CAM-type femoroacetabular impingement in male elite junior cross-country skiers and non-athlete controls: a cross-sectional MRI study

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ABSTRACT

Objectives Cross-country (CC) skiing consists of two main techniques: classic and skating. Hip motion during the skating technique is similar to that in ice skating and is considered a risk factor for femoroacetabular impingement (FAI) in ice hockey players. We aimed to compare the presence of CAM-type FAI in a cohort of elite junior CC (EJCC) skiers with a control group of non-athlete (NA) high school students.

Methods Observational cohort study: EJCC skiers and NAs were recruited from a sports school and a regular high school, respectively. Baseline demographics and training history were obtained via a questionnaire. Bilateral hip MRI was performed and the alpha angle was measured in three planes. CAM deformity was defined as an alpha angle >55° on at least two MRI planes per hip.

Results A total of 20 EJCC skiers and 10 NAs participated. All participants were male, aged 16–19 years. Average training volume was 528.10±68.34 hours per year for the EJCC skiers compared with 153.50±57.09 for the NAs (p<0.001). The prevalence of CAM deformity was found to be 50% in both groups (10 CC skiers and 5 NAs). The average alpha angles were 52.4±6.1° in the EJCC group and 52.5±4.9° in the NA group (p=0.94).

Conclusion Radiographic evidence of CAM-type FAI was not more common in the CC skiers compared with NAs. The type, rather than volume or intensity of training, may be more important risk factor for the development of CAM-type FAI in young athletes.

INTRODUCTION

Femoroacetabular impingement (FAI) syndrome is a diagnosis based on a triad of appropriate symptoms, positive clinical signs and correlating imaging findings. Abnormal morphology of the proximal femur and/or acetabulum is the underlying cause, resulting in premature contact between these two structures during hip motion. FAI can be classified based on the abnormal morphology with CAM-type impingement involving the proximal femur and pincer-type isolated to the acetabulum. A mixed-type involves abnormalities of both the femur and acetabulum.

FAI has received considerable attention in the scientific community over the past several years as our understanding of the causes, natural history and treatments has evolved. While this has identified some possible aetiologies for the development of the syndrome, there remain many questions about risk factors and preventative strategies. One proposed aetiology for the creation of CAM deformity is the effect of high-volume training on the developing proximal femoral physis. This has been implicated in the creation of CAM deformity in several sports, including ice hockey, soccer, basketball and athletics. It is unclear if this relationship is true for all athletic activities or specific to certain sports. Specifically, there is a paucity of information related to the risk of developing CAM-type FAI in cross-country (CC) skiing.

CC skiing is one of the most popular Nordic sports and competitive athletes must devote a substantial amount of time to training. CC skiing consists of two main techniques: classic and skating (figure 1). Hip motion during the classic technique primarily consists of repeated flexion and extension, while the skating technique involves a more complex movement pattern adding abduction, adduction and rotational actions. This motion is similar to ice skating, which is a proposed risk factor for CAM-type FAI. The purpose of this...
METHODS
Study design
This observational cohort study was implemented to study the relationship between excessive training and the development of CAM-type FAI. EJCC skiers and NA were recruited from a sports school and a regular high school, respectively. Baseline demographic information and training history were obtained via a questionnaire (online supplementary file 1). Subjective assessment of hip function was evaluated with the International Hip Outcome Tool-33 (iHOT-33) for each hip (online supplementary file 2). Inclusion criteria for the EJCC skiers consisted of a minimum weekly training volume of 10 hours, while the maximum weekly training volume was 3.5 hours for the NA. Exclusion criteria included previous hip surgery or other diagnosed hip pathology.

Clinical examination
Hip range of motion was recorded through clinical examination which was performed by two authors (SAS and LE). The presence or absence of impingement signs was assessed with the Flexion-Adduction-Internal Rotation (FADIR) and Flexion-Abduction-External Rotation (FABER) tests, with a positive result defined as a provocation of symptoms during testing.

