FEMOROACETABULAR IMPINGEMENT SYNDROME

TRENDS AND OUTCOMES AFTER ARTHROSCOPIC TREATMENT IN THE GENERAL AND ATHLETE POPULATION

IDA LINDMAN

Department of Orthopaedics
Institute of Clinical Sciences
Sahlgrenska Academy, University of Gothenburg

UNIVERSITY OF GOTHENBURG

Gothenburg 2021

Layout by Guðni Ólafsson at GO Grafik, gudni@gografik.se
Illustrations by Pontus Andersson

Femoroacetabular impingement syndrome
Trends and outcomes after arthroscopic treatment in the general and athlete population

i.lindman@hotmail.com

ISBN 978-91-8009-348-4 (PRINT)
ISBN 978-91-8009-349-1 (PDF)

Printed by Stema Specialtryck AB, Borås

Hard work
always pays off

CONTENTS

ABSTRACT

Femoroacetabular impingement syndrome (FAIS) is a common cause of hip pain in the young and athletic population. The diagnosis - FAIS - is based on a triad of symptoms, clinical evaluation and radiographic signs. The impingement is caused by an abnormal morphology of the femoral head (cam) and/or the acetabulum (pincer). It is proposed and widely accepted that the abnormal morphology of cam in particular develops due to repetitive motion and a heavy load on the hip joint during adolescence, and is more common in sports imposing high demands on the hip joint. Moreover, it has been proposed that FAIS contributes to the development of osteoarthritis of the hip joint. Current evidence has acknowledged promising outcomes after arthroscopic hip surgery aiming to correct the abnormal morphology to reduce pain and increase range of motion. Despite rapid improvements in diagnosis, treatment and scientific research in terms of FAIS, several unresolved issues remain.

The purpose of this thesis was to examine the midterm outcomes for patients undergoing hip arthroscopy for FAIS for the general population, and with the emphasis on the results for elite athletes, including high-level ice hockey players. Moreover, to investigate the influence of loss to follow-up in studies of hip arthroscopy and the impact of a prior hip arthroscopy with a subsequent total hip arthroplasty.

Study I is a prospective case-series study evaluating the five-year outcomes after hip arthroscopy in 64 elite athletes. The outcomes showed both statistically significant and clinically relevant improvements in symptoms, hip function, quality of life and pain reduction. Over 90% of the elite athletes reported satisfaction with the surgery. The study reveals that elite athletes experience good results after hip arthroscopy for FAIS.

Study II is a registry-based study evaluating the impact of the loss to follow-up in studies related to hip arthroscopy. It concluded that there are no differences between patients lost to follow-up compared with those included in the follow-up in terms of validated patient-reported outcome measures. The study suggests that loss to follow-up has little effect on conclusions drawn from similar studies evaluating hip arthroscopy.

Study III is a prospective case-series study evaluating the two-year outcomes after hip arthroscopy in 172 high-level ice hockey players. It revealed both statistically significant and clinically relevant improvements in patient-reported outcomes for both goalkeepers, forwards and defensemen. No relationship was found with the affected hip and stick handedness. The study reveals that ice hockey players experience good results after hip arthroscopy for FAIS regardless of player position.

Study IV is a propensity-score matched study appraising the consequence of a prior hip arthroscopy on a subsequent total hip arthroplasty. No inferior outcomes in patients with a prior hip arthroscopy were detected compared with patients who had not undergone previous hip arthroscopic surgery. It is reassuring that patients in need of a hip arthroscopy are able to undergo an intervention of this kind, without risk of compromising the results of a potential future hip arthroplasty.

Study V is a systematic review where the trends in the literature related to studies evaluating surgery for FAIS with the emphasis on PROMs are studied. It comprised 196 studies and displayed a continuous and almost explosive growth in the scientific publications with the vast majority exploring arthroscopic treatment.

KEYWORDS: femoroacetabular impingement syndrome, FAIS, hip arthroscopy, athletes, ice hockey, cam, pincer, osteoarthritis, total hip arthroplasty, hip pain

SAMMANFATTNING PÅ SVENSKA

Femoroacetabulärt impingement syndrom (FAIS) är en vanlig orsak till höftsmärta hos unga individer och framförallt idrottsaktiva. Till följd av avvikande morfologi i höftleden där antingen höftkulan har förlorat sin naturligt runda form (så kallad cam) och/eller avvikande struktur i acetabulum (så kallad pincer), skapas ett inklämningsfenomen vilket framförallt vid aktivitet och specifika rörelser genererar smärta utgående ifrån höftleden. Diagnosen FAIS baseras på avvikande radiologiska fynd, klinisk anamnes och undersökning som motsvarar syndromet. Tung fysisk aktivitet med repetitiva rörelser och hög belastning på höftleden under ungdomsåren, innan tillväxten av skelettet är färdig, har beskrivits öka risken för att utveckla dessa förändringar. Vidare har framförallt cam-förändringar påståtts öka risken för att i framtiden utveckla artros i höftleden. Forskning har visat goda resultat på kort och medellång sikt efter artroskopisk behandling, där syftet är att korrigera dessa anatomiska avvikelser och således öka rörligheten och minska smärta. Trots en nästan häpnadsväckande ökning i kunskap avseende diagnos, behandling och en explosionsartad ökning i antalet publicerade artiklar i ämnet finns det kvarstående obesvarade frågeställningar.

Syftet med den här avhandlingen är att med patient-rapporterade utfallsmått utvärdera resultaten efter höftledsartroskopi för FAIS på medellång sikt. Med fokus på elitidrottare inklusive ishockeyspelare som genomgått operation, samt bedöma framtida prognos hos patienter vilka genomgått en sådan artroskopisk behandling.

Studie I är en prospektiv studie, som utvärderar resultatet fem år efter artroskopi för FAIS hos 64 stycken elitidrottare. Såväl statistiskt signifikant som kliniskt relevant skillnad observerades. Över 90% av idrottarna rapporterade att de var nöjda med operationen.

Studie II är en register-baserad studie, som syftar till att utvärdera hur bortfallet av patienter påverkar resultatet av studier ifrån ett höftartroskopiregister. Detta genom att jämföra utfallsmått och demografiska data mellan patienter inkluderade i uppföljning gentemot patienter som inte deltagit i ordinarie uppföljning. Studien konkluderade att det inte var någon skillnad mellan de två patientkategorierna med avseende på patient-rapporterade utfallsmått.

Studie III är en prospektiv studie om 172 ishockeyspelare, som undersöker utfallet två år efter höftledsartroskopi för FAIS. Studien påvisade förbättring av patient-rapporterade utfallsmått två år efter kirurgi oavsett position. Studien undersöker även om klubbhänthet påverkar vilken höft som är symptomatisk och sedermera blir opererad.

Studie IV är en kohortstudie, som syftar till att undersöka påverkan av en tidigare höftledsartroskopi på en eventuell framtida höftledsprotes. Inga försämrade resultat kunde påvisas ett år efter genomgången total höftledsplastik för patienter som tidigare genomgått en höftledsartroskopi.

Studie V är en systematisk översiktsartikel, som undersöker trender i vetenskapliga publikationer avseende kirurgi för FAIS med fokus på patient-rapporterade utfallsmått. Totalt inkluderades 196 publikationer, vilka påvisade en fortsatt nästintill explosionsartad ökning i antalet publikationer genom åren där majoriteten studerade höftledsartroskopi.

LIST OF PAPERS

This thesis is based on the following studies, referred to in the text by their Roman numerals.

I. Lindman I, Öhlin A, Desai N, Samuelsson K, Ayeni OR, Hamrin Senorski E, Sansone M.
FIVE-YEAR OUTCOMES AFTER ARTHROSCOPIC SURGERY FOR FEMOROACETABULAR IMPINGEMENT SYNDROME IN ELITE ATHLETES.
Am J Sports Med. 2020;48(6):1416-1422.

II. Lindman I, Olsson H, Öhlin A, Hamrin Senorski E, Stålman A, Ayeni OR, Sansone M.
LOSS TO FOLLOW-UP: INITIAL NON-RESPONDERS DO NOT DIFFER FROM RESPONDERS IN TERMS OF 2-YEAR OUTCOME IN A HIP ARTHROSCOPY REGISTRY.
J Hip Preserv Surg. 2020;6;7(2):281-287.

III. Lindman I, Abrahamsson J, Öhlin A, Wörner T, Eek F, Ayeni OR, Hamrin Senorski E, Sansone M.
IMPROVEMENTS AFTER ARTHROSCOPIC TREATMENT FOR FEMOROACETABULAR IMPINGEMENT SYNDROME IN HIGH-LEVEL ICE HOCKEY PLAYERS: 2-YEAR OUTCOMES BY PLAYER POSITION.
Orthop J Sports Med. 2021;18;9(3); doi: 10.1177/2325967120981687.

IV. Lindman I, Nåtman J, Öhlin A, Svensson Malchau K, Karlsson L, Mohaddes M, Rolfson O, Sansone M.
PRIOR HIP ARTHROSCOPY DOES NOT AFFECT 1-YEAR PATIENT-REPORTED OUTCOMES FOLLOWING TOTAL HIP ARTHROPLASTY: A REGISTER-BASED MATCHED CASE-CONTROL STUDY OF 675 PATIENTS.
Acta Orthop. 2021; 10:1-5.

V. Lindman I, Nikou S, Öhlin A, Hamrin Senorski E, Ayeni OR, Karlsson J, Sansone M.
EVALUATION OF OUTCOME REPORTING TRENDS FOR FEMOROACETABULAR IMPINGEMENT SYNDROME - A SYSTEMATIC REVIEW.
J Exp Orthop. 2021;8(1):33; doi: 10.1186/s40634-021-00351-0

ADDITIONAL PUBLICATIONS BY THE SAME AUTHOR ON THE SAME TOPIC

Öhlin A, Ahldén M, Lindman I, Jónasson P, Desai N, Baranto A, Ayeni OR, Sansone M.
GOOD 5-YEAR OUTCOMES AFTER ARTHROSCOPIC TREATMENT FOR FEMOROACETABULAR IMPINGEMENT SYNDROME.
Knee Surg Sports Traumatol Arthrosc. 2020;28(4):1311-1316

Abrahamson J, Lindman I, Sansone M, Öhlin A, Jónasson P, Karlsson J, Baranto A.
LOW RATE OF HIGH-LEVEL ATHLETES MAINTAINED A RETURN TO PRE-INJURY SPORTS TWO YEARS AFTER ARTHROSCOPIC TREATMENT FOR FEMOROACETABULAR IMPINGEMENT SYNDROME.
J Exp Orthop. 2020;25;7(1):44.

Abrahamson, J, Lindman, I, Sansone, M, Öhlin A, Jónasson P, Karlsson J, Baranto A.
HORSEBACK RIDING IS COMMON AMONG FEMALE ATHLETES WHO HAD ARTHROSCOPIC TREATMENT FOR FEMOROACETABULAR IMPINGEMENT SYNDROME.
Transl Sports Med. 2021; 00: 1– 8 doi.org/10.1002/tsm2.236

Lindman I, Löfskog M, Öhlin A, Abrahamsson J, Hamrin Senorski E, Karlsson J, Ayeni OR, Sansone M.
RETURN TO SPORT FOR PROFESSIONAL AND SUB-ELITE ICE HOCKEY PLAYERS AFTER ARTHROSCOPIC SURGERY FOR FEMOROACETABULAR IMPINGEMENT SYNDROME.
Submitted Am J Sports Med. 2021.

