■ HIP

The prevalence of acetabular labral tears and associated pathology in a young asymptomatic population

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Acetabular labral tears and associated intra-articular pathology of the hip have been recognised as a source of symptoms. However, it is now appreciated that there is a relatively high prevalence of asymptomatic labral tears. In this study, 70 young asymptomatic adult volunteers with a mean age of 26 years (19 to 41) were recruited and underwent three tesla non-arthrographic MR scans. There were 47 women (67.1%) and 23 men (32.9%).

Labral tears were found in 27 volunteers (38.6%); these were an isolated finding in 16 (22.9%) and were associated with other intra-articular pathology in the remaining 11 (15.7%) volunteers. Furthermore, five (7.1%) had intra-articular pathology without an associated labral tear.

Given the high prevalence of labral pathology in the asymptomatic population, it is important to confirm that a patient's symptoms are due to the demonstrated abnormalities when considering surgery.

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The mechanism by which acetabular labral tears cause pain in the hip has become clearer with the development of improved CT, MR imaging, and arthroscopic techniques.[1-6] The aetiology, anatomy, and function of the labrum and labral tears have been well described.[7,8] Femoroacetabular impingement (FAI) as described by Ganz et al[9] has been shown to be associated with labral tears and chondral damage.[10-12] A number of investigators have suggested that if left untreated, labral tears can be the precursor of osteoarthritis.[13-15] Treatment by arthroscopic debridement or repair of labral tears and associated bony dysmorphism has been shown to be an effective treatment for pain associated with these abnormalities.[2,5,16,17]

As interest in labral pathology and FAI has increased, it has become apparent that labral tears and FAI are relatively prevalent in an asymptomatic population.[18,19] This has also been found in elite athletes playing high-demand sport in which impingement can arise, such as ice hockey.[20] The prevalence of asymptomatic labral pathology in young non-elite athletes remains unknown.

This study assessed this prevalence in asymptomatic young adult volunteers using a 3.0 Tesla (3-T) non-contrast MR scan. Our hypothesis was that symptomatic acetabular labral tears, with or without associated intra-articular pathology, are significantly prevalent in young normally active subjects. We believe that identifying the prevalence and epidemiological factors associated with abnormal intra-articular anatomy would allow a better understanding of this pathology and improve management.

Patients and Methods

Between January 2012 and June 2012, 70 volunteers were recruited from medical students and allied health professionals at Christchurch Hospital, New Zealand. Invitations to enrol in the study were sent by email and potential volunteers were required to complete a questionnaire as part of the inclusion and exclusion criteria (Fig. 1). The frequency and duration of any sporting or recreational activities undertaken in the past ten years were recorded, and these data were correlated with a modified University College Los Angeles Activity Level Scale (UCLAS),[21,22] (Table I) by the principal investigator (AJJL). The study had ethical approval and all volunteers gave informed consent.

The mean age of the volunteers was 26 years (19 to 41). There were 47 women (67.1%) and 23 men (32.9%). In all, 60 volunteers (85.7%) were of European ethnicity and the remainder were Oriental. The mean BMI was 23.5 kg/m^2 (17 to 32).

Clinical examination. Both hips of all volunteers were examined prior to MR scanning by

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Table I. Modified University College Los Angeles Activity Level Scale[21]

Level	Activity	Examples
1	Inactive	Wholly inactive. Dependent on others. Cannot leave residence
2		Mostly inactive. Restricted to minimum activities of daily living.
3	Mild activity	Sometimes participates in mild activities such as walking, limited housework and shopping.
4		Regularly participates in mild activities - *sedentary occupational work.*
5	Moderate activity	Sometimes in moderate activities such as swimming and can do unlimited housework or shopping.
6		Regularly participates in moderate activities - *light occupational work.*
7	Active	Regularly participates in active events such as bicycling, aqua aerobics, gardening or working out in the gym once or twice a week.
8	Very active	Regularly participates in very active events such as bowling, golf, riding, hunting. Aerobics, gardening or working out in the gym three times per week or more - *moderately heavy occupational work, farming*
9	Impact sports	Sometimes participates in impact sports such as running, jogging, tennis, cricket, baseball ,rugby, football, hockey, racquet sports, judo, karate and other martial arts, skiing, acrobatics, ballet dancing, backpacking and mountaineering - *heavy occupational work.*
10		Regularly participates in impact sports as described above.

