Prevalence of Asymptomatic Acetabular Labrum Abnormalities in the Active Pediatric Population

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Background: The prevalence of labral tears in asymptomatic active adults has been reported, but the prevalence of labral tears and other incidental hip lesions in the asymptomatic active pediatric population remains unclear. The purpose of this study was to determine the prevalence of hip abnormalities detected on 3T MRI in an active pediatric population with no hip symptoms and to compare with hip abnormalities found in children and adolescents who underwent an MRI for a hip-related condition.

Methods: After IRB approval, pediatric patients self-reporting as athletes and presenting with isolated, acute-onset knee pain requiring knee MRI were prospectively recruited to undergo 3T MRI of their asymptomatic contralateral hip (ASx). A comparison group of pediatric subjects who underwent an MRI for hip pain was enrolled retrospectively (Sx). All MRI scans were anonymized and randomized. Fifty subjects were enrolled for each cohort. Two fellowship-trained musculoskeletal radiologists independently evaluated MRIs for abnormal hip lesions, including labral tears. Inter-reader reliability was evaluated using Cohen Kappa. χ^2 or Fisher exact test was used to compare the prevalence of hip lesions between the 2 cohorts.

Results: The average patient age was 14.9 years for both cohorts (range 9 to 18 y) and 48% were male. In the ASx group, incidental labral tears were found in 18%, labral/paralabral cysts 6%, cartilage lesion 0%, subchondral cyst 0%, ligamentum teres tear 0%, femoral fibrocystic change 0%, cam lesion 30%, acetabular bone edema 0%, acetabular rim fracture 0%. The prevalence of labral tears (30%, *P*-value 0.16) and cam lesion (36%, *P*-value 0.52) in the Sx group was not significantly different from the ASx cohort. No significant correlation was found between the presence of femoral neck osseous bump and labral tear, labral cyst, or paralabral cyst in either cohort.

Conclusions: Labral tears were present on 3T MRIs of active pediatric patients with and without hip pain. Although MRI is essential to confirm the surgeon's suspicion and to detect unexpected pathology, clinical examination and history are crucial in pinpointing clinically relevant abnormal imaging findings.

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Management of non-arthritic hip pain has traditionally focused on nonoperative measures in the adolescent.[1] However, with recent advances in diagnostics and operative techniques, the amount of adolescent arthroscopic hip procedures is increasing at a higher rate than general orthopaedic procedures.[2] From 2008 to 2018, the number of hip arthroscopies performed in the pediatric and adolescent populations increased 6.2-fold.[2] Although there are many pathologies that can exist on either side of the hip joint such as osseous/cartilaginous defects, edema, and cystic changes, the majority of pediatric hip arthroscopies are performed to treat labral injuries and impingement.[3]

The labrum of the acetabulum is a triangular-shaped fibrocartilaginous ring structure that serves several functions, notably to provide hydrostatic pressurization of the hip joint, enhance joint stability, and preserve the articular cartilage.[4,5] The etiology of labral tears is may be multifactorial but can be grouped into 4 categories: traumatic, congenital, degenerative, and idiopathic.[6] Although tears can occur throughout the labrum, the anterior segment is most susceptible, likely due to mechanical stress during the flexion arc and loading demands, as well as relatively poor vascularity.[7] The rate of incidental labral pathology seen on MRI in asymptomatic patients has been well established in the adult population, ranging from 35% to 87%,[8–14] and has received some evaluation in the pediatric population (1.4% to 3%).[15,16] Although the studies in adults typically include cohorts of healthy active volunteers, the cohorts from studies of younger patients are typically less active and with underlying health conditions.[15] Therefore, the prevalence of asymptomatic hip labrum tears in an active pediatric population has yet to be studied.

