THE RELATIONSHIP BETWEEN SPORTS AND HIP MORPHOLOGY IN (PRE) ADOLESCENT HOCKEY PLAYERS AND THE DEVELOPMENT OF FEMOROACETABULAR IMPINGEMENT.

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Abstract

Background

Femoroacetabular impingement (FAI) is a frequently occurring condition and has an underestimated prevalence in general practice. CAM-type FAI often leads to development of coxarthrosis with additional long-term treatment, morbidity and cost. FAI is more often seen in athletes and this already at a young age. Due to lack of knowledge about clinical presentation, examination, literature on FAI in (pre) adolescent athletes and reluctance to use RX, this results in underdiagnosis in general practice. More and more, cheap and easily accessible ultrasound imaging is being utilized as an imaging modality by general practitioners. This could be a viable alternative to radiography for the diagnosis of FAI.

Purpose

To investigate the impact of sports load on the development of both clinical and morphologic signs of CAM type impingement in young hockey players and non-athletes of the same age group.

Methods

In this case-control study, 21 male hockey players (13.3 years ±1.23) and 18 controls not involved in competitive sports (13.28 years ±1.27) were included. For the morphologic results, all participants underwent ultrasound of both hips. The clinical examination of the hip consisted of passive range of motion (ROM) and impingement test. Training intensity was measured by the amount of training hours per week.

Results

The mean alpha angle of the left hip in the hockey players was significantly larger than in the control group ($p = 0.002$). ROM of athletes is significantly smaller for hip extension left ($p = 0.031$), seated internal rotation left ($p= 0.008$) and right ($p = 0.004$), seated external rotation left ($p = 0.007$) and right ($p = 0.027$), prone internal rotation left ($p = 0.028$) and right ($p = 0.034$). For other ROM no statistical difference was seen, flexion left ($p= 0.097$), flexion right ($p= 0.210$), extension right ($p= 0.083$), prone external rotation left ($p= 0.135$), prone external rotation right ($p= 0.129$). Within the hockey players, 16 of the 21 participants had at least one positive clinical impingement test versus 6 of the 18 of the controls. For FABER (combined flexion abduction and external rotation) this was statistically significant for both sides with p values < 0.001 using the Chi-square test. The athletes showed a statistical difference in left and right alpha angle, with a mean difference of 2.32° ($p = 0.007$).

Conclusion

Hockey players were associated with larger alpha angles in the left hip and showed a predominance for FADIR impingement on that side. Ultrasound as a mean to measure cam-type deformity is challenging and not considered to be the imaging modality of choice. Clinical signs like diminished ROM and impingement tests could not be correlated to the size of the alpha angle.

Abstract in Dutch

Achtergrond

Femoroacetabulair impingement (FAI) is een frequent voorkomende aandoening en kent een onderschatte prevalentie in de huisartsenpraktijk. FAI van het CAM type gaat vaak gepaard met de ontwikkeling van coxartrose met bijkomende langdurige behandeling, morbiditeit en kosten. CAM wordt vaker gezien bij bepaalde sporters en dit reeds op jonge leeftijd. Door gebrek aan kennis over de symptomen, klinisch onderzoek en literatuur over FAI bij (pre)pubertaire atleten en een gezonde terughoudendheid voor het gebruik van RX wordt deze diagnose vaak gemist in de huisartsenpraktijk. Meer en meer vindt echter echografie zijn intrede in de huisartsenpraktijk. Het kan als een alternatief voor radiografie dienen bij de diagnose van FAI.

Onderzoeksvraag

De impact nagaan van uitgebreide sportieve belasting op de ontwikkeling van zowel klinische als echografische tekenen van CAM type bij jonge hockeyspelers vergeleken met geringe belasting bij niet-atleten van dezelfde leeftijdsgroep.

Methode

In deze case-control studie werden 21 mannelijke hockeyspelers (13.3 years ±1.23) en 18 niet-sportende controles (13.28 years ±1.27) onderzocht. Voor de morphologische resultaten ondergingen alle deelnemers een echo van beide heupen. Het klinisch onderzoek van de heup bestond uit passieve ROM en impingement testen. Trainingsbelasting werd gemeten aan de hand van het aantal trainingsuren per week.

Resultaten

De gemiddelde alfahoek links van de hockeyspelers was significant groter dan de controlegroep ($p = 0.002$). ROM van de atleten is significant kleiner voor volgende bewegingen: heupextensie links ($p = 0.031$), zittende endorotatie links ($p = 0.008$) en rechts ($p = 0.004$), zittende exorotatie links ($p = 0.007$) en rechts ($p = 0.027$), endorotatie links ($p = 0.028$) en rechts ($p = 0.034$). Voor de andere ROM werd geen statistisch verschil gezien, flexie links ($p= 0.097$), flexie rechts ($p= 0.210$), extensie rechts ($p= 0.083$), buikligging exorotatie links ($p= 0.135$), buikligging exorotatie rechts ($p = 0,129$). Binnen de hockeyspelers hadden 16 van de 21 deelnemers ten minste één positieve impingement-test versus 6 van de 18 van de controles. Voor FABER was dit statistisch significant voor beide kanten met p-waarden < 0,001 bekomen met de Chi-kwadraat-test. De atleten vertoonden een statistisch verschil in linker en rechter alfahoek van de heup, met een gemiddeld verschil van 2,32° ($p = 0.007$).

Conclusie

Hockeyspelers vertoonden een grotere alfahoek in de linker heup en toonden voornamelijk een positieve FADIR impingementtest aan die zijde. Echografie van de heup is ingewikkeld voor het berekenen van cam morfologie en wordt niet beschouwd als eerste keuze voor het verkrijgen van beeldvorming. Klinische tekenen zoals ROM en impingementtesten konden niet gecorreleerd worden met de grootte van de alfahoek.

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1. Introduction

Smith-Peterson was the first to describe the concept of hip impingement in 1936 (1). It was only later, in 2001 and 2003, that Ganz et al. discussed femoroacetabular impingement (FAI) in more detail and theorized it could be seen as a cause for osteoarthritis (OA) in cases that were previously considered idiopathic (2). Since then, the interest in FAI has increased and numerous publications on the subject followed. The Warwick Agreement defined FAI syndrome as a motion-related clinical disorder of the hip with a triad of symptoms, clinical signs and imaging findings, representing symptomatic premature contact between the proximal femur and the acetabulum (3). Two types of FAI exist, depending on morphologic changes in the hip and consist of CAM and pincer morphology. The CAM morphology is characterised by an epiphyseal extension or bump at the junction of the femoral head and neck (figure 1), whereas the pincer morphology comprises of an overcoverage and retroversion of the acetabulum (figure 2) (4). Both result in premature contact between femoral neck and acetabulum. Often these morphologic types appear together, giving rise to a so-called mixed-type impingement.

