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ORIGINAL ARTICLE

Mid-term evaluation of clinical and functional outcomes after arthroscopic medial longitudinal and bucket-handle meniscus repair

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The menisci have roles in shock absorption, proprioception, knee joint stability, and lubrication.[1] Previously, it was demonstrated that contact pressure significantly increased even after partial meniscectomy.[2] Meniscectomy has been associated with osteoarthritis in the long-term.[3] Thus, repair of meniscal tears is recommended by most authors, particularly in young patients.[4] Since partial meniscectomy predisposes to osteoarthritis, preserving menisci may reduce the risk of degeneration and disability.[5]

Longitudinal tears are common and are often repairable.[6] Bucket-handle tears are complex and

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ABSTRACT

Objectives: The aim of this study was to evaluate clinical and functional outcomes following the arthroscopic medial meniscal repair.

Patients and methods: A total of 50 patients (42 males, 8 females; mean age: 32.9±7.6 years; range, 17 to 48 years) who underwent arthroscopic repair for longitudinal and bucket-handle medial meniscal tears between March 2005 and October 2011 were retrospectively evaluated. The patients were divided into two groups as those having a longitudinal tear (patient group, n=31) and having a bucket-handle tear (control group, n=19). Preoperative and final follow-up functional outcomes were evaluated using the Lysholm Knee Score (LKS), International Knee Documentation Committee (IKDC) score, Tegner Activity Scale (TAS) score, and Knee Injury and Osteoarthritis Outcome Score (KOOS).

Results: The mean follow-up was 61.7±22.8 (range, 36 to 110) months. The mean preoperative LKS, IKDC score, TAS, and KOOS scores were significantly improved at the final postoperative follow-up ($p<0.05$). There was no significant difference in functional outcome scores between longitudinal and bucket-handle repairs ($p>0.05$), and isolated repairs and concomitant meniscal repair and anterior cruciate ligament reconstruction ($p>0.05$).

Conclusion: Arthroscopic meniscal repair provides similar mid-term functional and clinical outcomes for longitudinal and bucket-handle medial meniscal tears. Concomitant meniscal repair does not seem to affect meniscal healing.

Keywords: Anterior cruciate ligament, International Knee Documentation Committee, Lysholm Knee Score, meniscal repair, meniscal tear, meniscus.

larger in size with displacement. Partial meniscectomy and meniscal repair are the treatment choices for both longitudinal and bucket-handle meniscal tears.[7]

Meniscal repair provides the improvement of knee function and, pain and mechanical symptom relief. The all-inside and inside-out techniques are commonly used in the meniscal repairs. In the literature, no significant difference has been shown in clinical outcomes and failure rates between the two techniques.[8] However, there are still controversies regarding the effect of age, sex, concurrent anterior cruciate ligament (ACL) reconstruction, chronicity, involving medial or lateral meniscus on meniscal healing rates.[1,9,10]

In the literature, satisfactory outcomes have been reported following longitudinal and bucket-handle meniscal repairs.[1,11,12] In the present study, we aimed to evaluate the functional and clinical outcomes of the patients undergoing arthroscopic repair of longitudinal and bucket-handle tears with a mean five-year follow-up, based on the hypothesis that comparable clinical and functional outcomes would be obtained after longitudinal and bucket-handle meniscal repair.

PATIENTS AND METHODS

This single-center, retrospective study was conducted at University of Health Sciences, Baltalimani Bone Diseases Education and Research Hospital, Department of Orthopedics and Traumatology between March 2005 and October 2011. A total of 91 patients underwent arthroscopic meniscal repair surgery during the study period. Inclusion criteria were longitudinal and bucket-handle meniscal tears located in red-red or red-white zones, tears larger than 1 cm length and isolated tears or concomitant meniscal and ACL rupture. Exclusion criteria were radial, horizontal, flap and degenerative tears, patients underwent other procedures not related to the meniscal repair in the same session and, the presence of another pathology such as osteoarthritis, avascular necrosis, osteochondritis dissecans or rheumatoid arthritis. After exclusions, 50 patients (42 males, 8 females; mean age: 32.9±7.6 years; range, 17 to 48 years) who fulfilled the inclusion criteria were included. The patients were divided into two groups as those having a longitudinal tear (patient group, n=31) and having a bucket-handle tear (control group, n=19). A written informed consent was obtained from each patient. The study protocol was approved by the Metin Sabancı Baltalimani Bone Diseases Training and Research Hospital Ethics Committee (No: 14.04.2021/506). The study was conducted in accordance with the principles of the Declaration of Helsinki.

