Meniscal Repairs in the Adolescent Knee

Can the Number of Fixation Sites Improve Outcomes?

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Background: Meniscal pathology in children and adolescents is now a common occurrence because of their ever-increasing participation in youth sports.

Purpose: To investigate the outcomes of arthroscopic meniscal repair in an adolescent cohort and analyze the variables that may affect outcomes, specifically the number of fixation sites utilized during repair.

Study Design: Case series; Level of evidence, 4.

Methods: A retrospective review of all children and adolescents younger than 18 years who underwent arthroscopic meniscal repair at a single institution was performed. Patient characteristics, operative details (eg, tear pattern, tear location, method of repair, and number of fixation sites [determined based on the number of sutures used for repair]), and concomitant procedures were recorded.

Results: A total of 175 primary meniscal repairs met inclusion criteria and were analyzed. Of this cohort, 115 were able to be contacted and were included in the final study cohort. The mean follow-up was 41 months. The mean age of the children was 14.9 years, and 91 (79%) had concomitant anterior cruciate ligament reconstructions with their meniscal repair. The mean Pediatric International Knee Documentation Committee functional outcome score was 91 (range, 43-100), and the mean Lysholm functional outcome score was 91 (range, 47-100). Of the 115 meniscal repairs, there were a total of 19 reoperations (17%); 15 (13%) were because of meniscal repair failures. The only variable that statistically increased the risk of meniscal repair failure was low number of fixation sites, with the failure group having a mean of 1.79 sutures and the nonfailure group having a mean of 2.97 sutures ($P = .03$).

Conclusion: Successful meniscal repairs and a lower failure rate may be achieved with a greater number of fixation sites with promising results at a minimum 2-year follow-up. Validated functional outcome scores were good, with a 13% failure rate. Larger cohort, longer term, multicenter multisurgeon data are still needed to further elucidate the number of fixation sites needed when performing a meniscal repair in the pediatric and adolescent knee.

Keywords: meniscus repair; all-inside; inside-out; arthroscopy

Surgical treatment of meniscal tears has been the focus of recent investigations, and meniscal tears continue to be one of the leading indications for arthroscopic knee surgery.[10,12] The important role of the meniscus cannot be overstated, and appropriate treatment of meniscal pathology, especially in the pediatric and adolescent knee, can prevent significant long-term debilitating symptoms.[2,10,14]

Meniscal repairs heal more quickly in the pediatric and adolescent populations.[4,7,8] The blood supply of the pediatric meniscus is abundant compared with the adult meniscus, which creates a favorable milieu for healing.[3,6,18-20] In addition, meniscectomy in this population imposes greater risk of cartilage degeneration and symptomatic instability.[8-11,14] The long-term outcomes of cartilage degeneration after partial meniscectomy have been well-elucidated with radiographic progression of osteoarthritis in 40% of the patients.[9,21]

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The current literature on the outcomes of meniscal repairs in the adolescent population has shown varied results, with failure rates ranging from 0% to 66%.[§] Additionally, the outcomes based on the type of meniscal repair (inside-out, all-inside, and outside-in repairs) have not been well differentiated.

The purpose of this study was to investigate the outcomes of arthroscopic meniscal repairs in a pediatric and adolescent cohort and analyze the variables that may affect outcomes, specifically the number of fixation sites utilized during repair.

METHODS

After approval by our institutional review board, a retrospective review of all children and adolescents younger than 18 years who underwent arthroscopic knee surgery for meniscal tears between January 2009 and December 2016 at a single institution was performed. Children with a previous meniscal procedure or those who had less than 2-year follow-up were excluded from this study. The characteristics and details of the injury were collected from the patient's chart. Operative reports were investigated, and details such as tear pattern, tear location, method of repair (inside-out, outside in, or all-inside repairs), number of fixation sites (determined based on the number of sutures used for repair), and concomitant procedures were recorded.

An all-inside repair was carried out using either Fast-Fix 360 (Smith & Nephew) or Meniscal Cinch (Arthrex) implant. When an inside-out repair was performed, zone-specific cannulas and 2.0 FiberWire suture (Arthrex) were utilized. The majority of the repairs were fixed on the tibial and femoral side of the tears with a vertical mattress configuration; however, a horizontal mattress can be used if the tear morphology or location is not amendable for a vertical mattress. Each implant or suture placed was considered a single fixation site during data collection. It is worth nothing that although we did not measure how often we used the Fast-Fix 360 or Meniscal Cinch on our all-inside repairs, the majority of our cases involved the Fast-Fix 360 implant.

Completed validated outcome scores, the Pediatric International Knee Documentation Committee (Pedi-IKDC) and Lysholm functional survey, were obtained at a minimum follow-up of 2 years. Children who underwent a second procedure because of meniscal pathology after repair were considered to have failed results. Additional procedures because of other injuries were also noted, and details of the surgery were evaluated.

