Arthroscopic Meniscal Repair

Analysis of Treatment Failures

Bernard R. Bach Jr, MD
Michael Dennis, MD
Jefferson Balin, MS
Jennifer Hayden, RN, MSN

Abstract: The rationale for meniscal repair is based on the importance of the meniscus in overall knee function and stability as well as the inferior results seen with meniscectomy. The high success rate usually seen with arthroscopic meniscal repair has made it the treatment of choice for peripheral meniscal tears. The purpose of this study is to look at a group of patients who have failed meniscal repair surgery in order to gain greater understanding of the factors that may predispose a patient to a failed outcome.

From 1987 to 2002, three hundred meniscal repairs were performed (203 medial and 97 lateral). Thirty-seven patients had failed meniscal repairs. Records were available for thirty-three patients (89%) and comprise the study group. The mean age was 25 years (range 13-48) at the time of meniscal injury. The average initial tear size was 2.7 cm with a mean rim width of 2.3 mm. Eighty-eight percent occurred in the setting of ACL tears. The average time interval from initial repair to the recurrence of symptoms was 34 months. Patients who were older at the time of meniscal repair failed significantly later than those patients who were younger at the time of repair. With age stratification, those patients who were age 29 or less at time of meniscal repair failed at an average of 23 months. In contrast, patients who were thirty years or older at the time of repair failed at an average of 53 months. Larger initial tears failed significantly sooner than smaller tears. Initial tears with larger rim widths demonstrated a trend toward shorter time to failure. ACL deficient patients who underwent combined ligament reconstruction with meniscal repair failed at an average of 37 months. Patients who underwent isolated meniscal repairs (ACL intact) failed at an average of 16 months.

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INTRODUCTION

The purpose of this study was to evaluate patients who have failed meniscal repair surgery in order to gain greater understanding of the factors that may predispose a patient to a failed outcome.

The rationale for meniscal repair is based on the importance of the meniscus in overall knee function and stability as well as the inferior results seen with meniscectomy. In 1889, Annandale reported on the first successful meniscal repair.[2] However, meniscal repair did not become popular until the late 1970s. DeHaven[14] popularized open meniscal repair as an alternative to meniscectomy. With the development of improved arthroscopic equipment and advanced surgical techniques, arthroscopic meniscal repair became possible. Additionally, arthroscopy allowed for the treatment of meniscal tears previously not amenable to open repair. Scott et al[37] popularized the inside-out suture technique that employs arthroscopically directed cannulas coupled with a posterior incision.[37] The outside-in suture technique emerged as an attempt to decrease the risk to neurovascular structures associated with the inside-out technique. This technique is most appropriate for tears involving the anterior and middle thirds of the meniscus.

Drs Bach, Dennis, Balin, and Hayden are from Rush University Medical Center, Chicago, Ill.

Reprint requests: Bernard R. Bach Jr, MD, Rush University Medical Center, 1725 W Harrison St, Ste 1063, Chicago, IL 60612.

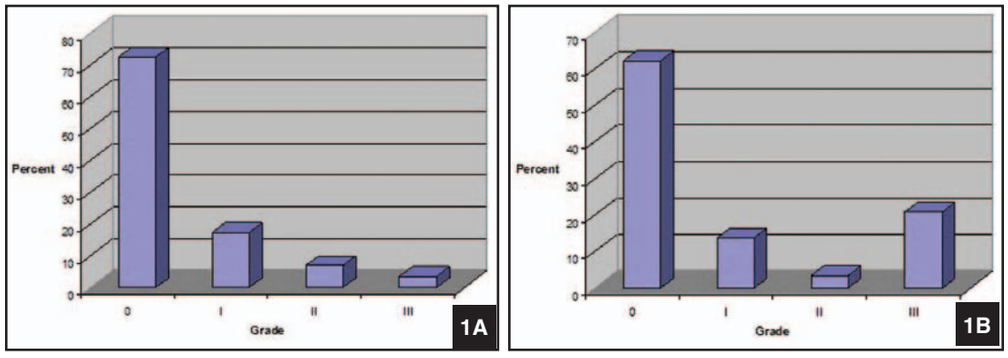

Figure 1. Ipsilateral cartilage status, in the same compartment as the meniscal tear, at the time of index arthroscopy (A). Other cartilage status at the time of index arthroscopy (B).

