TITLE

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JOURNAL

Journal of Science and Medicine in Sport

DATE DEPOSITED

29 November 2017

This version available at

95% prevalence of abnormality on hip MRI in elite academy level rugby union: A clinical and imaging study of hip disorders

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Abstract

Objectives To identify the prevalence of hip disorders in elite level academy rugby union players using clinical and radiological investigation comparing findings to active controls.

Design Cross-sectional, controlled study.

Methods Participants were assessed clinically using validated questionnaire (HAGOS) and physical testing procedures. Active ROM of all hip movements were measured using a goniometer and hip-specific clinical tests including the FABER and the Thomas test examined functional hip motion. Physical tests were compared to age, gender and activity matched controls. The rugby-playing participants underwent dedicated non-arthrographic 3 T MRI imaging of the hip in axial oblique, sagittal and coronal planes to assess anatomical abnormality.

Results The rugby cohort had significantly reduced ROM of internal/external rotation, extension and FABER scores compared to the controls. Symptoms were reported by 65% of rugby players (HAGOS symptom score <89.3) versus 15% in controls. There was a 95% prevalence of abnormality on MRI (19 of 20 players); 80% of the elite rugby players had labral pathology, 55% had a cam deformity (45% left sided 30% right-sided) and 25% had either unilateral or bilateral chondral wear.

Conclusions The prevalence of abnormality on MRI of the hip is high in rugby players at 95% of study participants. The percentage reporting symptoms was lower at 65% of the cohort although this was significantly higher than (non-rugby) matched controls at 15% of participants. Rugby players demonstrated significantly reduced ROM of the hip compared to controls. Further prospective research is required to investigate the long term sequelae of these findings.

Keywords Rugby, Hip injury, Radiology

Introduction

Rugby Union is a physical sport with a high incidence of injury (91/1000 h) and Brooks et al. demonstrated that in male rugby players, groin and hip pathology accounted for 3.8 injuries/1000 h, resulting in an average 19 days lost from training and matches.[1]Research identifies Femoral Acetabular Impingement (FAI) and labral pathology as common problems in the sporting population[2,3].

There are two types of FAI: ‘cam’ and ‘pincer’. In cam impingement, an osseous bump forms on the femoral head–neck junction and causes abnormal contact with the joint and acetabular rim.[4,5] Cam deformities are more common in young male athletes.[6]Pincer defect refers to acetabular over-coverage of the femoral head with a retroverted acetabulum causing abutment of the femoral neck and compression of the labrum when at end range positions.[5,7] This leads to pathological changes resulting in labral tears and articular cartilage lesions. The labrum is most often disrupted in cases of FAI.[8] The labrum provides stability through its seal on the joint and maintains negative pressure and proprioceptive feedback as well as providing a barrier for the articular fluid to be maintained within the joint.[9,10] It has been proposed the loss of the integrity of the labrum can increase joint stresses by 92%.[11]Despite being a relatively newly recognized condition, it is believed to be a cause of osteoarthritis of the hip.[5,12,13]

Screening of the athlete may identify signs consistent with FAI and those at risk of chondrolabral damage. Clinical tests that examine hip range of movement are useful in identifying risk for hip and groin pathology; players with reduced hip rotation are more at risk of developing chronic pathology in the forthcoming season.

Methods

Twenty members of the Rugby Academy of an Irish Provincial team were invited and agreed to take part in the study. The control participants were individuals who were at least moderately active (as determined by the BAECKE questionnaire[16]), who were not involved in contact sport. Each player was age and gender matched with a member of the control group. Participants were excluded if they had previous hip surgery, or reported previous hip, groin or lumbar spine pathology within the previous six months. All participants gave written informed consent to be involved in the study, after receiving a written explanation of the study objectives, including information on the potential risks and benefits. The local Ethics Committee granted ethical approval for the study.

All participants were clinically tested in a single session by the primary investigator with over 17 years experience and by a final year physiotherapy student. The test participant group was tested on the day of their imaging. They also completed the HAGOS questionnaire. The HAGOS is valid[17] and reliable[18] consisting of six separate subscales, assessing pain, symptoms, physical function in daily living, physical function in sport and recreation, participation in physical activities and hip and/or groin-related quality of life.