ABBREVIATIONS

ADL:	Activity of Daily Living
BMI:	Body Mass Index
CT:	Computed Tomography
EQ-5D:	European Quality of life 5 dimensions
EQ VAS:	European Quality of life 5 dimensions Visual Analogue Scale
FABER:	Flexion Abduction External Rotation
FADIR:	Flexion Adduction Internal Rotation
FAI:	Femoroacetabular Impingement
FAIS:	Femoroacetabular Impingement Syndrome
GDPR:	General Data Protection Regulation
HAGOS:	Copenhagen Hip and Groin Outcome Score
HSAS:	Hip Sports Activity Scale
iHOT:	international Hip Outcome Tool
LCEA:	Lateral Center Edge Angle
LFCA:	Lateral Femoral Circumflex Artery
MFCA:	Medial Femoral Circumflex Artery
mHHS:	modified Harris Hip Score
MIC:	Minimal Important Change
MRI:	Magnetic Resonance Imaging
NAHS:	Non-Arthritic Hip Score
NHL:	National Hockey League
NSAID:	Non-Steroidal Anti-Inflammatory Drugs
OA:	Osteoarthritis
PASS:	Patient Acceptable Symptomatic State
PROM:	Patient-Reported Outcome Measure
QoL:	Quality of Life
RCT:	Randomized Controlled Trial
ROM:	Range Of Motion
RTS:	Return To Sports
SD:	Standard Deviation
SHAR:	Swedish Hip Arthroplasty Register
SHD:	Surgical Hip Dislocation
SMD:	Standardized Mean Difference
SNP:	Single Nucleotide Polymorphism
THA:	Total Hip Arthroplasty
VAS:	Visual Analogue Scale

BRIEF DEFINITIONS

ALPHA ANGLE: Angle used to measure cam morphology.

CAM: Abnormal morphology of femoral head, disrupting the round shape of the femoral head.

CASE SERIES: Observations of a group of patients, all with the same treatment, with no control group, i.e. uncontrolled compared with a cohort study.

CEILING EFFECT: When a high proportion of patients report the highest possible on a test, making differences above this score undetectable.

COHORT STUDY: A study including a control group or comparison of different groups or outcomes.

FAI: Femoroacetabular Impingement. In this thesis, it is used for impingement morphology in general with either cam and/or pincer.

FAIS: Femoroacetabular Impingement Syndrome. The diagnosis when all three criteria of symptoms, radiographic signs and positive examination findings are fulfilled.

LCEA: Lateral center edge angle, used for measuring pincer morphology.

MIXED IMPINGEMENT: Both cam and pincer morphology.

PASS: The threshold level of symptoms beyond which patients consider themselves well.

PINCER: An acetabular focal or global over-coverage of the femoral head.

PROPENSITY SCORE MATCHING: A statistical matching used to balance the baseline covariates that predict obtaining the treatment. Used in Study IV.

PROSPECTIVE STUDY: A study where the enrollment of the included participants starts before the outcome has occurred.

RANDOMIZED CONTROLLED TRIAL: Patients are randomly allocated to the groups to either receive treatment or not.

RELIABILITY: The consistency of a measurement and to the extent it is free from measurement error.

RETROSPECTIVE STUDY: A study where the outcome of interest has already occurred and the participants are recruited to observe their past.

SENSITIVITY: Ability to correctly identify the true positive.

SPECIFICITY: Ability to correctly identify the true negative.

SYSTEMATIC REVIEW: A methodical search of the literature, with a distinct a priori formulated question.

VALIDITY: How accurately an instrument measures what it is intended to measure.

WARWICK AGREEMENT: An international consensus statement on the diagnosis of femoroacetabular impingement syndrome.

INTRODUCTION

AIMS

METHODS

SUMMARY OF STUDIES AND RESULTS

DISCUSSION

LIMITATIONS

CONCLUSION

FUTURE PERSPECTIVES

HISTORICAL PERSPECTIVE

The anatomical variations we currently associate with femoroacetabular impingement (FAI) are described in the literature as early as during the 19th century[1]. Furthermore, there are case reports describing surgical corrections of the deformities associated with FAI during the early 20th century[1]. The concept of pain caused by hip impingement was then extrapolated by Smith-Petersen in 1936[2]. It was theorized that the impingement occurred between the femoral neck and the acetabulum, causing pain. Smith-Petersen described the surgical removal of the parts causing the impingement, in order to relieve pain and increase range of motion (ROM). Moreover, he performed this surgical treatment on a patient with “bilateral intrapelvic protrusion of the acetabulum” and later in patients with similar impingement caused by a variety of different diagnoses[2]. However, it was not until 1999 that the term “femoroacetabular impingement” was first used in the literature by Myers et al[3]. A couple of years later, in 2003, Ganz et al.[4] presented the concept of femoroacetabular impingement in more detail when introducing a new surgical technique. They presented an open dislocation for diagnoses other than hip replacement, where the majority of the patients were described as having an anterior impingement[5]. It was then hypothesized that this abnormal bony morphology could contribute to the development of osteoarthritis (OA)[4]. After this, there has been a rapid advancement in the knowledge of FAI, the number of patients treated has increased extensively and, consequently, a corresponding escalation in published articles in the field has occurred[6]. This rapid development in the area of impingement led to an agreement on the diagnosis and consensus of femoroacetabular impingement syndrome (FAIS) in 2016 called the Warwick Agreement[6].

The idea of the Warwick Agreement was to create an international consensus, mainly for clinicians, on the diagnostic evaluation and treatment of patients demonstrating FAIS. It was agreed upon that the syndrome is a triad of symptoms, clinical signs and correct imaging findings[6]. Based on this agreement, henceforth the diagnosis is called femoroacetabular impingement *syndrome* to emphasize its complexity.

HISTORY OF HIP ARTHROSCOPY

Hip arthroscopy was first described in 1931, however, due to limited visualization in the hip joint, and the weakness of former arthroscopic instruments not having the flexible capacity to reach the depth in the joint, the use of it was restricted[7]. It was not until the 1980s that hip arthroscopy started to advance, as the technique and instruments enabled improved reach in the hip joint[7, 8]. Whereas hip arthroscopy originally was used as a diagnostic tool, its utilization has developed and the indications for surgery have increased with good results when treating both extra- as well as intra-articular diagnoses[4, 9, 10]. In terms of FAIS, Ganz and colleagues initially treated this with an open hip dislocation[5]. However, hip arthroscopy developed rapidly as a minimally invasive alternative to perform the same surgery previously performed using an open technique, with reduced risk of complications. A meta-analysis by Zhang et al.[11] revealed less risk of reoperations, higher patient-reported outcome measure (PROM) scores, improved recovery of function and reduced hip pain in patients treated with hip arthroscopy compared with open dislocation. Further benefits of the minimally invasive approach are the shorter duration of surgery, quicker hospital stay and improved postoperative recovery[12]. Moreover, a systematic review demonstrated improved health-related quality of life when using arthroscopy compared with an open technique[13]. The benefits of the minimally invasive technique in treating FAIS led to an increase in the numbers of performed arthroscopies even further[14].

ANATOMY OF THE HIP JOINT

JOINT

The hip joint is a ball-and-socket synovial joint consisting of an articulation between the femoral head and the acetabulum of the pelvis. The ball-and-socket type of joint enables movement in flexion, extension, abduction, adduction, external and internal rotation. Although the joint enables motion in all directions, the articulation between the spherically shaped femoral head and the concavity of the deep acetabulum is mainly designed for weight-bearing and stability.

The "ball" in the joint is the femoral head. The femoral head is covered with hyaline cartilage with the exception of the center of the femoral head - the fovea capitis, which is the non-articular part of the femur. The "socket" in the joint is the deep acetabulum. The latter is formed by all three bones of the pelvis - the ilium, the pubis and the ischium. There is usually an anteversion of the acetabulum. The articular surface of the acetabulum is covered with hyaline cartilage as a C-shaped collar resembling a horseshoe. At the anteroinferior aspect of the acetabulum, where the opening of the horseshoe is, is called the acetabular notch. Running around the margins of the acetabulum is a collar of fibrous cartilage - the acetabular labrum. The labrum covers the superior and lateral parts of the acetabulum and forms an incomplete collar. Anteroinferiorly, at the acetabular notch is an opening in the labrum, where it is bridged by the transverse ligament which connects the two ends of the labrum into a circle. Continuous with the acetabular notch is the cotyloid fossa. It is located superior to the notch, at the center of the acetabulum hosting the attachment of the ligamentum teres. The fibers of the labrum are thickest posteriorly, where they are perpendicular to the chondrolabral junction, whereas, anteriorly, they are parallel in orientation, creating a more vulnerable place for tearing and injuries to the labrum. The acetabular labrum seal increases the stability of the hip joint through a suction-seal mechanism and by increasing the acetabular weight-bearing area. It also enables to maintain a constant layer of intra-articular fluid during loads and subsequently protects the underlying cartilage(15).

LIGAMENTS

The ligaments can be divided into intracapsular and extracapsular ligaments. The intracapsular ligament, briefly introduced above as the ligamentum teres attached to the head of the femur, is arriving from the transverse ligament of the acetabulum. The extracapsular ligaments of the hip joint consist of three major stabilizers. The iliofemoral ligament is the strongest of the three, and even the strongest ligament in the body. It has a bifurcational shape arising from the anterior inferior iliac spine and attaching to the intertrochanteric line of the femoral bone. Its anterior location prevents the hip from hyperextension. The second ligament, the pubofemoral ligament, has a triangular shape and runs from the superior pubic rami before it attaches along the femoral neck. Its main action is to prevent both hyper-abduction and extension. The last ligament is the ischiofemoral ligament, with a spiral alignment, running from the ischium and attaches at the trochanteric line armoring the capsule posteriorly and in line with the previous two ligaments, it helps preventing hyperextension. The ligaments are arranged in a spiral fashion and fuse in the capsule, which further improves stability without excessively impairing mobility.

BLOOD SUPPLY

The blood supply to the hip joint is primarily from four arteries; the deep femoral artery giving rise to the medial and lateral circumflex arteries (MFCA and LFCA respectively), the obturator artery and the superior and inferior gluteal arteries. Branches from the MFCA and LFCA create an extracapsular ring and further give rise to anastomoses forming the retinacular arteries. In addition, a small branch of the obturator artery creates the artery of the head of the femur within the ligamentum teres. If the other previously mentioned arteries are divided, in for example a fracture, this blood supply is insufficient. This branch is, however, critical in the pediatric patient, as the epiphyseal line of cartilage prevents sufficient blood flow from the previously mentioned arteries to reach the femoral head.

