings. Second, although functional outcomes were evaluated with validated scoring systems (VAS, AOFAS, DF angle), advanced imaging or biomechanical analyses were not performed. Third, no bilateral hallux rigidus cases operated during the study period were included; therefore, all patients represented unilateral procedures. Finally, the follow-up duration was limited to the short- to mid-term, and longer follow-up is required to confirm the durability of the procedure.

In conclusion, the microfracture procedure performed in addition to cheilectomy in the treatment of hallux rigidus positively affected surgery by significantly increasing AOFAS scores in the short-medium term. However, prospective long-term studies are needed to reach a definitive conclusion about its long-term effectiveness in treating hallux rigidus.

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