With posterior tears, the outside-in technique places the neurovascular structures at increased risk.[35]

MATERIALS AND METHODS

After obtaining approval from the medical center institutional review board, the surgical log of a single surgeon was reviewed in order to identify those patients who had a failure of their meniscal repair and required a reoperation. Complete medical records including operative reports, operative diagrams, and arthroscopic photographs were reviewed. Retrieved information included data regarding patient gender, affected knee, meniscal side, patient age, and mechanism of injury. The specific findings such as meniscal tear location, tear pattern and size, rim width, status of the articular cartilage, and anterior cruciate ligament status, at the time of arthroscopic meniscal repair were recorded. The meniscal repair technique, total number of sutures, and suture material were analyzed. The time from index surgery to onset of symptoms, the nature of the re-tear, and management were recorded. Statistical analyses (Chi-square, Mann-Whitney, Spearman's correlation) were performed where applicable. A *P* value <.05 was considered significant.

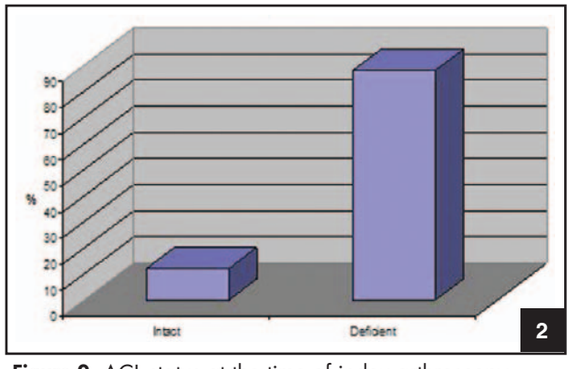

Figure 2. ACL status at the time of index arthroscopy.

We acknowledge that a reoperation represents the ultimate definition of a meniscal failure. Magnetic resonance images, (MRIs) were not used to define a failure and patients were not evaluated clinically to ascertain suspected failures. Inclusionary criteria included patients who underwent either "inside-out" or "outside-in" techniques. No meniscal implants were used (ie, barbs, darts, etc.). Our standard technique included meniscal rim abrasion and/or debridement. Fibrin clots were not inserted as the majority of repairs are performed concurrently with ACL reconstruction. Sutures were tied with the knee in complete extension to avoid "capturing" the posterior capsule that could contribute to a knee flexion contracture. Patients who underwent meniscal trephination for partial thickness tears were excluded. Intercondylar notch microfracture was not specifically performed, however, notchplasty is routinely performed in our ACL patients reconstruction and meniscal repair.

RESULTS

Patient Characteristics

From 1987 to 2002, 300 meniscal repairs were performed (203 medial and 97 lateral). Thirty-seven patients had failed meniscal repairs. Records were available for 33 (89%) patients and comprise the study group. The gender distribution consisted of 19 (58%) men and 14 (42%) women. The left knee was involved in 58% of the patients, whereas the right knee was affected 42% of the time. The medial meniscus was involved 85% of the time. The ages in the study group ranged from 13 to 48 years of age (mean: 25 years), at the time of meniscal injury and 26 years at the time of meniscal repair. The time interval from meniscal injury to repair ranged from 0.3 to 132 months (mean: 7.1 months). The median time interval was 1.5 months. The average age at repeat injury or onset of symptoms was 28 years. Figure 1A. Ipsilateral cartilage status, in the same compartment as the meniscal tear, at the time of index arthroscopy.

