RESEARCH ARTICLE

Arthroscopic Meniscal Repair: "Modified Outside-In Technique"

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Abstract

Background: Despite the introduction of different techniques for meniscal repair, no single procedure is superior in all situations. The new method for meniscal repair named "*modified outside-in technique*" aims to achieve higher primary fixation strength by an alternative suture technique as well as avoid disadvantages of outside-in, inside-out, and all-inside suture procedures. Additionally, the mid-term results of surgically treated patients with meniscal injuries by our new technique were evaluated.

Methods: The current prospective study included 66 patients who underwent meniscal repair by the modified outside-in technique. The International Knee Documentation Committee (IKDC) Subjective Knee Evaluation Form was completed pre- and post-operatively. At final follow-up, Lysholm score was completed and patients were questioned about their return to previous sport activities. Clinical success was defined as lack of swelling and joint line tenderness, absence of locking, negative McMurray test and no need for meniscectomy. Patients' satisfaction was evaluated using the visual analogue scale (VAS). Patients were followed for 26±1.7 months.

Results: Clinical success was achieved in 61 patients (92.4%) and 5 candidates required meniscectomy (7.6%). IKDC Subjective Knee Evaluation Form score increased significantly from 54.2±12.7 preoperatively to 90.8±15.6 postoperatively (P<0.001). Lysholm score was excellent and good in 49 (80.3%) patients and fair in 12 (19.7%). Patients' satisfaction averaged at 8.35±1 (6-10). Neurovascular injury, synovitis and other knot-related complications were not reported.

Conclusions: The modified outside-in technique has satisfactory functional and clinical outcomes. We believe that this procedure is associated with better clinical and biomechanical results; however, complementary studies should be performed to draw a firm conclusion in this regard.

Key words: Arthroscopy, Meniscus, Modified outside-in technique

Introduction

Arthroscopic meniscal repair was first introduced by Ikeuchi in Tokyo, in 1979 (1). Later, various modified approaches have been proposed by investigators (2, 3). Over the recent years, arthroscopic meniscal repair has gained popularity; however, despite advances in equipment and techniques, the method of choice still remains a matter of controversy among orthopedics.

Arthroscopic repair techniques can be categorized into four groups: inside-out, outside-in, all-inside, and hybrid repairs, supplementing previous techniques (4). Presently, no single meniscal repair technique or device is superior in all situations. The outside-in technique, described by Morgan and Casscells, is best suitable for mid or anterior third meniscal tears (5). The procedure employs the passage of single sutures through the superior and inferior surfaces of the meniscus, retrieved

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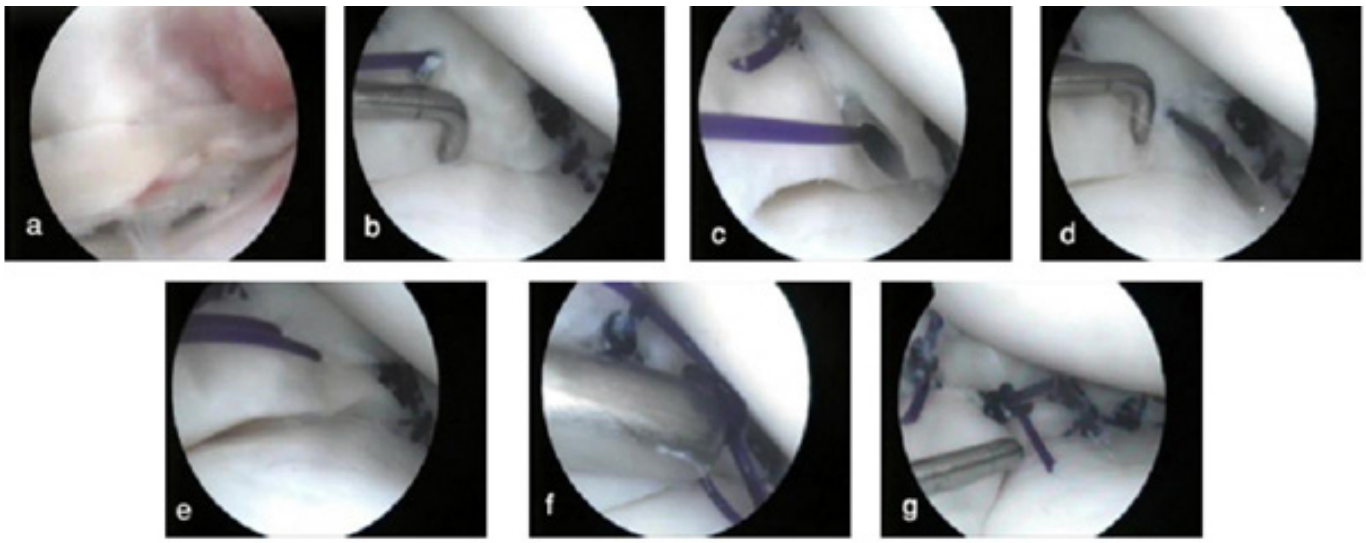

