Capsular Repair Restores Resistance to Axial Traction in Pediatric and Adolescent Hip Arthroscopy Patients: An *in vivo* Study

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INTRODUCTION: Controversy exists surrounding the necessity of capsular repair in patients undergoing hip arthroscopy. Historically, the capsule would be left open to scar and heal on its own. However, capsular repair using figure-of-eight sutures has become increasingly commonplace in an attempt to address the potential development of postoperative clinical hip instability. In adults, studies show capsulotomy decreases the hip joint's resistance, and capsular repair restores this resistance to native-state levels. However, no literature exists evaluating hip distraction characteristics in pediatric patients and it is unclear if pediatric patients are biomechanically similar to adult patients. The purpose of this study is to assess, in the pediatric population, whether capsulotomy compromises the hip joint's resistance to axial distraction, and whether capsular repair can restore native state resistance to axial traction.

METHODS:

Pediatric patients undergoing primary hip arthroscopy for the treatment of femoroacetabular impingement syndrome by the senior author from January 2019 to April 2022 were selected for study inclusion. Under general anesthesia, a post-free traction table system with built-in tensiometer was used to conduct axial distraction testing. This was performed prior to instrumentation (native state), following periportal capsulotomy (capsulotomy state), and after capsule repair (repaired state). Sequential fluoroscopic imaging was taken at 0-, 25-, 50-, 75-, and 100- lbs. of applied traction (Figure 1) and a previously published methodology was used to calculate the distraction distance of the hip at the lateral joint space and normalize the fluoroscopic measurements to millimetric values.

A paired sample T-test was performed to compare the traction distances between the native state, capsulotomy state, and the repaired state. A subgroup analysis comparing the distraction profiles of patients < 16 years of age and > 16 years of age was conducted using an independent samples t-test.

RESULTS:

Thirty-two hips were included for analysis, with a mean age of 16.3±1.1 years at time of surgery. Compared to the native state, hips in the capsulotomy state distracted to significantly greater distances at 50, 75, and 100 lbs ($p = 0.002$, $p < 0.001$, $p < 0.001$, respectively). Compared to the capsulotomy state, repaired hips distracted significantly less at 50, 75, and 100 lbf ($p = 0.045$, $p < 0.001$, $p < 0.001$, respectively). No significant differences in distraction distance at any force between the native and repaired capsule states ($p > 0.05$) (Table 2). Results of the independent sample t-test stratified by age (< 16 and > 16) resulted in a significant difference only within the 100 lbf distraction distance in the capsulotomy state ($p < 0.029$), indicating on average patients older than 16 distracted 2.1 ± 1.9 mm more than individuals younger than 16 (Table 3).

DISCUSSION AND CONCLUSION:

This study provides *in-vivo* biomechanical data suggesting that pediatric patients have similar distraction characteristics to those seen in adults when undergoing capsulotomy that capsular closure should be considered in this patient population. Capsulotomy resulted in increased distraction compared to the native hip, suggesting a greater propensity for clinical hip instability if left unrepaired. When the capsule was repaired, the hip was restored to native-state distraction characteristics.

Age was not associated with differing distraction characteristics in our cohort. However, the results of the present study indicate increased overall distraction at 100 lbs in pediatric hips compared to adult hips as reported in the literature. This may serve as further justification for capsular repair in pediatric patients. This may be due to a plethora of factors, from differences in overall ligamentous size and soft tissue elasticity and overall time undergoing both clinical and subclinical stressors to the hip capsule.

Overall, this study provides an objective analysis of hip physiology in a growing hip arthroscopy patient population. Our findings highlight the need to consider capsular repair during pediatric hip arthroscopy in this patient population, as it helps to restore the hip joint to native state biomechanics.

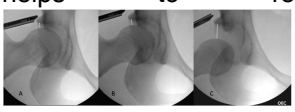

Figure 1: Fluoroscopic images of a right hip taken at the following traction levels in the capsulotomy state in a pediatric patient: (A) 0 pounds of traction, (B) 50 pounds of traction, and (C) 100 pounds of traction. The white line drawn indicates distraction distance from the lateral aspect of the acetabular sourcil to the closest portion of the femoral head to the sourcil. Millimetric conversion of this measurement in pixels was utilized to calculate and exact distance as has been done in previous studies.

Variables	Mean ± SD or N (%)
Average Age	16.4 ± 1.101
< 16 years old	8 (25.0%)
> Patients older than 16 years old	24 (75.0%)
BMI	23.2 ± 4.362
Preoperative Alpha Angles	58.60 ± 13.130
Lateral Center Edge Angle to the Acetabular Sourcil	32.813 + 5.522
Beighton scores	1.09 ± 1.823
Sex	
Male	8
Female	24

Table 1: Descriptive statistics of selected cohort including demographic information, and measurements made on preoperative imaging including alpha angle, lateral center edge angle, and calculated Beighton scores.

	Distraction (mm)			
Traction (lbs)	**Native State**	**Capsulotomy**	**Δ**	**p-value**
0	5.55	5.48	-0.07	0.086
25	5.59	5.74	0.15	0.320
50	6.28	7.81	1.53	0.002*
75	9.36	12.67	3.37	<0.001*
100	11.70	14.45	2.75	<0.001*
	Capsulotomy	**Capsular Repair**	**Δ**	**p-value**
0	5.48	5.56	0.08	0.764
25	5.74	5.83	0.09	0.616
50	7.81	6.46	-1.35	0.045*
75	12.67	8.05	-4.62	<0.001*
100	14.45	10.18	-4.27	<0.001*
	Native State	**Capsular Repair**	**Δ**	**p-value**
0	5.55	5.56	0.01	0.233
25	5.59	5.83	0.24	0.112
50	6.28	6.46	0.18	0.216
75	9.36	8.05	-1.31	0.094
100	11.70	10.18	-1.52	0.068

Table 2: Intra-operative distraction distances for the three capsular states including the native state, capsulotomy state, and capsulotomy repair state. (* indicates significance set at $p < 0.05$)

State	Mean Difference	Standard Error	95% CI lower	95% CI Upper	p-value
Initial state at 100 lbs. of distraction	1.468	1.853	-2.317	5.252	.435
Capsulotomy state at 100 lbs.	2.131	0.912	.24103	4.021	**.029***
Repair state at 100 lbs. of distraction	1.712	1.239	-0.209	4.258	.179

Table 3: Results of independent samples T-test comparing individuals younger than 16 to older than 16. (* indicates significance set at $p < 0.05$)