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Arthroscopic Meniscal Repair in Outside-In Technique: A Clinical and Paraclinical Study

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Abstract

Background: Nowadays open meniscal repair approach is completely replaced by arthroscopic meniscal repair.
Objectives: The current study aimed at assessing the results of arthroscopic meniscal repair using the outside-in technique.
Methods: Patients diagnosed with meniscal tearing from 2008 to 2014 fulfilling the inclusion criteria were entered to the current cohort study. Outcomes of arthroscopic meniscal repair were assessed by 2 known questionnaires, IKDC (international knee documentation committee) and KOOS (knee injury and osteoarthritis outcome score), as well as magnetic resonance imaging (MRI) of knee.
Results: A total of 63 patients were assessed. The mean age and follow-up period were 28.8 $\pm$ 4.8 years and 44.3 $\pm$ 20.3 months, respectively; 82% of the subjects were male and 60.3% had injuries in both meniscus and anterior cruciate ligament (ACL); 76% of the patients had medial meniscal injury; 67% had posterior horn tear, and 56% had longitudinal meniscal tear. There was no significant association between age, gender, grade of tear, number of sutures, anatomic site of tear, and type of tear with the level of patient's satisfaction. Patients with simultaneous reconstruction of ACL had significant difference compared with the ones with isolated meniscal injury. Grading of tear in MRI had no association with the better outcomes according to the questionnaires.
Conclusions: Arthroscopic meniscal repair using the outside-in technique yielded acceptable results.

Keywords: Meniscus, Outside-in, IKDC, KOOS

1. Background

In 1945, Fairbank declared that in the absence of meniscus, the affected compartment of the knee undergoes degenerative changes (1). This finding raised the knowledge about the meniscal biomechanics and led to a revolution in the treatment of meniscus injuries. Arthroscopic meniscal repair was introduced for the first time in 1979 by Ikeuchi in Tokyo (2). A variety of methods with different approaches were explained by researchers (3-5). Today, there is no doubt that arthroscopic method has more advantages than the open repair method, but there are disagreements about the best arthroscopic meniscal repair technique.

The arthroscopic meniscal repair can be categorized into 4 groups including: inside-out, outside-in, all inside, and hybrid repair method, which is complementary to the mentioned methods (6). Studies evaluated and compared these methods (7, 8); however, advantages and disadvantages of these methods were not compared thoroughly. According to some published studies, there is more failure in all inside method compared with the regular suturing method.

2. Objectives

The current study aimed at assessing the result of arthroscopic meniscal repair using the outside-in technique.

3. Methods

In the current prospective cohort, all patients visited in Rasule-Akram hospital (Tehran, Iran) with meniscal tear from 2008 to 2014 fulfilling the inclusion criteria entered the study. The inclusion criteria were: patients aged 18 to 45 years with confirmed meniscal injury. Patients with previous surgery on the knee, history of meniscal and tendon

repair or reconstruction, medical history like diabetes, hypertension, or inflammatory diseases, and patients with any confirmed pathology in knee were excluded. Demographic data of patients including age and gender, anterior cruciate ligament (ACL) injury, site of meniscal tear, type of tear and the number of sutures done for meniscal repair were recorded. Failure in treatment was defined as repeated surgical interventions such as renewal of the repair or removal of injured meniscus.

In the current study, patients underwent the outside-in technique of arthroscopic meniscal repair. In this method, Ethiband 2 String (Ethicon, San Angelo, TX, USA) passes into knee joint through skin with a catheter under arthroscopic guidance. Then using the second catheter and looped nylon string, head of the string is led out again. In the current study, input and output strings were both placed horizontally. It was performed for each number of sutures required to repair the meniscus. Finally, using small incisions on skin, both ends of the strings were tied together. Weight bearing was not intended for patients for 4 weeks (6 weeks for professional athletes) regardless of the site and type of meniscal injury and presence or absence of ACL injury and after that partial weight bearing was intended according to patient's tolerance. Knee active range of motion was allowed soon after meniscal repair.

Level of satisfaction and arthroscopic meniscal repair were assessed by the 2 questionnaires of IKDC (the international knee documentation committee) (9) and KOOS (knee injury and osteoarthritis outcome score) (10) at least 1 year after the process. Reliability and validity of these questionnaires were confirmed in different studies (11, 12). Also the Persian versions of these questionnaires were available and their reliability and validity were confirmed (13).