Figure 1. a) A meniscal tear. b) The needle is inserted and PDS suture is passed through the outer and inner parts of the meniscus tear by the needle. c) The suture is held by a grasper passed through the other portal. d) The needle is withdrawn to the outer membrane of the capsule, then re-inserted parallel to the first site of insertion toward the joint and perpendicular to the tear. e) The suture is pilled through the needle outside the joint space. f) The suture is tied outside the joint and the sliding knot is placed on the periphery of the meniscus by a knot pusher. g) The tie is locked with four sequential half-hitches and tails are cut intraarticularly.

and tied in a Mulberry knot, and finally ligated over the capsule (5). In the all-inside technique, a posterior cannula and Linvatec spectrum suture hook is applied to pass the suture through the posterior horn for all inside ligation (6). The technique is particularly useful for posterior horn tears, to limit the chance of neurovascular injury and improve tissue re-approximation. However, this approach is indicated for posterior meniscal injuries within 2 mm of the joint capsule and can be difficult because of the size of the cannula and passage of the needle through the tight joint space (6).

Bearing in mind the shortcomings of the aforementioned techniques, the "modified outside-in technique" was designed to attain higher primary fixation strength by a suturing technique and avoid drawbacks associated with outside-in, inside-out, and all-inside suture procedures. In our study we have also reported the mid-term results of patient management with meniscal injuries applying our new technique.

Methods

Meniscal tears were diagnosed in 82 consecutive patients from March 2012 to April 2013 in Akhtar Orthopedic Hospital. Candidates with tears in the white-white zone of Copper's classification, posterior horn tears of medial or lateral meniscus, arthritis at the time of surgery and history of meniscal surgery were excluded. Ethical committee approval and patient informed consent were obtained. Clinical examination and magnetic resonance imaging evaluations were done to identify meniscal tears. Patients with arthroscopic findings of degenerative meniscal ruptures were excluded. Length of tear, number of sutures and duration of the operations were recorded. International Knee Documentation Committee (IKDC) Subjective Knee Evaluation Form and Lysholm scores were completed and anterior tibial displacement was measured by KT-2000 pre-operatively.

Surgical Technique

Arthroscopy of the knee joint is performed through anteromedial (medial to the patellar tendon) and anterolateral (lateral to the patellar tendon) portals. Through one portal the surgical field is visualized, while through the other, the surgical procedure is performed. The length of the meniscal tear determined the number of sutures needed. Suture material employed was No: 0 PDS (Ethicon, San Angelo, TX, USA).

Technical steps are illustrated in Figure 1. The modified outside-in technique employs a vertical or horizontal loop suture with one needle (18 gauge). After initial inspection of the joint, and shaving and rasping of the ruptured area of the meniscus and the fat pad, the needle is passed from outside the capsule towards the joint and perpendicular to the tear line within the most inferior surface of the meniscus and is exited from the superior surface of the innermost segment of the ruptured meniscus. The suture is then passed through the needle into the joint and held by a grasper, introduced through the second portal. Thereafter, the needle is withdrawn to the outer membrane of the capsule (the space between the capsule and subcutaneous tissue) while the suture is still within the needle [Figure 2]. The needle is re-inserted parallel to the initial site of insertion within the most superior surface of the meniscus (the same plane as the first), towards the joint and perpendicular to the tear line. A grasper is introduced through the portal to pull the suture through the needle outside the joint

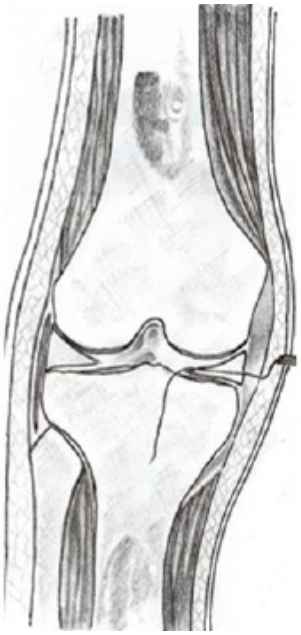

Figure 2. Schematic view of the needle that is withdrawn to the outer membrane of the capsule and will be re-inserted parallel to the initial site of insertion toward the joint and perpendicular to the tear line.

space, having withdrawn the needle. The free ends of the suture, both within the same portal through a cannula (in order to avoid the entrapment of soft tissue in the sutures), are tied outside the joint. The sliding knot is placed on the meniscus by a knot pusher and locked with two non-sliding knots. After ligation, the suture tails are cut intra-articularly with scissors and the process is repeated as many times as necessary to stabilize the tear.

Post-operative management included immobilization for 10 to 14 days. Touch-down weight bearing was allowed for the first two weeks, partial weight bearing after 2 to 4 weeks and full weight bearing after 4 to 6 weeks. Candidates were allowed to perform sport activities after 6 months.