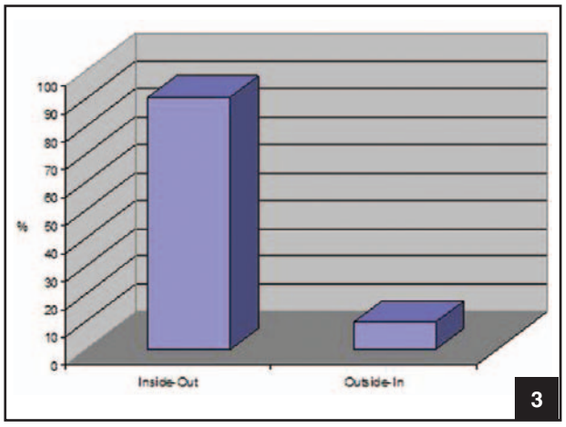

Figure 3. Meniscal repair technique employed at the time of index arthroscopy.

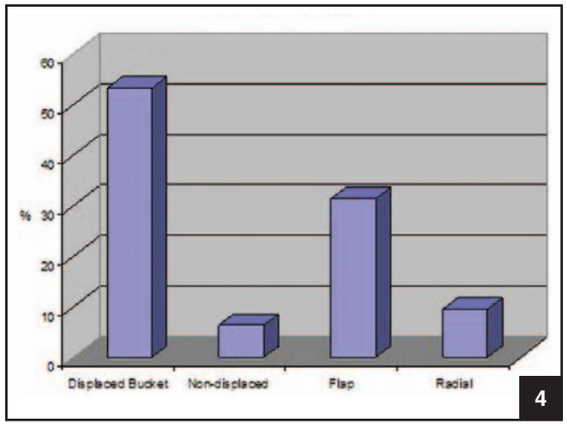

Figure 4. Meniscal re-tear pattern at the time of follow-up arthroscopy.

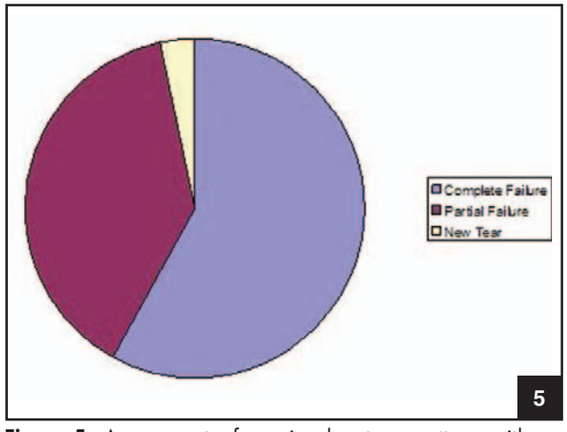

Figure 5. Assessment of meniscal re-tear pattern with respect to the initial repair.

Meniscal Tear Characteristics

One hundred percent of the patients described a traumatic mechanism of injury for their initial meniscal repairs. Seventy-seven percent of the initial meniscal tears were located in the posterior third of the meniscus, whereas the remaining 23% of the tears spanned the posterior and middle segments. Sixty-three percent of the initial meniscal tears were displaced bucket-handle tears. The remaining 37% were non-displaced peripheral tears. The tears ranged in size from 1 cm-5 cm. The average initial tear size was 2.7 cm. The mean rim width from the meniscocapsular junction was 2.3 mm (range 1mm-5.5 mm). Seventy-two percent of the patients had no ipsilateral articular cartilage disease, whereas the remainder had varying grades of associated chondrosis (Figure 1A). In Figure 1B, the severity of articular cartilage involvement in the other compartments not involving the torn meniscus is depicted. Eighty-eight percent of the meniscal tears occurred in the setting of anterior cruciate ligament tears (Figure 2).

Meniscal Repair

Those patients that were ACL-deficient (88%) underwent ligament reconstruction in conjunction with meniscal repair. The "inside-out" meniscal repair technique using non-absorbable sutures (# 2-0 Ti-Cron) was performed in ninety percent (n=28) of the patients. The remaining 10% were repaired by the "outside-in" technique using absorbable (# 0-PDS) sutures (Figure 3). Vertical or horizontal sutures were used 45% and 7% of the time respectively. The remaining 48% were hybrid repairs. The number of meniscal repair sutures placed ranged from 2 to 12 (mean 6.0 sutures).