A Universal Goniometer (UG) was used to measure hip ROM with all subjects. No practise or warm up was performed prior to measurements. The UG is a valid and reliable tool showing good to excellent ICCS when one examiner is used[19]; assessments were conducted in the order suggested by Clarkson.[20] Range of movement deficits are common in FAI,[21] therefore, external rotation and internal rotation were measured as outlined. Special tests that attempt to replicate the primary mechanism of labral tears namely flexion and rotation are most favoured. The Thomas test has shown good diagnostic accuracy for FAI.[20] FABER is a useful test in differential diagnosis of hip pathology.[22] All tests were performed in supine except for extension, which was conducted in prone. Hip internal and external rotation where the motion is conducted in the same plane, were measured consecutively. Hip flexion, was measured with the knee fully flexed; internal-external rotation, FABER, Thomas Test and hip extension were measured with the knee at 90° flexion. Measurements were noted as positive for Thomas Test if they were above 0° (more flexed than neutral position) and negative if they fell below the horizontal position (more extended than neutral position). The mean of three measurements was calculated and recorded.

The test participants underwent dedicated non-arthrographic 3 T MRI imaging of the hip in axial oblique, sagittal and coronal plains. The images were independently assessed for abnormality in a number of anatomical areas namely:

(1) Presence of a bony prominence at the femoral head/neck junction.

(2) Oedema and cystic change at the femoral head neck/neck junction.

(3) Alpha angle of the femoral head/neck junction.

(4) Labral tearing and the site of tearing.

(5) Defects in the articular cartilage.

(6) Subchondral oedema and cystic change in the acetabulum and femoral head.

Using the method of Nötzli et al.[23] alpha angle was determined at two positions along the femoral head-neck junction, anterior and superior (at 3.00 and 1.30 clock face positions). The first arm of the angle was the long axis of the femoral neck defined as a line drawn between the centre of the femoral neck at its lowest point and the centre of the circle. The second arm of the angle was drawn from the centre of the circle anteriorly to the point where the femoral head extended beyond the margin of the circle. A value of greater than or equal to 50.5° at the 3.00 position was defined as the gold standard as indicative of a head neck junction consistent with a cam deformity.[24–26]

Images were independently reviewed by two experienced musculoskeletal radiologists (BH, FMcG) who were blinded to any clinical details of participants. In the case of disagreement, the images were reviewed by a third experienced musculoskeletal radiologist (ML). Intraobserver agreement with this method was 85%.[14,15]Screening involving MRI and clinical tests of range of motion can identify those with signs consistent with FAI and at risk of chondrolabral damage.

While optimal identification of hip disorders is with the use of imaging such as MRI, the use of clinical testing is more widely used and more economical. Furthermore, a hip disorder is characterized initially by pain and dysfunction; such findings do not always correlate with radiological findings, may be more important and should always pre-empt radiological investigation.

Thus, the aim of this study was to identify the prevalence of hip pathology on imaging in elite level Academy Rugby Union players using clinical and radiological investigation. Objectives were to establish the association between clinical and radiological investigation and to compare prevalence and clinical findings to moderately active controls.

Results

The demographic data for the two groups are shown in Table 1. The groups were not significantly different in terms of their heights, but the rugby players were significantly heavier than the control group (mean difference 21 kg heavier). All players had a minimum of 10 experience of playing rugby through schoolboy and club structures.

The results for the clinical tests for the two groups are shown in Table 2. There were significant differences for both left and right hips on the internal rotation test, external rotation test and extension tests. In each case the control group scored higher. Similarly, there was a significant difference for FABER distance scores, with the rugby players recording higher values thus having a significantly reduced available range. For HAGOS scores, only the symptom score was significantly different between the two groups, with rugby players scoring a mean of 9 points lower than the control group.

