Meniscal Repair Using the outside-in Suture Technique

Ahmed M Gouda,MBBch; *Osama G Ahmed, MD and **Ayman M Ebied, MD

Orthopedic Surgery Department, Faculty of Medicine, Menoufia University, Menoufia, Egypt.
* Assis. Professor in Orthopaedic, Menoufia University, Egypt .
Gamal Abdel Nasser Street, Shebin El kom, Menoufia Governorate, Egypt
Telephone: 00201009686620
Fax: 0020482317508
Email: osagam2004@yahoo.com

** Professor in Orthopaedic, Menoufia University, Egypt
+20 10042 62759
aymanebied@gmail.com

Correspondence to: Ahmed Mahmoud gouda, MBBCh,
salama Street, berket elsabaa, Menoufia, Egypt

Tel: +201007709200;
e-mail: dr_goda2000@yahoo.com

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Abstract

Background
Meniscus tears are one of the most common injuries to the knee and should often be included at the top of the differential diagnosis for patients presenting with knee pain. Meniscal preservation in younger active individuals presenting with symptomatic meniscal disease is important for knee joint function.
Hypothesis
Arthroscopic repair of the meniscus tear by outside-in technique achieves good results in these patients.
Patients and methods
Twenty five patients (25 knees) presenting with symptomatic torn meniscus were included in the study. The age ranged from 9 to 35 years, with a mean of 26.16 years. 23 of them were males and two were females. Nine of them had locked knee owing to displaced bucket handle tear or displaced discoid meniscus. 15 patients had a vertical longitudinal tear. All cases experienced knee pain and swelling. Clinical evaluation of the patients was done according to the subjective and objective International Knee Documentation Committee (IKDC) 2000 forms. Moreover, radiological evaluation was performed using plain radiographs and MRI. All patients were managed by arthroscopic outside-in meniscus repair by two 18 gauge spinal needles and number of sutures was regard to the tear length. The duration of follow-up ranged from 19 to 30 weeks, with a mean of 24.24 weeks.
Result
18 patients showed significant postoperative improvement. The average postoperative subjective IKDC score was 81.64 % as compared with 42.2% preoperatively, which is highly significant (P<0.014).
The Postoperative IKDC objective grade was A in eight (32%) cases, B in ten (40%) cases and C in seven (28%) cases at the end of follow-up, as compared with the preoperative values, which was D in eighteen (72%) cases and C in seven (28%) cases.
Conclusion
Torn meniscus can be a potential cause of symptomatic knee pain and effusion and should not be overlooked. Arthroscopic outside-in meniscal repair can give good results in the majority of cases.

Keywords
Outside in sutures, meniscus tear, meniscus repair.

Introduction

The menisci provide mechanical support and secondary stabilization, localized pressure distribution and load sharing, and lubrication and propioception to the knee joint [1].

Many changes had been observed in the knee after meniscectomy as: an anteroposterior ridge projecting distally from the margin of the femoral condyle, flattening of the peripheral half of the articular surface of the condyle, and narrowing of the joint space [2].

The meniscal tears commonly classified as longitudinal tears, transverse and oblique tears, combination of longitudinal and transverse tears (complex tears), tears associated with cystic menisci, and tears associated with discoid menisci [3].

The vascular supply to the meniscus determines its potential for repair [4].De Haven considered meniscus tears in the peripheral 3mm as being vascular (red-red zone), tears 3-5mm from the periphery as variable (red-white), and tears more than 5mm from the periphery as avascular (white-white zone) [5].

The indications for meniscal repair include: complete vertical longitudinal tears (>10 mm), tears in the peripheral 10–30% of the meniscus or those within 3–4 mm from the meniscocapsular junction, tears without

secondary degeneration and tears in a stable or in a knee that was stabilized [6].

A number of arthroscopically assisted techniques have been subsequently developed and include inside-out, outside-in, and all-inside repairs [7].

The success of meniscal repair depends on appropriate meniscal bed preparation and surgical technique and is also influenced by biologic factors such as tear rim width and associated ligamentous injury [8].

Despite the increasing popularity of new-generation all-inside meniscus repair devices, the outside-in meniscus repair technique which first described by Warren in 1985 is still used by many surgeons to preserve the meniscus in the anterior two thirds of the meniscus [9,10].