Radiological examination
All subjects were scanned in a GE Achieva 1.5 T MRI scanner with a torso coil. No contrast material was administered. Only one sequence, a three-dimensional isotropic T1-weighted turbo spin-echo sequence (3D PelvicView), 350×350 matrix, 1 mm voxel, repetition time (TR)=400, echo time (TE)=shortest, flip angle=90°, was acquired. The scan covered pelvis and both hips. All measurements were done by one blinded radiologist (EA).

The MRI examination was sent to Picture Archiving and Communication System (PACS) (Carestream Vue PACS) where the study was loaded into a multiplanar reconstruction tool. Three reconstructions were made on both sides: one oblique axial along the femoral neck axis, one coronal oblique along the femoral neck and one oblique coronal/axial (figure 2).

This provided three sets of images per hip depicting the anterior, anterosuperior and superior femoral head–neck junction with respect to the femoral neck axis. The alpha angle was measured in these three planes. Using PACS tools, a best-fit circle was drawn around the femoral head and a centre was defined. Alpha angle was
measured between one line parallel to the neck axis through the head centre, and one line through the head center and an intersection point of the best-fit circle and the head-neck border anteriorly (figure 3). Presence of CAM deformity was defined as an alpha angle>55° on at least two out of three of these MRI planes.9 10

The proximal femoral physis was assessed and graded as open or closed. An open physis was defined as a visible hypointense line through the femoral head.

Statistical analysis
Thirty persons (60 hips) were recruited and all participated in the study. Comparisons were conducted using t statistic tests and descriptive statistics. Statistical calculations were performed using GraphPad software. The alpha level for accepting statistical significance was set at 0.05.

RESULTS
Baseline data
A total of 20 EJCC skiers and 10 NA participated, and all participants were male. No participants were excluded from the study due to a history of previous hip surgery or other diagnosed hip pathology. Baseline demographic information is presented in table 1.

No difference was detected in the evaluation of the iHOT-33. A score of 0 represents a significant amount of pain, while a score of 100 means that there is no hip pain. EJCC skiers scored on average 94.97±5.36 vs 92.49±5.60 in the NA (p=0.249).

Clinical examination
EJCC skiers had less hip abduction (p=0.014) and external rotation (p=0.032) versus the controls. Flexion, extension, adduction, and internal rotation were not statistically different (table 2).

Radiological examination
Radiographic findings are summarised in tables 3–5.

The rate of CAM deformity in at least one hip on MRI was 50% in both groups (10 EJCC skiers and 5 NA). Three EJCC skiers and four NA had evidence of bilateral CAM deformity (p=0.3520) (table 5). The average alpha angle in the EJCC skier group was 52.35±6.10° compared with 52.45±4.89° in the NA group (p=0.938). There was no statistical difference in alpha angles between the participants with open and closed physes (table 4). Average alpha angles were higher in participants with positive clinical impingement signs than in those without clinical impingement (table 6).

DISCUSSION
Main findings
The most significant finding of this study was that CAM-type FAI was not more common among a group of young elite CC skiers who devote a substantial amount of time to training versus the same age group in the general population. There was no statistical difference in the prevalence of CAM-type FAI on MRI or clinical impingement signs, and the 2° difference in average alpha angle between groups may be within measurement error. The EJCC skiers attend a sports school that accommodates their athletic training and competition schedules and allows at least one workout during school hours along with normal academic activities. The students at the sports school all participate in one specific sport, and they have to be at an elite level in their sport to be admitted. These student athletes engage in high-volume, high-intensity and sport-specific training throughout the year.
Future directions

This study challenges the theory that high-intensity training increases the risk of developing CAM-type FAI. Future research should seek to quantify not only the training volume threshold but also the type of training activities that place young athletes at risk.

CONCLUSION

Radiographic evidence of CAM-type FAI was not more common in EJCC skiers compared with non-athlete controls. The type, rather than volume or intensity of training, may be a more important risk factor for the development of CAM-type FAI in young athletes. Future investigations should include the ‘type’ of training variable.

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REFERENCES

Correction: CAM-type femoroacetabular impingement in male elite junior cross-country skiers and non-athlete controls: a cross-sectional MRI study


The published version misspelled co-authors’ names as Kyle Martin and Lars Engbretsen. The correct names should have been R Kyle Martin and Lars Engebretsen.

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