There was a 95% prevalence of abnormality on MRI (19 of 20 players presenting with some pathology). In total, 80% of the elite rugby players had labral pathology on MRI, and 25% had either unilateral or bilateral chondral wear. MRI findings (Table 3) revealed that 45% (9/20) (95% CI 24–68) of players had a head and neck deformity of the femur to either the left or right side, while nearly a third (30%) had deformities to both. Alpha angle was greater than 50.5° in nine of 20 players (45%, 95% CI 26–68) on the left side and in six players (30%, 95% CI 11–58) on the right side and thus a cam defect was observed in 55% of players overall (95% CI 30–78). Six players (30%, 95% CI 11–58) had the condition in both hips. The mean Alpha angle of the right hip was 49.5 (12.2)° and the mean left Alpha angle was 52.3 (11.7)°. Chondral wear was detected in 15% (3/20) on the left (95% CI 4–48) and 15% (95% CI 4–48) of players on the right. And 5% had bilateral chondral wear.

When clinical tests were correlated with MRI findings, there was a difference in right side FABER test score for those who had a normal left labral (24.6 cm (3.29)) and those who had an abnormal reading (28.4 cm (3.5)) (mean difference −3.8, −7.55 to −0.05, $t = -2.13$, $df = 18$, $p = 0.047$). There were also differences in both left and right FABER scores for those who exhibited a right labral tear and those who did not (Right: mean difference −4.35, −8.08 to −0.62, $t = -2.49$, $df = 18$, $p = 0.025$. Left: mean difference −3.6, −6.76 to −0.44, $t = -2.39$, $df = 18$, $p = 0.028$) It was also found that there was a difference in the right alpha angle of those who had right cam defect and those who did not (mean difference −5.27, −9.4 to −1.15, $df = 18$, $p = 0.15$).

Discussion

This study shows that the overall prevalence of hip pathology on imaging is high in elite academy rugby players (95% of participants). However, when cam-defect only is compared, this study reported a 55% prevalence which compares to similar study in soccer[27] which showed a prevalence of abnormal MRI findings at 62%(13/21) of the cohort. A recent study in hockey showed a 64% (25/39) prevalence of imaging abnormality in elite and sub-elite hockey players of a similar age and playing profile to the cohort in this study.[28] This suggests that the prevalence of abnormal MRI findings of the hip in rugby is similar (when cam defects alone are compared) to other sports with similar activity profiles. Nepple et al.[29] reported mean values of 17% prevalence for male controls and 41% for those involved in high-impact sports; this indicates that rugby has a higher prevalence than many other sports of similar activity profiles.

The HAGOS sub-scale symptom scores reported by the rugby playing cohort had a mean of 80.3/100, which was statistically different to the age matched controls. Without having a comparison for rugby players, Thorburg et al. reported a normative symptom score of less than 89.3/100 in asymptomatic soccer players.[30] So, the rugby cohort reported a high level of hip symptoms compared to the control cohort who were within the normative range when compared to the Thorborg study. Further examination reveals that 13 of the 20 (65%) rugby players had a symptom score less than 89.3 versus 15% (3/20) in the moderately active controls. It is not possible to determine if these symptom scores are a true reflection of prevalence of abnormality or as a result of the training load of the rugby players at the time of completion of the questionnaire. Testing was done in-season and could be symptomatic of post game symptoms which are a significant factor involved in post game recovery in collision sports. A better indicator of pathology or symptoms may be the pain section of the questionnaire as it is somewhat reflective of longer term symptoms. There was no statistical difference between the elite playing group and the age matched controls for this section of the questionnaire. As competitive rugby games are associated with transient, non specific, post-game soreness, further research is required at baseline or out of the competitive season to determine a true prevalence of abnormality. Furthermore, adaptations of the HAGOS for the game of rugby could better capture symptoms not directly associated with a period of competitive contact.

On clinical range of motion testing, there was a significant difference between the rugby and control cohort in a number of tests: internal rotation; external rotation; hip extension; and the FABER test. The rugby participants produced significantly lower mean scores demonstrating decreased motion in a number of hip movements. Normal hip range for a cohort of this age is documented to be between 32–34°IR and 33–35°ER,[31] similar to the non-elite age matched cohort of this study. Decreased hip ROM is a significant predictor of future hip injury in Australian Rules Football; hip stiffness is associated with later development of chronic groin injury and as such may be a risk factor for this condition.[15] There have been no previously published studies documenting normative hip rotation values for elite rugby players. Reduction in range could be the result of the demands of twisting, turning and use of weights to increase body mass leading to stress and inflammatory changes to the hip capsule and ligaments as proposed by Verrall et al.[15] FAI is proposed to be a slow development disorder of the hip joint[5] and thus further prospective studies are warranted in this population to investigate both the predictive nature of clinical tests and also to examine long term sequelae of hip range changes.