The aim of this prospective study was to evaluate the clinical outcome of arthroscopic meniscal repair in the knee by outside in meniscus repair.

Patients and methods

A total of 25 patients experiencing knee symptoms presented to us from October 2016 to July 2018. Their ages ranged from 9 to 35 years. 23 of them were males whereas 2 were females. All of them experienced knee pain and antalgic gait, whereas 9 (36%) cases presented to us with locked knee (incomplete extension) due to displaced bucket handle tears or displaced discoid meniscus. Knee swelling was also a significant presentation, and it was mild in five cases whereas moderate in 14 cases and severe in 6 cases. 15 patients were operated within 8 weeks from injury were rated acute (60%), and (10) meniscal tear patients were rated chronic (40%) as Injury to repair interval more than 8 weeks. The average interval for the acute cases was 6.08 weeks and the average interval for the chronic cases was 32.4 weeks. The condition was preceded by a considerable sport related incidence in 16 (64%) cases, road traffic accident in 5 (20%) cases and fall in 4 (16%) cases. Clinical evaluation was done according to the 2000 Subjective and Objective International Knee Documentation Committee (IKDC) evaluation forms. The average preoperative range of movement was 66.25°. Nine cases had extension lag ranging from 15° to 25°. The preoperative subjective IKDC ranged from 30 to 50, with an average of 42.02. The preoperative objective IKDC was D in eighteen (72%) cases and C in seven (28%) cases.

The inclusion criteria were symptomatic meniscal tear, patient age less than 40 years, vertical longitudinal tear, bucket handle tears with good remaining portion, tear length 1–3 cm, tear location in the red–red or red–white zone, tear reducible at the time of arthroscopy, and adequate tear site apposition.

The exclusion criteria were patient age greater than 40 years, tear location in the white–white zone, cases with knee fractures and chronic debilitating diseases or inflammatory conditions.

Preoperative evaluation

Patients underwent a careful evaluation of their history and underwent full clinical examination of their knee, including meniscal tests, cruciate ligaments tests, knee effusion tests, collateral ligament test and chondromalacia patella tests. Plain X-ray and MRI was used in this study. MRI is the most informative diagnostic tool for delineation of different knee problems.

Operative Technique [11]:
All patients were placed in the supine decubitus position, with the lower limb secured by a leg holder. Procedures were done under general or spinal anesthesia and performed under tourniquet control.

Instrumentation include: knee arthroscopy instruments, 18-gauge needles and No. 2-0 Prolene suture (Ethicon, Somerville, NJ), No. 2-0 Ethibond suture (Ethicon) and 45 curved suture passer plus arthroscopic cannula 8 mm in diameter.

Diagnostic arthroscopy was performed and the reparability of the meniscal tear was determined (Fig 1A). It is important to abrade the inner surfaces of the meniscal tear using a 3.5 mm resector, in order to create a bleeding bed and stimulate vascular ingrowth (Fig1B).

The first 18-g needle is inserted from outside to inside the joint, penetrating the skin, subcutaneous tissue, joint capsule, outer fragment of the meniscal tear, tear site and inner fragment of meniscal tear and then appearing inside the joint. The first needle loaded with No. 2-0 Prolene suture, then the Prolene suture was advanced (Fig 1C) to be retrieved from the anteromedial portal and the needle was pulled out of the skin slit. The Prolene suture was used to relay No. 2-0 Ethibond suture (Ethicon) instead through the anteromedial portal (Fig 1D).

A second needle preloaded with the Prolene suture was introduced through the skin 2-3 mm from the first needle (Fig 2A). This Prolene suture was advanced in the same manner as the first suture to be retrieved through the anteromedial portal (Fig 2B), and it was used to relay the other end of the Ethibond suture.

The other end of the Ethibond suture was pulled back into the knee and out through the skin slit by use of the second Prolene suture (Fig 2C). Finally, a small skin incision is made between the two ends of the Ethibond suture and a sliding arthroscopic knot is applied tying the suture over the capsule to create a vertical meniscal suture (Fig 2D). The procedure is repeated, applying the appropriate number of sutures needed.