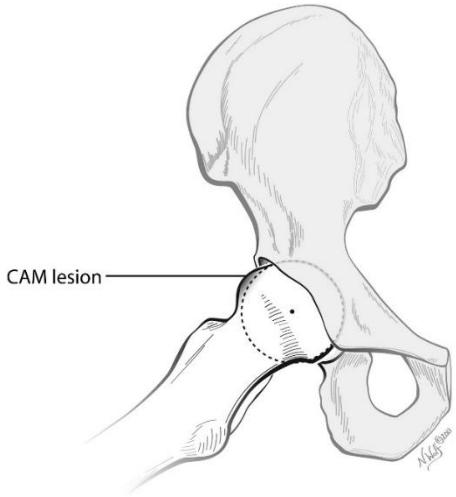


Figure 1: Cam morphology of FAI (4)

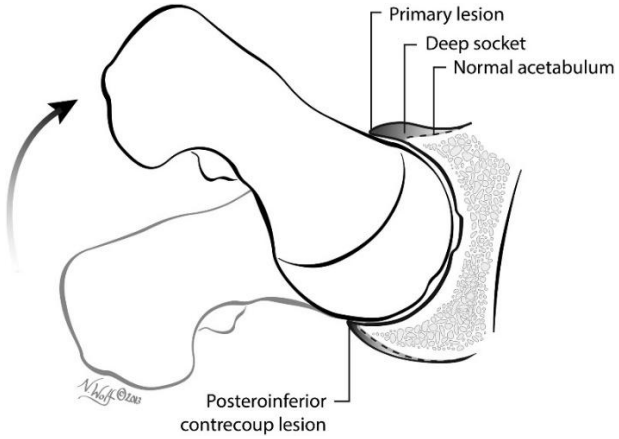


Figure 2: Pincer morphology of FAI (4)

The most frequent reported symptom is pain typically located in the groin but can also be experienced in the lower back, buttock, trochanteric region and thigh, mostly during or after athletic actions or even when performing daily activities (4,5). Other mechanical symptoms can be a locking or clicking sensation precipitated by turning, pivoting or lateral movements (6). To try and describe their complaints caused by deep interior hip pain, patients will sometimes use the "C-sign" where they cup their hand above the greater trochanter with the fingers gripping the anterior groin (6). Due to the altered bony architecture and the sequential abutment of the femoral neck against the acetabular rim, certain observations can be made during clinical examination. A reduced range of hip motion, generally internal rotation in hip flexion and a reduced FABER distance (i.e. the distance between knee and examination table when maintaining the hip in flexion, abduction and external rotation) is common, as well as the anterior impingement test which reproduces the patients familiar pain elicited by flexion, adduction and internal rotation (FADIR) of the affected hip (3,5–7).

To determine CAM or pincer morphology on imaging several concepts are used to analyse hip deformities. The alpha angle described by Nötzli et al. is the most common tool to evaluate CAM-type deformity (8). To measure this angle, a circle is fitted to the femoral head and a line is drawn through the axis of the femoral neck and the centre of the femoral head (figure 5). A second line is drawn from the centre of the head to the point where the surface of the head-neck junction departs from that circle. These two lines form the alpha angle. Cut off values for CAM deformity are quite different in numerous publications, although angles surpassing 60°, as set by Agricola et al., were found to define the presence of CAM morphology (9). Other instruments such as anterior femoral distance (AFD) and anterior head-neck offset (AOS) are widely used as well to determine whether a CAM-type deformity is present (10,11). Pincer deformity can be assessed by using the cross-over sign and the lateral centre-edged angle (LCEA) (4). This is the angle between a vertical line through the centre of the femoral head and a second line combining that centre with the most lateral point of the acetabulum.

Conventional radiography is the first choice for imaging with antero-posterior and lateral views to establish CAM, pincer or mixed morphologic alterations. More detailed information such as labral and cartilage integrity, can be obtained by CT or MRI scans which can be important for surgical purposes. However, investigation time and cost in taking and interpreting these investigations are high, as often only radiologists are capable of constructing and analysing these scans, not forgetting the radiation load emitted by CT scans. Lerch et al. proposed ultrasonography (US) as an alternative imaging modality of the hip joint (12). It is quick, cheap and more and more finding its way into general practices. They found US was as reliable as plain radiographs to discover CAM-type deformity using the same parameters (alpha angle, AFD, AOS) (13). All in all, there are various ways to measure pathological hip structure with their respective cut off values, but they must always be associated with symptoms and clinical findings of FAI (3).

As previously mentioned, Ganz et al. were the first to ascertain a causative relation between FAI syndrome and osteo-arthritis (OA) (2). Because of these aberrant morphologic features of the hip, abnormal and premature contact between the proximal femur and the acetabular rim occurs during terminal motion of the hip. This abnormal contact leads to lesions of the labrum and adjacent cartilage, and when not addressed properly, further deterioration resulting in degenerative disease of the joint (2,4). The correlation between FAI syndrome and OA has been proven in a vast number of studies (2,14–17). Initially, some criticism existed about whether FAI syndrome was the cause of OA rather than being the result, as bony changes such as osteophyte formation can lead to restricted motion and secondary impingement. Research in younger populations, however, showed a relatively high prevalence of OA in subjects with FAI (14,17). Reichenbach and colleagues also demonstrated the labral damage and decreased cartilage thickness on MRI in patients suffering from CAM type morphology (16).
About 25% of the general population, and some studies even depict numbers up to 37%, appear to have some form of FAI morphology (18–20). The male sex seems disadvantaged as men are 5 times more likely to have a CAM-type deformity (18,20). A specific population is that of athletes. It is strongly suggested athletes suffer more from FAI syndrome, not only by presenting more symptoms but also showing CAM-type morphologic alterations in 50-75% of the athletes,

depending on the article (6,18,19,21,22). The correlation between CAM morphology and sports is proven to be quite strong, unlike pincer morphology and has therefore been the subject of the greater part of studies concerning FAI syndrome (19,21,22). It gives rise to the assumption that sporting activities might be a major cause of the development of CAM-type FAI. Roels et al. theorized vigorous exercise imposes high loads on the epiphyseal growth plate thus initiating the formation of CAM-type alterations (23). This was investigated further by Agricola et al. in a prospective study which proved the CAM deformity evolved further in young soccer players, but not after the growth plate was closed (24). The lack of a control group was an important limitation, weakening the claim that sports are a clear inducer of the hip modifications.

The aetiology of FAI in athletes is an interesting one. Zadpoor proposed several hypotheses for future research, such as (1) the correlation between training intensity and radiologic signs of FAI, and (2) the higher prevalence of FAI markers in one particular leg in asymmetric sports (21). Recent investigation by the department of rehabilitation sciences at Ghent University focused on training intensity and associated symptoms and clinical signs of FAI syndrome in young hockey players, comparing them to controls (25). They noted significantly smaller ROM and more positive impingement tests in hockey players. They also emphasised the need of prospective studies combining clinical testing and imaging to establish formation of CAM morphology due to sports.

The diagnosis of FAI syndrome rests on the combination of symptoms of hip pathology, clinical signs indicating impingement and typical CAM, pincer or mixed type morphology on imaging. The basis is continuous abutment of the proximal femur against the acetabulum. Treatment of this problem could be seen as obvious, i.e. to relieve the hip of this diminished ROM by removing excessive bone. Indeed, Ganz et al. developed a surgical technique of dislocation to have a clear view of the damaged cartilage and aberrant bony architecture which can then be removed in order to restore physiologic anatomy of the hip (2). The technique was applied successfully by others for several years (26). The rise of arthroscopy, however, tilted the scales to a less invasive approach with equal and sometimes better outcomes (27,28). Although surgery has proven to be effective in treating FAI syndrome, it is not the only option. More and more, physiotherapy is seen as a viable alternative to treat FAI. Mansell et al. found no difference in outcome between arthroscopy and physiotherapy in a 2 year follow-up study, but had to acknowledge some limitations (29). Nevertheless, it shows that a conservative approach could be a promising tactic.

Osteoarthritis is an already common and disabling condition, and with the global population getting older as well as increasing obesity and joint injuries, it is becoming even more prevalent. Hunter and Bierma-Zeinstra presented a review on this disease addressing the burden for individuals suffering from OA on one hand, but also in terms of cost for society in high income countries (30). As FAI syndrome causes OA, it is clear that early diagnosis and treatment might be beneficial in preventing further development of OA. Many of the patients with joint pain and discomfort present themselves at a general practitioner. Some of these are younger athletes with symptoms of FAI syndrome. The diagnosis of FAI syndrome is often missed, however, because of a lack of knowledge about presentation, clinical assessment and scarce literature on (pre) adolescent athletes. As first-line practitioners are well placed to detect early signs of FAI syndrome,

either in an athletic or general population, a certain familiarity with the condition could increase the rate of diagnosis and treatment which in turn could reduce the amount of OA cases caused by FAI syndrome. Not only would this be advantageous for the specific patients, there is also an important economic benefit as costs for treatment of OA would decline. The screening of athletes that are at risk of developing FAI syndrome by general practitioners is an easy and cheap way to discover this syndrome in an early stage. Practicing vigorous sports activities has been identified as a possible cause of the development of CAM-type morphologic changes in the hip joint, which means this could be an important risk factor.