At the same time, magnetic resonance imaging (MRI) study was done for each patient. A radiologist and an orthopedic surgeon did the reporting separately. According to the classification presented by Munk et al. (14) meniscal injury is divided into 4 grades including grade 1, focal intensity without extending to the surface of meniscus; grade 2, linear intensity, without extending to the surface of meniscus; grade 3A, internal linear intensity reached to the superior or interior meniscal surface but not punched it; grade 3B, irregular internal linear intensity reached to the superior or interior meniscal surface but not punched it; grade 4, complete tear, which actually ruptured intensity of meniscal surface. Grading either by the radiologist or orthopedic specialist was analyzed separately to realize a significant difference in MRI report. All stages of the analyses, descriptive and analytical, were conducted by SPSS version 23 software.

The current study was approved by IRB of our university and the patients signed written consent to enter the study and publish the obtained data.

4. Results

A total of 65 patients with meniscal injury requiring arthroscopy by outside-in technique entered the study after obtaining informed consent in the intended time range. Two patients were lost in the follow-up. Therefore, analysis and follow up were conducted on 63 patients and 52 of them were male. The mean age and follow-up period were 28.8 $\pm$ 4.8 years and 44.3 $\pm$ 20.3 months, respectively. Out of these 63 patients, 25 had isolated meniscal injury and the rest had simultaneous ACL tear and meniscal tear, 48 patients had tear in medial side (76.2%) and 42 (66.7%) had posterior horn tear of meniscus. In 35 patients (55.6%) the tear was vertical and in the rest it was bucket handle type. Out of the 63 patients, 9 of them did not consent to perform MRI after surgery. MRIs of the 54 remaining patients were reported once by a radiologist and the second time by an orthopedic specialist. Both physicians used the same criteria for grading (Table 1).

Table 1. Comparison of MRI Reports of Meniscal Injury Grading

Variables	Value, %
Radiologist report	
Grade 1	44.4
Grade 2	38.9
Grade 3	11.1
Grade 4	5.6
Orthopedic report	
Grade 1	537
Grade 2	42.6
Grade 3	1.9
Grade 4	1.9

Central indexes and indexes of dispersion were used to analyze quantitative variables in the current study, which are shown in detail in Table 2. Overall situation of patient's satisfaction and recovery after meniscal repair, which was measured by 2 questionnaires, IKDC and KOOS, is shown in Table 3. In Table 4, the association between age, follow-up time, grading done by radiologist, and orthopedic specialist are shown. In Table 5, the relationship between qualitative variables of the study (gender, site of injury, ACL injury at the same time, and type of tearing) are shown including the questionnaire scores. Finally, there were no neurovascular complications.

Table 2. Qualitative Analysis Using Central and Dispersion Indices

Variables	Number	Minimum	Maximum	Mean	SD
Age	63	19	42	28.8	4.82
Suture	63	1	4	-	-
Follow	63	12	70	44.3	20.35
Grade R	54	1	4	-	-
Grade O	54	1	4	-	-
KOOS S	63	0	89	43.1	21.03
KOOS P	63	75	100	89.8	6.11
KOOS A	63	75	99	94.4	4.79
KOOS SP	63	60	100	81.2	10.18
KOOS Q	63	75	100	88.8	8.02

Abbreviations: A, Daily Activities; IKDC, International Knee Documentation Committee; KOOS, Knee Injury and Osteoarthritis Outcome Score; O, Orthopedic Surgeon; P, Pain; Q, Quality of Life; R, Radiologist; S, Symptoms, SP, Sport Activities.

Table 3. Patients' Scores of the Questionnaires

Variables	> 60%	> 80%	> 90%
IKDC	100	60.3	28.1
KOOS S	27	1.6	0
KOOS P	100	85.7	63.5
KOOS A	100	98.4	77.8
KOOS SP	100	63.5	28.6
KOOS Q	100	92.1	46

Abbreviations: A, Daily Activities; IKDC, International Knee Documentation Committee; KOOS, Knee Injury and Osteoarthritis Outcome Score; P, Pain; Q, Quality of Life; S, Symptoms, SP, Sport Activities.

5. Discussion

The outside-in technique was explained by Morgan et al. (15) in 1986. They reported good outcome for meniscal repair after 18 months of follow-up. Fewer neurovascular injuries occurred due to smaller posterior incisions (16). Recently, different studies are performed on outside-in meniscal repair. Keyhani et al., (6) evaluated the result of meniscal repair by this method on 66 patients. They found clinical success in 92.4% of the patients and improved the score of patients regarding IKDC questionnaire to 90.8 $\pm$ 15.6. They also reported that 5 patients (7.6%) needed meniscectomy at last. Also Hantes et al., (8) compared different methods of arthroscopic meniscal repair. Level of success for outside-in technique was reported 100%. According to grading system of IKDC all patients had normal or close to normal knee after repair. In a similar study performed by Abdelkafy et al., (17) in Egypt, 39 of 41 patients (95%) achieved a high score according to IKDC. Five of them needed meniscectomy and 1 had ACL injury at the same time.

