Outcomes of Meniscal Repair
Minimum of 2-Year Follow-Up

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Abstract
Purpose: The purpose of this study was to determine the success rate of meniscal repair achieved in our sports medicine practice, particularly with interest in characterizing the outcomes observed with the newer all-inside repair devices.

Type of study: Retrospective chart review with telephone follow-up.

Methods: 157 patients that had undergone a meniscal repair procedure between 1996 and 2001 were identified. Twenty-four of these patients were lost to follow-up. Thus, the study group consisted of 133 patients providing a follow-up rate of 85%. All patients included had a minimum of two years of follow up. Failure was defined as the need for meniscectomy in the area of the meniscus that was initially repaired. The time interval from injury to surgery was divided into less than six weeks (acute) and greater than six weeks (chronic). The etiology of the meniscal tear was broken down into three categories: sports related trauma, non-sports trauma, and atraumatic. The repair techniques used in these patients included outside-in sutures, inside-out sutures, darts, arrows, meniscal screws, T-fix, FastFix, and the RapidLoc.

Results: The failure rate was 36%. No association was found between failure and the length of preoperative symptoms, rim width, etiology, concomitant meniscectomy, chondroplasty or anterior cruciate ligament (ACL) reconstruction. There was a higher rate of failure of tears in the medial versus lateral meniscus (20.3% vs. 44.8%). No statistical comparisons could be made between devices due to small sample sizes.

Conclusions: The all-inside meniscal repair devices have simplified the meniscal repair procedure. This may have lead to a broadening of the indications for repair.

Clinical Relevance: The newer generation meniscal repair devices, while simplifying the procedure, do not appear to lead to an increased clinical success rate.

As the functional and activity demands have increased over the past decades in our patient population, so has the emphasis on comprehensive reconstruction and restoration of ideal knee function postoperatively. Meniscal injury is currently a well-recognized source of knee dysfunction. Subsequently, arthroscopic treatment of meniscal pathology has become one of the most common orthopaedic procedures in the United States, constituting 10% to 20% of all surgeries performed in many centers.1

The shift in focus from meniscectomy to preservation and repair of the meniscus has come from the recent evolution in the understanding of the biomechanical and functional properties of the intact meniscus in relation to knee mechanics and patient outcomes. It is now well-recognized that the menisci increase the surface area for femoral-tibial load transmission,2-8 aid in the mechanics of joint lubrication,9 and act as a secondary anterior-posterior stabilizer, especially in ACL-deficient knees.10,11 Maintaining an intact and functioning meniscus is felt to be a major factor in reducing the ultimate risk of progression to radiographic findings consistent with arthritis. Thus, by maintaining physiologic knee kinematics as best as possible, we aim to prevent, or at least delay, the premature onset of osteoarthritis in our patient population.

Reports on the outcomes of meniscal repair have varied based on the method of evaluation (specifically with regard to the definition of failure) and the technique being evaluated. The purpose of this study was to determine the success rate of meniscal repair achieved in our sports medicine practice,
particularly with interest in characterizing the outcomes observed with the newer all-inside repair devices being used at our institution. Additionally, we aimed to determine if any specific patient factors contributed to the success or failure with these various meniscal repair techniques.

**Methods**

Following proper institutional review board procedures, a retrospective chart review was performed identifying 157 patients that had undergone a meniscal repair procedure in our sports medicine practice between 1996 and 2001. Twenty-four of the patients were lost to follow-up and were excluded. The study group consisted of 133 patients which provided a follow-up rate of 85%. Patient records from four board-certified orthopaedic surgeons were reviewed. Only patients with a minimum of 2-years of follow-up were included. The mean age at the time of repair was 30.1 years (range: 8 to 58 years). There were 110 medial meniscal repairs and 23 lateral repairs performed in this patient population.

The time interval from injury to surgery was divided into: less than six week (acute) or greater than six weeks (chronic). Information on the duration of the injury was available for 99 patients. Forty-eight were classified as acute and 51 as chronic.

The etiology of the meniscal tear was broken down into three categories; sports-related trauma, non-sports trauma, and atraumatic. There were 102 (76%) in the sports trauma group, 24 (18%) in the non-sports trauma, and 8 (6%) tears were classified as atraumatic. There were a number of injuries associated with the meniscal tears that were discovered at the initial examination or at the time of arthroscopy (Table 1).