Research questionnaire

1. Have you had any problems with your hips as a child requiring bracing, splinting or casting that you are aware of?

2. Have you ever had any form of treatment for previous hip injury, including physiotherapy, acupuncture, chiropractic manipulation or surgery?

3. Have you suffered from fracture or dislocations of your hip joint?

4. Have you ever been told that you have Perthe's disease/developmental dysplasia or slipped upper femoral epiphysis of your hip?

5. Do you have any current undiagnosed hip pain/catching/locking/instability/crepitus?

6. Do you suffer from claustrophobia (MRI machine is a bit of a tight donut and some find the enclosed space difficult)?

7. Are you currently pregnant or trying to get pregnant?

8. Do you have any metal objects in your body i.e. cochlear implants, cardiac pacemakers, metal foreign body in the eye, neuro-electrical stimulators and/or cerebral aneurysm clips?

9 Have you ever had an operation on your hip?

Regular recreation/sporting activities (please state all activities including those in the past):

Type				
Period / duration				
Average hours per week				

Fig. 1

Screening questionnaire showing the inclusion/exclusion criteria and table for activity analysis.

the principal investigator (AJJL), to reduce observer bias. All examinations were performed prior to analysis of the level of activity. Flexion, extension, abduction, adduction and rotation were measured using a goniometer. Additional tests included an anterior impingement test (passive flexion beyond 90° combined with internal rotation and adduction), a posterior impingement test (external rotation with the hip in extension and abduction) and a FABER test (flexion, abduction and external rotation). These tests were considered positive if they elicited reproducible pain in the groin.

Radiological assessment. In order to reduce selection bias, the results of the MR scans were not offered to the volunteers, and the side chosen for investigation was determined by random number allocation. All volunteers underwent MR scanning of their allocated hip.

Two senior radiologists with musculoskeletal fellowship training interpreted all imaging (MHC, ACLK). If there was a disagreement between the radiologists concerning the presence or absence of a labral tear or other associated pathology, a third post fellowship trained musculoskeletal radiologist also interpreted the images and provided an opinion. The labrum was assessed using validated criteria,[1,23] and was classified as follows:

- Normal – triangular, homogenous, low signal intensity.
- Torn – high signal abnormality extending into the substance or at the base of the labrum, with or without change in shape.

Table II. Reliability of the anterior impingement and flexion, abduction and external rotation (FABER) tests to identify MRI proven labral tears

Anterior impingement			**FABER**		
	Tear	**No tear**		**Tear**	**No tear**
Positive test	4	4	Positive test	4	2
Negative test	23	39	Negative test	23	41
Sensitivity (%)	*14.8* (4/27)		Sensitivity (%)	*14.8* (4/27)	
Specificity (%)	*90.7* (39/43)		Specificity (%)	*95.4* (41/43)	

- Normal variant recess – well defined linear signal abnormality at the labral base/cleft at the antero-inferior or inferior position without fraying or change in shape.

- Labral ossification – bone marrow, signal intensity extending into the substance of the acetabular labrum.

The radiologists were also asked to comment on other intra-articular pathology, including cysts, chondral delamination and osseous abnormalities (features associated with FAI). The alpha angle,[24,25] the acetabular version and presence or absence of coxa profunda were assessed, as described by Kang et al.[19]

Imaging. Imaging was performed on a 3-T system (Signa Excite HDXT Version 16 software, GE Medical systems, Milwaukee, Wisconsin). Volunteers were positioned supine, with the leg in the neutral position. The following sequences were used: Axial Proton Density with chemical fat saturation in the orthogonal plane 4 mm slice with 0.5 mm interslice gap. Frequency Phase matrix of 288 / 288 with a 240 mm FOV (TR 2900 TE 32 ETL 10 Nex 1); axial oblique Proton density parallel to the femoral neck 3 mm slice with 0.3 mm interslice gap. Frequency Phase matrix of 288 / 288 with a 200 mm FOV (TR 2900 TE 42 ETL 12 Nex 2); coronal oblique Proton density with chemical fat saturation 4 mm slice with 0.5 mm interslice gap. Frequency Phase matrix of 288 / 288 with a 200 mm FOV (TR 2500 TE 32 ETL 10 Nex 2.); coronal oblique Proton density 4 mm slice with 0.5 mm interslice gap. Frequency Phase matrix of 288 / 288 with a 200 mm FOV (TR 2500 TE 32 ETL 10 Nex 2); sagittal oblique Proton density with chemical fat saturation 4 mm slice with 0.5 mm interslice gap. Frequency Phase matrix of 288 / 288 with a 200 mm FOV (TR 2500 TE 32 ETL 10 Nex 2); and sagittal oblique Proton density 4 mm slice with 0.5 mm interslice gap. Frequency Phase matrix of 288 / 288 with a 200 mm FOV (TR 2500 TE 42 ETL 10 Nex 2).