Although direct visualization through arthroscopy remains the generally preferred standard for diagnosing hip labral tears, Magnetic resonance (MR) is the most used diagnostic test of choice. Historically, MR arthrography (MRA) was a common method for achieving visualization of intra-articular structures by means of introducing a contrast agent directly into the joint to

better visualize labral pathology. However, more recent advances in non-contrast protocols through MR imaging (MRI) have been shown to describe excellent sensitivity in the diagnosis of labral injury and have the benefit of being less invasive.[17,18] In particular, 3T MRI has been shown to have comparable sensitivity to MRA and higher specificity for the diagnosis of hip labral tears, leading many to recommend a 3T MRI as the diagnostic study of choice.[19]

The purpose of this study was to determine the prevalence of hip abnormalities detected on 3T MRI in an active pediatric population with no hip symptoms and, secondarily, to compare with hip abnormalities found in adolescents who underwent an MRI for a hip-related condition.

METHODS

Approval from the Institutional Review Board was obtained for this study. The study design included 2 cohorts. The first cohort (asymptomatic or Asx) included prospective enrollment of pediatric patients indicated for an MRI of the knee for an acute injury. After obtaining consent, a contralateral hip MRI was obtained during the same session to evaluate for hip pathology in an asymptomatic hip. The second cohort (symptomatic or Sx) was extracted retrospectively from our institutional registry of patients with hip pain who underwent an MRI in between January 2018 to September 2021. Appropriate patients were gathered for this symptomatic cohort retrospectively through age and sex matching to correspond with the demographics of the first cohort. Prospective imaging expenses were covered by an institutional fund. Informed consent was obtained from all patients. A power analysis assumed a 25% difference in labral tear incidence between symptomatic and asymptomatic cohorts based on prior literature.[14] Preliminary data showed a labral tear prevalence of 18% within asymptomatic cohort which determined 50 patients per cohort were required per sample size calculations provided by G*Power.[20] Inclusion criteria for both cohorts included age between 8 and 18 years old and involved in at least 1 organized sport. We used a standardized sports medicine intake form to determine the extent of athletic participation of each study participant. For the Asx cohort, the patients were recruited to obtain informed consent when they were indicated to undergo a knee MRI by their sports medicine provider and had no history of contralateral hip/leg pain, prior injury, or prior surgery. The exclusion criteria included a prior diagnosis of leg or hip bone infection, osteonecrosis, claustrophobia, excessive body weight over 300 lbs, Paget's disease of bone, or other routine MRI contraindications such as pacemakers, ferromagnetic foreign bodies, and metallic implants. Data were collected from the patient medical records and included demographics, past medical history, level of baseline activity, cause of injury, date of injury, date of presentation, radiographic measurements, and radiographic findings.

MRI of the asymptomatic hips was acquired using a 3T scanner (Ingenia Elition 3.0T; Philips, Amsterdam, Netherlands) and a Torso coil over the pelvis, without intravenous or intra-articular contrast. The hip MRI protocol includes fat-saturated proton density sequence in radial and sagittal acquisitions, and T2 DIXON sequence in axial plane producing fat-saturated and non-fat-saturated images (Radial PD FS: 232 × 197 matrix, FOV 150 to 170 mm, TR/TE 4000/30 ms, slice thickness 3 mm. Sagittal PD FS: 248 × 204 matrix, FOV 150 to 170 mm, TR/TE 4000/30 ms, slice thickness 2.5 mm. Axial T2 DIXON: 252 × 244 matrix, FOV 150 to 170 mm, TR/TE 3000/70, slice thickness 3 mm.) Similar sequences from both cohorts were anonymized and randomized. Imaging analysis was performed independently by 2 fellowship trained musculoskeletal radiologists who were blinded to the cohort status as well as patient demographics and clinical data. Each examination was evaluated for the presence of labral tears, labral and paralabral cysts, femoral neck osseous bumps (Cam lesions), fibrocystic changes, bone marrow edema, subchondral cysts, chondral lesions, acetabular rim fractures, and ligamentum teres tears. Inter-reader reliability was assessed using Cohen's Kappa with agreement noted between reviewers ($k = 0.822 - 1$).