Indications for meniscal repair in this population were full-thickness, vertical longitudinal tears greater than 1 cm in length that were in the red-red or red-white zones of the meniscus. Meniscal repair was not attempted in patients with tears involving other configurations, as well as those in the white-white zone or tears in ACL deficient knees not undergoing ligament reconstruction. There were numerous different repair techniques used in the patients involved in the study. The arthroscopically assisted inside-out and outside-in suture techniques were used in 22 patients while the first generation all inside techniques [Meniscus Arrow (Bionx, Blue Bell, PA), Meniscal Darts (Arthrex, Naples, FL) and Clearfix Meniscal Screws (Innovasive)] were used in 72 patients. The second generation all inside hybrid-suture techniques [T-fix (Smith and Nephew Endoscopy, Andover, MA), FaST-Fix (Smith and Nephew Endoscopy, Andover, MA) and RapidLoc (Mitek; Norwood, MA)] were used in 30 patients. Nine repairs were performed using a combination of techniques (Table 2). These included outside-in combined with screws (2 patients) or arrows (5 patients) and inside-out combined with arrows (2 patients). Table 3 shows the concomitant procedures performed at the time of the meniscal repair.

Patient charts were reviewed for demographic and surgical information including: patient age at repair, sex, mechanism of injury, length of preoperative symptoms, tear length, tear location, concomitant procedures, presence of chondral injury, repair technique used, complications, postoperative rehabilitation protocol, length of follow-up, and whether the patient underwent a revision surgical procedure. For this last group of patients (those having undergone revision), the duration of follow-up was calculated as the time to their second surgery. Patients were contacted by telephone. Failure was defined as revision surgery for the same tear that was initially repaired and which occurred in the absence of a new traumatic insult.

**Results**

Mean length of follow-up in patients that did not undergo reoperation for failed meniscal repair was 62 months (range: 24 to 116 months). Of the 133 patients with greater than two-year follow-up, 48 (36%) required a reoperation with partial meniscectomy of the portion of the meniscus that was previously repaired. The average time to reoperation in these patients was 27 months (range: 1 to 75 months). The clinical success rate was 64%. Chi-square and ANOVA tests were performed to determine if any association of the variables exists with regard to failure (Table 4).

The length of time from injury to repair was divided into acute (less than 6 weeks) and chronic (greater than 6 weeks).

**Table 1** Associated Injuries

<table>
<thead>
<tr>
<th>Injuries</th>
<th>Number</th>
<th>% of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anterior cruciate ligament</td>
<td>79</td>
<td></td>
</tr>
<tr>
<td>Meniscal tears in opposite meniscus</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>Chondral lesions</td>
<td>45</td>
<td></td>
</tr>
<tr>
<td>Posterior cruciate ligament</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Posterolateral corner</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

**Table 2** Repair Technique

<table>
<thead>
<tr>
<th>Technique</th>
<th>Number</th>
<th>% of Total</th>
<th>% of Failure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outside in</td>
<td>10</td>
<td>7%</td>
<td>30.0%</td>
</tr>
<tr>
<td>Inside out</td>
<td>12</td>
<td>9%</td>
<td>33.3%</td>
</tr>
<tr>
<td>Arrows</td>
<td>64</td>
<td>49%</td>
<td>34.4%</td>
</tr>
<tr>
<td>Darts</td>
<td>5</td>
<td>4%</td>
<td>0.0%</td>
</tr>
<tr>
<td>Screws</td>
<td>3</td>
<td>2%</td>
<td>66.6%</td>
</tr>
<tr>
<td>T-Fix</td>
<td>17</td>
<td>13%</td>
<td>47.0%</td>
</tr>
<tr>
<td>Fast Fix</td>
<td>10</td>
<td>7%</td>
<td>40.0%</td>
</tr>
<tr>
<td>Rapid Loc</td>
<td>3</td>
<td>2%</td>
<td>0.0%</td>
</tr>
<tr>
<td>Combined techniques</td>
<td>9</td>
<td>7%</td>
<td>55.6%</td>
</tr>
</tbody>
</table>

**Table 3** Concomitant Procedures

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Number</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACL recon</td>
<td>70</td>
<td>53%</td>
</tr>
<tr>
<td>ACL revision</td>
<td>7</td>
<td>5%</td>
</tr>
<tr>
<td>Chondroplasty</td>
<td>9</td>
<td>7%</td>
</tr>
<tr>
<td>Partial Meniscectomy</td>
<td>28</td>
<td>21%</td>
</tr>
<tr>
<td>PCL recon</td>
<td>1</td>
<td>1%</td>
</tr>
<tr>
<td>PL corner recon</td>
<td>1</td>
<td>1%</td>
</tr>
</tbody>
</table>
The failure rate for acute tears was 42.3% and for chronic tears 37%. There was no statistical difference between these failure rates (p = 0.820).