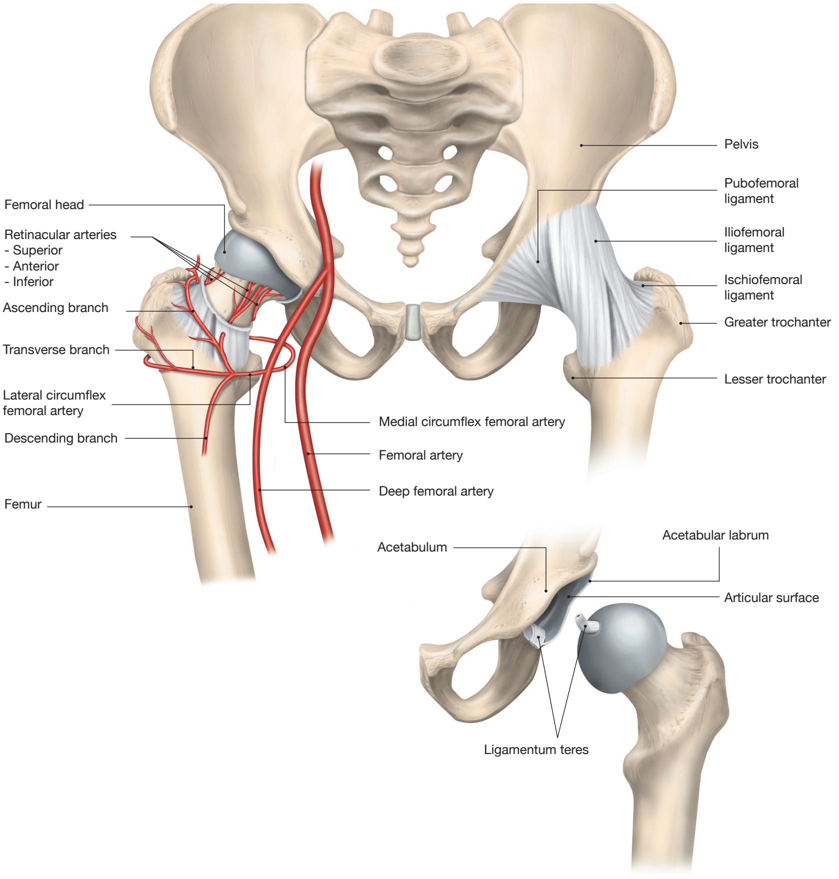

FIGURE 1: The upper figure is a frontal view of the hip and pelvis, showing the blood supply and ligaments of the hip joint. The lower figure illustrates the hip joint with the femoral head dislocated from the acetabulum.

IDA LINDMAN

NERVE SUPPLY

Innervation to the hip joint is maintained from branches emerging from the L2-S1 nerve roots diverging to the sciatic, femoral, obturator and gluteal nerves.

ARTHROSCOPIC HIP ANATOMY

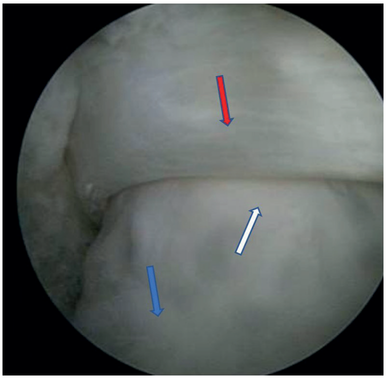

FIGURE 2: Arthroscopic view of the hip joint with cartilage on the femoral head (white arrow), the femoral neck (blue arrow) and healthy labrum (red arrow).

The hip joint can be divided into a central compartment and a peripheral compartment. The central compartment being the intra-articular cavity between the acetabulum and the femoral head containing articular cartilage, the intracapsular ligaments and the inner acetabular rim. The peripheral compartment embraces the space around the femoral neck and the joint capsule. The femoral head needs to be distracted in order to enter the central compartment arthroscopically. The peripheral compartment can be entered with the femoral head seated in the acetabulum.

ANATOMY OF FEMOROACETABULAR IMPINGEMENT

Femoroacetabular impingement is described as an abnormal bony morphology of the hip joint, either on the femoral side (cam), the acetabular side (pincer) or both (mixed impingement with both cam and pincer). The word cam derives from the Dutch word meaning "cog", while pincer comes from the French word meaning "to pinch".

Cam morphology is located on the femoral-neck junction, where the femoral head has lost its spherical shape, creating a decreased femoral head-neck offset. This is most commonly seen anterosuperiorly on the femur, yet can also extend around the entire femoral-neck junction. The pincer is an abnormal morphology on the acetabular rim, and can further be divided into either a focal or global over-coverage over the femoral head, creating a retroversion of the acetabulum. A focal over-coverage is usually seen at the anterior aspect, although it can occur at the posterior aspect as well. The more severe global version is primarily due to a deep coxa profunda, or protrusion acetabuli, where the femoral head has diverged medially into the pelvis and further caused the medial center of the femoral head to be misplaced[16]. The abnormal hip morphology caused by cam or pincer thus affects the normal anatomy, limiting mobility and leading to an impingement in the hip joint, and can further cause chondral damage and tears in the acetabular labrum[4, 17]. Both cam and pincer are thought to generate most harm during hip flexion and internal rotation, where cam is considered to primarily affect the acetabular cartilage and pincer the labrum. Cam morphology with its non-sphericity is thought to trigger a shear stress when the femoral head flexes through the acetabulum, causing injury at the junction of the labrum and the acetabular cartilage, which leads to a chondrolabral separation. The compression can further damage the acetabular cartilage and generate cartilage delamination. The “wave sign” or “carpet lesion” are terms used to describe this delamination due to its manifestation during arthroscopy. Pincer morphology, on the other hand, is first thought to disturb the labrum. When the hip flexes, the labrum is compressed and, with repetitive motion is eventually damaged. The damage to the labrum is located at the corresponding location for pincer, most commonly seen anterosuperiorly[18]. Further, a “contrecoup lesion” can be generated at the corresponding cartilage posteroinferiorly.

DIAGNOSIS

There are several possible underlying conditions causing hip pain, and for this reason, a correct diagnostic evaluation is crucial to identify the accurate etiology. Because of the complex anatomy of the hip joint and its surrounding structures, reaching an accurate diagnosis can be challenging. Many conditions causing hip pain have not yet established optimal treatment strategies, and further research in this area is of importance. Pain can be mediated not only from tissue injury, yet also from high intracapsular pressure, as well as from the bone or nerve entrapment. Further, an inflammatory process due to breakdown of intra-articular tissue may induce pain.

Over the years, the understanding of differential diagnoses due to hip pain has expanded tremendously. Experiences from the arthroscopic visualization of the hip joint have greatly expanded the understanding of hip joint pathology. A correct diagnosis is always crucial to decide on the optimal treatment.

As mentioned earlier, the diagnosis of FAIS was discussed at the Warwick meeting, and a consensus established that the diagnosis should include the triad of symptoms, clinical signs and radiographic findings[6]. All three features must be present to conclude that FAIS is present. This is exceptionally important, as radiological findings are prevalent in asymptomatic hips, and pain in the hip area and restricted motion can be related to different conditions other than FAIS.

SYMPTOMS

A patient with FAIS usually describes deep pain in the hip or groin, and often demonstrates this pain as a “C-sign” (Figure 3). There is a high risk of referred pain as well, with pain radiating, sometimes down the thigh towards the knee, and the pain can be perceived in thigh, back or buttock. The pain is usually related to certain joint positions or motions[19]. Pain can be experienced during sport and motion, yet with progression intensifies and persists for days after training. Many patients with FAIS experience reduced ROM and severe stiffness. Other sensations of FAIS are often described by the patient as clicking, locking, restrictions in movements, weakness and the feeling that the hip is not carrying - so called “giving way”[6]. A common finding in the patient’s history of anterior hip impingement is the “sitting” sign, where the patients experience deep groin pain after a certain period of sitting with the hip flexed, and the pain is relieved when extending the hip. This is similar to the mechanism of the “movie sign” in the knee, where increased pressure in flexion leads to patellofemoral pain and is relieved by extension[20].

FIGURE 3: A patient demonstrating the hip pain with the ”C-sign”.

CLINICAL SIGNS

A physical examination includes a standardized examination of the hip, groin and pelvis, including walking, leg control, muscles and ROM. Intra-articular pain usually induces a restriction in ROM, especially in flexion and internal rotation and pain in the outer ROM[19]. It is important to remember that the most common hip disorder, OA, is easily confused with FAIS, as stiffness and pain when testing ROM are cardinal signs of both FAIS and OA.

While many tests have been described for FAIS, one is widely accepted and is usually called "the impingement test"[6]. "The impingement test", also called the Flexion ADduction Internal Rotation (FADIR) test, is the most commonly described test, and has been shown to be interpreter reliable[21]. As the name indicates, the patient is in a supine position, and the hip is flexed at 90°, with a synchronized adduction and internal rotation (Figure 4). The FADIR test is positive if the maneuver induces pain and the idea is that the test reproduces the mechanical impingement of the femoral head towards the acetabulum. The sensitivity and specificity of FADIR when diagnosing FAIS have been discussed, and although it has been suggested that the test has high sensitivity, this might only be true if there is a high suspicion of FAIS[22]. A study combining magnetic resonance imaging (MRI) findings with the FADIR test in young ice hockey players without known FAIS, concluded that the sensitivity was only 41% (a positive test AND positive MRI findings)[23]. A further problem with the FADIR test is its low specificity, as it often induces pain even if FAIS is not present.

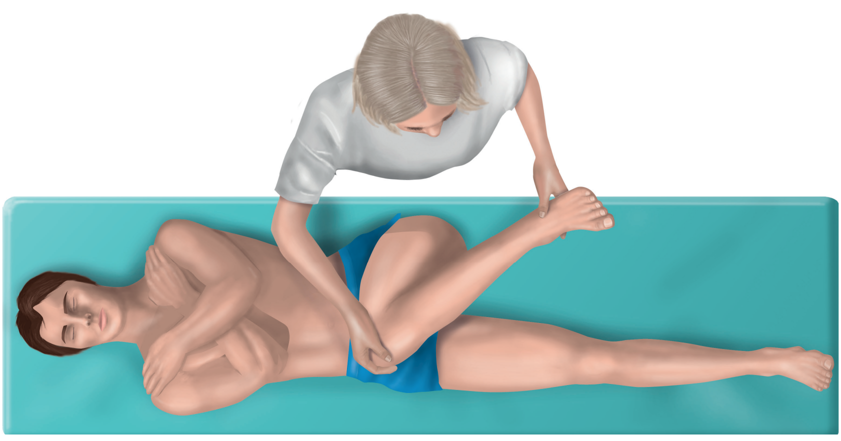

FIGURE 4: The Flexion ADduction Internal Rotation Test (FADIR) is demonstrated with the patient in a supine position.

IDA LINDMAN

Another test is the Flexion ABduction External Rotation (FABER) test. This test is reported to be useful when FAIS is suspected in patients with hip pain[24, 25]. In this test, the patient is placed in a supine position with the hip flexed, abducted and externally rotated (Figure 5). The ROM is measured from the table to the lateral femoral epicondyle of the affected leg. The contralateral hip is used as a reference and differences in ROM-measurements between hips may imply FAIS[26]. However, these tests should not be used as screening for FAIS. Both the FADIR and the FABER test can be positive with other hip pathologies and it is of importance to be careful and critical when interpreting the results. With their low specificity, it has been shown that the results of the tests only minimally change the outcome of the clinician's decision and that an experienced clinician working in the orthopaedics' or sports medicine settings would only benefit marginally from using these tests[22]. However, the clinical examination is still an important part of the diagnosis and it is crucial to take the entire situation into account.

