Failed Pediatric Meniscus Repair from >1100 Arthroscopic Meniscus Repairs with 2-year Follow-up: A Multicenter Report

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INTRODUCTION: The incidence of meniscal repairs in children and adolescent patients is increasing. The rates of failed meniscus repair in this population are variable, and previous reports have ranged between 0-42%. The purpose of this study is to establish the incidence of failed meniscus repair and risk factors associated with failed meniscus repair utilizing a large, multicenter, prospective quality improvement registry.

METHODS: A prospective, multicenter quality improvement registry (27 institutions and 43 surgeons) was queried for all meniscus repairs between 2018-2025. Participating sites logged de-identified data on consecutive patients into a HIPAA compliant electronic platform. Patients who underwent isolated meniscus repairs and meniscus repairs with concomitant anterior cruciate ligament reconstruction (ACLR) were analyzed. Patients aged ≤19 years, with a minimum follow-up of 2 years, or those who had a failed repair before the 2-year follow-up, were included. Demographics, tear characteristics, and repair techniques were analyzed for their association with failed meniscal repair. Failed repair was defined as a meniscus reoperation or evidence of repeat meniscus tear with advanced imaging. Patients were additionally classified by age groups of either <15 years or ≥15 years and BMI <24 or ≥24, determined by a receiver operating characteristic (ROC) curve analysis to identify a threshold value. Mann-Whitney-U test, and Chi-square test with Bonferroni post-hoc analysis were utilized. A multivariate logistic regression was performed on variables of clinical interest and those with p-value <0.2. Statistical significance was set at a p-value of 0.05.

RESULTS:

Patient characteristics

1152 pediatric meniscus repairs were analyzed. There were 840 (72.9%) meniscus repairs with ACLR and 312 (27.1%) isolated meniscus repairs. The mean age of the cohort was 14.9 years (range, 4-19 years) and 54.4% were male. The overall failed repair rate was 11.7% (135).

Isolated Meniscus Repair

Isolated meniscus repairs failed at higher rate when compared to repairs with ACLR (25.6% vs 6.5%, p<0.001). Medial repairs failed at a higher rate when compared to lateral repairs (32.7% vs 19.1%, p<0.001). Repairs of medial oblique/parrot beak tears had the highest failure rate amongst tear types with failure in 5/6 repairs (83.0%, p=0.046). Medial tears that extend from the red-red zone into the red-white failed at the highest rate compared to other vascular zones (53.0%, p=0.035). There was no difference in meniscus failure rate by tear location or repair technique in medial or lateral repairs. Differences in failed repair by tear characteristics are presented in table 1.

Meniscus Repair with ACLR

Medial meniscus repairs failed at a higher rate (11.8% vs 2.7%, p<0.001). Repairs of lateral tears with displacement failed at a higher rate than non-displaced tears (7.6% vs 1.4%, p=0.002). Medial displaced tears showed an increased, but not statistically significant, failure rate (16.5% vs 9.6%, p=0.058). There was no difference in repair failure by tear type, tear location, vascular zone, or meniscus repair technique in the medial or lateral meniscus. Differences in failed repair by tear characteristics are presented in table 2.

Multivariate Analysis

After controlling for demographics, tear, and repair characteristics, multivariate analysis revealed that in the isolated meniscus repair cohort, medial tears (OR 2.39; 95% CI 1.27-4.49; p=0.007), complex/degenerative tears (OR 2.33; 95% CI 1.17-4.65; p=0.016), and use of the outside-in technique (OR 5.58; 95% CI 1.44-21.57; p=0.016) had and increased risk of failure. Those with BMI >24.0 had a protective effect against failure (OR 0.39; 95% CI 0.19-0.80; p=0.01). In the meniscus repair with ACLR cohort, medial tears (OR 4.21; 95% CI 2.09-8.49; p<0.001) and displaced tears (OR 2.41; 95% CI 1.31-4.44; p=0.005) were risk factors for failure (Table 3).

