# Outcome of combined all-inside and outside-in arthroscopic meniscal repair: long-term study

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**Background**
The long-term unfavorable consequences of meniscectomy, either partial or total, are well documented. The purpose of the current study is to demonstrate the long-term clinical outcome after arthroscopic meniscal repair using combined all-inside and outside-in techniques.
**Patients and methods**
A retrospective study of patients who underwent meniscal repair was conducted between December 2005 and October 2013. A total of 48 patients were included (42 males and six females), with an average age of 24.3 years (range, 10–38 years) at operation. Meniscal repairs were done using combined outside-in and all-inside techniques. All meniscal tears were repaired using one Fast-Fix posterior all-inside suture and multiple outside-in sutures using the remaining Ultrabraid suture and PDS no. 2-0 nonabsorbable suture.
**Results**
Only four cases required a second procedure (partial meniscectomy). At the final follow-up of an average of 80.11 months (range, 24–121 months), the average International Knee Documentation Committee (IKDC) score of the meniscus repair group was 95.18±3.9, and the Lysholm score was 93.93±4.54.
**Conclusion**
Combined all-inside and outside-in arthroscopic meniscal repair is a safe and a cheap technique, with a good long-term clinical outcome.

**Keywords:**
all inside, meniscal repair, outside in

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## Introduction

For a long time, the menisci were counted as unnecessary appendages in the knee, so when malfunction and tear occurred, it was treated by meniscectomy [1]. After Fairbank described radiographic changes following meniscectomy [2], the concept of preservation of the meniscus has been raised. Later studies then demonstrated the load sharing [3] and the stabilizing function of the meniscus [4], making meniscal repair of repairable meniscal tears the standard of care to prevent development of arthritis [5].

With the popularity of knee arthroscopy, meniscal repair was shifted from open to all arthroscopic procedure. Arthroscopic meniscal repair can be categorized into three main categories. Inside-out techniques, outside-in techniques, and all-inside techniques. In the past decade, many suture-delivering devices and alternative biodegradable implants have been evolved and successfully used in all-inside meniscal repairs [6].

The inside-out technique of meniscal repair has the disadvantage of being performed using special needles and special cannulas that may not always be available all the time; besides, it carries a risk of injury to neurovascular structures around the knee, especially for repair of the posterior horns [7]. The outside-in tech is difficult to deploy in the tight posterior knee compartment. The all-inside techniques are more simple but have the disadvantages of high cost [8].

There are variable results regarding outcome of meniscal repair owing to the plenty of factors affecting the results including patient age [9], tear size and location [10], time of injury [11], associated anterior cruciate ligament (ACL) injury [12,13], repair technique [6], and assessment methods. The purpose of the current study was to present long-term results of cases treated by combined all-inside and outside-in meniscal repair techniques.

The aim of this study it to represent the long-term results of combined all-inside and outside-in arthroscopic meniscal repair, carrying the benefits of all-inside technique in the posterior horn of the

meniscus, and benefits of cheap, available tools, and easy method of the outside-in technique in the rest of the meniscal tear.

## Patients and methods

This is a retrospective study of patients who underwent meniscal repair between December 2005 and October 2013 in Benha University Hospital. Inclusion criteria were patients who had repair of a longitudinal or a stable bucket handle tears after reduction, using combined outside-in and all-inside techniques. The study was approved by the institutional ethics committee in the Orthopedic Department of Orthopaedic Surgery, Benha University, Egypt. Exclusion criteria included patients who were lost to follow-up, and patients repaired by other techniques.

A total of 48 patients were included (42 males and six females), with an average age of 24.3 years (range, 10–38 years) at operation. Our indications for repair using combined technique were (a) traumatic longitudinal tear more than 10 mm, extending to the posterior horn; (b) tears in the red–white or red–red zones; (c) stable knee, either intact or reconstructed ACL; and (d) nonarthritic knee either diagnosed radiographically (Kellgren and Lawrence grade 0 or 1), or during arthroscopy (Outerbridge grade 0 or 1).