Statistical analysis was performed on the data collected. Univariate logistic regression was performed to identify independent variables for meniscal surgery failures, followed by multivariate logistic regression with purposeful selection.

[§]References 5, 8, 13, 15, 16, 18, 19, 22-24.

TABLE 1
Summary of Types of Meniscal Repairs Based on Location of Repair (Medial or Lateral)

Repair	Medial Meniscus	Lateral Meniscus	Total
All-inside	33	45	78
Inside-out	24	10	34
Outside-in	1	2	3
Total	58	57	115

RESULTS

A total of 175 primary meniscal repairs that met inclusion criteria were analyzed. Of this cohort, 115 (66%) were able to be contacted and were included in the final cohort of our study. Numerous methods of contacting the patients and patients' families were attempted, including telephone calls and postal mail. Since the cases in our retrospective review began as early as 2009, the majority of the children who were not able to be contacted were from the first several years of the study and did not have up-to-date telephone numbers or addresses in our electronic medical records.

The mean follow-up was 41 months (range, 24-97 months). The mean age of the children was 14.9 years (range, 12-18 years). Our cohort included 60 girls and 55 boys. A total of 91 (79%) had concomitant anterior cruciate ligament (ACL) reconstructions with their meniscal repair. Table 1 summarizes the location of the repair (medial vs lateral compartment) and the type of repair (all-inside, inside-out, and outside-in) that was performed.

There were a total of 64 vertical (56%), 26 bucket-handle (23%), 12 complex (10%), 10 horizontal (9%), and 3 root tears (3%). The majority of the tears were located in the posterior horn (110; 95%), 3 (3%) in the anterior horn, and 2 (2%) in the body of the meniscus. However, it is important to know that many of the posterior horn tears likely propagated to the body of the meniscus.

The mean Pedi-IKDC functional outcome score was 91 (range, 43-100). The mean Lysholm functional outcome score was 91 (range, 47-100).

Of the 115 meniscal repairs, there were a total of 19 reoperations (17%). Fifteen (13%) were because of meniscal failures, while the remaining 4 were because of arthrofibrosis (n = 2), ACL implant removal (n = 1), and a superficial wound dehiscence (n = 1). Table 2 summarizes the different variables comparing the failures and nonfailures. The only variable that statistically increased the risk of meniscal repair failure was low number of fixation sites, with the number of sutures used in the failure group having a mean of 1.79 sutures (range, 1-13) and the nonfailure group having a mean of 2.97 sutures (range, 1-5) ($P = .03$).

DISCUSSION

Meniscal pathology in children and adolescents is now a common occurrence because of their ever-increasing participation in youth sports. The effectiveness of meniscal repairs, in comparison with resection, is an important area

TABLE 2
Summary of the Failures of Our Cohort[a]

	Failures	*P*
Total no. of failures	15 (13%)	
Mean age, y	Failures: 14.55 Nonfailures: 14.86	.669
Location of tear		.298
Medial	7	.686
Lateral	8	
Posterior	15	
Anterior	0	
Body	0	
Tear pattern		.777
Vertical	8	
Bucket	5	
Complex	1	
Horizontal	1	
Root	0	
Concomitant ACL reconstruction		.301
Yes	11	
No	4	
Type of repair		.801
Inside-out	5	
All-inside	10	
Location of all-inside		.243
Medial	5	
Lateral	5	
Location of inside-out		.243
Medial	2	
Lateral	3	
Number of fixation sites	Failures: 1.79 (range, 1-13) Nonfailures: 2.97 (range, 1-5)	.03

[a]Statistical analysis was performed to examine whether any independent variables imposed a greater risk for failure. Only the number of sutures used was found to be a statistically significant variable. ACL, anterior cruciate ligament.

of the study. Medlar et al[17] demonstrated that nearly 60% of children who underwent partial meniscectomy had knee pain and early degenerative arthritic changes on radiographs. In comparison, Majewski et al[16] performed a similar study and demonstrated that 24% of children had osteoarthritic changes seen radiographically. A systematic review comparing outcomes of meniscectomy versus meniscal repairs concluded that, although repairs were associated with better long-term outcomes, they also had a higher reoperation rate (3.9% vs 20.7%).[20]

The most common meniscal tear encountered and treated in this series was a vertical tear in the posterior horn of the lateral meniscus. The all-inside repair was most commonly utilized and represented 68% of the repairs. This number is not surprising because of shorter operating time, ease of use, and the fact that no further surgical dissection is required when compared with an inside-out repair.[22]

Our study cohort did include 34 inside-out repairs, which comprised 30% of our study population. Of these repairs, 21% were isolated meniscal repairs that did not involve ACL reconstruction during the same procedure. We are unaware of any current studies that focused on these different techniques when performing pediatric meniscal repairs, and so we believe this is a large number of inside-out repairs when considering how often the all-inside technique is used today.[13,21] Inside-out repairs were performed at the discretion of the senior author (J.A.S.), which was based on many factors related to the patient and meniscal tear. The inside-out technique is preferred both for isolated meniscal repairs of large and/or complex unstable bucket-handle tears and when located in the lateral compartment of the knee because of the close proximity of the neurovascular structures to the posterior horn of the lateral meniscus.