Meniscus Re-tear

The time interval from initial repair to the recurrence of symptoms was varied and ranged in length from 3 and half months to 10 years, with an average of 34 months. The median time to re-tear was 26 months. Thirty patients (94%) were pain-free within three months after their meniscal repair. Seventy-seven percent of the patients reported a new traumatic event that preceded the meniscal re-tear. Eighty-one percent (n=26) of the tears were located in the posterior third of the meniscus. The remaining 19% (n=6) spanned both the middle and posterior segments. Fifty-three percent (n=17) of the tears were displaced bucket-handle type tears. Flap and radial tear patterns comprised 31% (n=10) and 9% (n=3) of the meniscal tears, respectively (Figure 4). The average size of the re-tear was 2.6 cm (range: 1 cm-5 cm). The mean rim width from the meniscocapsular junction was 2.9 mm (range: 1 mm- 5 mm). Upon inspecting the re-torn menisci in the context of the prior meniscal repairs, 58% (n=18) had re-torn through the previously repaired area. Thirty-nine percent (n=12) had partially torn through the previous repair and 3% represented new tears (Figure 5). Twenty-nine (91%) of the patients were treated with partial meniscectomies, whereas 3 patients had repeat meniscal repairs.

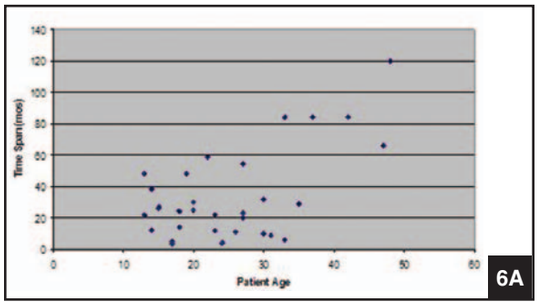

Figure 6. Patient age at the time of meniscal repair versus time to failure (A). Patient age groups at the time of meniscal repair versus time to failure (B).

Patients who were older at the time of meniscal repair failed significantly later than those patients who were younger at the time of repair (P=.044) (Figure 6A). With age stratification (Figure 6B), those patients who were aged ⩽29 at time of meniscal repair failed at an average of 23 months. In contrast, patients who were aged ⩾30 years at the time of repair failed at an average of 53 months (P=.040). Larger initial tears failed significantly sooner than smaller tears (P =.018) (Figure 7). Initial tears with larger rim widths demonstrated a trend toward shorter time to failure (Figure 8). Anterior cruciate ligament-deficient patients who underwent combined ligament reconstruction with meniscal repair failed at an average of 37 months. Patients who underwent isolated meniscal repairs (ACL intact) failed at an average of 16 months (Figure 9). There were no differences in gender, affected knee, or meniscal side with respect to time to failure.

DISCUSSION

The understanding of the importance of the meniscus and its function has increased greatly over the last few decades. Initially, the importance of the meniscus was poorly understood and led to meniscal excision as the primary treatment for meniscal injuries. Greater understanding of the natural history and biomechanical consequences of the post-meniscectomy knee has ushered in a new era committed to preserving the meniscus.[16] The primary function of the meniscus is to transmit load across the tibiofemoral joint, improve joint congruency, and increase the surface area of joint contact. The role that the meniscus plays in capacities such as shock absorption, load sharing, protecting the articular cartilage, joint stability and joint nutrition, is altered.[12,18] The medial and lateral menisci transmit 50% and 70% of the load to their respective compartments. The menisci transmit 50% of the joint load in knee extension and nearly 90% of the joint load while the knee is flexed.[41] One in vitro study demonstrated that excision of 16% to 34% of the meniscus yielded a 350% increase in joint contact forces.[38] Baratz et al[6] demonstrated that a 2-cm longitudinal tear of the meniscus increases peak contact stresses by 16%. They further showed that performing meniscal repair reduces these stresses to pre-tear levels. [6] Lynch et al[27] reported fewer Fairbank's[16] changes in stable knees that underwent meniscal repairs. The medial meniscus serves as a restraint to anterior tibial translation in the ACL-deficient knee.[25,26] Additionally, a biomechanical cadaveric study showed that knees with an absent ACL and a deficient medial meniscus had increased varus-valgus laxity when compared to ACL-deficient knees with intact medial menisci.[28]

