Does Delayed Anterior Cruciate Ligament Reconstruction Really Increase the Risk of “New” Meniscal Tears? Re-evaluating a Long-Standing Paradigm

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INTRODUCTION:

Anterior cruciate ligament (ACL) rupture is common among pediatric and adult patients. Historically, operative reconstruction in pediatric patients has been delayed to permit physeal maturation, with the understanding that early surgical intervention may increase the risk of angular deformity or leg length discrepancy due to growth plate disturbance. However, delayed repair of the ACL-deficient knee has been associated with increased risk of meniscal tears due to excess translational stress and loss of structural support from the ACL. Although this phenomenon has been described separately for both adult and pediatric patients, there has been little investigation into how the incidence of this injury pattern differs between these populations. Moreover, previous studies on this topic have neglected to stratify patients based on the presence or absence of meniscal tears at the time of initial injury. Here, we compare the incidence of meniscal injury secondary to delayed ACL reconstruction in adult versus pediatric patients, using magnetic resonance imaging (MRI) findings to isolate “new” meniscal tears.

METHODS:

All patients who underwent primary ACL reconstruction at a single urban, academic center from October 2013 – January 2022 were retrospectively identified. Exclusion criteria included history of ipsilateral knee injury, unknown injury date, unknown MRI date or findings, and severe joint derangement (e.g., intraarticular fracture). In order to limit ACL tears with extensive chronicity, patients were also excluded if the time from injury to MRI scan was ≥27 weeks or if their time from MRI scan to surgery was ≥52 weeks. Patients were classified as pediatric (<18 years) or adult (≥18 years) based on age at surgery. Operative delay was defined as ≥8 weeks gap between date of injury and surgery. Meniscal tears seen on initial MRI or visualized intra-operatively were recorded. “New” intra-operative meniscal injuries were defined as tears not detected previously on MRI. Student’s t-test and Pearson’s chi-squared test were used for univariate analysis. Logistic regression was used for multivariate regression. Significance was set at $p < 0.05$.

RESULTS:

A total of 657 patients (216 pediatrics; 449 adults) were included. Mean age at surgery was 15.3 (SD: ±1.9) years and 30.9 (±10.2) years, respectively. There were no differences in sex, injury laterality, or time from injury to MRI between pediatric and adult patients. Adults were more likely to undergo delayed ACL reconstruction ($p < 0.001$). Looking at MRI and intra-operative findings overall, there was no difference in the incidence of medial meniscus tears between pediatric patients undergoing early versus late ACL surgery ($p = 0.162$ and $p = 0.267$, respectively) **(Table 1)**. When isolating “new” meniscal pathology that was not present on the initial MRI, however, those who underwent delayed surgery had a higher incidence of medial meniscus tears ($p = 0.002$). Additionally, pediatric patients in the “no operative delay” subgroup were more likely to present with concomitant lateral meniscal tears at the time of ACL injury, as seen on MRI (37% vs 25%; $p = 0.068$), which was consistent with the incidence of lateral tears observed intra-operatively (64% vs 51%; $p = 0.068$) **(Table 1)**. On multivariate analysis, delayed ACL reconstruction was associated with higher odds of “new” medial (OR: 6.14; 95% CI: 2.06–18.32; $p = 0.001$), but not lateral (OR: 1.08; 95% CI: 0.54–2.16; $p = 0.836$), meniscal tears **(Figure 1)**. Among adults, a different pattern was observed. Delayed ACL reconstruction did not confer a significantly greater risk of “new” medial ($p = 0.462$) or lateral ($p = 0.671$) meniscus tears, as visualized arthroscopically.

DISCUSSION AND CONCLUSION:

It is commonly believed that delaying ACL reconstruction increases the risk of secondary meniscal injury due to abnormal kinetics at the ACL-deficient knee joint. However, previous studies have failed to demonstrate that meniscal tears discovered arthroscopically are, in fact, “new” injuries, instead of derangements that occurred concomitantly with ACL rupture. Here, we show that delayed treatment for pediatric patients results in a greater incidence of “new” medial meniscal tears, whereas no increased risk was found in adults, possibly reflecting a more responsible, less active, and less injury prone population compared to children and adolescents. Furthermore, concomitant lateral meniscal tears at the time of ACL injury were common among pediatrics and were associated with earlier surgery, supporting the hypothesis that lateral tears are suggestive of acute rather than chronic instability, whereas medial tears occur as a result of prolonged ACL-deficiency and instability.

Our findings suggest delaying ACL reconstruction in low-risk patients with appropriate bracing and weight-bearing limitations may be permissible in the adult, but not the pediatric, population. We hope these findings will encourage future studies to reevaluate the risk of “new” meniscal tear with delayed ACL reconstruction using post-injury MRI, rather than looking at all tears present at the time of surgery.