**Figure 1**

Intraoperative arthroscopic photograph sequence, demonstrating all-inside Fast-Fix suture of posterior medial meniscal tear. (a) Insertion of the fast fix device. (b) Advancing the needle inside the tear and the posterior capsule and releasing first anchor. (c) Insertion of the second bite. (d) Pulling the suture to approximate the edges of the tear. (e) Tightening the suture by specific knot pusher. (f) Cutting the suture.

### Surgical technique

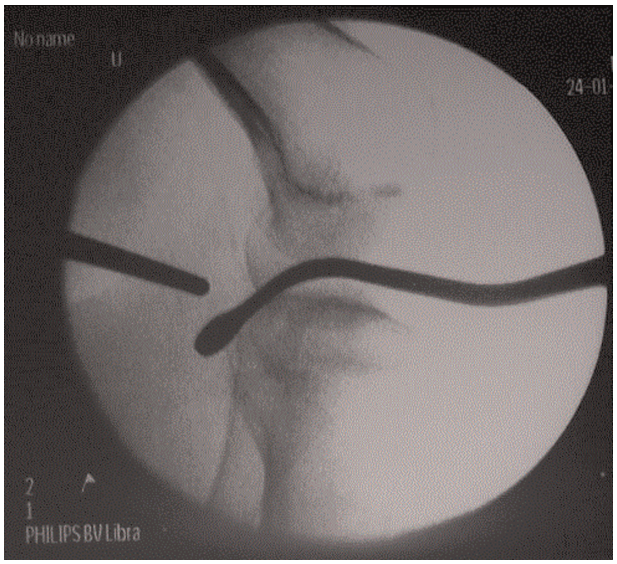
Spinal anesthesia was used in 46 patients, and general anesthesia was used in two children patients: one of them was 10 years old and the other refused spinal anesthesia. Patients were positioned supine on orthopedic table, with a lateral support used to facilitate opening the medial knee compartment. A pneumatic mid-thigh tourniquet was used with pressure adjusted to 450 mmHg.

Routine diagnostic knee arthroscopy using classic anterolateral and anteromedial portals was done with recording of the type, morphology, and reducibility of the tear, as well as any concomitant knee pathology. The tear length was measured using a graded probe. The meniscal tear edges were refreshed by using a meniscal rasp and motorized shaver to encourage the healing process. In cases of tight medial compartment, pie crusting of the MCL was performed to increase the space. The repair started from posterior to anterior. We used Fast-Fix device (Smith & Nephew, Andover, Massachusetts, USA) to made the posterior suture (all-inside) in the tight posterior horn (Fig. 1), and we used the remaining Ultrabraid 2-0 suture and PDS 2-0 in an outside-in technique for subsequent stitches.

The sleeve of the Fast-Fix needle was cut at an adequate depth to allow passing the capsule, and the needle was then inserted through the appropriate portal using the split plastic cannula. The needle passed through both parts of the meniscus and the joint capsule. The needle was then withdrawn from the meniscus after releasing the first stitch anchor superficial to the capsule behind the tear. The needle was advanced again 2–3 mm away from the first suture releasing the second anchor. The knot pusher was used for tightening, and the cutter for cutting the suture. The remaining Ultrabraid suture was then used in the outside-in sutures.

The outside-in suture (Fig. 2) was applied using two 18-G needles. A loop was done using proline 2/0 over the tip of the first needle, which was advanced percutaneously to pass through both limbs of the tear exiting inside the joint. The other needle was armed by the Ultrabraid suture and advanced percutaneously about 3 mm from the first needle and passing through the loop inside the joint. The ultrabraid suture was advanced, and the second needle was carefully withdrawn leaving the suture inside the loop.

**Figure 2**




Intraoperative photograph sequence, demonstrating outside-in technique. (a) Insertion of the first needle making a loop. (b) Insertion of the second needle. (c) Passing the second needle through the loop and advancing the free edge of the PDS suture into second needle. (d) Pulling the loop shuttling the free end of the PDS outside. (e) The transverse suture after shuttling. (f) Making 1 cm skin incision between both ends and fishing each end by the probe followed by knot tying.

The loop of the first needle was then pulled, shuttling the intra-articular end of the Ultrabraid outside the joint. A skin incision 10 mm was done between both suture ends, and both limbs were delivered using a curved probe, and a sliding knot was used with gradual tightening under arthroscopic vision. Knot was then augmented by two half hitches. The procedure was repeated according to tear length. The average sutures used was 2.4 (range, 1–5). In cases the remaining Ultrabraid suture was not enough (15 cases), PDS sutures were used to complete the remaining stitches.