Many studies have been performed that demonstrated the progressive degenerative changes that occur in the post-meniscectomy knee. The extent of degenerative change is generally directly proportional to the amount of

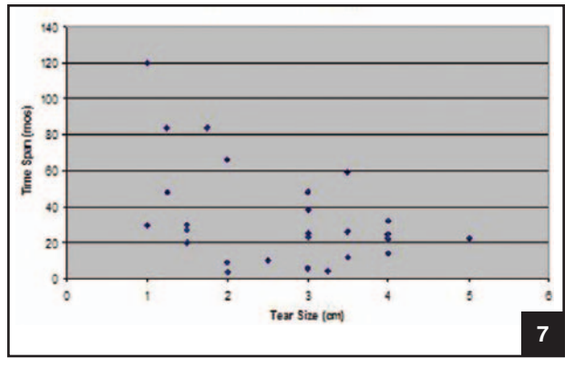

Figure 7. Meniscal tear size at the time of meniscal repair versus time to failure.

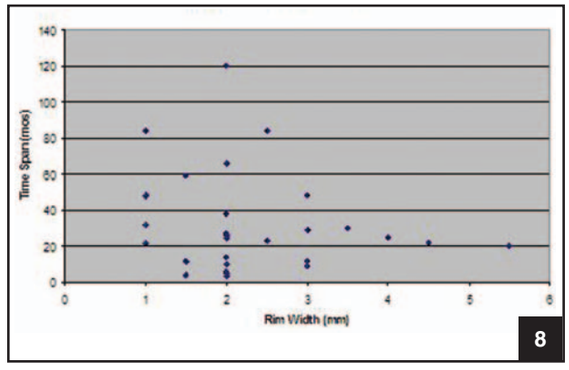

Figure 8. Meniscal tear rim width at the time of meniscal repair versus time to failure.

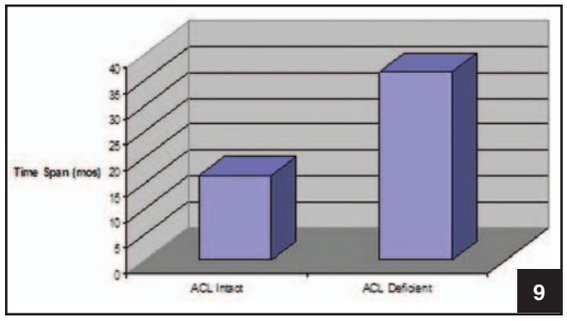

Figure 9. ACL status at the time of meniscal repair versus time to failure.

excised meniscus.[13,29] However, the degree of concomitant degenerative change is likely the most important factor determining the outcome after meniscectomy.[17,33,36] Fairbank,[16] in his classic paper, described three radiographic findings following meniscectomy: 1) ridge formation on the femoral condyle, 2) femoral condyle flattening, and 3) joint space narrowing. Several long-term studies have been performed confirming Fairbank's observations as well as reported high rate of knee symptoms and degenerative joint disease after meniscectomy.[23,39] Notably is the generally worse outcome following lateral meniscectomies.[23,42] Yocum et al[42] documented rapid deterioration of the lateral compartment following lateral meniscectomy.

More recently, studies have looked at patients who have undergone partial meniscectomies.[9,36] Degenerative changes after partial meniscectomy generally progress slower than those after total meniscectomy. McGinty et al,[29] in their comparative analysis of partial versus total meniscectomy, reported early radiographic changes in 62% of their patients having undergone total meniscectomy as compared to 36% of their patients treated with partial meniscectomy. Some studies have shown deterioration over time following partial meniscectomy.[21,36] Jaureguito et al[21] reported a 92% success rate at short-term follow-up of patients treated with partial lateral meniscectomy, but at a mean of eight years, only 67% had a successful result. In a similar study with longer follow-up, Schimmer et al[36] reported a 92% success rate at four years, that declined to 78% at 12 years.