In the current study, using IKDC and KOOS questionnaires, on 63 patients only 1 (1.5%) needed second repair who had grade 4 tear according to radiologist and orthopedic specialists reports. All patients received scores higher than 60% in IKDC and A (daily activities), SP (sport activities), P (pain), and Q (quality of life) scales of the KOOS questionnaire. Respectively, 28.1%, 63.5%, 77.8%, 28.6%, and 46% of the patients received scores higher than 90% in IKDC and P, A, SP, Q scales of KOOS (Table 3). The obtained results showed a great level of clinical success and satisfaction after surgery.

There was no complication for patients after arthroscopic meniscal repair in outside-in technique and during the follow-up in the current study. Different studies reported no complications if the technique was performed by a trained surgeon (18). However, in the study by Hantes et al. (8), in all 37 patients undergone meniscal tear repair by suturing technique, 4 had saphenous nerve neuropathy that all recovered during the follow-up. Other researchers also reported their consequences that all recovered during the study (19, 20). To prevent neurovascular injuries, it is important to consider some points including proximity of peroneal nerve to lateral meniscus; hence, knee should be kept in flexion position during lateral meniscal repair to prevent peroneal nerve injury. Also, while repairing posterior part of medical meniscus, to prevent the saphenous nerve and its branches, the injured knee should be kept close to full extension (16).

Decrease in the repaired meniscus motion in some cases of bucket handle tearing and ACL reconstruction of

Table 4. The Relationship Between Variables and Questionnaires Scores

Variables	IKDC	KOOS S	KOOS P	KOOS A	KOOS SP	KOOS Q
Age						
Correlation coefficient	0.05	0.16	-0.04	0.13	-0.03	0.01
P value	0.64	0.20	0.75	0.28	0.81	0.94
Suture						
Correlation coefficient	0.09	0.07	0.04	0.06	-0.09	0.67
P value	0.45	0.96	0.72	0.65	0.48	0.60
Follow						
Correlation coefficient	0.08	-0.01	0.09	-0.07	0.15	-0.01
P value	0.48	0.99	0.48	0.56	0.22	0.94
Grading R						
Correlation coefficient	0.01	0.15	0.06	-0.05	-0.01	0.13
P value	0.94	0.26	0.97	0.72	0.95	0.37
Grading O						
Correlation coefficient	-0.01	0.04	0.15	-0.17	0.18	0.19
P value	0.98	0.74	0.26	0.21	0.19	0.17

Abbreviations: A, Daily Activities; IKDC, International Knee Documentation Committee; KOOS, Knee Injury and Osteoarthritis Outcome Score; O, Orthopedic Surgeon; P, Pain; Q , Quality of Life; R, Radiologist; S, Symptoms, SP, Sport Activities.

Table 5. The Relationship Between Qualitative Variables and Questionnaires Scores

Variables	Gender	P Value	Isolated or Combined Injury	P Value	Anatomical Location	P Value	Anatomical Site	P Value	Type of Injury	P Value
IKDC	Male	0.044	Isolated	0.009	Medial	0.696	Ant. horn	0.825	Bucket handle	0.791
	Female		Combined		Lateral		Pos. horn		Longitudinal	
KOOS S	Male	0.006	Isolated	0.003	Medial	0.511	Ant. horn	0.634	Bucket handle	0.453
	Female		Combined		Lateral		Pos. horn		Longitudinal	
KOOS P	Male	0.521	Isolated	0.348	Medial	0.137	Ant. horn	0.680	Bucket handle	0.685
	Female		Combined		Lateral		Pos. horn		Longitudinal	
KOOS A	Male	0.287	Isolated	0.060	Medial	0.993	Ant. horn	0.277	Bucket handle	0.716
	Female		Combined		Lateral		Pos. horn		Longitudinal	
KOOS SP	Male	0.192	Isolated	0.019	Medial	0.334	Ant. horn	0.211	Bucket handle	0.031
	Female		Combined		Lateral		Pos. horn		Longitudinal	
KOOS Q	Male	0.386	Isolated	0.823	Medial	0.567	Ant. horn	0.543	Bucket handle	0.366
	Female		Combined		Lateral		Pos. horn		Longitudinal	

Abbreviations: A, Daily Activities; Ant., Anterior; IKDC, International Knee Documentation Committee; KOOS, Knee Injury and Osteoarthritis Outcome Score; P, Pain; Pos., Posterior; Q , Quality of Life, S, Symptoms, SP, Sport Activities.

chronic tearing is reported. Repairing the meniscus in full extension considerably reduces this event (18). Vascular injury is possible in the tear of posterior of meniscus that can be reduced using a curve needle. However, it is recommended that in cases of tear in very posterior part of meniscus all inside and inside-out techniques should be used; as they have posterior incision and direct view of the area (16, 18).

