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# Arthroscopic Repair of Extruded Meniscus Tears: Impact on Symptom Relief and Functional Improvement – A 2-Year Follow-Up Study

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Statistical Analysis C  
Data Interpretation D  
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**Background:** This retrospective study from a single center in Turkey aimed to evaluate 2-year outcomes of 21 patients undergoing knee arthroscopic repair of extruded meniscus tears without root tear.


**Material/Methods:** The retrospective study comprised 21 individuals who underwent arthroscopic extruded meniscus repair and were followed up for at least 2 years. The study analyzed the meniscus extrusion amounts in preoperative and postoperative MRI scans, the Kellgren-Lawrence stages in knee radiographs, and the Lsyhom and The International Knee Documentation Committee (IKDC) scores of the included patients.

**Results:** In this study, the repair operation extrusion levels were 3.30 mm from 4.01 mm preoperatively ( $P<0.001$ ). After the repair, there was a significant increase in the Lsyhom and IKDC scores ( $P<0.001$ ). According to the Kellgren-Lawrence scale, 12 patients were evaluated as stage 0, 6 patients as stage 1, and 3 patients as stage 2. According to the radiographs taken at the last follow-up, 2 patients progressed from stage 0 to stage 1, 2 patients progressed from stage 1 to stage 2, and 1 patient progressed from stage 2 to stage 3.

**Conclusions:** Arthroscopic treatment of extruded meniscus tears can enhance functional status and increase patients' functional status. Nevertheless, the absence of successful centralization extruded meniscus tears. This study discovered that radiological extrusion did not diminish beyond the critical threshold of 3 mm, which is associated with the development of osteoarthritis. This highlights the necessity of taking these elements into account when devising a treatment plan.

**Keywords:** **Arthroscopy • Extrude • Tibial Meniscus Injuries • Follow-Up Studies • Magnetic Resonance Imaging • Osteoarthritis, Knee**

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## Introduction

The knee joint's physiological function relies on the meniscus, a crucial anatomical component. The primary role of load bearing is to offer shock absorption and maintain joint stability. Regrettably, meniscus tears and extrusions impair the fundamental functioning of the meniscus [1]. Tearing or extrusion of the menisci can lead to alterations in knee mechanics, potentially triggering or expediting the progression of osteoarthritis [2].

Meniscus extrusion (ME) refers to the movement of the meniscus away from the margin of the knee joint [3]. During extrusion, the meniscus deviates from its original position between the tibiofemoral joint and protrudes into the groove, resulting in reduction of its mechanical functionality [2]. Physiological extrusion can be observed in both the medial and lateral menisci. Various patient- and joint-related characteristics influence the extent of extrusion. Higher levels of ME are associated with increasing age, body mass index (BMI), osteoarthritis, and meniscus tears [4,5]. Knee discomfort may be caused as a secondary effect of medial meniscus protrusion. Once the meniscus is displaced, the femoral condyle and tibial plateau make direct contact, causing degeneration of cartilage in the tibiofemoral joint and the progression of arthrosis [6].

Magnetic resonance imaging (MRI) is often regarded as the most reliable method for assessing ME [7]. Medial meniscus extrusion that extends more than 3 mm beyond the margin of the tibial plateau at the level of the medial collateral ligament on MRI has been linked to a notable increase in articular cartilage loss and the production of osteophytes [8-10].

The objective of extruded meniscus treatment is to minimize extrusion while also addressing the underlying cause of extrusion [11]. Allaire et al showed that a knee that had undergone knee meniscectomy following a meniscus root tear had extruded meniscus formations [12]. While modern surgical techniques can effectively fix the meniscus root at its anatomical attachment location, non-anatomical repair methods are unable to restore the contact area or average contact pressures of a healthy knee or anatomically repaired meniscus [9,13]. Recent biomechanical research indicates that employing peripheral stabilizing sutures can enhance the contact mechanics of the knee and decrease extrusion levels [14].