χ^2 and Fisher exact tests were used to determine the relationships between the categorical radiographic measurements. These analyses were done for the entire study population, as well as subsamples of Cohort 1 and Cohort 2. Mann-Whitney tests were utilized to compare our cohorts. Statistical analysis was performed using SAS software (version 9.4) SAS Institute Inc., SAS Software, Version 9.4. Cary, NC and SPSS (version 19) IBM Corp. Released 2019. IBM SPSS Statistics for Windows, Version 26.0. Armonk, NY: IBM Corp.

RESULTS

The average age for all participants in both cohorts was 14.9 (range 9 to 18) with 48% males. There was no statistically significant difference in age or sex between the cohorts (Table 1). The most common primary sports for both cohorts were basketball, football, soccer, and dance-related. The average hours of sports played per week were 9.3 hours for the asymptomatic cohort and 11.7 hours for the symptomatic cohort. Average years of sports participation were 6.2 years for the asymptomatic cohort and 7.6 years for the symptomatic cohort. No statistically significant differences in sports played, hours per week or year in sports participation between groups were noted (Table 1).

The most common imaging finding was the presence of an osseous bump near the femoral head-neck junction (Cam lesion) (Fig. 1C, Table 2). Approximately one-third of patients in either cohort presented with a femoral neck osseous bump (18 or 36% in Sx and 15 or 30% in Asx, $P = 0.52$). No statistically significant differences were noted in other imaging findings including fibrocystic change of the femoral neck or subchondral cysts, which were found in small numbers. No patient in the entire cohort had a rim fracture identified on MRI.

TABLE 1. Patient Characteristics

	Symptomatic (n = 50)	Asymptomatic (n = 50)	*P*
Male	50%	46%	0.69
Age	14.94	14.9	0.91
Primary sport	Symptomatic (n = 50)	Asymptomatic (n = 50)	
Basketball	3	14	
Football	8	10	
Soccer	14	12	
Dance-related	7	4	
Other*	18	10	
	Symptomatic (n = 47)	Asymptomatic (n = 24)	*P*
Hours of practice per week	11.70	9.3	0.31
	Symptomatic (n = 46)	Asymptomatic (n = 23)	*P*
Years of sports participation	7.6	6.2	0.11

*Includes: cheer, cross-country, golf, gymnastics, ice hockey, martial arts, softball, swim, track and field, volleyball.

TABLE 2. Radiographic Comparison of Cohorts

Variable	Symptomatic	%	Asymptomatic	%	*P*
Labral tear	15	30	9	18	0.16
Chondral defect	1	2	0	0	> 0.99
Ligamentum teres tear	0	0	0	0	—
Labral cyst	0	0	2	4	0.50
Paralabral cyst	3	6	2	4	> 0.99
Acetabular bone marrow edema	3	6	0	0	0.24
Fibrocystic change	1	2	2	4	> 0.99
Rim fracture	0	0	0	0	—
Subchondral cyst	1	2	0	0	> 0.99
Osseous bump	18	36	15	30	0.52

Labral tears were identified in 18% (9 cases) of the asymptomatic and 30% (15) of the symptomatic cohort. This difference was not statistically significant (Fig. 1A, B, and Table 2). 8% of Asx cohort was positive for labral and paralabral cysts (2 cases of each entity), compared with 6% in the Sx cohort (3 cases with paralabral cysts).

There was no significant correlation found between presence of a femoral neck osseous bump and labral tear, labral cyst, or paralabral cyst. This was true when cohorts were evaluated independently and in aggregate (Table 3).

DISCUSSION

Our results indicate that a significant number of hip labral tears are identified on 3T MRI in the active asymptomatic pediatric and adolescent population. Importantly, there is no statistically significant difference in the prevalence of labral tears, cam lesions, or other findings of femoroacetabular impingement between the asymptomatic volunteers and symptomatic patients seen in our study. Whether these findings indicate normal variants of the hip or asymptomatic pathology is unclear.