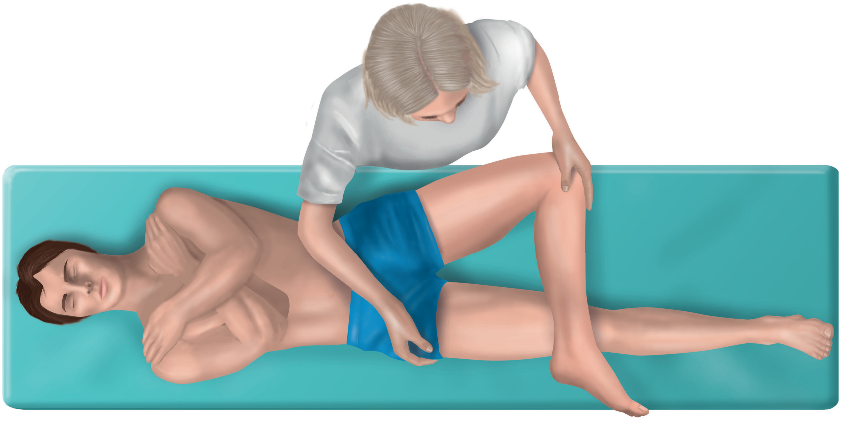

FIGURE 5: The Flexion ABduction External Rotation Test (FABER) is demonstrated with the patient in a supine position.

RADIOGRAPHIC FINDINGS AND MORPHOLOGY

The anatomical morphology presented in FAI can be seen either on plain radiographs, MRI or computed tomography (CT). However, it is suggested that the initial radiographic assessment should be with plain radiographs[6]. An anteroposterior (AP) view of the pelvis is a crucial view when evaluating the hip. Further, a cam projection, such as the Dunn, modified Dunn or Lauenstein view, is described as the preferred view to best display the head-neck junction. The FAI morphology is divided into cam, pincer or mixed impingement. Different radiographic features and signs have been described to measure cam and pincer morphologies. In terms of cam, the alpha angle is the most commonly described, while the crossover sign, lateral center-edge angle (LCEA) and ischial spine sign are commonly used for pincer[27-29].

To further describe damages to soft tissue correlating with FAIS, such as labral tears, chondral lesions including the "wave"/"carpet" sign and associated findings such as cysts or when struggling with differential diagnostics, an MRI is optimal.

CAM

Cam morphology is best profiled with "cam projections", such as the Lauenstein or modified Dunn view, mentioned above. The alpha angle is measured as the angle between a line from the center of the femoral head, through the middle of the femoral shaft, and a second line from the center of the femoral head through the point at which the shape of the femoral head diverges from a symmetric circle[30](Figure 6). There is an inconsistency at what alpha angle the patients develop symptoms, and further no clear cut-off when the patients should undergo surgery. It can even be argued that there is no actual cut-off value, since other factors contributing to the development of cartilage damage or pain may vary greatly. Numerous studies use >55 degrees as a threshold value[6]. However, a study by Gollwitzer et al.[31] described the normal alpha angle of many men as being >55 degrees, which should be considered when using this threshold. Moreover, a large alpha angle could be compensated for by under-coverage of the acetabulum or variants in the femoral version. It has been proposed that the threshold angle should be increased, and to further use different angles for women and men, as men generally have larger alpha angles[32].

PINCER

There are a numerous of radiographic signs indicating pincer morphology and these are best evaluated on an AP view. Beyond the occurrence of coxa profunda or protrusion acetabuli, the crossover sign, the LCEA and the ischial spine sign are widely applied (Figure 7). The crossover sign is defined as a line from the anterior acetabular wall to the posterior wall, creating a "figure of 8" associated with acetabular retroversion[29]. The LCEA describes the over-coverage of the anterior acetabulum by measuring the angle between a perpendicular line along the pelvis and a line from the center of the femoral head to the lateral edge of the acetabulum. Between 25-39 degrees, the LCEA should be regarded as normal. The LCEA was initially invented to describe dysplasia of the hip where <25 degrees indicates dysplasia. It has further been suggested that an angle of >40 degrees should be used as a threshold for pincer morphology(28, 33). The ischial spine sign is an indication of retroversion of the acetabulum and is considered positive when the ischial spine is visible medially to the iliopectineal line on a true AP radiographic view(34). In a patient with normal anteversion, the ischial spine is usually covered behind the acetabulum. However, the precision of these radiographic signs can be affected by the pelvic tilt and it is crucial to create a neutral position of the pelvis at the AP view. For example, an increased pelvic tilt on the AP view, or even a slight rotation to the evaluated hip, can generate a more prominent crossover sign, incorrectly indicating retroversion(27).

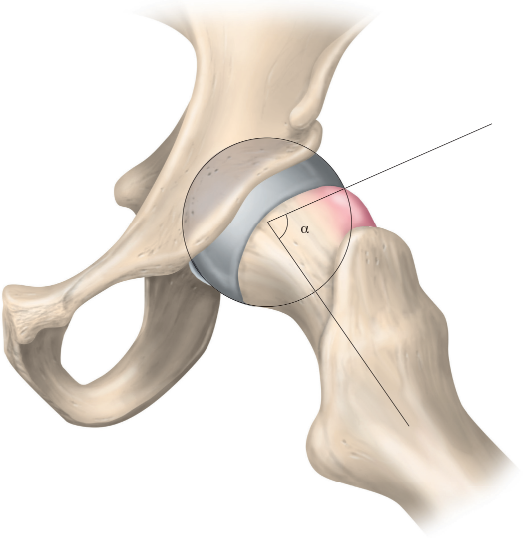

FIGURE 6: A hip with cam morphology including the alpha angle. The angle (approximately 79 degrees in this figure) is created between a line from the center of the femoral head, through the middle of the femoral shaft, and a second line from the center of the femoral head through the point at which the shape of the femoral head diverges from a symmetric circle.

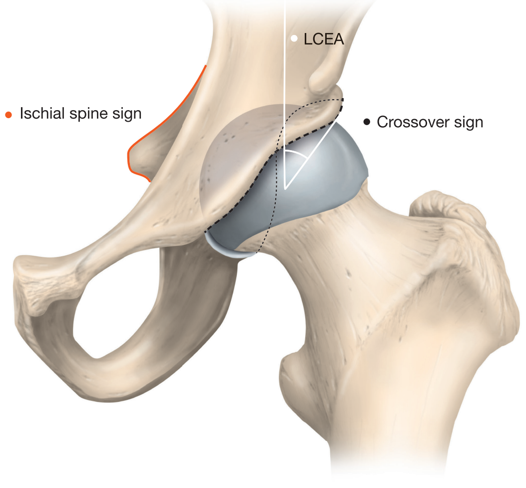

FIGURE 7: A hip with pincer morphology including three common radiographic measurements for pincer. The crossover sign is created as a line from the anterior acetabular wall to the posterior wall forming a "figure of 8". The lateral center-edge angle (LCEA) is an angle between a perpendicular line along the pelvis and a line from the center of the femoral head to the lateral edge of the acetabulum. The ischial spine sign is considered positive when the ischial spine is visible medially to the iliopectineal line on a frontal view.

INTRODUCTION

While there is a high prevalence of radiographic signs in patients with hip pain[28], many asymptomatic patients also present with these findings[35], hence no conclusions can be drawn from radiographic findings alone. It is therefore proposed that FAIS is a multifaceted combination of the abnormal contact between the femoral head and the acetabulum, where the anatomical profile in the hip joint varies in the population and that each individual suffers from symptoms depending on its unique characteristics of movement or position and anatomical variance[6]. This could be the reason why one person may have symptoms from slight FAI morphology, such as a dancer who places the hip in the extremes of motion every day. Another person may have developed large FAI morphology during intensive sporting in youth and subsequently ceased doing sports, and thereby minimizing putting the hip in impingement situations, resulting in fewer symptoms. It is therefore of importance to not only evaluate a radiograph when establishing the diagnosis and deciding on treatment, instead consider all three aspects of patient history, examination and radiographic morphologies, each being equally important.

ETIOLOGY

The complete etiology of FAI morphology has not yet been fully understood, although many theories and suggestions have been proposed.

Genetic disposition is thought to play a role in the etiology. Pollard et al.[36] described a 2.8 increase in the relative risk of a sibling having the same cam morphology and a 2.0 increased relative risk of having the same pincer morphology as the index patient compared with controls. Furthermore, the siblings were also more likely to develop symptoms when compared with controls. Attempts have also been made to find a correlation between genotype and the phenotype FAI. Studies have investigated single nucleotide polymorphisms (SNPs) and the association with FAI[37, 38]. While, Sekimoto et al.[37] found some association between seven "HOXB9" SNPs and acetabular coverage as seen in pincer morphology, however, more studies are needed to confirm this association. To date, there is no conclusion related to the genetic role in FAI[39].

The currently most accepted theory is that FAI morphology is acquired due to recurring overload and stress on the proximal femoral physis during the development of the skeleton[39]. There are several studies that have concluded that there is an increased risk of developing FAI if performing high-impact and high-volume sports during adolescence and growth[35, 40, 41]. The theory is that skeletal growth is disturbed and stimulated by repetitive loads and extreme range of motion[42]. During normal skeletal growth, there is a balance between load and growth. However, with an extremely high load, this balance is disturbed. Even further, with extreme pressure in variations of hip motions normally not performed (for example, the internal rotation during ice hockey skating), there is a mechanical provocation on areas of the skeleton not normally receiving this stimulus. This could theoretically generate inaccurate bone growth[42]. The idea of increased bone growth due to excessive load can easily be understood when applying Wolff's law. Wolff's law explains that bone tissue grows and remodels on the sites according to the forces and stresses that are demanded[43].

Agricola et al.[40] evaluated cam development during growth in soccer players. They found an increase in alpha angle and a flattening of the head-neck junction from 12 years of age. Another study retrospectively viewed CT-scans in children and adolescents without known hip pain and found cam morphology at the early age of ten years old[44]. While the alpha angle increases with age during adolescence[35], the development of cam morphology has not been seen after closure of the growth plate[45]. Moreover, the cam morphology does not appear to regrow after resection in patients with closed physis. This strengthens the theory that cam morphology develops during skeleton maturation, when it is most vulnerable and susceptible to mechanical load. Furthermore, the development of FAI morphology appears to be dependent on both extreme movements and intensity. A study comparing the frequency of football sessions played per week during adolescence found a possible dose-response relationship with sessions played[46].

Most studies have considered the development of cam, while there are a limited number of studies investigating the development of pincer morphology[39]. One study showed that the prevalence of pincer morphology, defined as an increase in LCEA, increases with age and starts to develop at 12 years of age[44]. The relationship between physical activity and cam morphology has not yet been confirmed with pincer morphology[39]. Although pincer morphology has been described in the athletic population, and in asymptomatic patients, there is a lack of knowledge regarding acquired pincer morphology.

How come some patients develop symptoms, while others, regardless of FAI morphology and intense workload during adolescence, do not develop symptoms? This is a complex issue and it is not yet fully understood. Each patient has a unique anatomical variation and an individual characteristic of movements or positions, imposing different loads on the skeleton and cartilage. In addition to this, external factors such as mindset and pain threshold most likely influence the degree of experienced pain. Moreover, the causes that trigger OA are largely unknown. Future research is needed to investigate this in more detail. A challenge is to clarify which movements and at what intensity the femoral bone is vulnerable to develop FAI morphology. This is important, as the avoidance of high mechanical loads during skeletal growth can limit the development of cam morphology and may reduce the risk of developing OA later in life.