The aim of extruded meniscus treatment is to minimize extrusion and apply the treatment method appropriate to the tear pattern. Non-anatomical repair methods that do not provide meniscus centralization may not improve contact mechanics and reduce extrusion levels. Meniscus extrusion can result from a tear in the root or from various types of tears in the meniscus, such as radial, longitudinal, horizontal, oblique,

or complex tears, without involving the root [15]. The purpose of this study was to determine if radiographic extrusion drops below 3 mm following arthroscopic repair of meniscus tears that are extruded more than 3 mm and do not involve a root tear, as there is currently no existing literature on this topic.

This retrospective study from a single center in Turkey aimed to evaluate 2-year outcomes of 21 patients undergoing knee arthroscopic repair of extruded meniscus tears without root tears.

## Material and Methods

### Ethics Approval and Informed Consent

Approval for the study was granted by the Local Ethics Committee, and informed consent was obtained from all the patients (2023/1292). The study retrospectively examined patients who underwent knee arthroscopy from January 2011 to January 2022. The data were obtained from the data system of Ankara Training and Research Hospital. Patients outside of this time range were excluded from the study, while all other patients were assessed. We enrolled patients who were assessed and had extruded meniscus tears without arthroscopically-treated root tears and had complete data.

### Study Design and Data Collection

Our study included male and female patients aged 18-55 years who had preoperative and postoperative MRI data. We specifically focused on patients with extruded meniscus tears larger than 3 mm but without root tears. Additionally, we only included patients who received arthroscopic meniscus repair without meniscectomy. Exclusion criteria were: age under 18 years or older than 55 years, did not have preoperative or postoperative MRI results, with meniscus tears of 3 mm or less, with meniscus root tears, underwent partial or total meniscectomy, did not undergo meniscus repair, had revision meniscus surgery, and those with knee-related issues. We also excluded patients with residual effects from fractures (**Figure 1**).

The study retrospectively recorded demographic information of the patients from the hospital data system. The patients' radiographs, which were taken in the anteroposterior and lateral positions with 30 degrees of flexion while standing with weight bearing, were assessed using the Kellgren-Lawrence (K-L) scale. The radiographs were categorized into 5 distinct groups ranging from stages 0 to 4. The study analyzed the degree of extrusion of the meniscus and the specific type of tear in the meniscus by examining the preoperative and postoperative knee MRIs of the patients included in the study. Meniscal extrusion is defined as meniscal tissue extending 3 mm or more beyond the edge of the tibial plateau, as measured by MRI.

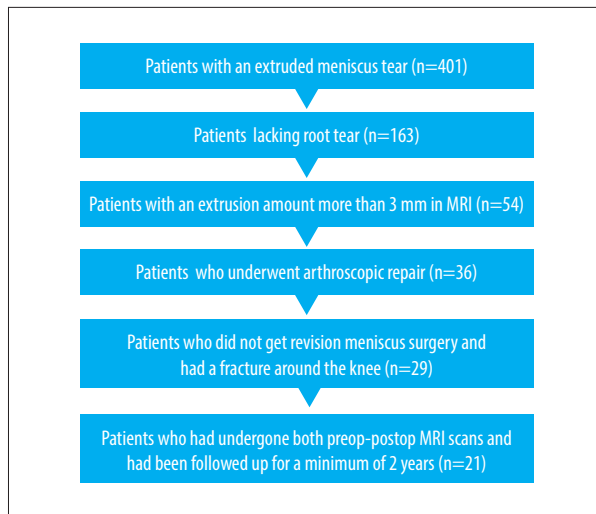


Figure 1. Study inclusion criteria flow chart.

One of the authors conducted radiological measurements. To prevent inter-rater mistakes, an additional author conducted measurements of all radiological parameters as well. To evaluate consistency between different raters, the measurements were conducted again 6 weeks later by the same authors. Reliability was assessed by calculating intraclass coefficient correlations (ICCs). The intraobserver reliability coefficient for MRI meniscal extrusion measures was determined to be 0.847, while the interobserver reliability coefficient was found to be 0.812.

