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Rotator cuff tears in the pediatric population: Comparing findings on arthroscopic evaluation to pre-operative magnetic resonance imaging

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1. Introduction

Rotator cuff (RC) tears are common injuries sustained by competitive overhead athletes resulting from acute trauma or more commonly, chronic degenerative changes from overuse.[1,2] These injuries have been frequently documented in both collegiate and professional level athletes in which a repetitive overhead throwing motion is used.[3–5] When RC tears occur in athletes and younger populations, they tend to result from trauma, multiple subluxations, or repetitive overhead motions where large rotational torques are observed, often occurring in athletes participating in sports such as baseball, tennis, or swimming.[6–9] Brockmeier et al. describes the pathophysiology of RC tears suggesting the microtrauma from repetitive overhead throwing results in supraphysiological tensile and shear forces on the RC.[6]

When the RC tendons experience excessive loads they become susceptible to tears, especially near the junction of the supraspinatus and infraspinatus.[10] The tears are categorized as either full-thickness or partial-thickness, and further categorized by location: on the bursal or articular side of the humerus.[11] A subtype of RC tears, known as partial articular-sided supraspinatus tendon avulsion (PASTA) lesions occur at the RC footprint where fibers of the supraspinatus and infraspinatus tendons separate from their bony attachment at the greater tuberosity of the humerus.[7,12,13] Schaeffeler et al. further described these lesions as a discontinuation of the undersurface of the supraspinatus or infraspinatus fibers located on the articular side, in which contrast material extends into the tendon.[7]

Although RC injuries are a common etiology for shoulder pain in adults, evidence suggests RC lesions occur less often in the pediatric population, and account for less than 1% of all total RC tears.[2,14] Current literature reports shoulder injuries comprise nearly 11% of all high school athlete injuries[15]. However, few studies have reported the incidence of RC tears in the pediatric population, with current evidence limited to case reports and small retrospective reviews.[14,15] Additionally, Alley, Banerjee, Papaliodis, Tsitos, Zanaros[2], reports the proximal humeral physes is physiologically weaker than the RC resulting in acute physeal separation or proximal humeral epiphysiolysis injuries occurring more commonly from repetitive stress in overhead throwing compared to RC injuries. However, to the best of authors' knowledge, no literature exists detailing differences in the pathophysiology between rotator cuff tears in the pediatric versus older populations.

Recent literature has reported inconsistencies in the correlation between RC lesions viewed with magnetic resonance imaging (MRI) and those found arthroscopically, [16–18] especially regarding partial-thickness tears.[19] Although studies have demonstrated partial-thickness RC lesions have a higher incidence in younger populations, the definition of younger population in these sources remains varied, with sources including patient populations up to 40 years of age.[7] Therefore, in an effort to increase our understanding of operative RC lesions in the pediatric population defined as patients aged 18 years or younger, we examined 1) the prevalence and characteristics of RC lesions in pediatric patients undergoing operative management for shoulder pathology at our institution and 2) compared the accuracy of MRI findings in

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diagnosing RC lesions confirmed arthroscopically. We hypothesized MRI would accurately detect the location and type of RC lesion in a pediatric cohort.

2. Materials and methods

Following Institutional Review Board approval, a retrospective review of patients with shoulder pathology that resulted in operative management from January 2010 to October 2016 was performed. Patients were identified from Department of Orthopaedics Sports Medicine Institute using the CPT codes listed in Appendix A. Of the 1136 cases identified that received operative intervention secondary to shoulder pathology, a total of 44 patients were aged 12–18 defining the pediatric population age range. Patients were excluded from final analysis if they were older than 18 years, or did not receive operative treatment for shoulder pathologies. A total of ten patients were included in the final observational analysis.

Operative reports and intraoperative arthroscopic images were evaluated to identify RC lesions. All patients underwent arthroscopy by one of three fellowship-trained sports medicine surgeons. A diagnostic arthroscopy was done with a 30° scope through the posterior portal, which is located 2 cm inferior and 1 cm medial to posterolateral corner of acromion. Through the posterior portal the following structures were identified for pathology: Biceps tendon, Supraspinatus, Infraspinatus, Teres Minor, Rotator interval, Anterior ligamentous complex (MGHL, IGHL), Subscapularis recess for loose bodies, Anterior labrum, Glenoid, and Humeral head.