DISCUSSION AND CONCLUSION: In this large, prospective, multicenter registry, the overall failed meniscus repair rate was 11.7% in a pediatric population. Isolated meniscus repairs were more likely to fail than those with concomitant ACLR.

Several meniscus repair factors revealed increased failure rates. Multivariate analysis demonstrated that in isolated meniscus repair, medial repairs, complex degenerative tears, and repair with the outside-in technique were at increased risk of failure.

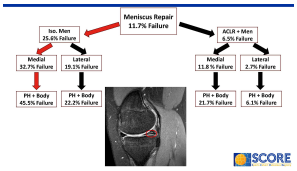

Table 1. Repair characteristics of isolated meniscus repairs (n=122).

	Medial Meniscus Failure Count (%)	P-value	Lateral Meniscus Failure Count (%)	P-value
	48/150 (32.7)		31/102 (28.1)	0.006
Tear Displacement				
Non-Displaced Tear	29/71 (29.2)	0.242	18/65 (18.8)	0.062
Displaced Tear	28/79 (37.1)		13/57 (18.4)	
Tear Type				
Longitudinal (vertical)	28/92 (25.2)	0.045	12/61 (18.0)	0.249
Radial	3/4 (56.0)		5/20 (14.3)	
Horizontal/cleavage	1/9 (11.1)		1/11 (9.1)	
Oblique/parrot's beak/flap	5/8 (62.5)*		3/9 (3.3)	
Complex/degenerative	11/30 (36.6)		13/44 (29.5)	
Root	1/6 (16.7)		0/3 (0.0)	
Vascular Zone				
RR	9/50 (18.0)*	0.035	9/51 (15.3)	0.407
RW	27/68 (39.1)		13/65 (21.1)	
RR + RW	6/13 (52.0)*		3/15 (20.0)	
WW	2/11 (18.2)		4/12 (33.3)	
RR + RW + WW	5/6 (16.7)		3/17 (17.6)	
Tear Location				
Posterior Horn	13/48 (26.1)	0.182	8/34 (23.5)	0.822
Body	2/6 (25.0)		8/40 (16.3)	
Posterior Horn + Body	25/55 (45.5)		13/42 (32.1)	
Posterior Root	3/11 (27.3)		0/5 (0.0)	
Other*	7/10 (25.5)		5/20 (13.3)	
Repair Technique				
All-inside	25/74 (33.5)	0.102	13/51 (18.5)	0.179
Inside-out	9/22 (22.7)		3/19 (6.3)	
Outside-in	2/3 (38.7)		6/10 (35.8)	
Suture	9/5 (0.0)		0/3 (0.0)	
Transosseous	0/5 (0.0)		0/1 (0.0)	
Combined (≥ 2 techniques)	1/140 (43.5)		8/43 (21.4)	

Abbreviations: RR = Red-Red, RW, red-white WW = White-White; *Denotes variable is associated with a statistically significant increase in failure in isolated meniscus repair following Bonferroni post-hoc analysis; **Denotes variable is associated with a statistically significant decrease in failed meniscus repair following Bonferroni post-hoc analysis; ***Denotes combination of other meniscus tear locations.

Table 2. Repair characteristics of meniscus repairs with concomitant anterior cruciate ligament reconstruction (n=144).