For ramp tears 45 curved suture passer pass through arthroscopic cannula 8 mm in diameter. Penetrating PMMH through the posteromedial portal, working on the tear from medial to lateral, and the same for lateral ramp tears [12].

For discoid meniscus tears arthroscopic reshaping of the meniscus by partial excision of the central part was performed before meniscal repair (Fig 3A, B,C, D).

If the patient had an ACL injury, arthroscopic reconstruction was conducted after the meniscus repair using a hamstring autograft with interference screw fixation.

Postoperatively, patients followed a functional rehabilitation program. The knee was put in a hinged brace, starting with 0° to 30° of range of motion. Weight bearing was allowed 2 weeks afterward as tolerated with the brace locked in extension, and the knee flexion range was gradually increased by 30° every 2 weeks to reach full range of motion at 8 weeks. Full athletic activity was permitted after 6 months [13].

Follow-up evaluation

All patients were evaluated preoperatively and this was repeated postoperatively at 24 weeks by the International Knee Documentation Committee (IKDC) [14].

Statistical analysis

The data collected were tabulated & analyzed by SPSS (statistical package for the social science software) statistical package version 23 on IBM compatible computer. Data are shown as mean, range, frequency and percent. The comparison between groups with qualitative data were done by using Chi-square test. The comparison between two independent groups with quantitative data and normal distribution were done by using independent t-test. ANOVA test was done to compare three variables; one qualitative variable and the other two are quantitative variables of normally distributed variables, and for all the analysis a p value < 0.05 was considered statistically significant.

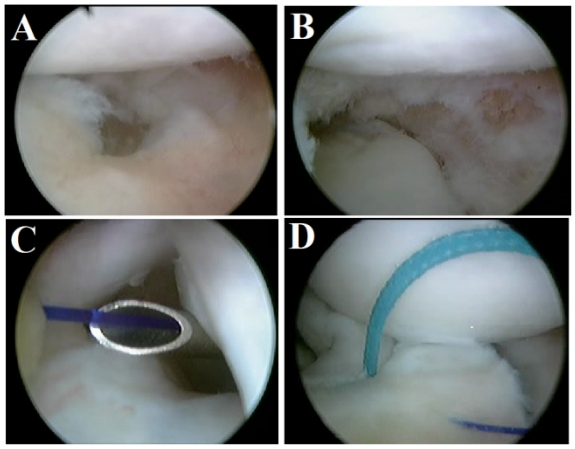


Figure 1: Arthroscopic view of left knee: (A)Bucket handle meniscus tear. (B) Abrading the inner surfaces of the meniscal tear. (C) Proline passed in 1st spinal needle. (D) The Prolene suture was used to relay No. 2-0 Ethibond suture.

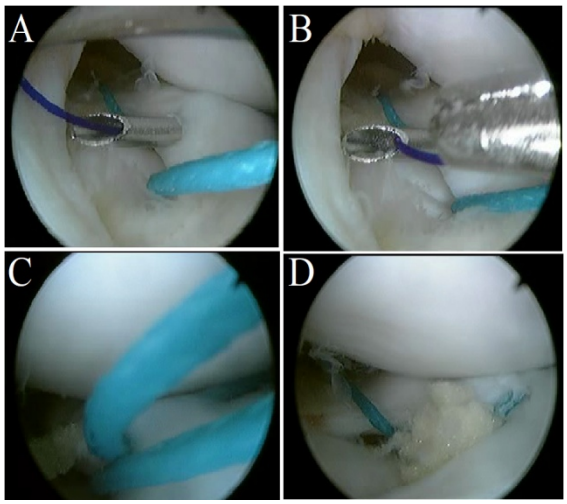


Figure 2: Arthroscopic view of left knee: (A) 2nd spinal needle positioning. (B) Prolene suture advanced to be retrieved through the anteromedial portal (C) The Prolene suture was used to relay No. 2-0 Ethibond suture. (D) The suture tied over the capsule to create a vertical meniscal suture.

