ORIGINAL ARTICLE

Early results of all-inside meniscal repairs using a pre-loaded suture anchor

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Objectives To report the clinical and radiological results of all-inside meniscal repairs using a pre-loaded suture anchor.

Design Case series.

Setting Regional hospital, Hong Kong.

Patients From January 2008 to June 2010, 51 patients with a mean age of 26 (range, 15-48) years with 57 meniscal tears underwent meniscal repair utilising the all-inside meniscal repair technique entailing a pre-loaded suture anchor. All tears were located at red-red or red-white zones. Concurrent anterior cruciate ligament reconstruction was performed in 37 (73%) of the patients. Patients were evaluated postoperatively based on the International Knee Documentation Committee score, clinical examination, and magnetic resonance imaging. Presence of locking, joint-line tenderness, effusion, and positive McMurray test were considered to indicate clinical failure.

Results The mean follow-up was 19 (range, 12-39) months. An average of 2 (range, 1 to 4) suture devices was used per patient. The mean tear size was 20 (range, 10-40) mm. In all, 10 (18%) of the tears had failed clinically and 11 (19%) appeared unhealed on postoperative imaging. The mean International Knee Documentation Committee score improved significantly from 62 preoperatively to 81 postoperatively ($P<0.001$). Patients with concurrent anterior cruciate ligament reconstruction had better corresponding scores postoperatively than preoperatively (mean, 83 vs 65, $P<0.001$). The clinical and radiological outcome was not related to the chronicity, location or length of the tear, or patient age. No postoperative extra- or intra-articular complications were encountered.

Conclusion All-inside meniscal repair using a pre-loaded suture anchor is safe and effective, and yielded an 83% clinical and 81% radiological success rate.

New knowledge added by this study

- All-inside meniscal repair using a pre-loaded suture anchor is an effective option for preserving torn menisci.

Implications for clinical practice or policy

- So as to preserve meniscal tissue, it is important to consider repairing every meniscus tear encountered during arthroscopy of the knee.

Key words
Arthroscopy; Knee injuries; Menisci, tibial; Rupture; Sutures

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Introduction

Many studies have demonstrated the importance of the meniscus in knee function.[1,2] It has also been shown that surgeons should preserve as much meniscal tissue as possible, because not just complete but also partial meniscectomy is associated with early degenerative osteoarthritis.[3-5] To preserve function, it is now suggested that meniscal tears be treated by meniscal repair instead of meniscectomy.

Currently, there are three arthroscopic meniscal repair techniques: inside-out, outside-in, and all-inside. The inside-out technique is considered the gold standard and has been used most commonly. It is reliable and reproducible for repairing meniscal tears, but there is a chance of damaging the peroneal nerve and vessels over the lateral side, and the saphenous nerve over the medial side, so most of the time a posteromedial or posterolateral incision must be made for suture relay. The outside-in technique was initially

designed to decrease such neurovascular risks, but was virtually limited to repairing the anterior horn of the meniscus. A recent systematic review reported success rates of 82% and 85% following inside-out and outside-in techniques, respectively.[6]

To avoid the risk of neurovascular injury and additional wounds, different types of all-inside meniscal repair with biodegradable products (eg meniscal arrows and tacks) were introduced. Although they could be applied quickly, several reports suggested that such products could cause synovitis and chondral injury,[7-10] and their biomechanical pull-out strength was markedly inferior to sutures.[11-13]

The FAST-FIX (Smith & Nephew, Andover [MA], US) all-inside meniscal repair device was designed to combine the advantages of the all-inside technique while providing superior biomechanical properties by means of sutures. It contains two 5-mm polymer suture bar anchors that are attached to a No. 0 non-absorbable braided polyester suture with a presliding slot.

This account describes clinical outcomes with the FAST-FIX meniscal repair system in a series of patients with meniscal tears.