EPIDEMIOLOGY

There is a large range regarding the prevalence of FAIS, depending on the classification and population investigated. Whether inspecting radiological signs of FAI or symptomatic individuals with FAIS, different prevalence is presented. Moreover, depending on the age group, gender, whether non-athletes or athletes are included, and even which type of sport performed show different prevalence. For this reason, the terminology is of importance when prevalence is assessed.

A systematic review and meta-analysis concluded that radiological cam morphology could be found in 22% and pincer morphology in 57% of asymptomatic individuals and mixed impingement in 9%(47). Large alpha angles (>50°) were noted in 12-25% of the asymptomatic individuals in the included studies, and were more commonly found in the male gender. Furthermore, when compared with individuals experiencing hip pain, both cam and pincer morphologies were more common in this population(47). Another systematic review revealed that cam morphology was found in 37% and pincer in 67% of asymptomatic volunteers, with a higher prevalence among asymptomatic athletes than among those not participating in sports(48). When assessing patients experiencing hip pain, FAI morphology was found in 61%, where mixed impingement with combined cam and pincer was most frequent(49). When dividing individuals by gender, cam morphology is described to be more common in males, while pincer morphology appears to be more common in females(50). Another cohort study found that 38% of the evaluated patients with hip pain fulfilled the criteria for both clinical symptoms, radiographic signs and a positive examination(51). There was also an increased incidence of the diagnosis of FAIS over the years.

A conclusion from the studies reporting on epidemiology is that FAI morphology is common in the asymptomatic population, more common in patients participating in sports and even more common in symptomatic patients. This further strengthens the importance of establishing the correct diagnosis.

TREATMENT

The management when treating FAIS is either surgical or conservative with a non-surgical approach. However, there is usually a process with an initial non-surgical approach including physiotherapy, non-steroidal anti-inflammatory drugs (NSAIDs) and exercise alterations, with or without affecting training level. The aim of conservative training is to reduce pain by modifying activity, mainly through removing or decreasing exercises and movements triggering pain and impingement of the hip, and to further add strengthening exercises for weak areas around the hip muscles[52, 53]. A meta-analysis including five randomized controlled trials (RCTs) revealed superior results in controlled programs with active strengthening and core-focused exercises compared with passive programs[54]. However, there is so far no consensus in terms of which approach of physiotherapy is the most successful, and further research on optimal protocols is needed. Furthermore, an intra-articular steroid injection could be added to relieve symptoms. This approach can also be used as a diagnostic confirmation of the articular source of the pain if combined with local anesthesia[55].

If conservative care is insufficient, surgical treatment is an option. The purpose of surgical treatment is to improve ROM and reduce pain by removing the abnormal morphology causing the impingement, and striving for a normal anatomy of the hip joint[6]. Previously, the open surgical hip dislocation (SHD) was the standard for many years. Further, another mini-open technique has been described to treat FAIS and has reported good outcomes[56]. In spite of this, after the minimally invasive arthroscopic technique evolved, the arthroscopic approach is currently the most frequently used technique and is now regarded as the gold standard[57]. Although the open technique showed good results in terms of functional outcome, the arthroscopic treatment is superior in terms of fewer complications, being less invasive and is more cost-effective[58]. Since the 2010s, SHD has decreased and the number of hip arthroscopies performed has increased substantially[51].

Although hip arthroscopy has been considered a successful treatment, there is always an inherent risk of complications when undergoing surgery. Major complications, such as hip dislocation, infection, thromboembolic phenomena, femoral neck fracture, avascular necrosis or death, are extremely uncommon. Minor complications are more frequent, of which chondrolabral and nerve injuries caused by the placement of one of the portals are the most common ones[59]. Conversion to a total hip arthroplasty (THA) is the most common reoperation and the rate of conversion varies depending on the duration of follow-up.

A systematic review declared a conversion rate of 7% at a mean follow-up of two years[60]. Kaldau et al.[61] reported a conversion rate of 18% at a five-year follow-up and Menge et al.[62] reported a conversion rate of 34% at a ten-year follow-up. Regardless of the follow-up period, higher age and the degree of OA with more severe chondral injury have been shown to increase the risk of undergoing a THA[61-63].

The question of whether conservative or surgical treatment is the best for treating FAIS remains. Three RCTs evaluating the efficacy of arthroscopy compared with physiotherapy have been published [53, 57, 64]. The first published RCT found no differences in included PROMs at the two-year follow-up between the group allocated to physiotherapy compared with the group allocated to hip arthroscopy. However, there was a high crossover rate in that study, where 70% of the patients in the group assigned to initial physiotherapy later underwent arthroscopic treatment[64]. Palmer et al.[53] on the other hand, reported superior results in PROMs and a greater range of hip flexion for patients allocated to arthroscopic surgery compared with physiotherapy eight months after enrolment in the study. The largest RCT of the three published trials showed significantly improved PROMs favoring patients treated with arthroscopy compared with conservative care twelve months after randomization[57]. A limitation to all three RCTs is the relatively short follow-up period, and it would be interesting to examine if the superior results of arthroscopic treatment remain in the long-term. The results in these studies suggest a superior outcome in arthroscopic treatment compared with physiotherapy, however, regardless of surgery or not, physiotherapy has a mandatory and important part both prior to surgery and as rehabilitation post-surgery.

Interestingly, a recent RCT comparing osteochondroplasty with lavage surgery revealed no differences regarding pain, hip function, sports function and health-related quality of life at the one-year follow-up[65]. In fact, there was a significant improvement in the lavage group in terms of activities of daily life compared with the osteochondroplasty-group. Yet, it was concluded that correction of the abnormal morphology was superior based on the fact that reoperation was significantly more common in the lavage group at the two-year follow-up.

EVALUATION OF SURGERY

Different domains can be used to evaluate the results after surgery. Several patient-reported outcome measures (PROMs) are frequently used and are accessible to report on the patients' perspective of the outcome following hip arthroscopic surgery. Diagnostic imaging with various radiographic measures is another tool that can be used to assess the outcomes. Less frequently used are functional tests, such as hip strength, ROM and specific exercises(66).

PATIENT-REPORTED OUTCOME MEASURES

There are multiple PROMs for evaluating hip-specific surgery. The most commonly used is the modified Harris Hip Score (mHHS) followed by the Non-Arthritic Hip Score (NAHS)(67). However, these are old tools which were initially established for a more elderly population and are not suited to the more active, younger patients. The mHHS was primarily developed for patients undergoing THA. The PROM covers dimensions of pain, function and activity of daily living (ADL), however, it includes questions such as "walking distance" and "need for support (cane, crutch)". These questions are not relevant to the patients undergoing hip arthroscopy, as these patients seldom have such problems since they more frequently experience difficulties during heavier activity or when performing their sport. When applying these PROMs to younger patients with a more active lifestyle, there is a considerable risk of a ceiling effect, making them less valuable tools for evaluation in this cohort(68). A ceiling effect, and its contrary, a floor effect, are considered to be present if a high proportion of the patients report the highest possible score or the lowest possible score respectively. In orthopaedic research, it is often defined if >15% of the included patients score the highest (or lowest) level of the score(69). The demand for more suitable outcome tools led to new, updated PROMs, as seen in the international Hip Outcome Tool (iHOT)(70) and the Copenhagen Hip and Groin Outcome Score (HAGOS)(71). These PROMs include suitable properties and are thus recommended for the younger, more active patients(6).

Not only is it important to use valid and suitable PROMs, the way the results of the outcomes are reported and interpreted is also important. Although a change might be statistically significant, it does not have to be clinically meaningful. As a result, several parameters have been described to interpret the clinical importance of the outcomes(72). The minimal important change (MIC) is regarded as “the smallest change that the patients perceive as relevant” and it is increasingly used when reporting PROMs[73]. Another, newer measurement is the Patient Acceptable Symptomatic State (PASS), and it is defined as “the level of symptoms beyond which patients consider themselves feel reasonably well”[74].

It would be preferable if the same PROMs were used worldwide to facilitate comparison between studies and centers performing hip arthroscopy. Especially with the increasing numbers of systematic reviews performed and the increased collaboration between centers. However, this has not yet been accomplished and many studies still use PROMs that are not recommended for the FAIS population, such as the mHHS. An explanation of the continuous use of old PROMs may be that these PROMs are well established and frequently used in the literature. Moreover, with the aim of following a group of patients for a certain time, it is necessary to use the same PROMs throughout the study period. Hopefully, this will change in the future across countries performing hip arthroscopy in order to obtain a standardized, homogeneous follow-up more suitable for the specific patient group. It is suggested that non-valid PROMS should be changed to modern, valid scales suitable for the target population, and that reasons such as comparisons with previous research and practical concerns do not outweigh the disadvantages of low validity scores.

The PROMs included in this project are the iHOT-12[70], the HAGOS[71], the European Quality of life 5 dimensions questionnaire (EQ-5D) and the EQ VAS[75], the Hip Sports Activity Scale (HSAS)[76] and a visual analogue scale (VAS) for hip function. These are further described in the methods section below.

FEMOROACETABULAR IMPINGEMENT SYNDROME AND THE ATHLETE

Femoroacetabular impingement syndrome is common in athletes, especially in athletes performing sports with high demands on the hip, such as soccer and ice hockey[17, 77]. Studies have reported a high prevalence of morphology corresponding to FAI in both symptomatic and asymptomatic athletes[78]. It is suggested that participating in high-level impact sports during the skeletal maturity increases the risk of developing cam morphology[79]. A higher prevalence of cam morphology in young soccer players compared with age-matched non-athletes has been reported[40]. Philippon et al.[35] reported similar results in young ice hockey players, with a high prevalence of cam morphology. Ice hockey players had a 4.5 increase in the risk of having cam morphology compared with skiers. Moreover, a study showed cam morphology in more than 85%, and acetabular retroversion corresponding to pincer morphology in more than 60% of National Hockey League (NHL) players[78]. Although soccer- and ice hockey players, due to their repeated motion and load on their hips, are considered having the highest prevalence of FAIS, a high prevalence is also reported in several other sports, such as basketball, dancing, track and field, martial arts and skiing[80].

Several studies have declared good outcomes after arthroscopic treatment for FAIS in athletes in general[81-83], and for professional athletes in specific sports[84-86]. While the majority of these studies report outcomes for ice hockey- and soccer players, there are even studies on the outcomes for yoga participants and golf players[87, 88]. However, most of these studies are midterm follow-ups and longer follow-up times are desirable.

FIGURE 8: Goalkeeper demonstrating the "butterfly" save with cam and pincer morphology on the left hip.