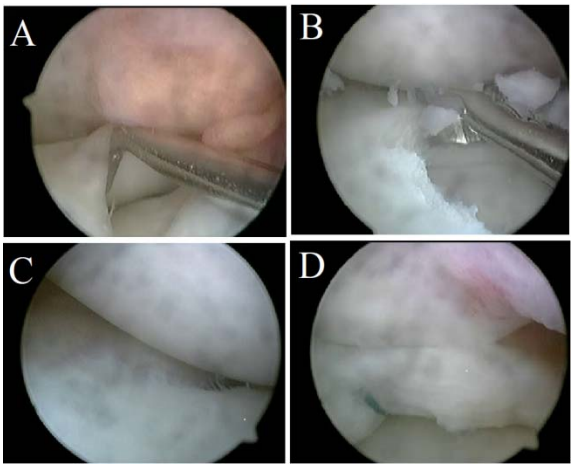


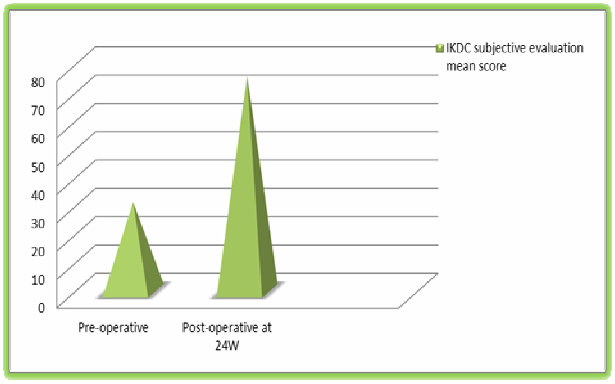
Figure 3: Arthroscopic view of left knee. (a) Lateral discoid meniscus (b) Trimming of discoid (meniscoplasty). (c) Vertical longitudinal tear (VLT). (d)After tear repair.

Results

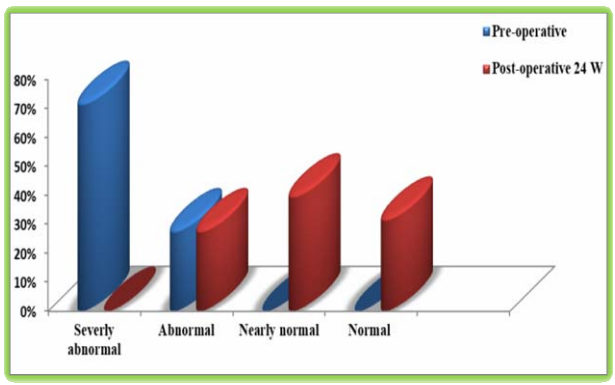
This prospective study consisted of 25 patients with meniscus tear repair by outside in techniques with follow up mean of 24.24 weeks.

The pre-operative mean IKDC subjective evaluation was 42.2 (range 30 to 50) in which all patients were poor score. The post-operative mean IKDC subjective evaluation at 24 W was 81.64 (range, 50 to 95) in which 8 patients were excellent (32%), 10 patients were good (40%), 7 patients were poor score (28%). Clinical success was in terms of absence of pain, catching, locking, and swelling, together with a negative McMurray test, occurred in 72% of treated cases. The improvements in the score were statistically significant ($P < 0.014$). (Graph 1)

The pre-operative IKDC objective evaluation results; there were 18 patients with severely abnormal knees (72%) (Grade D) and 7 patients with abnormal knees (28%) (Grade C). The post-operative IKDC objective evaluation results at 24 weeks; there were 7 patients with abnormal knee (28%) (Grade C), 10 patients with nearly normal knees (40%) (Grade B) and 8 patients with normal knees (32%) (Grade A). (Graph 2)



Graph (1): IKDC subjective mean score preoperatively and postoperatively.



Graph (2): IKDC objective score assessment preoperatively and postoperatively.

Intra-operative finding had reveled 12 patients had isolated meniscal injuries (48%), 13 patients had meniscus injuries associated with ACL tear (52%), 7 patients had discoid meniscus (Table 1).

Postoperatively at 24 weeks; 7 patients (28 %) had to quit from previous level of activity/ sports, 8 patients (32%) had returned to sports with lower performance and 10 patients (40 %) had regained their previous level in activity /sports.

The patients had a mean age of 25.16±7.69 years, (range, 9 to 35 years) the mean postoperative IKDC subjective score for the [(9-24) years group)] was 82.08; while in [(25-35) years group)] a postoperative IKDC subjective mean score was 81.23, there were no significant differences.