以預先裝上的縫合錨釘作全內置式半月軟骨修復的早期結果

目的 報告使用以預先裝上的縫合錨釘作全內置式半月軟骨修復的臨床及影像結果。

設計 病例系列。

安排 香港一所分區醫院。

患者 2008年1月至2010年6月期間共51名病人（半月軟骨破裂57例）接受以預先裝上的縫合錨釘作全內置式半月軟骨修復術。病人平均年齡26歲，介乎15至48歲。所有半月軟骨破裂病例的位置均在內⅓圈（red-red zone）或紅白交界中間的⅓部份（red-white zone）。有37名病人（73%）同時間接受前十字韌帶重整術。根據國際膝關節評分委員會（IKDC）得分、臨床檢查及磁共振影像來評估病人的術後結果。如果發現病人有關節卡住、疼痛、積液，以及膝關節麥氏試驗呈陽性，即代表臨床失效。

結果 本研究的追蹤期平均為19個月（介乎12至39個月），每名病人平均使用縫合錨釘2枚（介乎1至4枚）。半月軟骨破裂的長度為20 mm（介乎10至40 mm）。有10例（18%）修復失效，另11例（19%）的術後影像顯示半月軟骨未能修復。病人的平均IKDC評分由術前的62分升至術後的81分（P<0.001）。同時間接受前十字韌帶重整術的病人的IKDC評分較佳，由術前的65分升至術後的83分（P<0.001）。臨床及影像結果與以下因素並無關係：半月軟骨破裂的位置及長度、破裂的時間長短和病人年齡。術後並無關節外或關節內的併發症。

結論 使用以預先裝上的縫合錨釘作全內置式半月軟骨修復術不但安全有效，而且從臨床及影像結果可見，其成功率分別可達至83%及81%。

Methods

From January 2008 to June 2010, 54 consecutive suitable patients with meniscal tears underwent repair utilising the FAST-FIX device at a regional hospital in Hong Kong. Inclusion criteria for the procedure were: (1) full-thickness meniscal tear greater than 10 mm in length, (2) tear location less than 6 mm from the meniscocapsular junction (ie red-red or red-white tear), (3) no former meniscus surgery, (4) no evidence of arthritis during arthroscopy, and (5) no other form of meniscus fixation.

Of the 54 patients, two were lost to follow-up, and one had a repair by more than one technique. Thus, 51 of the remaining consecutive patients (mean age, 26; range, 15-48 years) with 57 meniscal tears were included in the analysis. The International Knee Documentation Committee (IKDC) questionnaires[14] were filled out by every patient 1 week before surgery.

Concurrent anterior cruciate ligament (ACL) reconstruction was performed in 37 (73%) of the patients, using bone-patella-bone tendon or hamstrings autografts at the time of the meniscal repair.

Surgical technique

At the time of surgery, the meniscal lesions (including length, site, zone, and morphology) were assessed and recorded by two orthopaedic specialists using a standard documentation system.

The technique of meniscal repair by the FAST-FIX device was in keeping with the manufacturer's recommendations. After the edges of the tear were prepared, the FAST-FIX device was introduced into the joint under arthroscopic guidance with the split cannula. The two T-Fix bars were then inserted to the meniscal fragment and deployed extra-articularly. Depending on the anatomy of the tear, vertical, horizontal, or oblique mattress loops could be utilised. After the delivery needle was withdrawn from the knee joint, the pre-tied self-sliding knots were tensioned and the sutures cut with the aid of the knot pusher–suture cutter.

Rehabilitation protocol

For patients who had meniscal repairs, their knee motion was restricted between 0° and 90° for the first 3 weeks post-surgery with partial-weight-bearing walking, followed by another 3 weeks with an increased range of motion (between 0° and 120°), and progression to full-weight-bearing walking by postoperative week 4. Squatting was prohibited for the first 3 postoperative months. Return to sport was permitted 9 months after repair.

Evaluation methods

All the patients were assessed by clinical examination and determining the IKDC score at postoperative weeks 1, 3, and 6, and postoperative months 3, 6, and 9, as well as at 1 year and then annually thereafter. The clinical examination was conducted by either one of the two authors. The results of the last follow-up were analysed. According to the Barrett's criteria,[15] the repair was considered a failure if there was any joint locking, joint-line tenderness, effusion, or a positive McMurray test.