Clinical success was defined as lack of swelling and joint line tenderness, absence of locking, negative McMurray test and no need for meniscectomy. At final follow up, the IKDC Subjective Knee Evaluation Form and Lysholm scores were completed for patients with clinically successful outcomes. Anterior tibial displacement was measured for those with ACL reconstruction. Return to initial sport activity was noted. Patients' satisfaction was evaluated by the visual analogue scale (VAS). In this setting, zero indicated nil satisfaction and 10 as maximal satisfaction. Statistical analysis was performed utilizing SPSS ver. 16 software. Paired t-test was used to compare the pre- and post-operative IKDC Subjective Knee Evaluation Form and Lysholm scores and anterior tibial displacement. $P<0.05$ was considered significant.

Results

A total of 82 patients with meniscal tears (anterior and/or middle third) were enlisted in our study. Five patients were lost during follow up and 11 candidates were excluded because of intraoperative findings of degenerative meniscal changes. Data regarding the remaining 66 patients is presented in Table 1. Meniscectomy following initial meniscal repair due to persistent knee pain and locking was performed for 5 patients (7.6%). The other 61 patients had full range of knee motion with no complains of pain, tenderness, swelling and locking in their final follow up visit. McMurray test was negative in these patients. The procedure displayed 92.4% clinical success rate.

IKDC Subjective Knee Evaluation Form score improved significantly from 54.2±12.7 (48-69) preoperatively to 90.8±15.6 postoperatively (84-95) ($P<0.001$). The outcome of the Lysholm score was excellent and good in 49 (80.3%) patients and fair in 12 (19.7%). Patient

Table 1. Demographic and operative data of the patients

No. of patients			66
Age (years)			24.2±5 (19-34)
Sex	Female		0
	Male		66
Location of rupture	Medial meniscus	Anterior third	16
		Middle third	31
	Lateral meniscus	Anterior third	7
		Middle third	12
ACL rupture			52
Length of meniscal tear (cm)			2.92±0.7 (1.3-4)
Number of sutures			2.6±0.9 (1-6)
Duration of surgery for meniscal repair (min)			26.5±4.1 (23-33)
Follow up (months)			26±1.7 (24-27)

satisfaction averaged at 8.35±1 (6-10). In all cases with ACL reconstruction, arthrometery demonstrated less than 3 mm anterior tibial displacement. No neurovascular injury, synovitis and other knot-related complications were documented.

Discussion

In the current study we introduced a new suture technique for meniscal repair (anterior and/or middle third) which produced encouraging preliminary outcomes. The novel technique is simple, safe, inexpensive, and after over 2 years of follow up, clinical success was achieved in a majority of the patients with optimal functional outcomes.

Prior investigators have proposed that arthroscopic meniscal repair may prevent early degenerative changes associated with meniscectomy and should be considered for peripheral and longitudinal tears, particularly in younger patients (7,8). Several studies have investigated the outcomes of meniscal repair by different techniques and various sutures, including suture-less procedures and found good clinical and functional outcomes. However, due to the lack of sufficient well-designed comparative studies, a heterogeneous patient population, and varying measurement methods, an optimal procedure with minimal complications, failure rates, and best clinical and functional outcomes remain controversial. Each procedure has specific advantages and disadvantages, documented in earlier studies.

The outside-in technique of arthroscopic meniscal repair is effective particularly for anterior horn and mid-third tears (4). It predictably avoids neurovascular injury without the need for a large posterior incision (9). However, difficulty of implicating perpendicular orientation of sutures for tears adjacent to the site of attachment of the posterior horn with accompanying risk of neurovascular injuries or cartilage damage exists (9).

The all-inside technique was developed to overcome the pitfalls of the outside-in re-fixation technique with promising biomechanical and short-term clinical results (10-16). However, opposing results have also been reported for meniscal tears with all-inside absorbable meniscal repair devices compared to traditional suture techniques. In an experimental study, Miller et al. repaired medial meniscal tears of both knees in 26 goats with three all-inside meniscal repair devices. They observed chondral injury in 75%-100% of knees operated on by all-inside devises; however, chondral injury was absent in the control goats without meniscal repair. Miller et al. concluded that although the all-inside technique is quick and easily performed, the outcomes may not be as good as suture techniques (17).

In another experimental evaluation, meniscal repair with the fast-fix and inside-out suture technique in goat models was compared by Hospodar et al. Fast-fix meniscal repair was associated with inferior healing end results (18). Seil et al. analyzed the behavior of several all-inside fixation devices under cyclic loading and observed that these devices may fail under repetitive loading conditions (19). Hantes et al. compared the results of meniscal repair with outside-in, inside-out and all-inside techniques and observed meniscal healing in 100%, 95%, and 65% patients, respectively (20).

Considering the merits and demerits of the above mentioned techniques, the main aim of designing the "modified outside-in technique" was to achieve higher primary fixation strength by an alternative suture technique while entailing advantages of both outside-in and all-inside suture techniques and meniscal fenestration that promotes meniscal healing. Our new technique displayed good clinical, and functional outcomes without serious complication. The success rate was satisfactorily high and surgery was not excessively long. The technique is inexpensive compared to previous methods, especially the all-inside technique. The current study has its limitations. We did not compare our results with other techniques - which remains a future protocol. Additionally, the modified outside-in method is technically demanding with a slow learning curve because this technique requires arthroscopic knot tying skills that are not easy to perform.

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