### Orthopedic Surgical Methods

While the patient was in supine position and the knee was flexed, access to the knee was made through the anterolateral and anteromedial portals. Meniscus tear was determined arthroscopically. The torn ends of the meniscus were freshened with a shaver and meniscus rasp. The meniscus tear was repaired using the all-inside and outside-in method. During arthroscopy, the size and location of the meniscus tear, the method used, and the number of stitches were recorded.

### Clinical Follow-Up

Prior to surgery, the patients' functional state was assessed using the non-disease-specific Lysholm knee scoring scale and the IKDC (The International Knee Documentation Committee) questionnaire, which were administered in person. The subjective IKDC questionnaire score, a score of 95-100 was graded excellent, 90-94 was excellent, 80-89 was good, 70-79 was fair, and less than 70 was poor, according to IKDC subjective classification. The Lysholm score consists of 8 items: limping, climbing stairs, squatting, locking, instability, pain, swelling, and use of support.

The patients were administered the preoperative Lysholm knee grading scale and IKDC questionnaire once again during their 12-month postoperative follow-up, and the results were documented. Therefore, the scores before and after the operation were compared.

### Statistical Analysis

The data analysis was conducted using SPSS 20 software. The normality of the data was assessed using the Kolmogorov-Smirnov test. The categorical data were analyzed using Fischer's exact test, while the quantitative data was analyzed using either an unpaired *t* test or one-way ANOVA, depending on whether the data followed a normal distribution or not. A significance level of  $P < 0.05$  was deemed acceptable to establish the presence of a statistically significant difference.

## Results

### Demographic Characteristics and Clinical Presentation of Patients

Of the individuals that took part in the study, 66.7% ( $n=14$ ) were male and 33.3% ( $n=7$ ) were female. The average age of the participants was  $34.86 \pm 2.66$  (range, 19-55) years. The right knee of 13 patients (61.9%) included in the study and the left knee of 8 patients (38.1%) were operated on due to extruded meniscus tear (Table 1).

### Radiographic Outcomes

While the average preoperative extrusion amount of the patients was 4.01, the postoperative average extrusion amount was 3.30 (Table 2). Following the repair procedure, extrusion levels were observed to decrease significantly ( $P < 0.001$ ).

In the control MRI taken after the surgery, 61.9% ( $n=13$ ) of the patients showed meniscus extrusion of less than 3 mm, which is the critical value. It was observed that adequate meniscus centralization could not be achieved after surgery in 38.1% of the patients ( $n=8$ ). No significant relationship was found between the type of meniscus tear and the inability to achieve adequate centralization ( $P=0.904$ ). There was no statistically significant relationship between the type of repair and failure to provide adequate centralization ( $P=0.063$ ). No statistically significant relationship was found between the time elapsed after the operation and the inability to achieve adequate centralization ( $P=0.804$ ).

The patients included in the study were evaluated according to the Kellgren-Lawrence (K-L) scale during the preoperative and final postoperative follow-ups, and were divided into

**Table 1.** Side, types of meniscus tears and technical repair.

		n	%
Side	Left	13	61.9%
	Right	8	38.1%
Type	L/Vertical	1	4.8%
	M/Horizontal+Elonge ACL	1	4.8%
	M/Horizontal	5	23.8%
	M/Bucket handle+ACL	3	14.3%
	L/Complex	1	4.8%
	L/Horizontal	3	14.3%
	M/Complex	3	14.3%
	L/Longitudinal+ACL	1	4.8%
	M/Horizontal+ACL	1	4.8%
	M/Complex Degenerate	2	9.5%
Repair	1 Piece all inside	6	28.6%
	2 Piece all inside	8	38.1%
	3 Piece all inside	2	9.5%
	1 Piece out in	2	9.5%
	1 All inside 1 out in	1	4.8%
	2 All inside 1 out in	1	4.8%
	3 All inside 1 out in	1	4.8%