The initial aim of this dissertation was to assess the impact of strenuous exercise on the development of radiologic and clinical signs of FAI syndrome in (pre) adolescent hockey players compared to an age-matched control group. By comparing the alfa angle using ultrasonography as an alternative to radiographic imaging on two sets of imaging 18 to 24 months apart in both groups, it was hypothesised that the hockey players would present greater changes in morphology showing a strong correlation between sports and CAM-type FAI. Because of the COVID-19 pandemic, however, shortly after the first round of testing the season of all players was cut short, training volume decreased significantly and follow up became extremely difficult. What set out to be a prospective study turned into a case-control study focussing on training intensity, possible asymmetric signs of FAI, and an evaluation of ultrasonography as mean to determine CAM morphology. This thesis could also provide general practitioners with some awareness of FAI syndrome and help with early discovery.

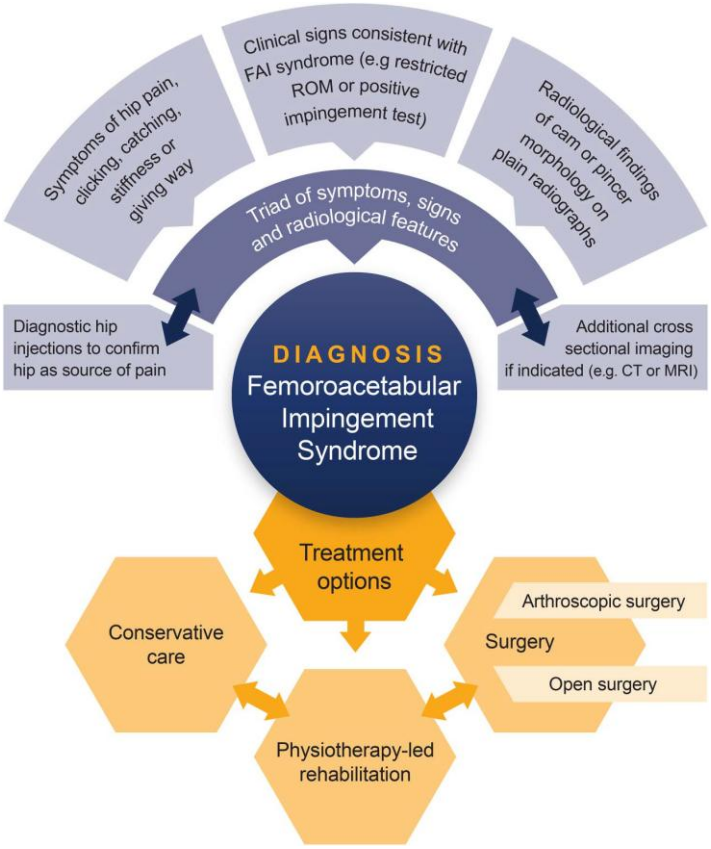


Figure 3: Pathway for the management of FAI syndrome

2. Methods

2.1. Study design

This case-control study compared asymptomatic youth hockey players to an age-matched control group. Approval was obtained by the ethical committee of UZ Ghent (B.U.N: B6702020001109). All participants and their parents signed an informed consent before study participation (*appendix 1*).

2.2. Participants

All participants were male and between 12 and 16 years old. The hockey players were recruited from the Indiana Hockey Academy in De Pinte, Belgium. Exclusion criteria were any known hip disorders such as hip dysplasia, Perthes disease, slipped capital femoral epiphysis, previous hip trauma or hip surgery. The hockey players couldn't perform any other sport for over 3 hours per week, whereas participants in the control group could not practise any sport for more than 2 hours per week. In any case, no participant had to be excluded. In- and exclusion criteria were checked through a questionnaire (*appendix 2*).

Using a second questionnaire (*appendix 3*), information was gathered on patient demographics, previous and current injuries, weekly training volume (match time included) and length of hockey career.

2.3. Clinical examination

Every contact between researcher and participant was done safely and with consideration of health measures concerning COVID-19. To our knowledge, no infection was reported in any of the participants or researchers that could be traced to interactions in this study. Biometric dimensions and clinical examination were performed by three investigators of the department of rehabilitation sciences of the University Hospital Ghent. These investigators collected this data not only for this study, but also for their research that led to their master thesis.

Passive ROM of the hip was measured for flexion, extension, internal (IR) and external rotation (ER). Impingement tests, FADIR and FABER test, were executed and were considered positive when the participant reported pain.

2.4. Morphologic examination

To objectify hip morphology, ultrasound was used with the Echo Wave II 3.7.1. program. Following the instructions of Lerch et al., sonographic examination was performed in the ventral longitudinal section in 20° IR, positioning the transducer along the course of the femoral neck (picture 3). The acetabular edge, femoral head and femoral neck were visible as anatomical reference points. Once properly positioned, a circle is drawn following the visible edge of the femoral head as to reproduce its entire circumference (fig 5). The alpha angle was measured using the method

described by Nötzli et al. as mentioned hereabove (8). No specific values were used to define CAM deformity as several cut-off values are brought up by various authors.

The examiners received sufficient training by an experienced sonographer. Some ultrasound measurements were repeated by the same examiner as well as the other to determine inter- and intra-observer variability.



Figure 4: Ultrasound of the right hip. When a clear image of the acetabulum and femoral head and neck is visible, the image is freezed and the alpha angle is measured as depicted in figure 5.

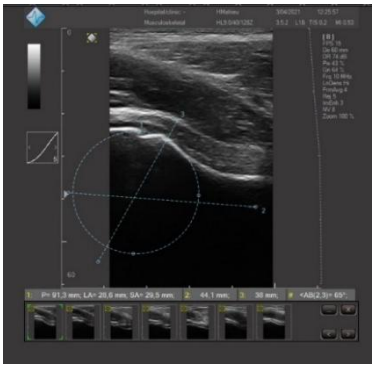


Figure 5: The alpha angle is measured using the technique developed by Nötzli et al.

2.5. Statistical analysis

All measurements were continuous variables except for the impingement tests FABER and FADIR which were designated as binary variables (pain = 1, no pain = 0). The normal distribution of all continuous variables was verified with the Shapiro-Wilk test, Q-Q plot and a histogram. The Independent T-test showed that the hockey players and the control group are matched in age, height, weight and BMI and can be worn out for further statistic tests.

Furthermore, the characteristics of the data set were calculated with descriptive statistics such as the mean, median, minimum, maximum, range and standard deviation (SD). For comparison of all continuous variable between both groups the Unpaired Samples T-test was used. Pearson correlation was used when comparing two continuous variables such as: alpha angle and training intensity, alpha angle and years of hockey, alpha angle and BMI, alpha angle and age. For assessment of the impingement tests, the Chi square test was used as well as Phi and Cramer V to measure the strength of association. Lastly, the Paired T-test was performed to verify unilateral asymmetry of the alpha angle in both groups.

Statistical analysis was performed using SPSS version 27 (IBM) and significance was set at a p value of 0.05, all tests were two-sided. Data analysis was completed using GPower version 3.1.9.2.

3. Results

3.1. Outliers

Outliers were checked with a histogram, scatterplot and boxplot analysis. Statistical analysis was performed without the obtained outliers and all results were in line with and without outliers. To maintain a big sample size the outliers were not excluded and were seen as natural variation and normal part of the normal distribution.