Compared with a prior study on the general pediatric population by Georgaidis et al[15] showing a 1.4% prevalence rate for incidental hip labral tears on pelvis MRI, our study found a higher prevalence of 18% in the active pediatric population. This difference in prevalence could be explained by the differences in average cohort age and activity level between the 2 studies. Other studies have reported a prevalence of asymptomatic labral tears of 3% in a population of volunteers aged 10 to 19[16] and 13% in volunteers aged 15 to 24,[21] although these studies did not control for baseline activity levels. This data seem to suggest that the prevalence of asymptomatic hip labral pathologies increases with patient age and may correlate with activity levels. These prior studies also used a combination of 1.5T and 3T MRIs which may have led to the reduced prevalence.

Asymptomatic adults have been shown to have a much higher incidence of labral pathology, ranging from 35% to 87% of asymptomatic hips.[8–14] Blankenstein et al[8] compared 3 cohorts of adult males with differing activity levels: professional rugby players, professional ballerinas, and a control group who did not participate in a professional sport. Using 3T MRI, they found an overall asymptomatic tear prevalence of 87% with no significant

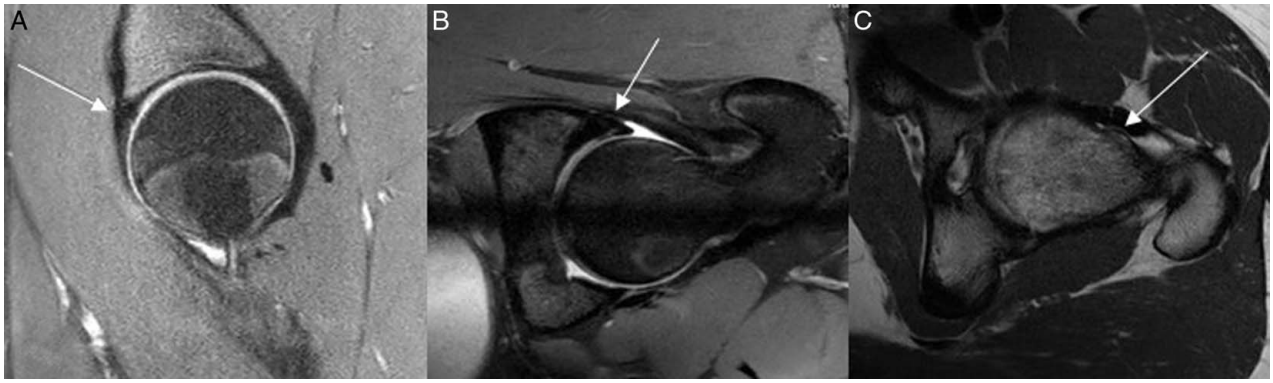

FIGURE 1. A, Sagittal fat-saturated proton density sequence of an asymptomatic hip demonstrating an anterosuperior labral tear. B, Axial T2 sequence of an asymptomatic hip demonstrating an anterior labral tear. C, Axial T1 sequence of an asymptomatic hip demonstrating an osseous bump (Cam deformity).

TABLE 3. Correlation of Osseous Bump and Labral Abnormalities

Correlation	Entire sample (*P*)	Symptomatic cohort (*P*)	Asymptomatic cohort (*P*)
Osseous bump+labral tear	0.62	0.35	0.71
Osseous bump+labral cyst	0.11	—	0.09
Osseous bump+paralabral cyst	0.99	0.99	0.51

difference among each of the groups, even with their differing activity levels. Gallo et al[22] evaluated a small cohort of asymptomatic professional hockey players and found that 71.4% of hips had an identifiable labral tear. Furthermore, 90% of these players were still playing professionally at 4-year follow-up. Tresch et al[14] compared adults with and without hip symptoms showing that 44% of asymptomatic volunteers had evidence of a labral tear compared with 61% of symptomatic patients which did not reach significance. They did, however, find the symptomatic cohort showed a statistically higher degree of articular cartilage defects. These studies suggest that the prevalence of asymptomatic hip labral pathologies continue to increase through adulthood. Although the percentage with labral pathology is higher numerically in the symptomatic cohort compared with the asymptomatic cohort, the difference is usually not statistically significant. This is consistent with what our study reports.