The location of the tear within the meniscus was looked at for association with failure. Locations were broken down into red-red tears and red-white tears. No meniscal tears in the white-white zone were repaired. In 17 patients, the location of the tear was not recorded. There were 38 tears in the red-red zone and 78 in the red-white zone. Failure rates were identical at 39.5% in both groups (p = 1.000).

Association of failure with either a medial or lateral location of the tear in the meniscus was also examined. There were 107 medial meniscal repairs with a failure rate of 20.3% and 25 lateral meniscal repairs with a failure rate of 44.8%. This was the only factor that was statistically significant (p = 0.023).

The etiology of the tear was either sports-related trauma in 101, non-sports related trauma in 24, or atraumatic in 8. The etiology was reviewed to determine if there as an association with failure rates. The failure rate was 37.6%, 41.7% and 75% respectively. This approached but did not reach statistical significance (p = 0.1179).

There were 22 partial lateral meniscectomies, three partial medial meniscectomies, and four combined medial and lateral meniscectomies. One hundred and two patients did not have a meniscectomy. There was no statistically significant difference in failure of the patients that had a concomitant meniscectomy compared to the patients that did not have a meniscectomy (p = 0.925).

Of the 45 patients that had chondral lesions, 8 had chondroplasty performed at the time of meniscal repair. There was no statistical difference in failure rates between the group that underwent chondroplasty and the group that did not (p = 0.875).

The rate of failure in patients that had an ACL reconstruction was 33.3% compared to 49.0% failure in the patients that did not have an ACL reconstruction at the time of meniscal repair. Though this was not statistically significant, it did approach significance (p = 0.208).

The results for each repair device are summarized in Table 2. Of note, the screws had the highest failure rate (66.6%) while the Rapid Loc and Darts had the lowest failure rate (no failures in either group). However, the sample size for these three groups is low.

There were 10 complications in the 133 patients. Arthrofibrosis occurred in four patients. This was resolved with arthroscopic release and manipulation. Three infections were noted: two superficial, which were treated with oral antibiotics, and one that required arthroscopic incision and drainage plus intravenous antibiotics. Two patients who had postoperative pain and clicking in the anterior part of the knee were noted to have fat pad fibrosis and scar in the anterior part of the knee upon arthroscopy. This pain resolved after fat pad and scar resection.

Discussion
No single accepted definition of failure for meniscal repair exists in the current literature. Several studies have found on second-look arthroscopy that the menisci can be partially healed in the absence of clinical symptoms. The use of magnetic resonance imaging (MRI) also has been of little value in this area. Muellner showed that MRI does not have the ability to differentiate between a meniscus that is healed and one that is not. Several investigators have used the absence of clinical symptoms as a definition of success. Many of these studies had a large number of concomitant procedures, including partial meniscectomy, ACL reconstruction, and chondroplasty. The clinical symptoms that one

![Table 4: Summary of Results](image-url)
associates with a failed meniscal tear, such as mechanical symptoms, pain, and effusion, can also result from ACL instability, early degenerative changes, scar tissue, or other pathology that is not related to the meniscal repair itself.

The definition of failure used in this study was the need for reoperation with removal of the area of the meniscus that had been previously repaired. It is the authors’ feeling that this represents the most accurate representation of failure. Patients with symptoms clinically resembling a failed repair all had an arthroscopy to diagnose and treat the failure, eliminating the possibility of confounding pathology masquerading as repair failure. Then there is the patient with pain, clicking, and recurrent effusions who also had an ACL reconstruction. One is hard pressed to call these patients successes. Yet, on the other hand, based on clinical examination and even MRI, the diagnosis of repair failure is not straightforward without the aid of an arthroscopic examination.

In 1986, Scott and colleagues reported on 260 meniscal repairs using the inside-out technique. Anterior cruciate ligament reconstruction was carried out concomitantly in 80% of cases. At the time of second-look arthroscopy or arthrography, 62% of repairs were healed, 17% were partially healed, and 21% were not healed at nearly a 2-year average follow-up. Clinically, however, 92% of patients were “stable” and 80% were able to return to active sports. In 1992, Cannon reported on 117 inside-out repairs. Sixty-eight patients had concomitant ACL reconstruction, while 22 had isolated tears. A successful outcome was noted in 93% of the ACL-associated repairs, while 50% of the isolated repairs were successful. Lateral repairs, tears less than 8 weeks old, tears with rim widths less than 2 mm, and tears with lengths less than 2 cm fared better overall in this population. Most recently, in 2002, a long-term follow-up study was published by Steenbrugge and associates. At 13-year follow-up, 20 patients that underwent meniscal repair using the inside-out suture technique were either examined (13 patients) or contacted through a telephone interview (7 patients). Of these 20, 17 had an excellent or good result and 3 had “fair” results. The investigators concluded that meniscal suturing by this technique can provide a good long-term clinical result.