3.2. Power of analysis

Post hoc power for alpha angle left between two groups was 65.2% and for alpha angle right 60.3%. For ROM following power was found: hip flexion left 26.3%, hip flexion right 18.5%, hip extension left 75.8%, hip extension right 50.8%, seated internal rotation left 88.1%, seated internal rotation right 86.9%, seated external rotation left 88.0%, seated external rotation right 88.2%, prone internal rotation left 85.7%, prone internal rotation right 54.1%, prone external rotation left 34%, prone external rotation right 30.3%. The impingement tests showed following power analysis: FABER left 20.7%, FABER right 21.5%, FADIR left 30.2%, FADIR right 31.3%. The years of hockey played showed a power analysis of 40.6% and the hours of hockey per week had a power of 42%.

3.3. Intra- and interobserver variability

While operating the ultrasound, the examinators were blinded to each other. Similarly, while remeasuring the alpha angle, the operators were blinded to their previous results. Ten participants were included in the interobserver group and eight in the intra-observer group.

Applying Bland-Altman analysis of agreement, no considerable variability was seen in the intra- and interobserver for the measurements of the alpha angle with ultrasound as seen in table 1.

Table 1. P- values intra and interobserver variability

	Left hip	Right hip
Intervariability	0.266	0.240
Intravariability observer 1	0.080	0.662
Intravariability observer 2	0.942	0.135

3.4. Baseline characteristics

The baseline characteristics were similar for participants in each group and are shown in Table 2.

Table 2. Baseline characteristics presented as mean ±SD and p value of the independent T-test

	Hockey players	Controls	P value
Weight in kg	51.2 ± 12.388	52.9 ± 9.659	0.753
Height in m	1.64 ± 0.117	1.66 ± 0.107	0.796
Body Mass Index	18.93 ± 2.277	19.16 ± 2.529	0.717
Age	13.33 ± 1.230	13.28 ± 1.274	0.601

3.5. The association of sport and the development FAI

3.5.1. Morphologic

A significant difference in alpha angle between hockey players and the control group could only be seen for the left hip. The mean alpha angle of the left hip in the hockey group was 62.22° (SD = 6.82°) and 56° (SD = 4.18°) for the controls (p = 0.002). No significance was seen for the right hip.

Table 3. Mean Alpha Angle ±SD and p value of the independent T-test

	Hockey players	Controls	P value
Alpha Angle left	62.22 ± 6.82	56.00 ± 4.18	**0.002**
Alpha Angle Right	60.70 ± 6.93	57.84 ± 4.24	0.129

3.5.2. Clinical

3.5.2.1. ROM

Overall, hockey players had a smaller mean ROM compared to boys of the same age who didn't play sports. Statistically significant results were found for numerous movements as seen in Table 4.

Table 4. Mean ROM ± SD and p value of the Independent T-test

	Hockey players	Controls	P value
Flexion L	125.75 ± 6.40	129.25 ± 6.39	0.097
Flexion R	127.52 ± 5.92	130.20 ± 7.22	0.210
Extension L	26.69 ± 3.42	29.64 ± 4.75	**0.031**
Extension R	28.03 ± 3.83	30.43 ± 4.60	0.083
Seated IR L	**34.01** ± 4.33	**39.22** ± 7.13	**0.008**
Seated IR R	**35.93** ± 4.69	**42.64** ± 6.94	**0.004**
Seated ER L	**48.90** ± 6.33	**55.59** ± 8.31	**0.007**
Seated ER R	**46.89** ± 6.78	**53.10** ± 9.93	**0.027**
Prone IR L	**37.30** ± 7.17	**43.45** ± 9.53	**0.028**
Prone IR R	**39.42** ± 10.6	**45.81** ± 10.6	**0.034**
Prone ER L	52.21 ± 11.88	46.56 ± 11.1	0.135
Prone ER R	52.75 ± 11.53	47.33 ± 10.02	0.129

3.5.2.2. Impingement tests

Overall, the hockey players reported more pain during the impingement tests compared to the control group. Within the hockey players, 16 of the 21 participants reported pain during at least one impingement test versus 6 of the 18 in the control group. For FABER this was significant statistically shown for both sides with p values < 0.001 using the Chi-square test. Furthermore, FADIR on the left hip elicited more pain in hockey players compared to the control group. Those findings could not be seen for the FADIR test on the right side (left hip: p = 0.033; right hip: p = 0.075). Findings are reported in Table 5. No statistical significance could be found in bilateral difference for all impingement tests in both groups (p = 0.570).

Table 5. Number of participants reporting pain during impingement tests and p- value of Chi-square test.

	Hockey players		Controls		P value
	Positive	Negative	Positive	Negative	
FABER L	13	8	1	17	**< 0.001**
FABER R	14	7	1	17	**< 0.001**
FADIR L	12	9	5	13	**0.033**
FADIR R	13	8	6	12	0.075

3.6. The association of age and development FAI

No correlation was found between the alpha angle and age in all participants (Pearson correlation coefficient r = -0.183 for the alpha angle left (p = 0.278); alpha angle right r = 0,035 (p = 0.832)). In other words, older participants didn't have a larger alpha angle compared to the youngest participants. Same results were seen when tested on the groups independently. For the athletes a Pearson correlation for the left alpha angle of -0.047 (p = 0.892) and right alpha angle of -0.150 (p = 0.641) was found. For their non-athletic peers, no correlation was found as well (left r = 0.374, p = 0.139; right r = -0.051, p = 0.842).

3.7. The association of BMI and development FAI

There is no correlation between the BMI of youngsters and the alpha angle of hips bilaterally (Left r = -0.260, p = 0.121; right r = -0.191, p = 0.245).

3.8. The association of years of sport and development FAI

The longevity of the players hockey career, measured in years of hockey played, could not be correlated with a larger alpha angle. The Pearson correlation coefficient was 0.074 and 0.062 for the left and right alpha angle respectively (resp. p = 0.830; p = 0.0848).

3.9. The association of sport intensity and development FAI

Also, no association was found between the intensity of sports and larger alpha angles. Hockey players with a higher sports load per week showed no correlation in the alpha angle in the left (r = 0.090, p = 0.791) and right hip (r = 0.174, p = 0.589).

3.10. Unilateral asymmetry in development of FAI in hockey players

The left alpha angle of participants playing hockey was significantly larger than the right side with a mean difference of 2.32° (p = 0.007). This difference could not be seen in the control group (p = 0.204).

3.11. Association of impingement tests and Alpha angle

Between alpha angle and positive impingement tests no correlation was found. This in all participants as seen in table 6 (left side p = 0.175; right side p = 0.209) and in the groups individually as seen in table 7 (hockey left p = 0.824; right p = 0.515; controls left p = 0.723; right = 0.972). Although the mean values of the alpha angles with a positive impingement are larger, those results are not statistically significant.

Table 6. Association impingement and alpha angle between groups

	Impingement test painful	Impingement test not painful	P value
Angle Left	61.34 ± 7.19	58.28 ± 5.97	0.175
Angle Right	61.00 ± 6.80	58.46 ± 5.44	0.209

Table 7. Association impingement and alpha angle between groups separately

	Hockey players		P value Hockey	Controls		P value Controls
	Pain	No pain		Pain	No pain	
Angle Left	61.07 ±8.49	60.00 ± 4.71	0.824	57.50	55.90 ± 4.29	0.723
Angle Right	58.94 ± 7.27	56.13 ± 5.54	0.515	58.00	57.83 ± 4.56	0.972

3.12. Association of ROM and Alpha Angle

A smaller ROM could only be associated with a greater alpha angle for bilateral seated external rotation (table 8).

Table 8. Association ROM and alpha angle between groups.