**Table 2.** Preop-postop extrusion.

Extrusion	N	Mean difference	Significance		Std. deviation	95% Confidence interval of the difference	
			One-sided p	Two-sided p		Lower	Upper
Preop	21	4.01714	<0.001	<0.001	0.40015	3.8350	4.1993
Postop	21	3.30286	<0.001	<0.001	0.24830	3.1898	3.4159

**Table 3.** The Kellgren-Lawrence (K-L) scale categorizes patients into different stages.

	Evre 0	Evre 1	Evre 2	Evre 3	Evre 4
Preop	12	6	3	0	0
Final postoperative follow-up	10	6	4	1	0

5 different groups stages 0-4. The patients were then divided into 5 groups based on their stage of knee degeneration, ranging from stage 0 to stage 4. **Table 3** shows that 12 patients were assessed as stage 0, 6 patients as stage 1, and 3 patients as stage 2, based on the Kellgren-Lawrence (K-L) scale. Based on the radiographs obtained during the latest follow-up, it was observed that 2 patients advanced from stage 0 to

stage 1, 2 patients advanced from stage 1 to stage 2, and 1 patient advanced from stage 2 to stage 3.

**Functional Outcomes**

Patients were evaluated with the Lysholm score before and after the repair procedure. The average Lysholm score of the

**Table 4.** Preop-postop Lysholm score.

Lysholm score	N	Mean difference	Significance		Std. deviation	95% Confidence interval of the difference	
			One-sided p	Two-sided p		Lower	Upper
Preop	21	61.00000	<0.001	<0.001	5.08183	58.6868	63.3132
Postop	21	74.30100	<0.001	<0.001	3.64072	72.5971	76.0049

**Table 5.** Preop-postop IKDC score.

IKDC score	N	Mean difference	Significance		Std. deviation	95% Confidence interval of the difference	
			One-sided p	Two-sided p		Lower	Upper
Preop	21	59.76381	<0.001	<0.001	3.23237	58.2925	61.2352
Postop	21	72.45300	<0.001	<0.001	2.56663	71.2518	73.6542

patients, whose preoperative Lysholm score was 61, was 74.3 after the surgery. Patients were evaluated with the IKDC score before and after the repair procedure. The mean IKDC score of the patients, whose preoperative IKDC score was 59.76, was 72.45 after the surgery. After the repair, there was a clear increase in the evaluation scores of both patient evaluation forms ( $P<0.001$ ) (Tables 4, 5).

## Discussion

In this study, the repair operation extrusion levels were 3.30 mm from 4.01 mm preoperatively ( $P<0.001$ ). After the repair, there was a significant increase in the Lysholm and IKDC scores ( $P<0.001$ ). According to the Kellgren-Lawrence scale, 12 patients were evaluated as stage 0, 6 patients as stage 1, and 3 patients as stage 2. According to the radiographs taken at the last follow-up, it was noted that 2 patients progressed from stage 1 to stage 2. The results of our study indicate a clear reduction in postoperative meniscus extrusion and a notable improvement in the functional status of the patients. Nevertheless, we observed that the meniscus extrusion did not decrease to a value lower than the crucial threshold of 3 mm (Figure 2).

Arthroscopic repair of extruded meniscus tears, in the absence of root tears, effectively realigns the position of the meniscus as observed by radiological imaging [16,17]. This surgical procedure also leads to significant clinical improvement in the functional status of patients [18,19]. In extruded meniscus tears, decreasing the radiological extrusion below 3 mm, which is the critical value for the development of osteoarthritis, is necessary