Statistical analysis. Data were entered into Access (Microsoft, Redmond, Washington). Anonymised datasets were cleaned and analysed using Stata version 12 software (StataCorp., College Station, Texas). Data were described using: means and standard deviations (SD) if parametric; medians and interquartile ranges if non-parametric; and proportions and percentages if categorical. Comparisons between groups were performed using the Student's *t*-test, Mann–Whitney U test or Pearson's chi-squared test (or where expected values were low, Fisher's Exact test) respectively. Possible associations were explored by calculating odds ratios (OR) with 95% confidence intervals (CI). A p-value < 0.05 was considered statistically significant.

Results

Demographics. A total of 27 volunteers (38.6%) had a labral tear; 16 (22.9%) of these did not have other associated intra-articular abnormality. The median age for those with a tear was slightly higher than those without a tear (26.6, IQR 24.4 to 28.8 *vs* 24.7 years, IQR 22.2 to 26.8, respectively; p = 0.047, Mann–Whitney U test). There was no difference in the prevalence of tears between males and females or in ethnicity (p = 0.56 and p = 0.55, respectively, chi-squared test). A total of 10 of 22 volunteers (45%) with a BMI ≥ 25 kg/m^2 had a tear. And 17 of 47 volunteers (35%) with a BMI < 25 kg/m^2 had a tear. However, this difference was not statistically significant (p = 0.42, chi-squared). A total of 49 volunteers (70%) had a UCLAS score of nine or ten. In univariable analysis, increasing UCLAS score was not associated with increased risk of tear (OR 1.1, 95% CI 0.83 to 1.51).

Clinical findings. There was no statistical difference in the mean range of movement (ROM) in any direction between those with and those without a labral tear. In those with a tear, there was no statistical difference in the mean ROM between both hips in each volunteer. A total of eight volunteers (11.4%) had a positive anterior impingement test and six (8.6%) had a positive FABER test. (Table II). None had a positive posterior impingement sign. The positive and negative predictive values of the anterior impingement test were 50.0% (4/8) and 62.9% (39/62), respectively, and for the FABER test were 66.6% (4/6) and 64.1% (41/64), respectively.

Radiological findings. There was a 98.6% interobserver agreement between the two radiologists (Kappa 0.97, 95% CI 0.91 to 1.00). A total of two labral tears were in an anterior location, whilst the remaining 25 were in an anterosuperior position. Sublabral recesses were identified in ten volunteers (14.3%). Other associated intra-articular abnormalities were identified in 11 volunteers (15.7%). A total of ten (14.3%) had labral ossification, five of whom also had a labral tear. A paralabral cyst was identified in one volunteer who had an extensive anterosuperior labral tear. Acetabular chondral delamination was identified in seven volunteers (10.0%), all of whom had a labral tear. Fibrocystic changes at the head-neck junction were found in four volunteers (5.7%). Overall, 32 (45.7%) had some

intra-articular pathology, with or without a labral tear. There was a strong association of labral tears with intra-articular pathology, compared with those without intra-articular pathology (90.9% *vs* 28.8%, respectively; $p < 0.001$, chi-squared).

The mean alpha angle in those with a tear seemed higher than in those without a tear (57.8°, 95% CI 54.4 to 61.1 *vs* 54.0°, 95% CI 51.6 to 56.4, respectively; $p = 0.058$, Student's *t*-test). There was no difference in the mean acetabular anteversion between those with and those without a tear (17.7° *vs* 17.3°, 95% CI 15.8 to 18.9 respectively; $p = 0.73$, Student's *t*-test). Coxa profunda was not identified in any volunteer.

Discussion

We found a prevalence of labral tears of 38.6%, and a total prevalence of intra-articular pathology of 45.7%. There was a trend towards a higher mean alpha angle in those with a tear, and the locations of the labral tears were consistent with those of Tamura et al,[6] who found that labral tears most often occurred at the anterior and anterosuperior aspects of the acetabulum in patients with FAI.