	Alpha Angle Left	Alpha Angle Right	Pearson Correlation
Hipflexion left	0.483		-,119
Hipflexion right		0.666	-,071
Hipextension left	0.273		-,185
Hipextension right		0.938	0.013
Seated IR left	0.637		-0.080
Seated IR right		0.651	0.075
Prone IR left	0.296		-0.176
Prone IR right		0.582	0.091
Seated ER left	**<0.001**		**-0.559**
Seated ER right		**0.043**	**-0.325**
Prone ER left	0.653		-0.076

4. Discussion

FAI syndrome as a cause for OA has been thoroughly discussed over the past two decades (2,4,14,17,30). Its part in sports related injuries and discomfort as well (5,19,22,25,31). About the aetiology of FAI in sports, there has only been speculation and assumption. A correlation has been proven, but a true causative relation has never been demonstrated (22,24). Agricola et al. illustrated the effects of sports on the development of CAM-type, yet recognised the need for a control group (24). Initially, this study aimed for such a prospective view on the development of CAM-type FAI in athletes compared to controls. This objective was halted early on by COVID-19. Nevertheless, this case-control study underlined the correlation between CAM deformity and sports.

The first purpose of this dissertation was to determine whether the alpha angle was larger in asymptomatic youth hockey players compared to the non-athletic control group. This was the case for the left hip. Moreover, when comparing the alpha angle of the left and right hip of the players directly, a significant result was obtained with a mean difference of 2.32°. Interestingly, these findings could confirm suspicions of asymmetric development of FAI in asymmetric sports like field hockey. Several movements in hockey require large ranges of motion, indeed, specifically around the left hip, and it would be fair to assume most morphologic, sports specific adaptations happen in that joint, therefore causing more discomfort or injuries on the left side. Our additional clinical data did not confirm this, however. Positive impingement tests and hip ROM restrictions were not entirely predominant for either side as will be elaborated further. Nonetheless, the morphologic difference between players and controls was notable and is in line with previous research (6,18,22).





Figure 6 & 7: Illustration of extreme hip ROM in field hockey players.

An important prerequisite for the evolution of CAM deformity is an open growth plate. After epiphyseal maturation, no more CAM-type changes (other than secondary changes caused by OA) are observed. The fact that a difference, albeit small, is already detected in these (pre) adolescent players compared to their non-athletic peers is a cause for concern as maturation of the growth plate is still in full effect. Stress on the epiphysis by sports activities could probably trigger these modifications. The exact mechanism of development of CAM-type FAI is not entirely known and can be subject of future research, but this was not the aim of this study. It was to show that sports and extreme ranges of motion in field hockey are at least factors that could cause CAM-type FAI.

With regard to the clinical side of this study, there was a collaboration with colleagues of the Department of Rehabilitation Sciences. These results were extensively published in their dissertation (25). Although the amount of participants in our research was slightly smaller because of follow-up issues in the hockey player group, the findings in both studies were comparable. Overall, hockey players showed significantly decreased hip ROM compared to the non-athletic control population. This was the case for internal and external rotation of the hip in seated position, and for IR in a prone position. Some significance was also seen in a decreased extension of the left hip, yet the mean difference was quite low. Therefore, it is not considered clinically significant. As for the impingement test, they were considerably more positive in the hockey player group compared to controls. This was the case for both FADIR and FABER tests. Only FADIR in the right hip was not significantly different.

As previously discussed, these clinical signs, apart from the FADIR impingement test, were not ascribable to just one side. This is in contrast to the morphologic findings that show a more pronounced alpha angle in the left hip. When trying to correlate clinical to structural data, only seated ER was found to be significant, but again in both hips. Neither remaining hip movements nor positive impingement tests were associated with a greater alpha angle, let alone unilaterally. A possible explanation could be that participation in sports causes reduced hip ROM in general (32,33). Furthermore, these athletes are young, and although larger alpha angles were measured it does not directly imply a CAM-type deformity was present. It merely shows sports could cause morphologic changes that could lead to CAM-type FAI. Some hypothesize these clinical signs are a risk factor for developing FAI syndrome. We were unable to demonstrate this in our study.

Another aim was to identify a correlation between high intensity in sports participation and larger alpha angles as was proposed by Zadpoor (21). Athletes that had many weekly training hours were compared to those with a lower amount. No significant correlation was found. More vigorous exercise seemed not to be a risk factor for the development of CAM-type deformities. This was also examined clinically and published by our colleagues in their research (25). Just like in our findings, they could not associate positive impingement and diminished hip ROM with sports intensity.

Beside intensity, the longevity of the hockey career couldn't be correlated with a larger alpha angle either. This was the same with the age of all participants, which is remarkable as the development of FAI morphology is typically something that happens over time during the period the epiphyseal

growth plate is still open. A possible explanation could be a lack of power on one side, but also the fact that the age range of the participants was to limited (i.e. 12 to 16 years). Development of these architectural changes could presumably demand more than just four years. These players are young and their career has often started just a few years ago. It is plausible to assume that a clearer effect of the years they played hockey is obtained when they are older.

Lerch et al. proposed ultrasonography as an alternative imaging modality for conventional radiographs to identify CAM morphology (12). Their research showed that ultrasound was as reliable as RX to measure not only the alpha angle, but also the anterior femoral distance and head-neck offset (two other measurements often used to describe CAM morphology) (13). This method, however, was never reproduced by other researchers thus supplying weak evidence of its efficacy. Even so, it does provide several advantages. All participants were of a young age, which implies higher risks when exposed to radiation produced by RX even if the radiation dose is low. Ultrasound produces soundwaves that are completely harmless. It also eliminates the need for the material and expertise of a radiologist when choosing US over radiography. Nonetheless, sonography requires a great amount of experience and even then a sonogram of the hip is not always obvious. In this study the investigators received ample training, but purposefully did not use any cut-off values of the alpha angle to define a CAM morphology. Whether a CAM-type FAI was present, was not very relevant. The aim was to prove sports would be associated with a higher alpha angle and thus implying a higher risk in developing FAI syndrome. The investigators agreed upon the specific techniques of examination and measurement of the alpha angle during training, and statistical analysis on inter- and intravariability showed no significant differences between the two examinators. Even if the angles would have had different values when measured on radiographs, the consistency of the examination method made sure the data was reliable. In conclusion, US can be a useful tool in the hands of an experienced sonographist to determine CAM-type FAI, especially for a quick view of the hip joint, but should not be the first choice for a general practitioner. More research comparing US to RX as a mean to evaluate CAM morphology could help in using sonography for hip examination by primary care providers.

In the Warwick Agreement a consensus was reached on the diagnosis of FAI syndrome. It requires the combination of symptoms, clinical signs and imaging findings as was discussed briefly in the introduction of this dissertation (3). Impingement tests are widely used to examine patients with symptoms of FAI syndrome. Casartelli and colleagues assessed the accuracy of the FADIR impingement test as a screening tool for FAI syndrome in adolescents (34). They found a sensitivity of 41% and a specificity of 47% and concluded that the FADIR impingement test was inadequate to determine whether CAM or pincer-type FAI was present. In the past years a broad range of sensitivity and specificity values were assigned to FADIR and FABER testing. It is therefore wrong to base the clinical assessment solely on impingement tests. Other examinations should be included. It is important to inspect gait, single leg control, muscle tenderness around the hip and hip ROM (3). If these investigations suggest a hip pathology, either a diagnostic ultrasound by an experienced general practitioner should be performed or a swift referral for radiologic imaging is recommended.

If CAM-type morphology is detected, several treatment options could follow. Minor discomfort can be addressed with oral analgesia, activity and lifestyle modifications and intra-articular steroid injections but if complaints are more serious, physiotherapy or surgical intervention is needed. Physiotherapy has been proven to be as effective as surgery and is often the first treatment choice. When symptoms are severe, or if athletes need to perform at very high levels, surgery is preferred. Because sport is seen as a potential inducer of CAM-type FAI, effective prevention strategies should be implemented. Many preventive measures have been developed and are effective in reducing sport specific injury, even specifically for field hockey (35,36). If these measures are effective in reducing the development of CAM-type morphology, however, is unknown. Future research on such a prevention program is needed.