MRI reported the prevalence of acetabular labral tears in this study at 80% of the cohort. The findings of this study would support the hypothesis that acetabular labral tears are frequently asymptomatic and are part of a normal degenerative process,[32] although there has been shown to be an increased prevalence in sports that involve repetitive twisting and turning.[3] Prevalence of labral tears have been reported at 56% (22/39) in professional hockey.[28] In this rugby cohort, 55% had an alpha angle greater than 50.5°, this compares with reports of 62.5% in soccer[33] and 56% in elite ice hockey[34] but is higher than reported in hockey players by Silvis et al. at 39% (15/39).[28] In agreement with the current findings, Silvis et al. report a lack of symptoms despite a high prevalence of MRI findings. The MRI readings may overestimate the actual prevalence of labral injury with false-positives when compared to the gold standard of arthroscopy and magnetic resonance arthrography. Unlike previous studies, this study used coronal images and reported chondral wear in 25% of the subjects. There is moderate evidence linking increased alpha angle with the progression of FAI, but this should be interpreted with patient history and clinical examination.[35] While there is a lack of clarity regarding the exact mechanism of the effect of high-impact activity on the head–neck junction and subsequent development of pathology, a recent systematic review concluded that 'males participating in specific high level impact sports are at an increased risk of physeal abnormalities of the anterosuperior head–neck junction that result in a cam deformity at skeletal maturity'.[29] The same study reported that high level athletes are 1.9–8 times more likely to develop a cam deformity than male controls and mean prevalence of cam deformity in this group is 41% (cf 17% in controls) which is somewhat lower than our finding of 55%.

It has been well documented that pathological findings are often visualised on magnetic resonance imaging of the lumbar spine despite a lack of clinical signs or symptoms.[36] The interpretation of these high imaging abnormalities must be treated with caution. MRI may detect the result of cumulative trauma and overuse and not demonstrate the acute symptoms.[28] A recent systematic review of FAI studies concludes that there is a lack of available evidence to support a case for intervention by surgical means in asymptomatic patients.[37] There is a lack of clarity surrounding the definition of FAI and what defines progression of the syndrome.[35]

The diagnosis of hip pathology can be challenging due to the complex mechanics. This study found correlation between right FABER and left labral tear and right and left FABER and right labral tear; the reasons for this are unclear as FABER is not defined as a test to predict labral tears. The numbers however are low in this current study and results should be interpreted with caution.

There are some limitations to this study. Magnetic Resononce Arthography would be the investigation of choice for intra-articular hip pathology and thus the findings should not be compared to studies that use MRA. However, it would not be deemed appropriate to use intra-articular contrast for screening and the benefit of 3 T MRI is that, it is possible to identify impingement and labral pathology in most cases. This study was limited to a sample size of 20 male academy rugby players, therefore the results cannot be extrapolated to other sports. The sample involved players that were in search of professional contracts and although informed consent was gained and anonymity was given there may have been an under-reporting of symptoms.

The 95% prevalence of imaging abnormality was very high in this cohort; this is difficult to compare to other sports as previous studies have reported cam defects only. However, range of movement scores were similar to other elite athletes in AFL. HAGOS Pain scores were also similar to controls. Prospective cohort studies are needed to follow up to investigate if pathology visualised on MRI predicts future abnormality in a rugby population. This study did not account for exposure which could account for lower symptom scores and should be considered in future studies. Further study and monitoring of these players is essential to identify the significance of these imaging abnormalities in predicting future injury and post sporting retirement disability. FAI is a complex pathology and a detailed subjective examination with pertinent objective test and special tests are vital in conjunction with imaging. Special tests for FAI were not conducted on this rugby cohort and this is a flaw of the study, however the intention of the study was not to be a clinical investigation into FAI therefore special tests for FAI diagnosis were not used. It was the intention to assess the available hip mobility in this group of athletes and compare to age matched controls. It was demonstrated that the available range is significantly reduced in the rugby cohort. This has significance in behaviour modification in these athletes. Specifically, the management of these athletes training protocols, reducing exposure to end range positions under load, which may further wear and stress the hip joint and in the interpretation of normal daily monitoring and screening scores for mobility in this athletic population.