In a 2015 systematic review of 26 studies of asymptomatic FAI by Frank et al,[23] the average prevalence of an asymptomatic Cam deformity was found to be 37% with a wide range (7% to 100%). Interestingly, this study reported a prevalence of 54.8% in athletes versus 23.1% in the general population. The average prevalence of asymptomatic hips with pincer deformity was found to be 67% with a narrower range of 61% to 76% between studies, although they did note that a Pincer deformity was poorly defined. This contrasts with our study, which found a femoral neck osseous bump (Cam deformity) prevalence of 36% and 30% in our symptomatic and asymptomatic cohorts, respectively. In addition, pincer-type acetabular impingement was not assessed in our study given the difficulties of measuring acetabular overcoverage with either continuous or categorical variables.

The diagnostic evaluation of hip labral tears has continued to evolve in recent times. There are fewer MR arthrograms being performed, as non-contrast 3T MRIs provide higher resolution and signal-to-noise ratio, and have been shown to detect labral tears with high sensitivity and specificity.[17,18] In a 2005 study by Mintz et al,[18] the sensitivity reported for labral tears seen on MRI was noted to be 94.5% between 2 specialized radiologists with a 92% interobserver agreement when compared with intraoperative findings. This has been affirmed by other studies, especially when compared with 1.5T MRA in particular.[24] However, there may be a slight decrease in sensitivity when compared with 3T MRA.[25] Despite the improvement in the ability of a 3T MRI to detect labral pathology, a limitation of this study may be the absence of an MR Arthrogram.

The true nature of these asymptomatic labral tears, particularly in our pediatric population, is not entirely clear, nor is the natural progression of this disease course. Whether these findings indicate underlying asymptomatic pathology or normal variants in pediatric and adolescent hips remains unclear. Future studies would benefit to focus on understanding which patients become symptomatic and when in life this is more likely to occur. One modality would be to assess our asymptomatic cohort with positive radiographic findings for positive exam findings or new onset complaints. Additional study should also include serial evaluations in those patients with evidence of pathology noted on the MRI when asymptomatic.

Our study is not without limitations. One potential limitation is selection bias due to our institution representing a specialized pediatric sports medicine and regional referral center. Our patient population has a greater number of high-level competitive athletes with more hours of play per week and greater years of sports participation than an average pediatric population participating in amateur sports. Consequently, our results could skew to a higher prevalence of pathology. The study population was also limited to parent-reported athletic activity which may not portray the average population. Another limitation was that there was no arthroscopic correlation to definitively verify the presence of the labral pathologies detected on MRI. MRI imaging is a snapshot in time, evaluating the patient in a static, non-weightbearing position. Therefore, our selection of diagnostic study may limit conclusions made about the temporal aspect of labral tears, and their potential for being a pain generator in the weightbearing position or during range of motion. Future studies may benefit from the addition of dynamic ultrasound as a diagnostic tool. Our study also did not evaluate or quantify underlying hip dysplasia which may predispose to labral pathology. The last limitation of the study was that the overall grade and classification of the detected labral tears were not assessed. It is certainly possible that particular morphologies and grades of labral tears are more prone to symptoms and may be more clinically relevant than others. This is an interesting question that may be addressed in future studies where a larger number of asymptomatic cohorts are available.

In conclusion, asymptomatic hip labral tears and cam lesions are present on MRI in a significant number of the physically active pediatric population. This is seen in patients with or without symptoms at similar rates. MRI is an invaluable tool to confirm the surgeon's suspected pathology and to detect extra-articular causes of hip pain that cannot be evaluated during arthroscopy. The presence of these pathologies on imaging does not guarantee that they are clinically significant or that surgery is warranted. It is always prudent to confirm the clinical significance of these

imaging abnormalities using history and clinical examination, diagnostic injection, physical therapy and conservative management, before considering surgery.

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