Our research showed a connection between sport and increased alpha angles which underlines associations that were made by previous publications. A prospective study would have provided a stronger significance, but it still shows participation in sports might be an important risk factor for the development of CAM-type FAI syndrome. As FAI syndrome has been identified as a clear cause for OA of the hip, screening of a population at risk of developing CAM deformities is necessary. Athletes are such a specific group and they often present themselves in a general practice. General practitioners are well placed to detect FAI syndrome early. A certain awareness of this relation between sports and FAI, and an understanding of clinical signs and symptoms could guide general practitioners to radiology more quickly. Presently, hip complaints in athletes are regularly attributed to muscular injuries. These athletes are then prescribed physiotherapy without proper imaging information. If FAI-syndrome causes these complaints, the effect of therapy is likely short-lasting as a more specific treatment is required. A close collaboration between general practitioners and physiotherapists can help to identify the correct diagnosis and optimize treatment.

Another important illation is that CAM deformity is acquired over time, and a one-time screening is insufficient to declare a player free of any deformity. Follow-up on a regular basis is necessary to detect signs of FAI syndrome in an early stage to take appropriate action. If CAM morphology is discovered on imaging, all treatment options should be considered not only to make sure the athlete is able to perform at the required level, but also to decrease the risk of developing hip OA in the future. Larger prospective cohort studies with suitable imaging modalities focussing on the effect of sporting activities on CAM morphology over time in (pre)adolescent athletes could provide more insight into the aetiology of FAI syndrome, thus setting a basis for research on additional effective preventive measures.

4.1. Limitations

While making this dissertation two important obstacles were encountered. The first was the COVID-19 pandemic, naturally, that interfered with our initial plans for a prospective cohort study. The hockey season was cut short and training sessions were rare. This made recruitment and follow-up challenging and so our population size turned out smaller than expected, in turn providing this research with a statistical lack of power. The second limitation was the use of ultrasound as imaging modality. Although the investigators were trained to measure the alpha angle using sonography, it remained difficult. Furthermore, US is always more subjective than other modalities. Even though statistical analysis on inter- and intravariability showed no significant differences between the two examinators, other imaging modalities should provide more reliable data.

5. Conclusions

The formation of a CAM-type deformity is probably associated with sports activities which was underlined by the larger alpha angle in the hockey player population compared to non-athletic peers. Furthermore, the morphologic changes appeared to be asymmetric with predominance of the left hip. This was also the case for the FADIR impingement test. Impingement tests, however, have insufficient sensitivity and specificity to identify a FAI-syndrome. The diagnosis relies on the combination of specific symptoms of hip pathology, a variety of clinical exams and typical radiologic signs. Ultrasound of the hip proved to be challenging and is not recommended as a first-choice imaging modality. Clinical signs seemed to be independent of the size of the alpha angle. Possibly, sports cause diminished ROM in general. Prospective studies are needed to further observe the impact of sports on the development of CAM-type morphology and subsequently impose preventive measures to avert these morphologic changes.

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7. Appendix

7.1. Approval Ethics Committee

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BC-09116	NVT	10/02/2021	1/2

Betreft : Advies voor monocentrische studie met als titel:

"Relatie tussen sportbelasting en morfologie van de heup bij (Pre)pubertaire sporters enerzijds en ontwikkeling van femoroacetabulaire impingement anderzijds - Scriptie Vicky Cnops"

B.U.N.: B6702020001109

* Begeleidende brief dd. 1/12/2020
* Adviesaanvraagformulier dd. 1/12/2020 Ontvangen dd 2/12/2020
* Antwoord onderzoeker dd 03/02/2021 (Ontvangen dd 04/02/2021) op opmerkingen EC dd 22/12/2020)
* **Patiënteninformatie- en toestemmingsformulier dd 3/2/2021**
  kinderen vanaf 12-jaar
  TMP
* Patiëntenmateriaal:
  Infodocument hockey
  Infodocument jeugdbeweging
* Vragenlijsten: **exclusie hockey Versie 1.1**

Advies werd gevraagd door: Dr. Diego Schrans

BOVENVERMELDE DOCUMENTEN WERDEN DOOR HET ETHISCH COMITÉ BEOORDEELD. ER WERD EEN POSITIEF ADVIES GEGEVEN OVER DIT PROTOCOL OP 09/02/2021 INDIEN DE STUDIE NIET WORDT OPGESTART VOOR 09/02/2022, VERVALT HET ADVIES EN MOET HET PROJECT TERUG INGEDIEND WORDEN.
Vooraleer het onderzoek te starten dient contact te worden genomen met HIRUZ CTU (09/332 05 00).

THE ABOVE MENTIONED DOCUMENTS HAVE BEEN REVIEWED BY THE ETHICS COMMITTEE.A POSITIVE ADVICE WAS GIVEN FOR THIS PROTOCOL ON 09/02/2021 IN CASE THIS STUDY IS NOT STARTED BY 09/02/2022, THIS ADVICE WILL BE NO LONGER VALID AND THE PROJECT MUST BE RESUBMITTED.
Before initiating the study, please contact HIRUZ CTU (09/332 05 00).

DIT ADVIES WORDT OPGENOMEN IN HET VERSLAG VAN DE VERGADERING VAN HET ETHISCH COMITE VAN 16/02/2021.
THIS ADVICE WILL APPEAR IN THE PROCEEDINGS OF THE MEETING OF THE ETHICS COMMITTEE OF 16/02/2021.

° *Het Ethisch Comité werkt volgens 'ICH Good Clinical Practice' - regels*
° *Het Ethisch Comité beklemtoont dat een gunstig advies niet betekent dat het Comité de verantwoordelijkheid voor het onderzoek op zich neemt. Bovendien dient U er over te waken dat Uw mening als betrokken onderzoeker wordt weergegeven in publicaties, rapporten voor de overheid enz., die het resultaat zijn van dit onderzoek.*
° *In het kader van 'Good Clinical Practice' moet de mogelijkheid bestaan dat het farmaceutisch bedrijf en de autoriteiten inzage krijgen van de originele data. In dit verband dienen de onderzoekers erover te waken dat dit gebeurt zonder schending van de privacy van de proefpersonen.*
° *Het Ethisch Comité benadrukt dat het de promotor is die garant dient te staan voor de conformiteit van de anderstalige informatie- en toestemmingsformulieren met de nederlandstalige documenten.*

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° *Geen enkele onderzoeker betrokken bij deze studie is lid van het Ethisch Comité.*
° *Alle leden van het Ethisch Comité hebben dit project beoordeeld. (De ledenlijst is bijgevoegd)*
° *The Ethics Committee is organized and operates according to the 'ICH Good Clinical Practice' rules.*
° *The Ethics Committee stresses that approval of a study does not mean that the Committee accepts responsibility for it. Moreover, please keep in mind that your opinion as investigator is presented in the publications, reports to the government, etc., that are a result of this research.*
° *In the framework of 'Good Clinical Practice', the pharmaceutical company and the authorities have the right to inspect the original data. The investigators have to assure that the privacy of the subjects is respected.*
° *The Ethics Committee stresses that it is the responsibility of the promotor to guarantee the conformity of the non-dutch informed consent forms with the dutch documents.*
° *None of the investigators involved in this study is a member of the Ethics Committee.*
° *All members of the Ethics Committee have reviewed this project. (The list of the members is enclosed)*

Namens het Ethisch Comité / On behalf of the Ethics Committee

Prof. dr. P. Deron
Voorzitter / Chairman

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Mevr. C. VANCAENEGHEM (patiëntvertegenwoordiger)
Dhr. B. VANDERHAEGEN (UZG - moraaltheoloog, ♂)
Prof.dr. W. VAN BIESEN (UZG – nefroloog, ♂)
Dr. J. VAN ELSEN (huisarts, ♂)
Dr. G. VAN LANCKER (UZG – klinisch farmacoloog, ♀)
Prof.dr. K. VAN LIERDE (UG – logopediste, ♀)
Prof.dr. H. VERSTRAELEN (UZG – Vulva-arts, ♂)

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7.2. Informed consent

Informatie- en toestemmingsformulier voor deelnemers vanaf 12 jaar

Titel van de studie: **Relatie tussen sportbelasting en morfologie van de heup bij (pre)pubertaire sporters enerzijds en ontwikkeling van femoroacetabulaire impingement anderzijds**

Hallo,

Men heeft je gevraagd om deel te nemen aan een studie. Hockey is een opkomende sport waarmee, zoals bij elke sport, ook letsels gepaard gaan. De doelstelling van dit onderzoek is om na te gaan of intensief sporten de vorm van de heup verandert en hierdoor last veroorzaakt. Dit wordt femoroacetabulaire impingement genoemd. Om dit te onderzoeken zal eenmalig een echografie van je heupen genomen worden. Echografie is een compleet veilige manier om te kunnen kijken wat er zich in het lichaam afspeelt, je voelt er niets van. Hetzelfde toestel wordt gebruikt bij de zwangerschap om de groeiende foetus te visualiseren.