to preserve the load-bearing function of the meniscus [17,20]. However, we noted that the meniscus extrusion did not diminish to a measurement below 3 mm. Consequently, our findings indicate that in the arthroscopic treatment of extruded meniscus tears, failure to achieve centralization of the meniscus through tibial fixation will not prevent the onset of osteoarthritis in patients in subsequent years, as the meniscus loses its capacity to bear weight. This study was conducted based on long-term follow-ups and a large sample size because there is no existing literature that demonstrates whether radiological extrusion decreases below 3 mm, which is the critical value for the development of osteoarthritis, after arthroscopic repair of meniscus tears without a root tear and with extrusion greater than 3 mm. This failure occurs because the load-bearing function of the meniscus is disrupted [21,22]. There were 5 patients who experienced progressive osteoarthritis over the course of several years. The severity of the patients' condition also advanced by 1 stage based on the Kellgren-Lawrence (K-L) scale. K-L values of 5 patients with progressive osteoarthritis were compatible with extinction values. It is thought that in these patients, the extrusion did not improve sufficiently in postoperative MRI; therefore, the meniscus was non-functional, causing osteoarthritis to develop in the knee. Additionally, degeneration of the meniscus had begun in these patients.

Chernchujit and Agrawal conducted a study in 2019 to examine the decrease of medial meniscus extrusion by the use of arthroscopic techniques [23]. Other studies on centralization of the extruded meniscus have also shown that tibial fixation improves extrusion [18]. A strong correlation has been discovered between the techniques used and the outcomes





**Figure 2.** (A) In the preoperative MRI of 1 of the patients participating in the study, the amount of meniscus extrusion was measured as 4.4 mm. (B) In the postoperative control MRI of the patient in Figure 1A, the amount of meniscus extrusion was measured as 3.2 mm, and it was noteworthy that the meniscus centralization was over 3 mm.

obtained. In these studies, functional and radiological results were reported to be significantly improved. Our study, like the study mentioned above, found a significant decrease in meniscus extrusion and functional results after arthroscopic surgery. However, in our series, 38.1% (n=8) of extrusion patients did not recover sufficiently.

From a radiological perspective, many authors have observed a significant reduction in meniscal protrusion following arthroscopic surgery [16,23], and they reported better radiological results with fixation of the meniscus on the side of the tibial joint. In our study, we found insufficient radiological improvement in 8 patients because the meniscus extrusion did not decrease below 3 mm.

Likewise, the rise in preoperative and postoperative knee evaluation ratings also signifies a substantial enhancement in the patients' functional condition. The observed enhancements in Lysholm and IKDC scores demonstrate the therapeutic efficacy of arthroscopic repair, leading to improved daily activities and quality of life for patients. Our investigation demonstrated a notable enhancement in clinical ratings, aligning with the results of previous studies [24-26]. The notable enhancements reported in Lysholm and IKDC scores imply a substantial change in the patients' functional condition.

The authors showed that the development of osteoarthritis increased as the amount of meniscus extrusion and degeneration of the meniscus increased in patients who underwent partial meniscectomy [27]. Our study showed that the excessive amount of meniscus extrusion and the postoperative extrusion that did not decrease below 3 mm may be clinically responsible for the development of osteoarthritis. Insufficient extrusion recovery was detected in 38.1% (8) of our patients, and an increase in the development of osteoarthritis was detected in the radiographs of these patients.

### Limitations

This study has certain limitations. First, it was retrospective. Second, the number of patients was small. Third, the repair method applied to patients may be a combination of inside-out or outside-in methods. Furthermore, since our study had a small sample size, it would be more precise to compare our results with studies that have been conducted using bigger samples. However, extruded meniscus tear without root tear is a very rare condition and the primary pathology is often overlooked. This study emphasizes that more attention should be paid to extruded meniscus tears without root tears.

## Conclusions

Arthroscopic treatment of extruded meniscus tears can enhance functional status and increase patients' functional status. Nevertheless, there was no successful meniscus centralization in patients whose osteoarthritis level progressed from stage 1 to stage 2. This study discovered that radiological extrusion did not diminish beyond the critical threshold of 3 mm, which is associated with the development of osteoarthritis. This highlights the necessity of taking these elements into account when devising a treatment plan. Our study's results align with

previous related studies. While arthroscopic repair effectively reduces extrusion without employing meniscus centralization techniques like tibial fixation, it cannot achieve an extrusion level lower than the desired optimal amount.

## Declaration of Figures' Authenticity

All figures submitted have been created by the authors who confirm that the images are original with no duplication and have not been previously published in whole or in part.

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