Characteristics of patients and features of the tears were noted. Preoperative radiographs and magnetic resonance imaging (MRI) scans were evaluated. Operative video records were reviewed to determine the type, the length, the localization and the vascular zone of the meniscal tears. The repair technique, the type of the suture material, the number of the sutures, and the orientation of the sutures in the meniscal body (vertical, horizontal or oblique) were recorded.

Surgical technique

Surgery was performed under general anesthesia. Standard anteromedial and anterolateral portals were used. The meniscal tear was assessed for the localization, stability, and reparability using an examination probe. Displaced bucket-handle type meniscal tears were reduced with a probe. If the patient was found to have a repairable tear, an arthroscopic shaver was used to prepare the tear edges before the repair. A rasp was, then, used to generate capillary bleeding.

The PDS 2/0 (Ethicon Inc., NJ, USA) suture material was used for all-inside-out repairs. For inside-out technique, suture needles were passed through both ends of the meniscal tear using cannulated guides and taken out of the skin with meticulous attention to be as close as possible (a maximum distance of 1 cm). Additional incisions were not used to protect saphenous nerve medially and peroneal nerve branches laterally in any patients.[13] Instead, stab incisions were used to tie the knots on the joint capsule. Stab incisions and portal incisions were closed with a nylon suture at the end of the surgery.

All-inside repairs were performed arthroscopically using the devices Fast-fix® (Smith & Nephew, Inc., MA, USA), Sequent (ConMed, Linvatec, Largo, FL, USA) and Meniscal Cinch (Arthrex, Naples; FL, USA) following the manufacturers' technical guidelines.

In patients with concomitant ACL injury, single bundle ACL reconstruction with hamstring autografts was performed at the same session with the meniscal repairs.

Clinical and radiological evaluation

The clinical evaluation was performed by a blinded orthopedic surgeon. The range of motion (ROM) and knee stability, the presence of effusion, joint line tenderness was evaluated, and McMurray test was performed. Knee stability was evaluated

with Lachman and pivot-shift tests. Neurological examination was performed for possible nerve irritation or neuroma that may be occurred due to meniscal repair. Preoperative and final follow-up Lysholm Knee Score (LKS), International Knee Documentation Committee (IKDC) score, Tegner Activity Scale (TAS) score, and Knee Injury and Osteoarthritis Outcome Score (KOOS) were used for functional evaluation between longitudinal and bucket-handle tears.[14-17]

Statistical analysis

Statistical analysis was performed using the IBM SPSS version 22.0 software (IBM Corp., Armonk, NY, USA). Descriptive data were expressed in mean ± standard deviation (SD) or median (min-max) for continuous variables and in number and frequency for categorical variables. The distribution of variables was evaluated using the Kolmogorov-Smirnov test. The analysis of the quantitative data was performed with independent t-test and Mann-Whitney U test. The chi-square test was used to analyze the quantitative values, whereas the Fisher test was applied when the chi-square test was not appropriate. Spearman correlation analysis was performed for correlation analysis. The Wilcoxon signed-ranked test was performed for repeated measurements. A p value of <0.05 was considered statistically significant.