Also, this study post-operative results comparison showed no significant differences in related to gender, knee side (right and left), tears side (lateral and medial) or tears zone (red-red and red white) with regard to their mean score.

The duration between injury and surgery ranged between 4 and 72 weeks, with a mean of 16.76 weeks. Patients with shorter injury durations (less than 8 weeks) had better scores, with statistical significance as the mean post-operative IKDC subjective score for the (acute group) was 88.6 (SD= 11.02); while in (chronic group) score was 71.2 (SD= 17.13).

Of the patients, 13 (52%) had a concurrent ACL reconstruction with their repair procedure by use of ST autografts, and although these cases had better mean scores, statistical significance was found. The mean post-operative IKDC subjective score for the (ACL reconstructed cases) was 88.46 (SD= 10.4); while in isolated meniscal repair cases was 74.25 (SD= 18.09).

The vertical longitudinal tear cases had better mean scores, statistical significance was found as The mean post-operative IKDC score for the (vertical longitudinal tear cases) was 71.2 (SD= 17.13); while in (bucket handle tear cases) was 88.6 (SD= 11.02).

The patients with shorter meniscus tear length had better mean scores, statistical significance was found. As the mean post-operative IKDC score for the (10-15 mm tear group) was 91.89 (SD= 2.97), and that for the (16-20 mm tear group) was 74.11 (SD= 19.62) while in (21-25 mm tear cases) was 78.14 (SD= 15.64).

Summary of postoperative results in relation to age, injury-to-repair interval, associated ACL reconstruction, zone, side, location, and length of tear are shown in (Table 2).

Table 1: Intraoperative findings

	Diagnosis	Number of patients	N (%)
Tear side	Medial meniscus	17	68
	Lateral meniscus	8	32
Associated	ACL	13	52
	Discoid	7	28
Tear site	Mid third	10	40
	Post third	2	8
	Post horn	3	12
	Post third +post horn	10	40
Tear zone	Red -red	10	40
	White -red	15	60
Tear pattern	Bucket handle	10	40
	Vertical longitudinal	15	60
Tear length	10-15 mm	9	36
	16-20 mm	9	36
	21-25 mm	7	28

ACL, anterior cruciate ligament, post third, posterior third , mid third middle third.

Table 2: Summary of comparison postoperative results

	Diagnosis	Postoperative IKDC subjective score mean	P- value
Age(years)	9-24 years	82.08(SD =16.65)	0.898
	25-35 years	81.23(SD =16.084)	
Injury- repair interval	Acute cases(<8weeks)	88.6 (SD =11.02)	0.05
	chronic cases (>8weeks)	71.20 (SD = 17.13)	
Tear side	Medial meniscus	79.12 (SD = 16.94)	0.26
	Lateral meniscus	87 (SD = 13.26)	
Associated	ACL repair	88.46 (SD = 10.4)	0.029
	Isolated repair	74.25 (SD = 18.09)	
Tear zone	Red -red	84.1 (SD = 16.54)	0.542
	White -red	80 (SD = 15.74)	
Tear pattern	Bucket handle	88.11 (SD = 6.17)	0.013
	Vertical longitudinal	93.72 (SD = 3.37)	
Tear length	10-15 mm	91.89 (SD = 78.14)	0.038
	16-20 mm	74.11 (SD = 19.62)	
	21-25 mm	78.14 (SD = 15.64)	

ACLR, anterior cruciate ligament reconstruction; IKDC, international knee documentation committee; LM, lateral meniscus; MM, medial meniscus *P<0.05 is significant.

Postoperatively at 24 weeks; 7 patients (28%) were evaluated by MRI. There are 4 patients asymptomatic in which MRI showed that 3 menisci were healed and one meniscus was partially healed. 3 patients symptomatic in which MRI showed that, one meniscus was partially healed and two menisci were not healed.

Failure occurred in 7 patients (28%) with recurrence of pain, swelling, and locking, as well as positive McMurray, Apley tests, together with poor postoperative IKDC scores at the 6 month follow-up visit, and partial excision was required.