RETURN TO SPORTS

The rate of return to sport (RTS) is widely discussed in the literature, and the RTS for patients undergoing hip arthroscopy for FAIS has been investigated in several studies[89-92]. Many of these studies report a high rate of RTS after arthroscopic surgery for FAIS[90, 93]. Yet, the definition of RTS is vague and varies between studies. It is often defined as return to any participation in any sport and rarely includes performance status. For example, the RTS can be reported simply as a binary outcome, and could be defined as "having gone back to one game after surgery" or "return to participation in some sort of sport or exercise regardless of level" [92, 94, 95]. Instead, preferably would be to use a more complex definition, with several parameters such as level of play, frequency and intensity. It has been suggested that RTS should be seen as a continuum from participation in the sport and further to performance[96]. The definition of RTS must therefore be interpreted with caution. For an athlete, one of the major concerns after surgery is if and when he/she can return to sports activity again. Younger patients, elite athletes and patients with shorter symptom duration have been reported to have a higher RTS[97]. An elite athlete, whose income and professional career may depend on the ability to return to sports and at a high level of performance, usually has a greater motivation than a recreational athlete. Moreover, an elite athlete might have a team physiotherapist with an individual strategy to RTS, and a higher capability to RTS with residual symptoms. In contrast, a recreational athlete whose goal after surgery is to remain at a functional level may therefore have a lower RTS after surgery. It has therefore been suggested to use different definitions of RTS for elite and recreational athletes[97].

Many studies use PROMs to investigate the RTS, however, with the use of a PROM not developed for RTS, there is a risk of erroneous results and assumptions. There is a difference between return to any sport and return to preinjury performance, which should be accounted for in the RTS. Not defining the RTS properly could indicate falsely elevated levels of RTS, if performance status, dose of training or level of sports are not taken into account. Only a few studies investigate the return to preinjury level or performance status and the rate of return is, as expected, lower than when investigating RTS in general[90, 94]. Intrinsic factors, self-motivation, surrounding support, kinesiophobia due to the fear of pain, and health history all influence the possibility to RTS[98]. Exploring both the physical, psychological, the contextual factors and the patients' individual goal with RTS may provide the patient with more correct information.

FEMOROACETABULAR IMPINGEMENT AND OSTEOARTHRITIS

The natural history of FAIS is not completely understood. It has been proposed that the abnormal morphology found in FAI is a contributor to the risk of developing OA[4, 16, 99]. The relationship between FAI and developing OA is most often seen in patients with cam morphology, while pincer appears to have less influence on the development of OA[99]. The non-spherical femoral head, as seen in cam morphology, causes impingement towards the acetabular rim, mainly during flexion and internal rotation, further causing labral tears and cartilage damage. Agricola et al.[100] proposed that there was a high correlation between hip pain caused by impingement due to cam morphology and the risk of developing severe OA. However, while most studies have found a correlation between FAIS and the development of OA[16], Wyles et al.[101] compared the natural history between patients with FAI morphology and patients with normal hip morphology, finding a similar risk of later receiving a THA in the two groups. This instead proposes that patients with FAI morphology run a similar risk of developing OA as those with normal hip joint morphology. However, the study only reviewed radiographs and did not appraise the patients' symptoms.

The question of whether early intervention and the prevention of FAIS may prevent or delay a future hip arthroplasty has been discussed[16]. Theoretically, arthroscopic surgery with the aim of correcting abnormal morphology could either prevent the development of OA or, by causing a distress to the joint, increase its progression. Improved outcomes for patients treated with arthroscopy for FAIS with concomitant mild OA have been reported[102, 103]. However, hip arthroscopy as treatment of OA alone is the subject of intensive debate. Even though some studies report improved outcomes in the short-term follow-up, it is proposed that arthroscopy is not indicated for OA[104, 105]. Another reflection is the possible influence on the outcomes of a THA with a prior arthroscopic hip surgery. Most studies evaluating this have not found inferior outcomes in patients with a prior hip arthroscopy[106, 107]. It is worth mentioning that the occurrence of FAI morphology does not always cause FAI syndrome and subsequent OA. Regardless, FAI morphology without symptoms should not, based on the current knowledge, be corrected surgically to prevent the development of OA.

GOTHENBURG HIP ARTHROSCOPY REGISTRY

Since 2011, all hip arthroscopies performed at two centers in Gothenburg, Sweden; Orthocenter Gothenburg and Mölndal Hospital/Sahlgrenska University Hospital, are collected in a local registry[108]. The registry was initially started as a quality registry to collect both surgical and epidemiological data, facilitating the evaluation of hip arthroscopy related in particular to surgical decision-making. The registry has since then led to several publications[85, 102, 109, 110]. The registry contains all hip arthroscopies performed at the two hospitals, regardless of diagnosis, although the most common diagnosis is FAIS. The patients are enrolled in the registry prospectively, and since 2011, more than 2,600 patients have been enrolled. It covers both patient demographic data, surgical procedures and PROMs. At the time of surgery, a form with demographic data including participation in sports is completed, as well as perioperative data such as findings, procedure performance and traction time. Before surgery, and then at regular follow-ups (two, five and eventually ten years after surgery) the patients are asked to fill out web-based PROMs, including the HAGOS, iHOT-12, EQ-5D, EQ VAS, HSAS and a VAS for overall hip function, and at the follow-up they also answer a question regarding satisfaction with the surgery. The answers to these PROMs are then stored in the registry. The surgeon is responsible for including the surgical variables in the registry for each patient.

RATIONALE FOR THIS THESIS

Femoroacetabular impingement syndrome is still a relatively new diagnosis and the treatment with arthroscopic surgery is still evolving. The incidence of FAIS is increasing, probably not due to higher incidence per se, yet rather due to increasing knowledge of the diagnosis[51]. Further, there has been a rapid expansion of hip arthroscopic surgeries performed, with a corresponding escalation in published articles in the field[10]. With such a rapid development, it is of great importance to follow the outcome of the procedures with high-quality, validated methods. Several outcomes are still performed and reported using old-fashioned PROMs, which are not recommended for the young and typically athletic FAIS population[67]. This thesis uses the local hip registry in Gothenburg, which has a good compliance using validated and recommended PROMs enabling the evaluation of prospectively collected data[108].

This thesis also confirms the responsiveness and the representativeness of the registry. Although RCTs are regarded as the highest evidence of research, it is important to include different cohorts, where prospective and retrospective studies might be suitable. For the individual patient, regardless of the question of athletic performance or the future risk of OA, their individual result is important. Clinical studies with homogeneous cohorts are desirable in order to present a credible outcome. In the end, it is not only important to perform skilled surgery, the most important issue at hand is to choose the right patient for surgery. Good, high-quality research on all levels of research will in the end eventuate in high evidence in general. This thesis is another piece of the puzzle designed to achieve evidence-based research in the arthroscopic treatment of FAIS.

OVERALL AIMS

The overall purpose of this thesis was to evaluate the midterm outcomes after hip arthroscopy for femoroacetabular impingement syndrome both in the general population and with greater emphasis on the athletic population.

STUDY I

The purpose of Study I was to evaluate the outcomes after hip arthroscopy for femoroacetabular impingement syndrome in elite athletes five years after surgery in terms of patient-reported outcome measures.

STUDY II

The purpose of Study II was to evaluate whether patients not responding to follow-up after hip arthroscopy differ in their clinical outcomes compared with those responding, and to examine the impact of loss to follow-up.

STUDY III

The purpose of Study III was to assess the outcomes of hip arthroscopy in ice hockey players and to further evaluate the differences in outcomes between player positions and to assess whether stick handedness affects the hip that is symptomatic.

STUDY IV

The purpose of Study IV was to determine the influence of a prior hip arthroscopy on a subsequent total hip arthroplasty.

STUDY V

The purpose of Study V was to evaluate the trends seen in the publications in terms of surgery for FAIS with the emphasis on PROMs.

INTRODUCTION

AIMS

METHODS

SUMMARY OF STUDIES AND RESULTS

DISCUSSION

LIMITATIONS

CONCLUSION

FUTURE PERSPECTIVES

ACKNOWLEDGEMENTS

REFERENCES

STUDIES I-IV

All patients included in Studies I-IV are prospectively included in the local hip registry in Gothenburg, Sweden[108]. Prior to surgery, a form including demographic data is completed, and the patients further fill out the preoperative PROMs. The form with demographic data includes age, gender, body mass index (BMI), symptom duration and sports participation. At the two-, and five-year follow-up, the patients fill out the same PROMs again, with the addition of a question related to satisfaction with surgery (yes or no). The surgeon describes the perioperative findings and performed procedures in the patients' notes and in a specific form included in the registry.

The hip arthroscopies were all performed at two centers in Gothenburg, Sweden - Orthocenter Hospital or Mölndal Hospital, Sahlgrenska University Hospital. Indication for surgery was a diagnosis of FAIS according to the Warwick Agreement with radiographic signs, a history of pain and an examination correlating with FAIS. The Lauenstein/modified Dunn view projection was used for plain radiographs to evaluate radiographic signs. As previously mentioned, there is no defined cut-off value for the alpha angle, and it was therefore up to the surgeon to evaluate the radiographs and no measurements or cut-offs are included or described in the studies. Moreover, a failed non-surgical treatment with physiotherapy was mandatory before undergoing surgery. General contraindications for surgery are advanced OA or severe dysplasia.

SURGICAL TREATMENT

The surgical arthroscopic technique for the patients in this thesis has previously been described[85].

The patient is positioned on an appropriate traction table in a supine position. Two portals are preferable, one located anterolaterally and one mid-anteriorly. With the use of fluoroscopy, the portals are placed to minimize the risk of iatrogenic injury to the articulating surfaces. The needle is inserted under fluoroscopic guidance into the peripheral compartment through the anterolateral portal. A Seldinger technique is used to place the trocar correctly into the peripheral compartment and thereafter to insert the camera. A shaver is then inserted using the same technique through the mid-anterior portal. After the establishment of portals, the instruments are switched and the camera is put in the mid-anterior portal and the instrument in the anterolateral. A capsulotomy is performed longitudinally in the direction of the ligaments to avoid excessive damage to the joint capsule. No transverse capsulotomy is performed and no capsular closure is therefore deemed necessary at the end of the procedure. The need for capsular closure is still the subject of debate amongst surgeons performing hip arthroscopy and a consensus has yet to be reached[111]. The iliofemoral, pubofemoral and ischiofemoral ligaments creating the capsule perform an important function, primarily in stabilizing the hip joint, and the surgeons performing the interventions in this study thus perform a longitudinal capsulotomy with minimal damage to the capsule. A transversely oriented capsulotomy, on the other hand, could theoretically, lead to instability of the hip joint to a greater degree.

The central compartment is accessed after the capsulotomy using axial traction of the leg, distracting the femoral head from the acetabulum. The central compartment, including the acetabular and femoral cartilage, the labrum, the chondrolabral junction, the cotyloid fossa, ligamentum teres and the transverse ligament, can be viewed. These structures are briefly described in the chapter on anatomy. Procedures in the central compartment may involve loose-body removal, cartilage debridement, microfracture, ligamentum teres debridement and a diagnostic evaluation. When the visualization of the central compartment is completed, the traction is released. Nowadays, the traction generally lasts only five to six minutes.

To visualize the peripheral compartment, including the labrum and synovium, a similar approach is executed, yet without traction. When performing procedures in the peripheral compartment, the camera is in the mid-anterior portal and the instrument (shaver or burr) is placed in the anterolateral portal and can be switched if needed. Pincer morphology can be dealt with as needed with an acetabuloplasty using an "over-the-top" technique, often without the need for a labral take-down. After the acetabuloplasty, the integrity of the labrum is appraised. The labrum is usually left in situ in the event of minor pincer resections, however, if the labrum is considered unstable or its attachment compromised, it may be re-attached to the acetabulum using suture anchors. The femoral deformity (cam) is then resected throughout the femoral neck in a posterior-medial direction to prevent damage to the retinacular vessels, which could lead to osteonecrosis of the femoral head. Perioperative fluoroscopy is used throughout the surgery allowing for a dynamic evaluation of the joint ensuring optimal resection and correction of the morphology causing the impingement, in order to achieve the best possible result.