RESULTS

The mean follow-up period was 61.7±22.8 (range, 36 to 110) months. Right knee was operated in 33 (66%) patients, and left knee was operated in 17 (34%). Medial meniscus was repaired in all patients. Concomitant ACL rupture was present in 30 (60%) patients in which ACL reconstruction was performed in the same session with the meniscal repair. Twenty-four (48%) patients were operated in the acute and subacute period (in the first 3 months after the initial trauma), whereas the remaining 26 (52%) patients were operated in the chronic period (after the first three months). Forty-four (88%) of the meniscal tears were localized in the red-red zone, while the remaining six

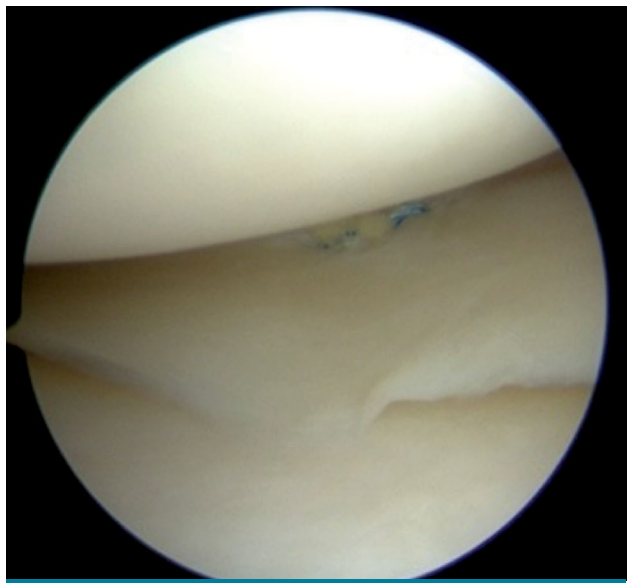

FIGURE 2. Repaired medial longitudinal meniscus tear.

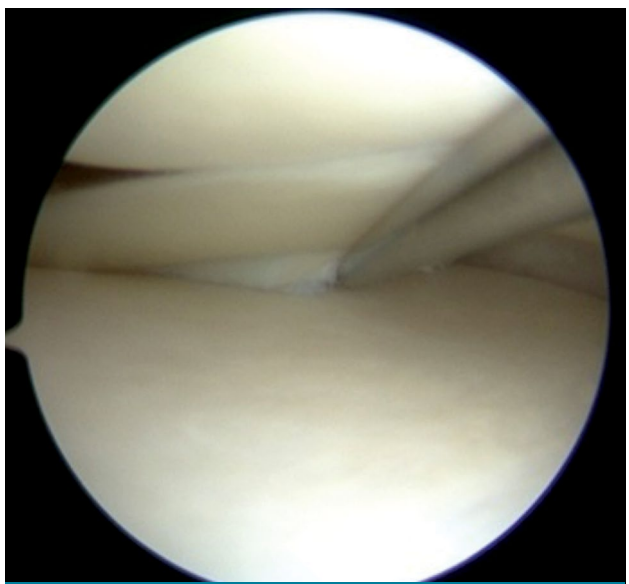

FIGURE 1. Medial longitudinal meniscus tear.

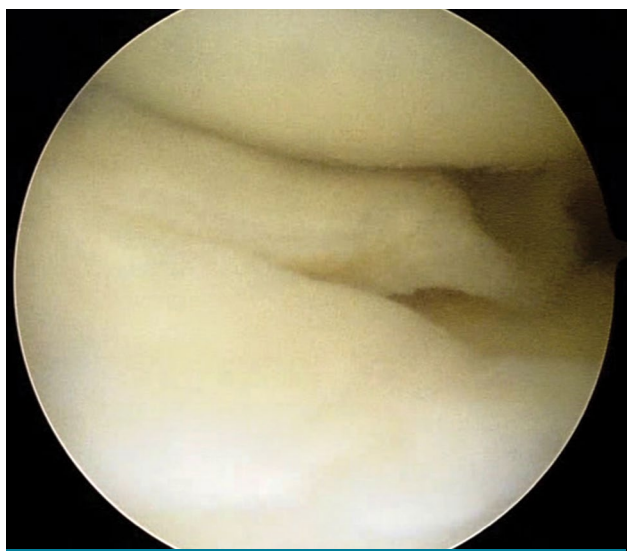

FIGURE 3. Displaced unstable medial bucket-handle meniscus tear.