Retear seen in 3 patients (12%) due failed repair in old bucket handle tears. In addition, 2 patients (8%) had flexion deformity with loss of 15 extension, for which manipulation under general anesthesia was performed. acute infection seen in one patient (4%) and treated by debridement and drainage, also meniscal cyst seen in one case (4%) and treated by cyst de-

compression .No neurovascular complication was encountered in any patient.

Discussion

The main role of the menisci within the knee joint is load bearing. The shape, structure and attachments of the menisci contribute to this essential function for the well-being of the knee joint [15]. Also the geometric structure of the menisci provides an important role in maintaining joint congruity and stability [16].

Recent studies show better results with repair of the meniscal tears, as it is preventing subsequent arthrosis which increases with partial meniscal excision and preserve knee joint kinematics [17].

This study had concentrated on evaluation of outside in arthroscopic repair technique using spinal needles in the treatment of meniscal tear. IKDC subjective and objective knee score showed acceptable psychometric parameters to justify its use as an outcome of meniscus injuries pre-operatively and post-operatively [18].

The results of this study also approached the published results of Van Trommel et al. [19] and Plasschaert et al. [20] .

This study matched the published results of Majewski et al. they have reported the long-term follow-up (5-17 y) of outside-in repair of isolated vertical meniscus tears in 88 patients, with a healing rate of 72.7% on clinical assessment [21].

The results of this study were lower than the published results of Abdelkafy et al. [22]. At a mean of 11.71 years' follow-up, 36 patients (88%) were clinically successful and 5 (12%) were considered as failed, with failure defined as requiring a meniscectomy after meniscus repair. Also lower than results of Sobhy et al. [23]. This due to lower number of patient in this study, high chronicity of meniscal tears also many cases had complex meniscus tears which complicated by late retear and required partial meniscectomy.

Mariani et al. [24] studied 22 meniscal repairs with concomitant ACL reconstruction for a mean of 28 months. The authors reported that 77.3% of the patients showed good clinical results. In this study better result was present with concomitant anterior cruciate ligament reconstruction.

Buchalter et al. [25] reported that there were no statistically significant associations between failure and tear age, tear complexity, tear vascularity, patient age, patient sex or isolated meniscal repair. In this study, there were statistically significant associations between results and tear pattern, length and concomitant anterior cruciate ligament reconstruction.

Regarding injury to "repair interval" The mean post-operative IKDC subjective score for the (acute meniscal tear group) was 88.6, while in ("chronic meniscal tear) was 71.2 and there was significant statistical difference. Also Barrett et al. [26] in a study on 37 cases found that patients with older tears had a higher failure rate than those with acute tears.

This study result matched with Pujol et al. [27] study showed there were no differences between lateral and medial menisci, in stable or stabilized knees.

Regarding to tear length there were high incidence of meniscal healing occurred with small tears. Also, Kimura et al. [28] found that, the healing rate was in excess of 90% if the length of the tear was less than 2 cm, whereas it was only 50% with tears larger than 4 cm.

In this study there were Seven failed repairs, sex of all failed cases were red-white tears and only one was red-red tear, only the peripheral 10% to 30% of the adult meniscus retains its vascularity. Barrett et al. [26] showed that the location of the tear is one of the most important factors influencing the healing rates of meniscal repairs.

The follow-up arthroscopic evaluation is an invasive procedure and therefore unsuitable to be used only for experimental purposes. MRI with intra-articular contrast is considered the imaging method-of choice in patients with meniscal repair [29].

In this study 4% patient had acute infection and 4% patient had chronic meniscal cyst formation. Plasschaert et al. [20] reported a 7% rate of wound infection. Also ahn et al. [30] reported meniscal cyst incidence ranges from 0.4 to 2.0%.

A relative drawback of this study is the small number of cases, which were 25 cases collected over near 2 years. This relatively small number of cases might not give a true impression about the tear type and configuration. Despite the satisfactory short-term to mid-term results during the follow-up period which ranged from 19 to 30 weeks, longer duration of follow-up might be needed to study the long-term effects of this procedure.

Conclusion

Meniscal repair is the treatment of choice for recent vascular longitudinal tears more than old complex and

bucket handle tears. The knee should be stable or stabilized and well aligned. The outside-in meniscal repair is a minimally invasive, simple and inexpensive technique with a good clinical outcome.

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