In cases of combined ACL reconstruction, we only put the outside-in sutures and tied them after completing the ACL reconstruction. In cases without ACL reconstruction, three to four drill holes were done anterior to ACL insertion to deliver bone marrow stem cells and enhance healing.

### Postoperative follow-up

The knee was put in an immobilizer for 6 weeks during walking and at sleep. Partial weightbearing was allowed after the first 4 weeks and increased to full weightbearing in the next 2 weeks. Isometric quadriceps and hamstring exercises, and range-of-motion exercises were started from first postoperative day under the supervision of physiotherapists. Running was allowed after 3 months and contact sports after 9 months. All patients completed at least 12 months of follow-up.

Patients were contacted in October 2016, and full knee examination was done. Lysholm and IDKS scores were completed. A visual analog scale (VAS) for pain (where 0 indicate no pain and 10 indicating severe unbearable pain) and VAS for patient satisfaction (where 0 is unsatisfied and 10 is completely satisfied) were used. New radiograph of both knees, standing anterior-posterior and lateral views, were obtained, and arthritis was graded according to Kellgren and Lawrence classification [14]. Failure was defined as having a meniscectomy procedure postoperatively.

## Results

The average time of follow-up was 80.11 months (range, 24–121 months). Medial menisci were operated upon in 36 patients, and lateral meniscus in 12 patients. Average tear size was 2.43 cm (range, 1.5–4.1 cm).

Only four patients had meniscectomy at 9, 11, 12, and 14 months after the repair procedure (main criteria of failure), and we grouped these patients in a meniscectomy group. However, 44 patients did not have any other procedure in the operated knee after the arthroscopic meniscal repair procedure (main criteria of success), and we grouped them as the meniscus repair group.

At the final follow-up, the average International Knee Documentation Committee (IKDC) score of the meniscus repair group was 95.18±3.9, Lysholm score was 93.93±4.54, VAS for pain was 1.8±1.45, and VAS for satisfaction was 9.1±0.91. There was a significant correlation between postoperative Lysholm and IKDC scores, and the chronicity of the tear ($P<0.001$). There was no significant association between outcome scores and patient age ($P=0.09$), tear size ($P=0.12$), and concomitant ACL reconstruction ($P=0.065$).

According to the Kellgren and Lawrence classification of knee arthritic changes, 24 patients had grade 0, 10 had grade 1, and four had grade 2, and six had grade 3. When compared with the contralateral healthy knee, only four had a higher grade.

## Discussion

The present study is considered one of the longest meniscal repair follow-up studies in our community, with a mean follow-up of 80.11 months (range, 36–121 months). The main finding in our series was successful meniscus repair in 91% of patients (only four failures in 48 patients), with all failures reported in the first

14 months. Most long-term follow-up studies on meniscal repair reported a clinical success rate between 59 and 100%. The high percentage of success rate in the current series is owing to punctate patient selection. The clinical outcome of our study in comparison to different studies is summarized in Table 1.

In our series, we relied on clinical outcome to judge the success of repair. A second-look arthroscopy has financial and ethical issues, and meniscal healing is very difficult to interpret in MRI. Moreover, the results obtained by Morgan *et al.* [10] after second-look arthroscopy of 74 (16%) meniscal repairs showed that all failures were symptomatic, whereas all healed and incompletely healed menisci (84%) were asymptomatic.

Regarding the time from injury and the meniscus repair, we divided the meniscus repair group patients into three subgroups according to the chronicity of the tear (Table 2) and found no statistical difference between tears less than 6 and 12 weeks. However, a statistically significant difference was found between tears less than 12 weeks and more than 12 weeks. There is no consensus about the timing of tears and repair outcome. Venkatachalam *et al.* [8] found better results when repairs were carried out within 3 months of initial injury, whereas jakob *et al.* reported better results with tears of less than 8 weeks [15]. On the contrary, more recent series did not observe any correlation between chronicity of a meniscal tear and results [11,16].