In the current study, there was no significant association between the site of meniscal tear (medial, lateral, posterior horn, and anterior horn) or type of tear (linear or bucket handle) and patient's outcome. In IKDC and KOOS questionnaires, none of the scales had significant association with any special anatomical site and special tear pattern. Some studies, compared with the current study, reported low recovery rate for posterior meniscal tear in outside-in technique. Van Trommel et al., reported that patients with medial meniscus and posterior part of menis-

cus tearing had lower success than the other areas (21). The explanation was that biomechanics and forces acting on medial meniscus and lateral meniscus are different. On the other hand, there is no good access to posterior parts of meniscus in outside-in technique. Eggli et al., (22) also concluded that lateral meniscal injury associated with higher rates of recovery. However, there was no significant difference in this respect in the current study. It can probably be explained by technical improvements, better understanding of the biomechanics of meniscus during recent years, different physiological characteristics of the patients, and different grading for tears in studies. Although some studies reported that healing rate in the age range of 20 - 30 years was in its highest level (21, 22), in the current study, there was no significant association between age and recovery rate according to IKDC and KOOS questionnaires.

Although the prevalence of meniscal injury is higher in males than females, different studies showed no significant difference in the results of meniscal tear repair (8, 23). In the current study, there was a significant association between gender and IKDC and symptom (S) scale scores. According to these 2 variables, level of satisfaction was higher in females. There was no significant association between other scales of KOOS and gender. Similar to the results of the study by Barber et al. (24), no association was observed between follow-up or number of sutures and patients' level of satisfaction.

Out of 63 patients in the current study, 9 did not consent to undergo MRI after surgery. Overall, 54 MRIs were reported separately by the radiologist and orthopedic specialist. The results showed the tendency to lower grading in orthopedic specialist, compared with those of the radiologist as 53.7% were reported in grade 1 by the orthopedic specialist vs. 14.4% by the radiologist. Although this difference was not statistically significant and no association was observed between grading (by orthopedic specialist and radiologist) and level of satisfaction in patients after meniscal repair, however, according to the MRI reports, success rate of outside-in technique was very high. As 93.6% of patients according to orthopedic specialist and 83.3% according to radiologist's reports had grade 1 and 2 of meniscal injury, while these patients had complete tears before the surgery.

Thirty-eight patients (60%) had ACL injury simultaneously. Most studies mentioned better healing in patients with simultaneous ACL injury. In a study by Barber et al., 63 patients with meniscal tear underwent arthroscopic repair and were followed up for 2 years. According to their report, 92% of patients with concurrent ACL injury were cured completely compared to the ones with isolated meniscal repair with only 67% of complete cure (24). Many studies mentioned better meniscal healing in patients with ACL reconstruction at the same time, compared with isolated meniscal repair (17, 25). Hemarthrosis happens while ACL reconstruction releases growth factors and results in chemo taxis needed for meniscal repair (25). However, different researchers reported no significant difference regarding meniscal repair in isolated and with ACL reconstruction at the same time (26-28). In the current study, according to IKDC questionnaire and scales S, A, and SP, patients with ACL reconstruction at the same time had higher level of satisfaction compared with other patients. Although this significant difference was not observed in the scales P (pain) and Q (quality of life) in patients with ACL repair at the same time.

The current study had some limitations: IKDC and KOOS questionnaires were employed to evaluate patients' results. The KOOS questionnaire is not specific to patients with meniscal injury. There seems to be a gap for specific questionnaires for such patients in this field. Also, in the current study, similar to many other researches, self-assessment scores were used to evaluate patients, status. Despite the fact, according to different pain thresholds in patients, different levels of function and different expectations of patients, self-evaluation scoring may not be an accurate indicator. However, to overcome this problem, a paraclinical criterion (MRI) was added to the current study. It was concluded that according to MRI, most of patients achieved a significant recovery and personal symptoms were different from those of paraclinical results. In conclusion, despite contradictions in various studies, the current study showed that arthroscopic meniscal repair using the outside-in technique yielded acceptable results.

Footnotes

Authors' Contribution: Study design, Mehdi Moghtadaei, Hossein Farahini; data acquisition and interpretation, Saead Enayati, Mohsen Motalebi, and Habib-o-Lah Gorgani; draft of the manuscript and critical revision, Mehdi Moghtadaei, Hossein Farahini, Saead Enayati, Mohsen Motalebi, and Habib-o-Lah Gorgani; study supervision, Mehdi Moghtadaei.

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