	Medial Meniscus Failure Count (%)	P-value	Lateral Meniscus Failure Count	P-value
	42/355 (11.8)		13/485 (2.7)	<0.001
Tear Displacement				
Non-Displaced Tear	23/240 (9.8)	0.055	5/270 (1.4)	0.002
Displaced Tear	19/115 (16.5)		8/139 (7.0)	
Tear Type				
Longitudinal (vertical)	41/305 (13.4)	0.001	9/358 (2.5)	0.005
Radial	0/8 (0.0)		0/50 (0.0)	
Horizontal/cleavage	1/11 (9.1)		3/25 (0.6)	
Oblique/parrot's beak/flap	1/9 (20.0)		0/20 (0.0)	
Complex/degenerative	4/20 (22.0)		3/34 (1.1)	
Root	0/8 (0.0)		0/18 (0.0)	
Vascular Zone				
RR	21/173 (12.1)	0.854	6/112 (5.4)	0.881
RW	19/137 (11.9)		8/194 (2.5)	
RR + RW	1/18 (5.6)		0/13 (0.0)	
WW	4/18 (22.2)		1/35 (2.5)	
RW + WW	1/8		0/12 (0.0)	
RR + RW + WW	0/5 (0)		0/28 (0.0)	
Tear Zone Location				
Posterior Horn	23/122 (13.0)	0.325	7/200 (2.4)	0.184
Body	3/32 (9.4)		3/41 (4.5)	
Posterior Horn + Body	11/81 (13.6)		4/68 (6.1)	
Posterior Root	0/12 (0)		0/28 (0.0)	
Other*	5/17 (29.4)		0/47 (0.0)	
Repair Technique				
All-inside	33/279 (11.8)	0.855	10/387 (2.0)	0.286
Inside-out	5/28 (17.2)		3/32 (9.4)	
Outside-in	1/8		0/11 (0)	
Suture	0/3 (0.0)		0/5 (0.0)	
Transosseous	0/2 (0.0)		0/4 (0.0)	
Combined (≥ 2 techniques)	4/40 (42.5)		0/40 (0.0)	

Abbreviations: RR = Rose-Recessed; RR + Red-Red; RW= Red-White; WW = White-White; *Denotes variable is associated with a statistically significant increase in failed meniscus repair following Bonferroni post-hoc analysis; **Denotes variable is associated with a statistically significant decrease in failed meniscus repair following Bonferroni post-hoc analysis; ***Denotes combination of other meniscus tear locations.

Table 3. Multivariate analysis for isolated meniscus repair and meniscus repair with concomitant anterior cruciate ligament reconstruction.

Variable	Isolated Meniscus Repair		Meniscus Repair + ACLR	
	Ratio (95% CI)	P-value	Ratio (95% CI)	P-value
Sex				
Male	Reference		Reference	
Female	0.00 (0.46-1.64)	0.713	0.59 (0.32-1.09)	0.091
Age				
<35 years	Reference		Reference	
≥35 years	1.56 (0.85-2.79)	0.150	1.10 (0.72-2.42)	0.371
Tear Displacement				
Non-displaced	Reference		Reference	
Displaced	1.11 (0.9-2.09)	0.74	2.41 (1.27-4.44)	0.005
Tear Type				
Longitudinal/Vertical	Reference		Reference	
Radial	1.21 (0.35-4.12)	0.760		
Horizontal/Cleavage	0.00 (0.00-1.64)	0.035	1.08 (0.38-3.05)	0.204
Oblique/Parrot's Beak/Flap	2.07 (0.64-7.17)	0.170	1.02 (0.19-4.58)	0.869
Complex/Degenerative	2.33 (1.17-4.85)	0.016	0.88 (0.39-2.28)	0.807
Root	0.52 (0.02-13.76)	0.699		
Meniscus Tear Location				
Posterior Horn	Reference		Reference	
Body	0.56 (0.18-1.80)	0.288	1.13 (0.48-3.27)	0.812
Posterior Horn + Body	1.36 (0.82-2.83)	0.430	1.28 (0.91-2.79)	0.612
Posterior Root	1.46 (0.17-13.02)	0.722		
Other*	0.41 (0.15-1.10)	0.090	1.08 (0.46-2.15)	0.410
Repair Technique				
All-inside	Reference		Reference	
Inside-out	0.46 (0.19-1.34)	0.186	1.78 (0.88-4.05)	0.242
Outside-in	5.56 (1.66-27.57)	0.013		
Combined (≥ 2 techniques)	1.44 (0.67-3.73)	0.111	6.33 (0.86-4.44)	0.697

*Denotes combination of other meniscus tear locations.