Regarding patients' age, the average age in the current study was 24.29 (range, 10–38). Meniscus repair group patients were subgrouped into patients below 25 years old (27 patients) and patients 25 years or older (17 patients). No statistically significant difference was found in the results of both subgroups. This complies with the results obtained in many series [9,17]. Others, however, found better results in younger patients owing to greater healing potentials [18,19].

Regarding concomitant ACL reconstruction, we could not detect any statistically significant results in groups with ACL reconstruction and the group without. Most case series reported better healing in meniscal repairs done with ACL reconstructions [8,12,13,20,21]. This is likely owing to the favorable healing environment from the hemarthrosis and stem cells occurrence with ACL tunnel drilling. In our series, we created such environment in cases with intact ACL by making multiple drilling three to four drilling in the bony area in front of ACL insertion in the lateral femoral condyle, in addition to the intended partial synovectomy.

Regarding the development of arthritis, we recorded no change in 24 patients, and development of arthritic

**Table 2 Clinical outcome in different patients' subgroups according to chronicity of tears**

| Time to injury | Cases number | Lysholm | IKDS |
|---|---|---|---|
| Group 1 (<6 weeks) | 10 | 96.4 | 95.34 |
| Group 2 (6–12 weeks) | 12 | 96.91 | 96.01 |
| Group 3 (>12 weeks) | 22 | 91.23 | 89.92 |

**Table 1 Comparison of results of different meniscal repair series using different techniques**

| References | Cases number | Mean age at surgery | Follow-up (years) | Technique meniscal repair | Failure (%) | Clinical outcomes | Radiograph: grade of osteoarthritis |
|---|---|---|---|---|---|---|---|
| Rockborn and Gillquist | 31 | 25 | 13.5 | Open | 29 | Lysholm: 95 | 0: 77.4% 1: 16.1% 2: 6.4% |
| Owen | 112 | – | 5.4–12.9 | Inside-out | 11.8 | Lysholm: 86.4 IKDC: 82 | – |
| Majewski *et al.* | 88 | 29.8 | 10 | Outside-in | 23.8 | Lysholm: 94 (26–100) | 0: 65.4% 1: 30% 2: 3% 3: 1.6% |
| Abdelkafy *et al.* | 41 | 26.5 | 11.7 | Outside-in | 12.2 | Lysholm: 90.6±12 | 0: 29.3% 1:36.6% 2: 2.4% 3: 31.7% |
| Siebold *et al.* | 95 | 30 | 6 | All-inside Arrows | 28.4 | Lysholm: 90.5 (55–100) IKDC: 82.2 (62–100) | - |
| Logan *et al.* [9] | 45 | 23.2 | 8.5 | Inside-out | 24 | Lysholm: 87.4 (37–100) IKDC: 82.2 (18–100) | - |
| Melton *et al.* | 24 | 28 | 10 | Inside-out | - | IKDC: 84.2 | - |
| Tengrootenhuysen *et al.* [18] | 119 | 23 | 5.8 | Inside-out and arrows | 26 | Lysholm: 92 (51–100) | 0: 87% 1–2: 11% 3–4: 2% |
| Pujol *et al.* | 27 | 26 | 10 | All inside | 13 | IKDC: 94 | 0: 70% 1: 22.5% 2: 7.5% |
| Present study | 48 | 24.3 | 6.6 | Combined All-inside and outside in | 8.3 | Lysholm 93.93 IKDC 95.18 | K/l 9% grade 1 91% grade 0 |

IKDC, International Knee Documentation Committee.

changes in 20 patients. Such changes are actually attributed to aging, bearing in mind the long-term follow-up period. This is confirmed when the other side was considered as control reducing the significant changes in four patients only.

Regarding the cost, the described technique combined the advantages of the all-inside devices in the tight, dangerous zone (posterior horns), and the use of the suture remnants in doing multiple outside-in sutures, Which decrease the cost of the implants.

The failed four patients were studied to address the cause of failure. It is mainly instability, as partial ACL injury was recorded in three of them and the chronicity of the tear in the fourth case (6 months).

## Conclusion

Combined all-inside and outside-in arthroscopic meniscal repair is a safe and a cheap technique, with a good long-term clinical outcome.

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Nil.

**Conflicts of interest**

There are no conflicts of interest.

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