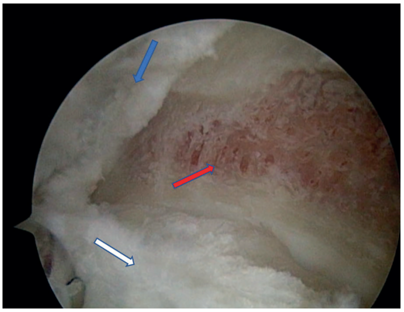

FIGURE 9: An arthroscopic view of the acetabulum after pincer resection (red arrow), with the joint capsule (blue arrow) and labrum (white arrow).

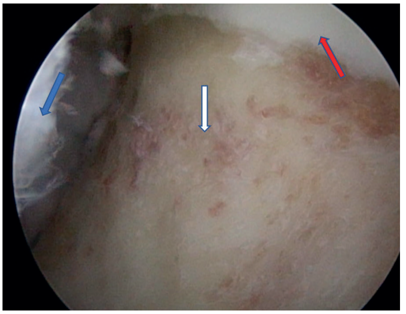

FIGURE 10: An arthroscopic view of the femoral neck after cam resection (white arrow), the femoral head cartilage (red arrow) and the inside of the joint capsule (blue arrow).

Cartilage damage is classified according to Konan et al.[112]. The earlier, commonly used classification by Beck et al.[113] was described for lesions found during SHD. Konan et al.[112] instead defined these lesions during arthroscopy and validated their classification. It was further reported to have high intra-observer reliability. The classification is a scale of 0 to 4 where 0 equals normal articular cartilage and 4 is pure exposed bone. The lesion is then defined as A, B or C, depending on the distance from the acetabular rim to the cotyloid fossa. The Konan classification is described in Table 1.

TABLE 1: Cartilage classification according to Konan et al.[112]

CLASSIFICATION	EXPLANATION
Grade of cartilage	
0	Normal articular cartilage
1	Softening or wave sign
2	Cleavage lesion between articular cartilage and labrum
3	Delamination of the articular cartilage
4	Exposed bone
Site of the lesion	
A	<1/3 of the distance from the acetabular rim to the cotyloid fossa
B	1/3 – 2/3 of the distance from the acetabular rim to the cotyloid fossa
C	>2/3 of the distance from the acetabular rim to the cotyloid fossa

There are no restrictions in terms of ROM or weight-bearing after the surgery. Patients are recommended to use crutches for outdoor activities during the first four weeks after surgery to limit the load and reduce the risk of femoral neck fracture. Individualized, monitored physiotherapy is suggested directly after surgery with focus on ROM, strength and balance. To minimize heterotopic ossification, the patients are prescribed a three-week course of NSAIDs. The patient is allowed to return to sport when tolerated and after assessment by the physiotherapist and, when relevant, in agreement with the individual or team coach.

PATIENT-REPORTED OUTCOME MEASURES INCLUDED IN STUDIES I-III

The PROMs included in the local hip arthroscopy are the iHOT-12[70], the HAGOS[71], the EQ-5D and the EQ VAS[75], the HSAS[76], a VAS for hip function and a single question related to satisfaction with surgery. There are sixty questions in total and it takes less than ten minutes to complete the PROMs. For the complete questionnaires, see the appendix.

THE INTERNATIONAL HIP OUTCOME TOOL: iHOT-12

The iHOT-12 score was published in 2012 and was developed from the iHOT-33, with the purpose of evaluating treatment in young, active patients with hip disorders[70]. Its former model included almost three times as many questions, and this shorter version was therefore invented to reduce the patient burden and administration in order to facilitate its use in clinical practice. It is a validated and reliable questionnaire including 12 questions covering aspects of daily life and function in sports and activity. The questions are answered with a VAS scale with anchor statements on the left (worst) and on the right (best). A Swedish version, also validated and tested for reliability, was used in this project[114].

THE COPENHAGEN HIP AND GROIN OUTCOME SCORE: HAGOS

The HAGOS was developed in 2011 as a reliable PROM suitable for young to middle-aged and active individuals with hip and/or groin pain[71]. The PROM contains six subscales, measuring pain, symptoms, physical function/activity in daily living (ADL), physical function in sport and recreation, participation in physical activity (PA) and hip and/or groin-related quality of life (QoL). Each subscale has its own set of questions specific to the topic and is answered on a five-level Likert scale, and a separate total score is calculated and interpreted for each subscale ranging from 0 (worst) to 100 (best). A Swedish version, also validated and tested for reliability, was used in this project[115].

EUROPEAN QUALITY OF LIVE- FIVE DIMENSIONS: EQ-5D

The EQ-5D is a widely used measure of health-related quality of life. It is frequently used both in clinics and in health surveys[75]. The initial purpose of the EQ-5D was to design a standardized, generic PROM that would complement other specific PROMs. The EQ-5D covers two parts to classify the patient's health, the first includes five questions covering different dimensions, and the second includes a VAS-scale (EQ VAS), measuring health, where 0 is worst and 100 is the best health the patient can imagine. The five dimensions cover mobility, self-care, usual activities, pain/discomfort and anxiety/depression. Each dimension is answered separately on a three-step severity level (no, slight or extreme problems). This is then converted into a summary index, with a range from -0.594 (worse than death) to 1 (perfect health).

HIP SPORT ACTIVITY SCALE: HSAS

The HSAS was invented to facilitate the rating of a patient's activity level in sports and was especially developed to target patients with FAIS[76]. It is based on the Tegner activity scale and adjusted for sports activity level from a hip perspective[116]. It is a scale with 9 grades with 0 as the lowest "no recreational or participation in sports", and 8 as the highest, including competitive sports at elite level. The classification differs depending on the sport, and the different levels reflect both intensity and demands on the hip joint. The patients fill out their current activity level and their level prior to onset of symptoms and in the adolescence. The HSAS is preferable when evaluating this patient group since it is a hip specific activity scale. A Swedish version, validated and tested for reliability, was used in this project[117].

VISUAL ANALOGUE SCALE FOR OVERALL HIP FUNCTION

This is a single question where the patient rates their overall hip function on a scale ranging from 0 (worst) to 100 (best).

SATISFACTION

The last item included in this project is a single question regarding satisfaction with surgery with a binary outcome. This is only asked at the follow-up and not preoperatively.

PATIENT-REPORTED OUTCOME MEASURES INCLUDED IN STUDY IV

Study IV includes the EQ-5D and EQ VAS described previously in this chapter. Two further PROMs are included, one addressing hip pain and one satisfaction. The PROM covering hip pain is a Likert scale with five levels, where one (1) equals no pain and five (5) equals severe pain. Further, the item covering satisfaction is a similar Likert scale of five levels where one (1) equals very dissatisfied and five (5) equals very satisfied.

STUDY I

Between November 2011 and December 2012, elite athletes undergoing arthroscopic surgery for FAIS were included. The inclusion criteria were age between 18-40 at the time of surgery, and a career as an elite athlete prior to symptoms. The definition of elite athlete was an HSAS of 7 or 8 prior to symptoms. The exclusion criterion was hip surgery on the current hip prior to arthroscopic treatment. Further, patients with a conversion to total hip arthroplasty during the follow-up were not included in the study. The follow-up was performed five years post-surgery.

Altogether, 85 elite athletes found with an HSAS of 7-8 underwent surgery between 2011 and 2012. One of these had received a THA and six had undergone prior surgery on the current hip. Of the patients eligible for the study, 82% had responded to the five-year follow-up, with 64 patients included in the study. To clarify the fact that the published study mentions 79 being eligible, see the flow of included athletes in Figure 11.

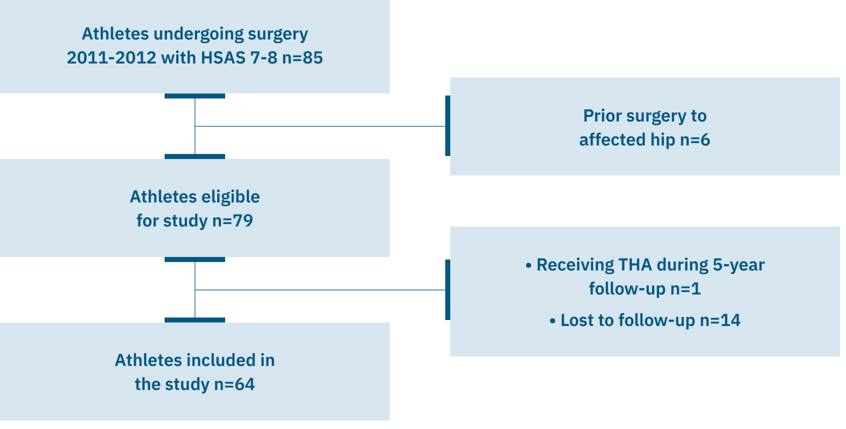

FIGURE 11: Flowchart of elite athletes included in Study I. HSAS, Hip Sports Activity Scale, THA, total hip arthroplasty

STATISTICAL METHODS FOR STUDY I

The Statistical Analysis System for Windows (SAS, version 9.1) was used. Demographic variables were presented with descriptive statistics, and expressed with mean and standard deviation (SD) for continuous variables and frequencies and percentages for categorical variables. The Wilcoxon signed rank test, and the sign test were used to compare the PROMs preoperatively and at the five-year follow-up for continuous and categorical variables respectively. The Spearman correlation was used to study correlation between HSAS and continuous variables. A p-value of <0.05 was considered statistically significant. The MIC values were used for iHOT-12 and HAGOS subscales. Definitions for the MIC values have previously been described and were used accordingly[114, 115].

STUDY II

Between January 2015 and December 2016 all consecutive patients reported in the hip arthroscopy registry with preoperative PROMs were included. The exclusion criteria were hip surgery on the current hip prior to arthroscopic treatment or a re-operation including a conversion to THA during the follow-up period. The patients were followed for two years. The cut-off of the two-year follow-up and the included years of 2015-2016 were chosen for two main reasons:

> **1: To increase the study population, as five-year data were not yet available.**
>
> **2: Data before 2015 were regarded as being too old, causing a large difference in the follow-up period between the two groups.**

The included patients were divided into two groups depending on whether or not they had responded to the two-year follow-up. A responder (R-group) was defined as having completed any of the follow-up data and a non-responder (NR-group) was defined if no data were completed. The patients considered NR were contacted and asked to fill in the missing two-year PROMs. Contact was made by email and phone calls in 2019 and the time span from first contact to answering PROMs was within three months. From the NR-group, two subgroups were defined: either responding to the follow-up defined as initial non-responders (INR) or not responding (unavailable). Of the 556 patients undergoing surgery between 2015-2016, 20 had undergone a THA and were excluded, 396 patients were included in the R-group and 107 were included in the INR-group. Figure 12 displays a flow chart of the included patients.

