ACETABULAR VERSION INCREASES DURING ADOLESCENCE SECONDARY TO A REDUCTION IN ANTERIOR FEMORAL HEAD COVERAGE

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The understanding of the underlying mechanisms leading to FAI continues to evolve; it is evident that both the femoral (cam, retroversion) and acetabular (pincer, retroversion) anatomy may contribute to its development. Several studies have demonstrated the development of cam morphology during the growing years of the skeleton and its association with increased activity during the adolescence years. However, considerably less is known about the development of the acetabulum and what changes occur during the adolescent years, which appear to be the key developmental stage.

Retrospective cross-sectional studies derived from CT-data (hence missing cartilaginous portions of the growing skeleton) noted that acetabular version increased with skeletal maturity – the authors noted that the posterior rim increased however recognised that this may have to do with the inability to detect the cartilage posteriorly. A recent MRI-based study, with MRIs performed at the 1-year interval of various developmental stages, showed that the acetabular version increases around adolescence, but did not identify how this may occur. Furthermore, none of the above studies accounted for the individual demographic data, the individual’s physical activity, or the femoral-sided anatomy.

The aims of this prospective longitudinal study were to determine how 1. Acetabular version and 2. Coverage to the femoral head the acetabulum provides change during the adolescent years. Furthermore, we aimed to determine whether patient factors (BMI, activity levels) or the femoral-sided anatomy contribute to any of the changes observed.

METHODS

19 volunteers (38 hips) were recruited. The mean age of the cohort was 10.5±1.3 years old and 10 patients were female (52%). The volunteers underwent clinical examination (BMI, range of movement assessment) and a MRI scan of both hips. All participants presented for further clinical examination of both hips and a second MRI scan at an interval of 6 ± 2 years. The mean age at follow-up was 16.6 ±1.3. At the follow-up visit, volunteers were also asked to fill in the HSS Pediatric Functional Activity Brief Scale (Pedi-FABS) questionnaire, which reflects the level of physical activity of each volunteer.

Assessments of MRI included the status of the tri-radiate cartilage complex (TCC) (Oxford Classification I – III: open – closed), the acetabular anteversion angle at various levels in the axial plane [5mm below the roof (top), at the middle of the femoral head (middle) and 3 equidistant slices in-between top and middle]. We measured three acetabular sector angles (anteriorly, posteriorly and superiorly) at the middle of the femoral head, reflecting degree of femoral head coverage by the acetabulum. Alpha angles anteriorly and antero-laterally were determined for each hip for each time-point.

Outcome measures included how the anteversion changed at each of the five levels and the mean change overall. We also determined how the sector angles changed over time anteriorly, posteriorly and superiorly. Change in anteversion and sector angles were influenced by the BMI, range of movement measurements, the Pedi-FABS or the alpha angle measurements.
RESULTS
At the baseline MRI, all hips had a Grade I (open) TCC; the TCC was Grade III (closed) by follow-up MRI in all of the hips. The acetabular anteversion increased moving, caudally, further away from the roof for both time-points (Figure 1). The mean anteversion increased from a mean of 7.4°±3.8 (initial) to 12.2°±4 (follow-up) (p<0.001). The increase in anteversion was 4.7° (range: 0 – 9). The increase in version occurred along all slices, but was greater at the rostral ¼ of the acetabulum (slices 1 and 2); 8/38 the hips had retroversion of the rostral ¼ of the acetabulum at the initial scan, whilst none of the hips had retroversion at follow-up. Females had greater anteversion than males (13.2° Vs 10.6°, p=0.04), however the change that occurred between scans was the same (4.6° Vs 5.0°; p=0.9).

The anterior sector angle reduced from 72°±8 to 65°±8 (p=0.002); the posterior sector angle remained unchanged (98°±5° Vs. 97°±5) (p=0.8), whilst the superior sector angle slightly increased from 121°±4 to 124°±5° (p=0.007). The change in the anterior sector angle correlated with the change in version (rho=0.5, p=0.02).

The change in version did not correlate with BMI, ROM, Pedi-FABS score or the measured alpha angles of the hip (p=0.1 – 0.6).

DISCUSSION
The native acetabulum orientation changes around adolescence, with the version significantly increasing. The version increases as a result of a reduction of the femoral head coverage anteriorly (rather than an increase in posterior femoral head coverage). Therefore, if the normal developmental change did not occur, the associated retroversion would be related to anterior wall over-coverage rather than posterior deficiency. We identified no patient factors (BMI, activity level, range of movement) or proximal femoral anatomical factors (alpha angles) that were associated with this change. The increase in acetabular version may be related with the reduction in femoral version that occurs over the same period and hence further study is necessary.

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