Voor deze studie hebben we je leeftijd, lengte, gewicht, en enkele algemene gegevens over belangrijk blessures en dergelijke die je in het verleden reeds opgelopen zou hebben nodig. We sturen je hiervoor een invullijst door.

Hierbij willen we je medewerking vragen om deel te nemen aan deze studie. De studie zal uitgevoerd worden door dokter Vicky Cnops en dokter Maxime Callant.

Je deelname vindt plaats op vrijwillige basis. Dit wil zeggen dat je je op elk moment uit de studie kan terugtrekken zonder dat dit gevolgen heeft voor jezelf of je ouders.

Deelname aan deze studie zal geen voordeel voor jou opleveren.

Alle gegevens zullen vertrouwelijk behandeld worden en anoniem/gecodeerd verwerkt worden (dat betekent dat niemand zal jouw naam weten), in overeenstemming met de wet op de persoonlijke levenssfeer.

Door het ondertekenen van het formulier voor geïnformeerde toestemming hieronder geef je je toestemming om deel te nemen aan deze studie. Wanneer je over het onderzoek nog iets meer wil weten, kan je contact opnemen met een van de onderzoekers, namelijk Maxime Callant of Vicky Cnops.

TOESTEMMINGSFORMULIER

Ik, _____ (naam van de deelnemer in drukletters) verklaar

- dat ik dit formulier heb gelezen.
- dat ik al mijn vragen heb kunnen stellen en tevreden ben met het antwoord.
- dat ik begrijp dat mijn gegevens zullen ingekeken worden door de mensen die hiertoe het recht hebben.
- dat ik begrijp dat deelname volledig vrijwillig is.
- dat ik voldoende tijd heb gekregen om over mijn deelname na te denken.

Ik stem ermee in om aan deze studie deel te nemen.

Naam en voornaam van de deelnemer	Handtekening	Datum
Naam en voornaam van de arts-onderzoeker*	Handtekening	Datum

2 kopieën dienen te worden vervolledigd. Het origineel wordt door de onderzoeker bewaard in het ziekenhuis gedurende 20 jaar, de kopie wordt aan de deelnemer gegeven.

* Aankruisen door de onderzoeker indien akkoord

Ik verklaar de benodigde informatie inzake deze studie (de aard, het doel, en de te voorziene effecten) mondeling te hebben verstrekt evenals een exemplaar van het informatiedocument aan de deelnemer te hebben verstrekt.	
Ik bevestig dat geen enkele druk op de deelnemer is uitgeoefend om hem/haar te doen toestemmen tot deelname aan de studie en ik ben bereid om op alle eventuele bijkomende vragen te antwoorden.	

7.3. Screening Questionnaire

FACULTEIT GENEESKUNDE EN GEZONDHEIDSWETENSCHAPPEN



VRAGENLIJST EXCLUSIE

ONTWIKKELING VAN FEMOROACETABULAIRE IMPINGEMENT BIJ HOCKEYSPELERS: IMPACT VAN EEN HOOG TRAININGSVOLUME

INHOUD

Dit document bevat enkele vragen om te bepalen of u(w kind) in aanmerking komt om deel te nemen aan deze studie.

Dag kandidaat-deelnemer

Bedankt voor je interesse in dit onderzoek! Vooraleer we kunnen starten, willen we je graag met behulp van deze korte vragenlijst een beetje leren kennen. Als je de antwoorden op de vragen niet direct weet, aarzel dan niet om dit samen met je ouders in te vullen. Indien één of meerdere vragen onduidelijk zijn, stuur dan een e-mail naar één van onderstaande leden van het onderzoeksteam.

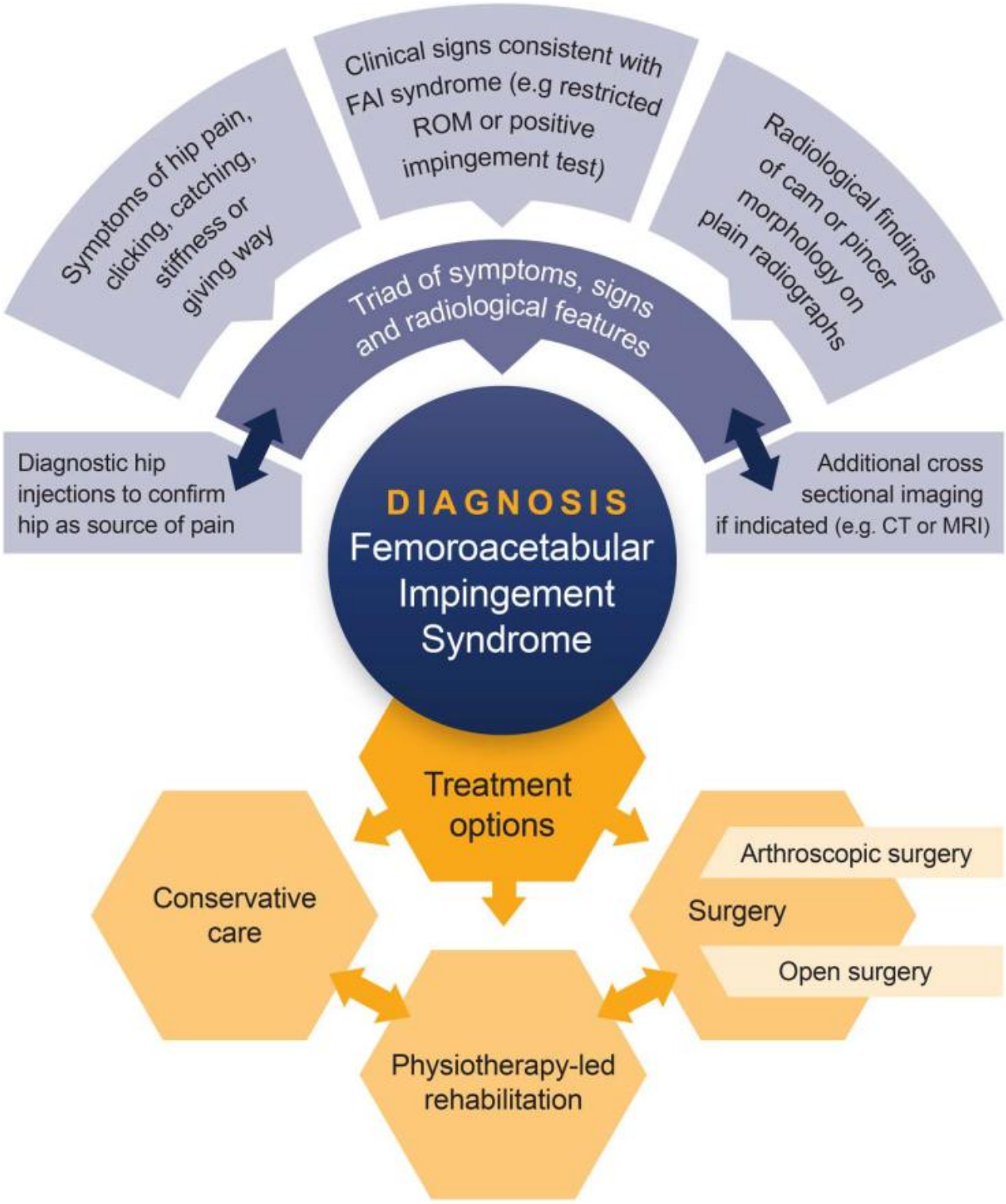
Prof dr Damien Van Tiggelen damien.vantiggelen@ugent.be	Dr Maxime Callant maxime.callant@ugent.be	Dr Vicky Cnops vicky.cnops@ugent.be

Neem deze ingevulde vragenlijst mee als je naar het onderzoek gaat!!!