Patients were examined by magnetic resonance imaging (MRI) 1 year post-surgery, and were performed with a 1.5 T MRI system (SignaHD, General Electric, Milwaukee [WI], US) by using a knee coil (General Electric). The following sequences were obtained: (1) sagittal T1-weighted spin echo: repetition time (TR) 660 ms, echo time (TE) 9 mm; (2) sagittal proton density (PD) fat-saturated spin echo: TR 2300 ms, TE 8 mm; (3) sagittal T2-weighted fat-saturated spin echo: TR 4200 ms, TE 64 mm; (4) coronal PD fat-saturated spin echo: TR 2300 ms, TE 8 mm; (5) axial T2-weighted fat-saturated spin echo: TR 4500 ms, TE 66 mm, and (6) axial PD fat-saturated spin echo: TR 2500 ms, TE 8 mm. The other parameters for all six sequences included matrix, 256 x 256; field of view, 16 cm; thickness, 4 mm; and space, 0.5 mm.

The MRI scans were then reviewed by the first author. Using the criteria by Crues et al,[16] a meniscus repair was considered to be a failure if there was a grade-3 signal, that is, linear signal intensity extending to the articular surface, whether to the tibial or the femoral site.

Statistical analysis

Fisher's exact test was used to compare patients with healed menisci (clinically and radiologically) and those in whom the surgery was regarded as a failure. Assessments were carried out with respect to patient age, chronicity of tear (elapsed time from injury to repair), length of tear, repair side (medial or lateral), zone of tear (red-white or red-red tear), and concomitant ACL reconstruction. Paired *t* tests were used to compare mean preoperative and postoperative IKDC Subjective Knee Scores. Any P value of <0.05 was considered statistically significant.

Results

There were 38 lateral (67%) and 19 medial meniscal tears (33%), and 23 red-red (40%) and 34 red-white tears (60%). Tear morphologies are listed in Table 1. An average of 2 suture devices was used (range, 1 to 4) per patient. The mean tear size was 20 (range, 10-40) mm. The mean follow-up was 19 (range, 12-39) months. No postoperative extra- or intra-articular complications were encountered.

TABLE 1. Morphology of the meniscal tears

Morphology	No. (%) of tears
Bucket-handle	8 (14)
Complex	4 (7)
Horizontal	3 (5)
Longitudinal	42 (74)

In all, 10 (18%) of the tears had failed clinically, and 11 (19%) appeared unhealed in the postoperative MRIs. Among these, seven (14%) of the patients had both clinical and radiological failures; six of these patients underwent further arthroscopies, which revealed that five of them had unhealed tears.

The mean IKDC score improved significantly from 62 preoperatively to 81 postoperatively (P<0.001, paired *t* test). Patients that had concurrent ACL reconstructions had better IKDC scores postoperatively than preoperatively (mean, 83 vs 65 respectively, P<0.001, paired *t* test). Clinical and radiological outcomes were not related to the chronicity or location of the tear, length of the tear, and patient age.

To identify the factors that affect the results of meniscal repair, patients with healed menisci (clinically and radiologically) were compared with patients with failed repairs. Age, chronicity of tear (elapsed time from injury to repair), length of tear, repair side (medial or lateral), zone of tear (red-white or red-red), and concomitant ACL reconstruction at the time of meniscal repair were not related to success or failure (Table 2). Based on the criteria of Barrett et al[15] and Crues et al,[16] the clinical and radiological success rates in our series were 83% and 81%, respectively.

Discussion

The meniscus plays an important role in load transmission across the knee joint. In knee flexion and extension, nearly 85% and 50% of the respective compressive loads are transmitted through the menisci.[17] Partial meniscectomy dramatically increases the contact pressures in the knee. The contact pressure increases 350% if 15% to 34% of the meniscus tissue is removed.[18] Moreover, the meniscus contributes to knee proprioception, lubrication and cartilage nutrition, and provides secondary antero-posterior knee joint stability.[19-21] Thus, surgeons should preserve as much of the meniscal tissue as possible, because even partial meniscectomy is associated with early degenerative osteoarthritis.[22,23] To preserve meniscal function, meniscal repair is therefore considered preferable to meniscectomy.