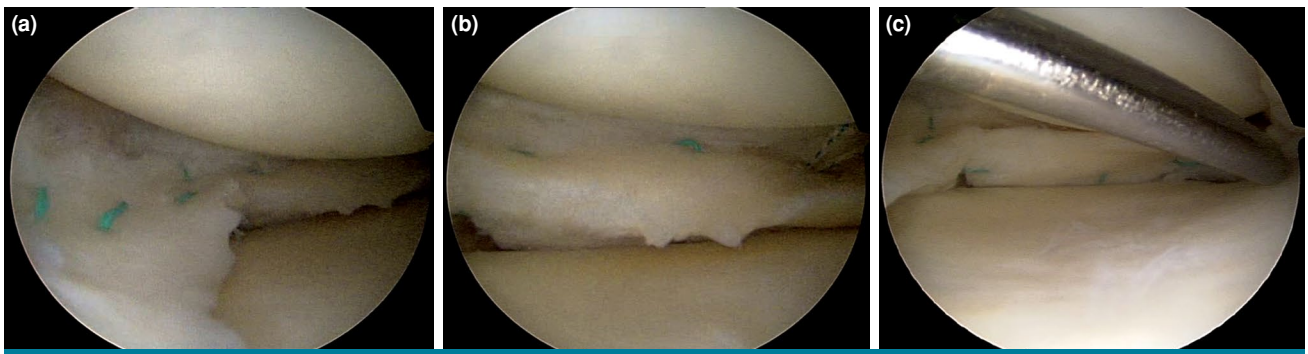

FIGURE 4. (a) Repaired medial bucket-handle meniscus tear from anterior horn to midbody. **(b)** Repaired medial bucket-handle meniscus tear from midbody to posterior. **(c)** Repaired medial bucket-handle meniscus tear of the posterior horn.

(12%) tears were in the red-white zone. The meniscal tear type was longitudinal in 31 (62%), and bucket handle type in 19 (38%). Inside-out meniscal repair was performed in 46 (92%) patients. All-inside repair was performed in four (8%) patients, and inside-out repair combined with all-inside technique was performed in eight (16%) patients (Figures 1-4). The mean number of the sutures performed was 3.6±2.4 (range, 2 to 11). The mean period between the onset of the complaints and surgery was 13.1±16.9 (range, 0 to 120) months (Table I).

There was a statistically significant improvement in the LKS, IKDC, TAS, and KOOS scores postoperatively (24.1±19.5 *vs.* 85.0±12.2, 23.8±10.1 *vs.* 74.6±21.3, 2.9±1.4 *vs.* 4.9±1.9 and 37.6±14.8 *vs.* 79.9±14.6, respectively) ($p<0.05$) (Table II). According to the results, LKS was perfect (80-100 points) in 38 patients (62.29%), good (70-79 points) in 17 patients (27.86%), fair (60-69 points) in three patients (4.91%), and poor (<60 points) in three patients (4.91%). The outcomes of the latter three (6%) patients considered as treatment failure.

There was no significant difference between bucket-handle and longitudinal tears regarding pre- and postoperative LKS, IKDC, TAS, and KOOS scores (Table III). Additionally, there was no significant difference between isolated repairs and concomitant meniscal repair and ACL reconstruction groups regarding functional outcomes ($p>0.05$).

Postoperative paresthesia in the medial side of the cruris was developed in eight patients. Of these, inside-out technique was performed in six patients,

TABLE I
Patient characteristics

	Longitudinal group (n=31)			Bucket-handle group (n=19)			Total			
	n	%	Mean±SD	n	%	Mean±SD	n	%	Mean±SD	*p*
Age (year)			33.9±7.2			30.7±7.4			32.2±8.3	0.235
Sex										1.000
Female	5	16.1		3	15.7		8	16		
Male	26	83.9		16	84.3		42	84		
ACL rupture										
Yes	18	58		12	63.1		30	60		
No	13	42		7	36.9		20	40		
Age of tear (month)			28±26.8			29.4±40				0.921
Zone of rupture										0.681
RR	27	87.2		19	100		46	92		
RW	4	12.8		0	0		4	8		
Length of tear (mm)			3.1±0.7			3.7±0.6				0.893
Suture number			3.58±1.1			4.3±3			3.62±2.4	0.821

SD: Standard deviation; ACL: Anterior cruciate ligament; RR: Red-red; RW: Red-white.