Clinical evaluations of the second generation all-inside techniques have also been reported. However, only the earlier devices have a large enough patient base and follow-up information for evaluation. In early 1997, Escalas and coworkers reported that the 6-month follow-up evaluation of 20 patients with T-fix repaired medial menisci showed that 90% of patients returned to pre-injury activity levels. Later that year, Barrett and colleagues reported the results of 21 meniscal repairs using the T-fix suture anchor with a minimum of 1-year follow-up evaluation. Clinical evaluations concluded that 81% of the repairs were successful. Avascular zone 2 repairs showed significantly lower healing rates than the peripheral zone 0 or 1 repairs. With a 92% success rate on vertical or bucket-handle tears of zone 0 or 1 repairs, these investigators concluded that the amount of apposition provided by the T-fix device is clinically sufficient.

Similarly, early clinical studies of the Bionix Arrow show encouraging results. A prospectively randomized study of 68 patients compared the healing rate using Arrows versus the inside-out horizontal suture technique. Unlike previous studies, meniscal healing was evaluated with second-look arthroscopy at 3 to 4 months. Healing rates were 91% for the arrow group and 75% for the suture group. Only 5 failures were clinically detected; the other 6 were not discovered until repeat arthroscopy, suggesting that only half of all failed repairs present with significant clinical symptoms. The investigators found that surgical time was cut in half using the meniscus arrow, and that “there was no statistical differences in healing (total and partial) between arrows and sutures in the subgroups with isolated lesions, lesions in ACL-reconstructed knees, and lesions in ACL-insufficient knees.” These results have been verified in recent clinical studies. These studies have had success rates greater than 80% for repair using arrows (89% of 85 patients at 3 years; 87% of 55 patients at 6 years) which in each case were concluded to be results comparable to those of traditional inside-out suture techniques. Complications in the above studies included infection, hemarthrosis, and arrow-induced irritation. Thus, these investigators agree that despite increased cost, arrows are an attractive alternative to traditional techniques because of the shorter surgical time, easier technique, and decreased risk of neurovascular injury.

The rate of failure in the current study was 36%. This is higher than in other published reports, each of which had short follow-up, and it is logical to conclude that results may deteriorate with longer follow-up. This study represents the evolution of the repair devices this group of surgeons has been using. As newer, “better” devices became available, they were quickly incorporated into the armamentarium for meniscal repair. The tradeoff was that these surgeons were on the steep part of the learning curve inherent in using a new device.

This study showed no association of failure with length of preoperative symptoms, location of the tear with respect to the capsule, or concomitant procedures such as meniscectomy, chondroplasty, or ACL reconstruction. The correlation with etiology of the tear approached but did not reach statistical significance. The atraumatic group had 75% failure compared to 37.6% in the sports trauma group, which was not statistically significant due to the low numbers of patients in the atraumatic group. The only significant association found in this study was with the location of the tear. Tears of the medial meniscus had a 20.3% failure rate compared to 44.8% in the lateral meniscus.

The all-inside techniques have simplified the previously laborious task of meniscal repair. They have obviated the need for a posterior incision along with its associated in-

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Referenced studies:

1. Scott et al. (1986)
2. Cannon (1992)
4. Escalas et al. (1997)
5. Barrett et al. (1997)
6. Bionix Arrow studies
7. Other clinical studies
creased operative time and morbidity. These advances, while increasing the ease of the procedure, may also be increasing the number of repairs performed. Tears that formerly would not have been repaired now often are, and this is primarily due to the ease of the procedure. However, since the time that the results of this study were first reviewed, we have given serious consideration to the criteria for repair in our own practice.

This study has several limitations. The total number of meniscal repairs reported is large; however, the number of repairs using the individual devices is small, limiting the ability to make useful comparisons among repair devices. Additionally, follow-up information was acquired on the basis of a telephone interview instead of a clinical examination, though it is our feeling that the clinical examination is of limited use in diagnosing repair failure.

In summary, the newer generation meniscal repair devices, while simplifying the procedure, do not appear to lead to an increased clinical success rate.

References