Our failure rate after meniscal repairs was 13%. On the basis of a literature review, we found that previous studies[18-20,22-24] had failure rates that ranged from 0% to 66%. Table 3 summarizes the results of previous studies and their findings.

When analyzing variables that caused a higher risk of failure, 1 variable that was statistically significant was the number of fixation sites based on the number of sutures used, with the nonfailure group having a mean of 2.97 sutures and the failure group having 1.79 sutures. This is most likely attributable to the higher degree of stability provided and better approximation of the torn tissue with an increased number of fixation sites. To our knowledge, this is the first study to report such a finding on number of fixation sites and risk of failure after meniscal repairs. Although there are many factors that influence the number of fixation sites chosen during each meniscal repair case (ie, size of tear, type of repair performed), in our study, we have lowered the threshold to using more fixation sites when performing a meniscal

TABLE 3
Comparison of Previous Similar Students on Adolescent Meniscal Repairs and Their Findings[a]

Author	Year	Sample No.	Mean F/u, mo	Failure Rate, %	Lysholm	Pedi-IKDC
Mintzer et al[18]	1998	29	60	0	90	91
Noyes and Barber-Westin[19]	2002	71	51	25	Not measured	Not measured
Accadbled et al[1]	2007	12	37	66	96.3	Not measured
Krych et al[15]	2008	44	70	38	Not measured	89.4
Kraus et al[14]	2012	25	28	16	95	Not measured
Schmitt et al[22]	2016	19	72	11	95.7	90.7
Shieh et al[23]	2016	129	40	23	Not measured	Not measured
Current study		115	41	13	91	91

[a]F/u, follow-up; Pedi-IKDC, Pediatric International Knee Documentation Committee.

repair. Nonetheless, further analysis on the number of sutures used should be undertaken to truly see how much this influences failures.

Shieh et al[23] focused their study on meniscal surgeries in general and the risk factors for revision surgery. The number of meniscal repairs included in their study was 129, and their revision rate for repairs was 18%. The independent risk factors that they found to be statistically significant were patients with an open physis and a bucket-handle meniscal tear. Their revision surgery was a mean of 14 months from the index procedure, which was similar to our mean of 16 months. In our patients with meniscal tears, only 3 of the 11 had a bucket-handle tear from the initial injury. A key difference that we believe our study provided but Shieh et al did not include was differentiating between the types of meniscal repairs (all-inside, inside-out, and outside-in). Ensuring that failure rates were not affected by the method of treatment, since they are technically different from each other, is of importance. In addition, we included 2 different functional outcome surveys at the final follow-up that showed that children typically do well up to at least 2 years after surgery.

Our study does have inherent limitations. The first would be the retrospective design of our study, which can lead to underestimation of the need for revision surgery. In addition, 34% of our cohort could not be included in our study because they were unable to be reached to obtain 2-year follow-up functional surveys. A significant portion of the patient's lost to follow-up were repairs that occurred earlier on in the study period. The meniscal repair was considered to be successful if there was a lack of symptoms, the patient was able to return to activity, and revision/repeat surgery was avoided. Magnetic resonance imaging was not performed to evaluate healing. Outcomes based on all-inside implant type were not performed.

There are numerous publications focused on meniscal repairs and success/failure rates in the adult population. However, publications that specifically evaluate the outcomes of meniscal repairs in an entirely pediatric and adolescent population are lacking. In the current literature focused on younger patients, the postoperative outcomes after meniscal repairs have variable sample sizes and a wide range of results. Because of the well-known fact that a healthy and properly functioning meniscus is needed to maintain stability and cartilage health, focusing on children with many years of high-level activity in their future is of utmost importance.

Based on our retrospective review, a greater number of fixation sites (2.97 vs 1.79 sutures) was associated with improved healing and a lower failure rate of meniscal repairs in our pediatric and adolescent cohort with a minimum 2-year follow-up. Validated functional outcome scores were good with a 13% failure rate. A larger cohort with longer term, multicenter, and multisurgeon data is still needed to further elucidate the number of fixation sites needed when performing a meniscal repair in the pediatric and adolescent knee.

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