TABLE II
Comparative results of pre- and postoperative outcome scores

	Preoperative	Postoperative	
	Mean±SD	Mean±SD	*p*
LKS	24.1±19.5	85.0±12.2	0.001
TAS	2.9±1.4	4.9±1.9	0.012
IKDC	23.8±10.1	74.6±21.3	0.001
KOOS	37.6±14.8	79.9±14.6	0.001

SD: Standard deviation; LKS: Lysholm Knee Score; TAS: Tegner Activity Scale; IKDC: International Knee Documentation Committee; KOOS: Knee Injury and Osteoarthritis Outcome Score.

TABLE III
Pre- and postoperative outcome scores of longitudinal and bucket-handle tear groups

	Longitudinal (n=31)	Bucket-handle (n=19	
	Mean±SD	Mean±SD	*p*
Preoperative LKS	23.0±21.4	23.3±15.9	0.470
Postoperative LKS	62.0±21.2	59.7±23.3	0.529
Preoperative TAS	3.0±1.7	2.8±1.1	0.975
Postoperative TAS	5.1±1.8	4.8±2.2	0.559
Preoperative IKDC	23.3±11.8	24.0±8.2	0.669
Postoperative IKDC	72.4±25.4	74.8±16.7	0.797
Postoperative KOOS	81.8±15.1	78.8±14.8	0.346

SD: Standard deviation; LKS: Lysholm Knee Score; TAS: Tegner Activity Scale; IKDC: International Knee Documentation Committee; KOOS: Knee Injury and Osteoarthritis Outcome Score.

and all-inside technique was performed in two patients.

DISCUSSION

The main finding of the present study was that repair of both longitudinal and bucket-handle meniscal tears caused improved clinical and functional outcomes with low failure rates. Outcomes of longitudinal and bucket handle tears were comparable regardless of concomitant ACL reconstruction or chronicity. According to our results, concomitant ACL reconstruction and chronic tear repair had no superiority over isolated repairs or acute tear repair. Our results are not consistent with various reports,[14,19,20] but compatible with Uzun et al.[1] and Nepple et al.[21] Of note, in the literature, most studies evaluating the meniscal repair results have up to three-year follow-up results.[22] Our study has a mean 61.7 months of follow-up.

Mid-term clinical and functional outcomes after arthroscopic meniscal repair for longitudinal and bucket-handle tears have been studied previously. Similar functional outcome scores have been reported in most of the studies. Uzun et al.[23] reported comparable functional outcomes for longitudinal and bucket-handle meniscal tear repair. They also found no significant difference for functional outcome between isolated repair and concomitant ACL reconstruction and meniscal repair. In their prospective observational study, Pande et al.[24] evaluated functional outcome after arthroscopic longitudinal and bucket handle tear repairs in a military population. They found successful postoperative functional outcome scores with high return-to-duty rates. Our findings are consistent with these reports.

Buyukkuscu et al.[25] reported 66.7% clinical improvement in patients older than 40 years and who underwent meniscal repair. Likewise, Noyes and Barber-Westin[26] reported 88% successful results in patients older than 40 years after repair of meniscal tears extending to the avascular region. We also believe that the meniscal repair should be performed in any age group and meniscal tissue should be

maintained as much as possible with consideration of the physiological age of the patient, activity level, ligament stability and level of postoperative rehabilitation potential. In our study, we also obtained satisfactory functional results in patients over 40 years of age, as well as young patients, suggesting that meniscal repair can be performed in older ages.