The high success rate usually seen with arthroscopic meniscal repair has made it the treatment of choice for peripheral meniscal tears. Several meniscal repair follow-up studies have been performed which have reported success rates ranging from 50% to 100%.* Meniscal repairs performed in conjunction with ACL reconstruction have a higher success rate than isolated meniscal repairs.[10,11,30,40] Meniscal tears resulting from acute injuries seem to have a greater healing potential after repair.[15,40] Cannon and Vittori[11] reported an increased healing rate with lateral meniscal repairs. Several authors reported that tears with rim widths <3 mm had better healing rates after repair.[10,11,15,22,40] Johnson et al[22] reported a 76% clinical success rate at long-term follow-up of >10 years in a group of 50 isolated arthroscopic meniscal repairs.

Complete vertical longitudinal tears, also known as bucket handle-tears tend to occur in younger individuals and are most commonly associated with ACL injuries.[37] Bucket handle-tears usually begin in the posterior horn and can vary in length from <1 cm to most of the meniscus. Likely due to its more rigid attachment to the tibial plateau, the medial meniscus is more commonly affected.[18,32]

There are several criteria for meniscal repair, however the most commonly accepted criteria include: 1) a complete vertical longitudinal tear >1 cm in length, 2) a tear that demonstrates instability with probing, 3) a tear within 3-4 mm of the meniscocapsular junction or within the peripheral 10% to 30% of the meniscus, 4) a tear associated with concurrent ligament reconstruction or in a ligamentously stable knee, 5) a tear without secondary degenerative changes or deformity, and 6) a tear in an active patient.[5,24]

Mintzer et al,[31] reported a 100% clinical success rate in a young athletic population of 26 patients at five-years follow-up. Based on the findings of Johnson et al,[22] the results of arthroscopic meniscal repair seem to hold up over time. Furthermore, 92% of the knees in his series did not demonstrate any evidence of degenerative change 10 years after meniscal repair.

Cannon and Vittori[11] in their study of 90 meniscal repairs, patients reported an overall healing rate of 82%. However, the success rate in those knees that had concurrent ACL reconstruction was 93%, whereas only 50% of isolated meniscal repairs healed satisfactorily. Tenuta and Arciero[40] reported a similar finding that 90% of their combined meniscal repair and ACL reconstruction patients healed their repairs versus a 57% healing rate in the isolated meniscal repair group. Other authors have reported similar findings as well.[7,20,34] This is consistent with the present study that isolated meniscal repairs failed in half the time of the combined ACL reconstructed knees. Scott et al[37]provide two possible explanations for this finding: 1) ACL reconstruction prevents anterior tibial subluxation thereby protecting the repair site from the biomechanical forces that originally caused the tear and 2) ACL reconstruction causes more intra-articular trauma resulting in greater bleeding and fibrin clot formation thereby promoting the healing process.

Although at birth the entire meniscus is vascular, by age nine months the inner one third has become avascular. With continued decreasing vascularity, by age 10 years the meniscus closely resembles the adult meniscus. Arnoczky and Warren[3] demonstrated that in the adult meniscus only the outer 10% to 30% of the medial meniscus and 10% to 25% of the lateral meniscus is vascular. Therefore, meniscal

**1,7,10,11,15,22,30,31,32,34,40.*

tears in the peripheral third have been shown to have superior healing rates.[5,10,11,15,22,37] Asahina et al[5] performed second-look arthroscopies in 98 of a 121 patients who had undergone meniscal repairs with ACL reconstruction in which they noted a significantly higher rate of healing (87%) in peripheral third tears. In contrast, there was only a 59% rate of healing in central third tears. Furthermore, they reported that 75% of the failure group and 69% of the incompletely healed group had rim widths >4 mm. Tenuta and Arciero[40] similarly reported on their meniscal repair experience. They reported an average rim width of 2.5 mm and found rim width to have a significant role in healing. In the satisfactorily healed group, the average rim width was 2.2 mm versus a 3.3 mm average rim width in the unhealed group. Furthermore, none of their meniscal repairs with rim widths >4 mm healed.[40] This is consistent with the present study's data in which a trend was noted whereby meniscal tears with larger rim widths had shorter time to failure.