Figure 1. Incidence of New Intra-Operative Meniscus Tears (not seen on MRI) by Age Group and Operative Delay

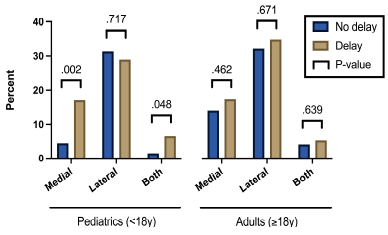

Table 1. Pediatrics (<18y): Patient and Injury Characteristics between Early and Delayed ACL Reconstruction

	Pediatrics (<18y)				
	No Delay (<8 weeks)		Operative Delay (≥8 weeks)		P-value
Included, N	134		76		
Age (y) at Surgery, Mean (±SD)	15.57	(±1.70)	14.89	(±2.22)	0.0106*
Sex, N (%)					0.893
Female	63	(47.01%)	35	(46.05%)	
Male	71	(52.99%)	41	(53.95%)	
BMI (kg/m^2), Mean (±SD)					0.308
Underweight (<18.5)	12	(8.96%)	13	(17.33%)	
Normal range (18.5-24.9)	84	(62.69%)	40	(53.33%)	
Overweight (25.0-29.9)	27	(20.15%)	15	(20.00%)	
Obese (≥30.0)	11	(8.21%)	7	(9.33%)	
ACL Injury Laterality, N (%)					0.991
Right knee	68	(50.75%)	38	(50.67%)	
Left knee	66	(49.25%)	37	(49.33%)	
Time from Injury to MRI, Mean (±SD)	1.20	(±1.02)	3.66	(±4.15)	<0.001*
Time from MRI to Surgery, Mean (±SD)	3.88	(±1.61)	11.75	(±9.00)	<0.001*
Time from Injury to Surgery, Mean (±SD)	5.08	(±1.59)	15.41	(±9.56)	<0.001*
Medial Meniscus Tears					
MRI					0.162
No	90	(67.16%)	58	(76.32%)	
Yes	44	(32.84%)	18	(23.68%)	
Intra-op					0.267
No	106	(79.10%)	55	(72.37%)	
Yes	28	(20.90%)	21	(27.63%)	
NEW Intra-op					0.002*
No	128	(95.52%)	63	(82.89%)	
Yes	6	(4.48%)	13	(17.11%)	
Lateral Meniscus Tears					
MRI					0.068
No	84	(62.69%)	57	(75.00%)	
Yes	50	(37.31%)	19	(25.00%)	
Intra-op					0.068
No	48	(35.82%)	37	(48.68%)	
Yes	86	(64.18%)	39	(51.32%)	
NEW Intra-op					0.717
No	92	(68.66%)	54	(71.05%)	
Yes	42	(31.34%)	22	(28.95%)	
Medial + Lateral Meniscus Tears					
NEW Intra-op					0.048*
No	132	(98.51%)	71	(93.42%)	
Yes	2	(1.49%)	5	(6.58%)	
Meniscectomy/repair, N (%)					0.232
No	63	(47.37%)	42	(56.00%)	
Yes	70	(52.63%)	33	(44.00%)	

Table 2. Adults (≥18y): Patient and Injury Characteristics between Early and Delayed ACL Reconstruction

	Adults (≥18y)				
	No Delay (<8 weeks)		Operative Delay (≥8 weeks)		P-value
Included, N	195		240		
Age (y) at Surgery, Mean (±SD)	30.03	(±10.00)	31.64	(±10.37)	0.0512
Sex, N (%)					0.888
Female	85	(43.59%)	103	(42.92%)	
Male	110	(56.41%)	137	(57.08%)	
BMI (kg/m^2), Mean (±SD)					0.062
Underweight (<18.5)	0	(0.00%)	1	(0.42%)	
Normal range (18.5-24.9)	93	(47.69%)	96	(40.17%)	
Overweight (25.0-29.9)	76	(38.97%)	88	(36.82%)	
Obese (≥30.0)	26	(13.33%)	54	(22.59%)	
ACL Injury Laterality, N (%)					0.557
Right knee	104	(53.89%)	122	(51.05%)	
Left knee	89	(46.11%)	117	(48.95%)	
Time from Injury to MRI, Mean (±SD)	1.10	(±0.83)	3.02	(±3.96)	<0.001*
Time from MRI to Surgery, Mean (±SD)	4.29	(±1.53)	13.73	(±8.83)	<0.001*
Time from Injury to Surgery, Mean (±SD)	5.39	(±1.57)	16.76	(±9.30)	<0.001*
Medial Meniscus Tears					
MRI					0.252
No	129	(66.15%)	146	(60.83%)	
Yes	66	(33.85%)	94	(39.17%)	
Intra-op					0.403
No	131	(67.18%)	152	(63.33%)	
Yes	64	(32.82%)	88	(36.67%)	
NEW Intra-op					0.462
No	178	(91.28%)	214	(89.17%)	
Yes	17	(89.17%)	26	(10.83%)	
Lateral Meniscus Tears					
MRI					0.498
No	128	(65.64%)	150	(62.50%)	
Yes	67	(34.36%)	90	(37.50%)	
Intra-op					0.464
No	106	(54.36%)	122	(50.83%)	
Yes	89	(45.64%)	118	(49.17%)	
NEW Intra-op					0.671
No	156	(80.00%)	188	(78.33%)	
Yes	39	(20.00%)	52	(21.67%)	
Medial + Lateral Meniscus Tears					
NEW Intra-op					0.639
No	190	(97.44%)	232	(96.67%)	
Yes	5	(2.56%)	8	(3.33%)	
Meniscectomy/repair, N (%)					0.846
No	113	(58.25%)	137	(57.32%)	
Yes	81	(41.75%)	102	(42.68%)	