The prevalence of labral tears and associated intra-articular pathology in this study was less than that reported by Register et al.[18] The mean age of our volunteers was much younger, which may explain this discrepancy. The prevalence of labral tears in asymptomatic military personnel and professional/collegiate level ice hockey players has been reported to be 85.7%[20] and 56%,[26] respectively. However, the subjects in these studies were not representative of the general population, being focussed on groups with specific levels of activity and behaviour. It is well-recognised that ice hockey in particular, is a potent cause of hip pathology.[20,27] The strength of our study is that it looks at a group of recreationally active, asymptomatic young adults, making it applicable to a wider range of the population.

There was no difference in the mean ROM between those with and those without a labral tear, and no difference in side-to-side ROM in those with a labral tear. This is not surprising, as the volunteers were asymptomatic and had no evidence of diffuse articular cartilage degeneration. To our knowledge, this study is the first to examine the relationship between special clinical tests (anterior impingement, posterior impingement and FABER) and asymptomatic acetabular labral tears. Our findings support those of Narvani et al,[28] who showed limited usefulness of the anterior impingement test in symptomatic patients with labral tears identified on MR arthrography (sensitivity 75%; specificity 43%). However, other authors have reported a sensitivity of up to 100% for the anterior impingement test in those undergoing surgery for a labral tear.[29,30] It can be suggested that these special tests have limited reliability and validity, especially in isolation, and must be interpreted cautiously in conjunction with the patient's history and imaging.

One concerning aspect of this study is the young age and prevalence at which these abnormalities have been identified. The long-term implications of these findings remain unknown, but several authors have suggested that the presence of a labral tear and bony abnormalities are precursors of osteoarthritis.[10,13,31] Bony abnormalities, such as cam or pincer deformities, have been shown in asymptomatic children as young as ten years of age,[32] and it has been suggested that excessive sporting activity in the skeletally immature may be a contributing factor.[33] Likewise, repetitive impingement is cited as a major cause of labral tears.[9,34,35] The volunteers in our study did not, however, have a history of an excessive sporting participation during adolescence or in young adulthood. Furthermore, the UCLAS did not confirm an increased association of labral tears with an increasing level of activity. This would suggest that limiting sporting activity would not prevent the development of labral pathology.

A potential limitation of this study was the use of non-contrast MR scan as the method for establishing the diagnosis. The use of gadolinium enhancement may have increased the accuracy of the findings, but this would not have been ethically justifiable. However, since the addition of contrast is used to assist in defining labral tears,[36] its use in our study would, in all probability, have increased the rate of diagnosis of pathology therefore strengthening, rather than weakening, the results of our investigation.

It could also be argued that this group of volunteers is not representative of the population at large, as young health professionals in training, with a high level of physical activity, in that 70% had a UCLAS of nine or ten. However, none of them was a professional athlete and none performed their chosen sports at an elite level. Neither does it seem likely that educational level has any influence on the prevalence of hip pathology.

Many questions remain unanswered. While there has been well documented evidence that labral tears are associated with FAI,[9,34,35,37] there were 16 volunteers in this study with a labral tear who had no anatomical abnormality. In addition, there was no history of trauma and only recreational sporting involvement. The following questions arise: what causes the labral pathology? Are these truly pathological findings or do they represent a normal variant? Will the tears have long-term consequences? Our intention is to follow this cohort longitudinally, to demonstrate the natural history and establish whether isolated labral tears are in fact a precursor to osteoarthritis of the hip.

The clinical relevance of these findings lies in the potentially asymptomatic nature of intra-articular pathology of the hip. In a patient presenting with pain in the groin or buttock, how does one ascertain that the pain is indeed arising from the demonstrated abnormalities? Clinical examination and added investigations such as intra-articular local anaesthetic infiltration may help improve the diagnostic accuracy.[16,38,39] It can be concluded that symptoms in a young patient complaining of pain in the hip cannot

automatically be attributed to a labral tear or associated MRI findings. Ultimately the decision to treat the patient with labral pathology must be based on the combination of symptoms, findings on examination and investigations. The decision to treat should not be based on the presence of a labral tear on MR scanning alone.

Supplementary material

A table showing no statistical difference in the mean range of movement (confidence interval) in any direction between those with and those without a labral tear is available alongside the online version of this article at www.bjj.boneandjoint.org.uk

Author contributions:
A. J. J. Lee: Study design, Data collection, Writing the paper.
P. Armour: Study design, Supervision, Writing the paper.
D. Thind: Statistician, Data collection, Data analysis, Writing the paper.
M. H. Coates: Data collection, interpreting MRI.
A. C. L. Kang: Data collection, interpreting MRI.

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