This study did not investigate the presence of pincer defect in this cohort. This is in line with the majority of other published studies and reflects that there is a lack of a valid and reliable measurement method at this time for MRI evaluation. However as FAI often presents as a mixed presentation, this is a limitation of the study and should be considered in future.

Practical Implications

- High prevalence of abnormality on MRI examination is unlikely to consistently correlate with symptoms; diagnosis of hip disorders in athletes should be made with a comprehensive battery of both clinical and radiological testing.

- Rugby players in this cohort presented with significantly decreased hip ROM compared to controls. As reduced range of motion of the hip is predictive of future morbidity, regular screening and longitudinal studies are required to examine long term effects on hip health in this sport.

- FABER scores were the only clinical test to correlate with MRI findings. Further research is required to design a comprehensive testing battery to diagnose hip disorders accurately and predict future injury.
- The findings of this study indicate that the prevalence of hip disorders in Rugby Union is much higher than previously reported and the reasons behind this warrant further investigation.

Acknowledgements

No grants, financial support or technical (or other) assistance were received for this study. The authors would like to thank the athletes for their participation in this project.

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Table 1. Demographic data of the study groups.

	Rugby players (n =20)	Controls (n=20)	P
Age (yr)	22±1.5	21.3±1.7	0.169
Mass (kg)	102.7±11.4	80.8±13.5	0.0001
Height (m)	1.9±0.1	1.8±0.08	0.3
Years playing	12.1±3.0	--	--

Table 2. Clinical tests for the two groups.

	Rugby (n=20) Mean±sd	Control (n=20) Mean±sd	Mean difference	P	95% CI
Right					
Prone Internal Rotation	25.7±6.8	35.6±7.2	-9.98	0.001	-14.5 to -5.5
Prone External Rotation	27.1±6.5	52.8±14.5	-25.73	0.001	-32.9 to -18.5
Prone Extension	11.0±4.0	15.2±2.7	-4.18	0.001	-6.4 to -2.0
Thomas Test	-1.0±5.4	-2.2±6.6	1.23	0.519	-2.6 to -5.1
FABER Distance	26.7±4.5	11.4±6.8	15.32	0.001	11.6 to 19.0
Flexion	108.2±5.8	110.3±7.3	-2.05	0.332	-6.3 to 2.2
Left					
Prone Internal Rotation	26.2±6.8	38.9±9.3	-12.65	0.001	-17.9 to – 7.4
Prone External Rotation	29.5±7.3	50.6±12.1	-21.13	0.001	-27.5 to 14.7
Prone Extension	9.5±3.8	15.5±3.7	-6.00	0.001	-8.4 to 3.6
Thomas Test	-1.1±6.0	-1.4±5.8	0.32	0.866	-3.5 to 4.1
FABER Distance	27.5±3.8	12.2±6.4	15.21	0.001	11.9 to 18.6
Flexion	107.6±5.6	107.8±7.0	-0.20	0.921	-4.3 to 3.9
HAGOS					
Symptoms	80.3±13.6	89.5±13.2	-9.19	0.037	-17.8 to 0.6
Pain	95.0±4.9	96.1±7.7	-1.13	0.585	-5.3 to 3.0
ADLs	97.4±4.4	98.0±4.0	-0.62	0.647	-3.3 to 2.1
Sport/Rec	86.9±8.0	92.3±11.5	-5.44	0.091	-11.8 to 0.9
Physical Activity	92.3±15.0	93.1±11.1	-0.86	0.837	-9.3 to 7.6
QOL	85.7±14.2	93.3±11.8	-7.54	0.076	-15.9 to 0.8

Table 3. MRI finding in rugby players (n = 20).

	Left		Right		Both sides	
	%	95% CI	%	95% CI	%	95% CI
Head & Neck	45	26 to 66	45	26 to 66	30	13 to 54
Alpha Angle	45	26 to 20	30	13 to 54	20	7 to 44
Labrum	75	51 to 90	50	30 to 70	40	20 to 64
Chondral surface	15	4 to 48	15	4 to 48	5	0.3 to 27
CAM	50	30 to 70	35	16 to 59	25	1 to 49