Tuckman et al.[27] found no significant difference in the healing of menisci between acute and chronic tears in at least two years of follow-up in series including 157 patients. Melton et al.[9] also found no significant difference between acute and chronic meniscal repair outcomes in 44 patients. In our series, no statistically significant difference was found between the functional outcomes of meniscus repairs applied in the acute and subacute period and those applied in the chronic period. We believe that the tissue quality of injured meniscus is more important than the age of meniscal tears in this regard. We, therefore, suggest that the meniscus repair would be successful, if the location of the meniscal tear is in the vascular zone, reducible, and the torn meniscus has not been already degenerated.

In their systematic review including 13 studies with at least five-year follow-up, Nepple et al.[21] found similar failure rates from the comparison of inside-out and all-inside repair techniques in meniscal repair. In our study, the inside-out technique was performed in 46 patients, while the all-inside technique was performed in four patients. In eight patients, a combined inside-out and all-inside technique was performed. There was no statistically significant difference among these groups regarding repair success, compatible with the current literature. The suture technique was preferred according to the pattern of the meniscal tear and the region in which it was located. We believe that all-inside technique is more useful, if one-third posterior of the meniscus is accessible, and all-inside or inside-out techniques are superior for repairing the middle-third portion of the meniscus and outside-in, or inside-out techniques are superior for repairing the anterior one-third portion of the meniscus.

Concomitant ACL reconstruction has been advocated in patients with coexistent ACL injury and meniscal due to the positive biomechanical contribution for meniscal healing.[28] This surgery is associated with significant excessive intra-articular hemorrhage and fibrin clots within the joint space are thought to have a benefit on the healing process.[18] DeHaven[29] reported 100% success in 33 meniscus repair cases in ACL-intact knees after a 10.9-year follow-up, compared to 67% success in unstable knees. In our study, ACL reconstruction and meniscus repair were performed simultaneously in 30 patients, and isolated meniscal repair was performed in 20 patients. The increase in the postoperative IKDC scores was found to be higher in patients with meniscus repair with ACL reconstruction than the isolated meniscus repair. However, it did not reach statistical significance. Accordingly, knee stability and marrow stimulation may not be important in meniscal repair.

Complications of arthroscopic meniscus includes temporary saphenous nerve lesion, arthrofibrosis, temporary fibular nerve lesion, infection, instrumental breakage, deep vein thrombosis, pulmonary embolism, meniscus cysts, reflex sympathetic dystrophy, and popliteal artery injury. Although posterior capsular dissection was used in the inside-out technique, nerve irritation was found to be 9% in the literature.[30] All-inside technique has lower nerve irritation rates from the inside-out, although 2% nerve irritation rates were found with all-inside technique.[30] Westermann et al.[31] also reported that the inside-out technique could cause significant local nerve damage, despite posterior capsular dissection. In our study, sensory hypoesthesia was detected in eight of 50 patients (16%) in the innervation area of the saphenous nerve. Of these eight patients, inside-out repair technique was performed in six (75%) and all-inside technique was performed in two (25%). No painful neuroma was detected in any of these patients. Unlike the literature, posterior capsular dissection was not performed with the inside-out technique in our study. The suture ends were knotted on the capsule after reaching the capsule from the stab skin incisions. Nerve irritation was detected in six (13.04%) out of 46 patients with inside-out technique. Although we did not use large posterior capsular dissection instead of a mini-incision, we believe that the rate of nerve complication is close to that in the literature.

The main limitations of our study are the use of heterogeneous repair techniques, and relatively small sample size including a heterogeneous patient population. Also, we were unable to evaluate meniscal healing with second look arthroscopy. Comparing the preoperative and the final follow-up outcomes also bears a bias for our study. Comparison of early postoperative and final follow-up scores would give more objective comparison. We obtained only postoperative KOOS scores. Lack of the preoperative KOOS brings additional bias for pre- and postoperative functional outcome change.

In conclusion, meniscal repair provides good functional and clinical results at a mean five-year follow-up. Concomitant meniscal repair and ACL reconstruction may enhance meniscal healing. Nerve irritation is a complication that can be encountered during meniscus repair.

Declaration of conflicting interests

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