The preoperative MRI was then retrospectively reviewed for documenting RC lesions and confirmed by a fellowship-trained musculoskeletal radiologist. All MRI examinations were performed on 1.5T systems and included the following parameters: Axial T2 FS (TR 3720–3800, TE 28–33, NEX 2 ETL 8, BW 230–240, matrix 384 × 250), coronal oblique T2 FS (TR 4120–4380, TE 57–65, NEX 2, ETL 8–11, BW 230–240, matrix 384 × 250), coronal oblique proton density (TR 2750–2980, TE 38–43, NEX 1–2, ETL 6–8, BW 240, matrix 512 × 307), axial proton density (TR 2650–2800, TE 39–41, ETL 6, BW, 240, matrix 512 × 307), sagittal oblique T1 (TR715- 769, TE 11–27, NEX 1–2, ETL 3–7, BW 165–230, matrix 512 × 307). No IV or intra-articular contrast was utilized. The radiologist was blinded to the original report and arthroscopic findings to minimize interpretation bias. The findings for both MRI and arthroscopy were categorized by anatomic location. Lesions to the rotator cuff tendons were detailed to specify the specific tendon and tear location. Lesions were classified as partial-thickness, full thickness, or footprint lesions. Footprint lesion were defined as lesions located at the insertion of the rotator cuff. The radiologists findings on MRI findings were then compared to the surgeons arthroscopic findings.

3. Results

A total of 1136 cases receiving operative management for shoulder pathology were identified. Of which, 44 patients were between age 12 to 18 years old. Of the 44 pediatric patients identified, 10 patients had RC lesions documented on operative reports. The average age of pediatric patients included in our analysis was 16.7 years (Min: 14 years, Max: 18 years, Table 1).

All 10 (100%) patients were males, with 9 of the 10 (90%) cases resulting from sports-related injuries. A majority of RC lesions resulted from baseball injuries, 7 of 10 (70%) cases, with the remaining 3 injuries resulting from basketball, weight-lifting, and chronic instability. An identifiable traumatic event occurred in 4 of 10 (40%) cases, with 2 of 4 (50%) traumatic events occurring during a baseball game. The most common associated pathology were SLAP tears and Bankhart tears (3 cases, 30%, Table 1), followed by bicep tendon tears in 2 cases, (20%, Table 1), Hill-Sachs lesions, internal impingement, and posterior capsule tightness in 1 case each. Table 2. details the characterization and management of RC lesions identified via MRI or arthroscopically in the operating room (OR). Four of the RC lesions were managed with debridement and the remaining 6 lesions were repaired in a side-to-side fashion if the lesion was a partial-thickness tear or via reattachment to the RC footprint with anchors if the lesion involved the footprint.

3.1. MRI findings

Of the 10 cases included in the analysis, 7 (70%) cases had preoperative MRIs, of which 5 (71.4%) cases identified RC lesions. Of the documented RC lesions, 2 (40%) were reported as footprint lesions (Table 2,Fig. 1) and 3 (60%) were reported as partial-thickness lesions (Table 2, Fig. 2).

Lesions were reported as articular-sided in 4 (80%) cases and bursal-sided in 1 (20%) case. Isolated involvement of the supraspinatus and infraspinatus tendon was reported in 2 (40%) and 1 (20%) of the cases, respectively. Involvement of both the

Table 1
Demographic data of reported lesions and their associated injuries.

Sample	Gender	Age	Side	Associated Pathology	Sport	Activity	Trauma
1	M	14	Right	Biceps tendon tear^	Basketball	Push off wall	Yes
2	M	18	Left	Tight posterior capsule†	Baseball	Pitcher	No
3	M	16	Right	–	Baseball	Pitcher	No
4	M	18	Left	SLAP tear‡	Baseball	Pitcher	No
5	M	16	Right	SLAP tear Internal impingement	Baseball	Pitcher	No
6	M	18	Right	Anterior labral tear	Baseball	Sliding into base	Yes
7	M	18	Right	Posterior labral tear	Weight-Lifting	Military press	Yes
8	M	17	Right	Bankart tear SLAP tear Hill-Sachs lesion Biceps tendon tear	Baseball	Dislocation	Yes
9	M	16	Right	Bankart tear°	–	Instability	No
10	M	16	Right	Bankart tear	Baseball	–	No

M = Male; SLAP = Superior labral tear from anterior to posterior.
– Data not available.
^ Biceps tear was debrided intraoperatively.
† Posterior capsule tightness was observed and released intraoperatively.
‡ Type 2 SLAP tear.
° Patient required posterior labral repair and capsulorrhaphy.

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