Naam:

Leeftijd:

1. Speel je hockey?	JA	NEE
• Zo ja, hoeveel uren per week (training + wedstrijd)?		
• Heb je afgelopen of huidig sportseizoen langer dan 3 maanden aan een stuk geen hockey kunnen spelen (de gevolgen van COVID-19 tellen NIET mee)?	JA	NEE
2. Beoefen je een andere sport dan hockey?	JA	NEE
• Zo ja, welke?		
• Hoeveel uren per week (training + wedstrijd)?		
3. Heb je ooit een operatie moeten ondergaan aan één of beide heupgewrichten?	JA	NEE
• Zo ja, welke en waarom?		
4. Heb je ooit een aandoening gehad aan één of beide heupen of benen? (bv Legg-Calve-Perthes disease, neurologische aandoening, systemische aandoening, …)	JA	NEE
• Zo ja, welke?		
5. Heb je ooit een andere aandoening gehad?	JA	NEE
• Zo ja, welke?		


Symptoms of hip pain, clicking, catching, stiffness or giving way
Clinical signs consistent with FAI syndrome (e.g restricted ROM or positive impingement test)
Radiological findings of cam or pincer morphology on plain radiographs
Triad of symptoms, signs and radiological features
Diagnostic hip injections to confirm hip as source of pain
Additional cross sectional imaging if indicated (e.g. CT or MRI)
DIAGNOSIS
Femoroacetabular Impingement Syndrome
Treatment options
Conservative care
Surgery
Arthroscopic surgery
Open surgery
Physiotherapy-led rehabilitation

Source: (3)

7.4. Persoonlijke reflectie Masterproef Huisartsgeneeskunde

Voor de masterproef voor huisartsgeneeskunde heb ik samengewerkt met een andere HAIO die tevens een goede vriend is. Het is de eerste keer dat ik een masterproef schreef met een andere persoon, in groepswerk vorm. Dit is uiteindelijk heel vlot en aangenaam verlopen. We hebben elkaar enorm goed aangevuld en aangesterkt op alle mogelijke vlakken. Waar ik iets beter omging met deadlines, contact met (co)promotor, logboek, administratieve zaken zoals ethisch comité, had mijn thesispartner dan weer een heel vlotte Engelse pen voor het ons masterproef tot een mooi einde te brengen.

Voor het vinden van een onderzoeksvraag zijn we hulp gaan vragen bij een prof van de revalidatiewetenschappen, die later onze (co)promotor werd. Die keuze werd gemaakt omdat we beide sportgeneeskunde hebben gestudeerd en dit ons sterk interesseert. Na het samen opstellen van de onderzoeksvraag heeft mijn thesispartner het protocol uitgetypt.

Helaas heeft COVID voor onze thesis heel wat roet in het eten gegooid waardoor we onze masterproef van een prospectieve studie naar een case-control moesten omgooien. Daarnaast bleek het recruteren van deelnemers ook een stuk moeilijker. Wie wilt er nu zijn kind laten onderzoeken door vijf verschillende personen in de zorg, die mogelijks dagelijks in contact komen met covid patiënten, midden in pandemie? De zoektocht en communicatie met de deelnemers en hun ouders was een taak die ik had opgenomen. Mijn thesispartner was dan weer in contact met het departement revalidatiewetenschappen in het UZ om de echo op tijd te bestellen en telkens op te halen en terug te brengen.

Na het recruteren van al onze deelnemers begonnen we aan de dataverzameling. De biometrische gegevens zijn aan de hand van vragenlijsten nagevraagd. Die vragenlijsten hebben we samen met de kiné's opgemaakt. Alsook de informatiebrochure voor zowel deelnemers als ouders, informed consent voor zowel kind als ouder hebben we ook samen opgesteld.

Eerst en vooral moesten we met een echo leren werken. Dit bleek een stuk moeilijker dan gedacht. Een fysische arts gaf ons de nodige uitleg en waarschuwing over de moeilijkheid ervan. Na enkele oefensessies begonnen we aan het echte werk. Afwisselend namen we de echo's, soms elk meerdere keren om zowel de inter als intra variabilteit te controleren.Voor het klinisch onderzoek hadden we heel wat hulp van drie kiné studenten die dezelfde data nodig hadden voor hun masterproef. Dit was heel nuttig zodat wij ons volledig konden focussen op het nemen van de echo's.

Na alle data te hebben verzameld merkten we op dat één bepaalde hockeyploeg sterk afwijkende resultaten had die we met echo hadden gemeten. Dit in complete tegenstrijd wat ongeveer verwacht zou moeten worden. Die groep bleek de allereerste getestte groep te zijn en door nog onvoldoende opgeleide echografisten. Die groep hebben we uiteindelijk kunnen hercontacteren voor een tweede en meer correcte meting.

Na het verzamelen van alle data en dit zorgvuldig samen in SPSS te steken moesten we goed nadenken over de statistiek. Op dat vlak heb ik eerst het voortouw genomen om te zoeken welke tests we nodig zouden hebben en hoe we die moeten gebruiken en interpreren. Na advies van de (co)promotor hebben we besloten hulp te vragen van een vriendin met enorm veel kennis over statistiek. Zij kon ons gelukkig direct geruststellen dat de reeds uitgevoerde statistiek helemaal correct is. Daarnaast heeft ze ons enkele tips gegeven over hoe we de statistiek verder kunnen fine-tunen.

De statistische testen laten lopen en interpreteren was vnl mijn job. Alsook het zoeken naar outliers en kiezen om die al of niet te verwijderen. Ten laatste heb ik de power van de data analyse met Gpower berekend.

Nadien kwam het eigenlijke schrijven van de masterproef. Ik was reeds begonnen aan de draft van de introductie, die mijn thesis partner helemaal heeft afgewerkt met sterkere referenties naar de literatuur.

De methode en de resultaten werd grotendeels door mij geschreven en nagelezen door mijn theisspartner. Discussie en conclusie werd dan weer door mijn partner geschreven en nagelezen door mij.

We probeerden ofwel samen te werken aan een deel zoals de statistiek zodat we beide het concept goed zouden begrijpen. Voor het schrijven daarentegen waren we telkens aan een ander deel bezig zodat er niet dubbel werk zou zijn. Dit lazen we zeker goed na met de nodige commentaar en aanpassing om de volledige stijl van de thesis in één lijn te houden.

Om de masterproef in schoonheid af te sluiten besloten we om de presentatie samen te maken. Helaas mochten we deze niet samen verdedigen. Als team zouden we dit vast en zeker uitstekend voorgesteld hebben omdat we elkaar mooi aanvullen.

In samenvatting was deze masterproef in groep zeker een meerwaarde om een sterker eindproduct te bekomen. Hoewel er zeker nadelen kunnen zijn aan samenwerken in groep heb ik die zeker niet ondervonden, zou ik het direct opnieuw doen en dit zelfs sterk aanbevelen.