Different meniscal repair techniques have been developed. Inside-out or outside-in repairing techniques are still considered the gold standard. A

TABLE 2. Factors affecting outcomes of meniscus repair

Factor	No. of tears	Clinical failure, No. (%) of tears	P value	MRI failure, No. (%) of tears	P value
Chronicity					
>3 Weeks	4	2 (50)	0.38	2 (50)	0.12
<3 Weeks	53	8 (15)		9 (17)	
Age					
>30 Years	44	7 (16)	0.68	10 (23)	0.25
<30 Years	13	3 (23)		1 (8)	
Meniscus side					
Medial	19	5 (26)	0.28	5 (26)	0.14
Lateral	38	5 (13)		6 (16)	
Tear length					
>25 mm	46	8 (17)	1.00	9 (20)	1.00
<25 mm	11	2 (18)		2 (18)	
Tear location					
Red-red zone	23	5 (22)	0.50	5 (22)	0.76
Red-white zone	34	5 (15)		6 (18)	
Concomitant ACL* reconstruction					
No	19	4 (21)	0.72	5 (26)	0.11
Yes	38	6 (16)		6 (16)	

* ACL denotes anterior cruciate ligament

recent systematic review reported a non-healing rate of 18% and 15% following the inside-out and outside-in techniques, respectively.[6] In order to facilitate the entire repair within the joint, a large number of all-inside arthroscopic meniscal repair devices have been introduced into the market. The biodegradable Meniscus Arrow by Bionx Implants (Blue Bell, PA) was first to be introduced in 1993.[7] However, according to a recent systematic review it was associated with a reoperation rate of 32%.[6]

In this study, the clinical and radiological outcome of 57 repaired menisci using the FAST-FIX meniscal repair system entailed a mean follow-up of 19 months. Based on the criteria of Barrett et al[15] and Crues et al,[16] the clinical and radiological success rates in our series were 83% and 81%, respectively. Clinical results similar to these have been reported in other studies with the FAST-FIX technique,[24-26] and clinical and radiological healing rates with this device have been reported to be 82-92% and 83%, respectively.[25-29]

Second-look arthroscopy is still the gold standard in assessing the meniscal healing. However, it is not feasible in routine clinical practice due to invasiveness of the procedure. Using clinical symptoms to evaluate repaired meniscal tears provides only indirect evidence of successful healing, but is a well-accepted method of assessing healing after meniscal repair, though absence of symptoms does not always reflect the true status of the meniscus.[30] A sensitivity of 58% and specificity of 75% has been reported.[28]

As it is non-invasive and easily available, MRI is considered a better diagnostic means of evaluating the meniscal healing. However, oedematous or fibrous scar tissue formed during the healing process may give rise to persistent pathological signals and interfere with image interpretation.[31-33] Consequently, its diagnostic value in meniscus repair is questioned. By combining several MRI sequences, a sensitivity of 92% and specificity of 99% has been reported.[28]

In our series, patients with concurrent ACL reconstruction had better IKDC subjective knee scores postoperatively than those who did not (mean, 83 vs 65), which may due to the stability provided by the reconstruction. Though we were not able to demonstrate any difference in failure rate between patients with and without concurrent ACL reconstruction, lower failure rates have been documented when meniscus repair is undertaken with concomitant ACL reconstruction.[6] Possibly, such reconstruction provides a more stable knee, and the postoperative haemarthrosis may provide a more favourable healing environment for the meniscal tear.[30] The rate of clinical and radiological failure was lower in patients undergoing repair within 3 weeks of injury. This difference was not statistically significant in our series, though a larger sample size might have yielded a significant result.

One weakness of our study was that we reported only short-term results. Moreover, our sample size was relatively small. Further study with longer follow-up and a larger sample appears necessary to evaluate

the long-term effectiveness of the device. Another limitation was the lack of any observer reliability analysis for determining clinically and radiologically failed meniscus repair.

Conclusion

Meniscal repair with the all-inside meniscal repair using a pre-loaded suture anchor is safe and effective in the short term; a success rate of 83% (clinically) and 81% (radiologically) was observed.

Declaration

No conflicts of interest were declared by the authors.

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