Younger patients are more likely to sustain meniscal tears as a result of acute traumatic events. This is reflected in our patient characteristics with a mean age of 25 years that 100% reported a traumatic mechanism of injury. Cannon and Vittori[11] demonstrated an increased healing rate with increased age. The potential for healing may be lower in older individuals, however non-athletic patients may have recurrent tears and remain asymptomatic.[11] Barrett et al,[8] studied meniscal repair in an older patient population with a aged ⩾40 years (mean: 44 years) at time of repair. In their series of 37 patients at a minimum of two-years follow-up, 87% had good clinical results.[8] Noyes and Barber-Westin[34] also reviewed their experience with meniscal repairs performed in older patients. In their series of 29 patients with a mean age of 45 years, 87% were asymptomatic at a mean of 33 months follow-up. However, Tenuta and Arciero[40] and Eggli et al[15] reported decreased healing rates in patients older than thirty years of age. Johnson et al[22] reported that patient age was not predictive of outcome. The current study showed a significantly longer time to failure in older patients (Figure 6).

In Kurosaka's study, the mean length of the original tear was 21 mm.[24] Tenuta and Arciero[40] reported an average tear length of 2.6 cm. Although not statistically significant, they demonstrated an 80% healing rate for tears measuring up to 3 cm, in contrast to a 64% healing rate for tears measuring 3 cm to 4 cm. In other studies, a relationship between tear size and healing was demonstrated.[11,15] In those patients with tear lengths <2 cm, 94% healed. In those with tear lengths of 2 cm to 4 cm, 86% succeeded. However, in those patients with tear lengths >4 cm, only 50% healed.[11]

Cannon and Vittori[11] found a difference in healing between meniscal sides in which lateral meniscal repairs healed better than medial meniscal repairs for both isolated meniscal repairs and those performed in conjunction with ACL reconstruction. Other studies reported a similar finding that medial meniscal repairs had a higher frequency of failure.[1,15,22,32] This study's results, like other reports, did not show any difference in meniscal side with respect to time to failure.[5,40]

The timing of symptomatic recurrence was from 12 to 28 months in one study.[4] In Kurosaka's study, the mean period between the repair and the observation of a repeat tear was 48 months.[24] However, in Albrecht-Olson et al's[1] study, 8 of 27 repaired menisci were excised after a median of 18 months. In the present study, the mean interval from time of meniscal repair to the recurrence of symptoms was 34 months and is consistent with other studies.

The strengths of this study include the fact that all meniscal repairs were performed by a single surgeon who has extensive experience with well over 300 meniscal repairs. Additionally, the senior author's technique remains unchanged, thereby, reducing the effect of confounders, surgeon variability, and varying techniques. Due to the same single surgeon explanation, medical record and data collection was facilitated and resulted in an 89% follow-up rate. In this series of 33 patients with re-tears after meniscal repair, a decreased time to failure was demonstrated in younger patients, those with larger initial tears, those with larger rim widths, and those who underwent isolated meniscal repairs. These results are in agreement with several other reports in the literature. A weakness of this study is the lack of a control group and this is a retrospective chart review of patients who required a reoperation. By definition, this study probably underestimates the meniscal failures that exist in this group. It does not address those who have "silent" small retears, patients with mild symptoms, or patients who have been treated by other physicians. This study characterizes those repairs that necessitated additional surgery and not the entire population of patients (n=300) who had a repair. Finally, radiographic assessment was not performed on the reoperated group. A follow-up study, presently under consideration analyzing the same parameters in our group of meniscal repair patients that successfully healed would provide this control group.

CONCLUSIONS

In this series of 33 patients with re-tears after meniscal repair, a decreased time to failure was demonstrated in younger patients, those with larger initial tears, those with larger rim widths, and those patients who underwent isolated meniscal repairs.

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