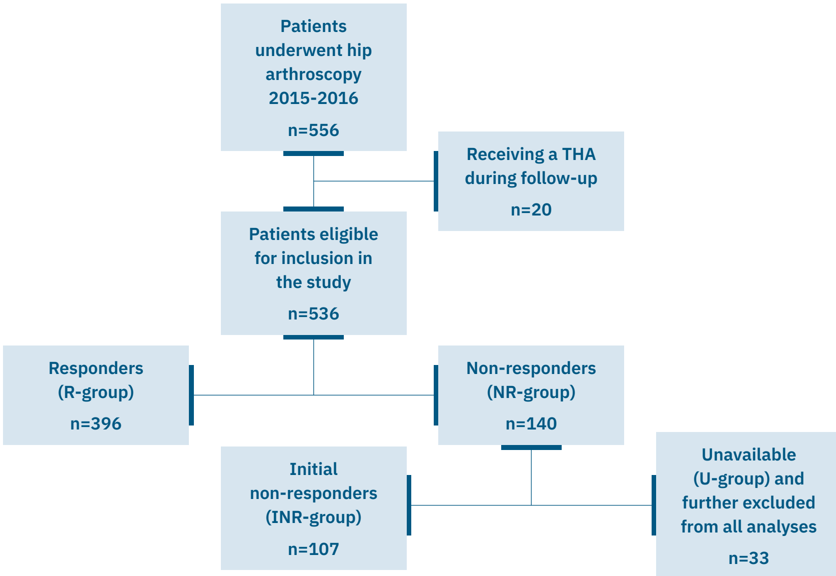

FIGURE 12: Flow chart of patients included in Study II. THA, total hip arthroplasty.

Both PROMs and demographic data were compared between the R- and INR-groups to find any discrepancies between the two groups.

STATISTICAL METHODS FOR STUDY II

The Statistical Analysis System for Windows (SAS, version 9.1) was used to perform the statistical analyses. Continuous variables were expressed as mean and standard deviation (SD), while categorical variables expressed as the count (n) and proportion. The Fisher's exact test was used for dichotomous variables and the Fisher's non-parametric permutation test was used for continuous variables when comparing the R- and INR-group. A linear regression analysis was performed to find correlation between variables. A p-value of <0.05 was considered statistically significant.

STUDY III

Between January 2011 and December 2019, all high-level ice hockey players undergoing hip arthroscopy and registered in the hip arthroscopy registry were included in the study. To determine high-level, an HSAS of 7 or 8 prior to symptoms or in the youth was applied corresponding to minor or college leagues and elite level respectively. The exclusion criteria were an absence of preoperative

PROMs, a lack of HSAS prior to surgery and conversion to a THA throughout the study period. The follow-up period was two years.

In addition to demographic data found in the local hip registry and patients' notes, data related to ice hockey were collected from publicly available sources. Player positions were defined as defenseman, forward and goalkeeper. Stick handedness was defined as right or left shooter.

The inclusion criteria were met by 172 ice hockey players. Several analyses were performed depending on available data. The players who underwent surgery prior to 2018 and with completed PROMs were included in the analysis regarding outcomes of PROMs. Players who underwent surgery during or after 2018 were not included as their two-year PROMs were not yet available. Further, players with both PROMs and verified hockey data were included in the specific analyses regarding player position and stick handedness. Figure 13 displays the inclusion of the ice hockey players and the numbers of players included in the different analyses.

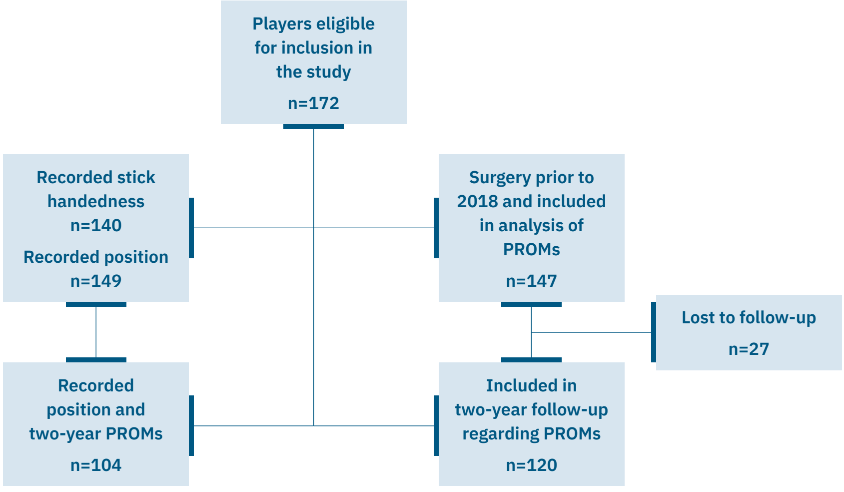

FIGURE 13: Flow chart of ice hockey players included in Study III. PROMs, patient-reported outcome measures.

STATISTICAL METHODS FOR STUDY III

The Statistical Analysis System for Windows (SAS, version 9.1) was used to perform the statistical analyses. A power analysis was performed a priori concluding that at least 75 players were necessary for the study. Demographic variables were presented with descriptive statistics, and expressed with mean and standard deviation (SD) for continuous variables and frequencies and percentages for categorical variables. The Wilcoxon signed-rank test was used to evaluate outcome in PROMs from before surgery to two-years post-surgery. To compare outcomes in PROMs between player positions, the Kruskal-Wallis test was applied. The chi-square test was used to evaluate any relationship between stick handedness and the side of the affected hip. A p-value of <0.05 was considered statistically significant. The MIC- and the PASS-values were used to decide clinical relevance of the changes seen in PROMs. Previously determined MIC- and PASS-values for the iHOT-12 and only MIC-values for the HAGOS were used[74, 114, 115].

STUDY IV

Between 2011 and 2018, all consecutive patients undergoing hip arthroscopy for FAIS were linked to the Swedish Hip Arthroplasty Register (SHAR) [118]. The SHAR is a national quality registry covering all primary THAs performed in Sweden with a 98% completeness. These two registries were linked to find patients with a hip arthroscopy prior to receiving a THA. In bilateral cases, the first operated hip was included. The exclusion criteria were a fracture or tumor as an indication for receiving a THA. Further exclusion criteria were missing preoperative PROMs or demographic data. Two different control groups were created from the SHAR. First, an overall control group covering all patients undergoing primary THA surgery between 2011-2018 was found. From this group, a 1:4 propensity-score matched (PSM-group) control group was created. This PSM-group was created to find differences in PROMs. Variables included in the PSM were age, gender, BMI, ASA classification, arthroplasty fixation, preoperative EQ VAS score and preoperative score of hip pain. As demographic data were included in the PSM, the overall cohort was included to identify variations in baseline data. The follow-up was one year after receiving a THA and PROMs and rate of reoperation were compared between the treated group and the PSM-group. The treated group with a hip arthroscopy prior to the THA consisted of 135 patients, the PSM-group consisted of 540 patients and the overall control group consisted of 71,891 patients. Figure 14 displays the flow of the included patients.

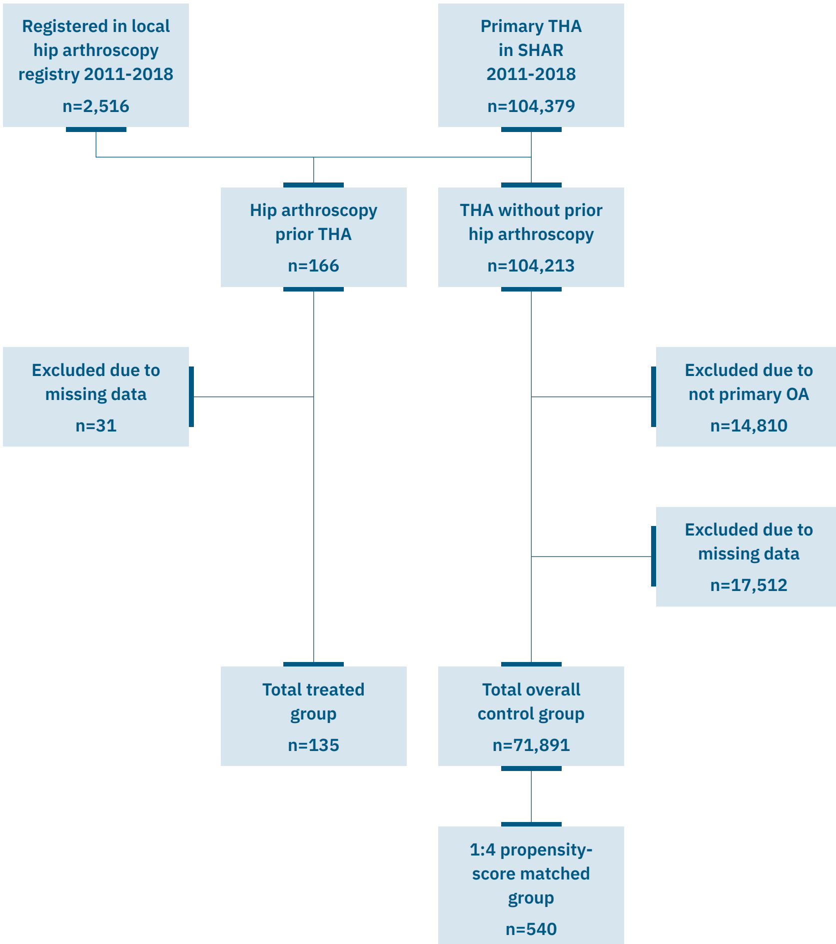

FIGURE 14: Flow chart of included patients in Study IV. OA, osteoarthritis. SHAR, Swedish Hip Arthroplasty Register. THA, total hip arthroplasty.

STATISTICAL METHODS FOR STUDY IV

The R version 3.6.1 (R Centre for Statistical Computing, Vienna, Austria) was used to perform the statistical analyses. The two-sample t-test was used for continuous variables and Pearson's chi-square test of independence for categorical variables was used to compare outcomes between the treated and the PSM-group. To compare the rate of reoperations, the Fisher's exact test was used. The mean, standard deviation and 95% confidence intervals were reported. A p-value of <0.05 was considered significant. The propensity score matched every treated patient with four patients without a prior hip arthroscopy. The 1:4 nearest-neighbor was matched without replacement, meaning that each patient treated with hip arthroscopy was matched to four patients without a prior hip arthroscopy. To examine the balance of covariate distribution between the two groups, a standardized mean difference (SMD) of <10% was considered a good propensity match. An improvement of 15 points was used as the MIC value for EQ VAS[119]. For the question regarding satisfaction, the Likert scale was dichotomized into "satisfied" and "dissatisfied".

STUDY V

This was a systematic review conducted in accordance with the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) protocols[120].

The inclusion criteria were clinical studies with patients who had undergone primary surgery for FAIS. The studies were obliged to include PROMs to be eligible. Both RCTs, prospective and retrospective designs were included and the study could be either therapeutic or prognostic. The definition of a therapeutic study was a study investigating the result of a treatment (for example arthroscopy for FAIS), while the definition of a prognostic study was a study considering the outcome of a disease (for example how a certain characteristic affects the result after FAIS surgery). English language was mandatory.

The exclusion criteria were:

- **Studies comprising fewer than eight patients.**
- **Inclusion of patients <18 years old including description of "open physes".**
- **Studies that primarily investigated diagnoses other than FAIS or only used patients with FAIS as a control group.**
- **Studies including radiographic outcomes, yet lacking PROMs.**
- **Studies investigating revision surgery.**
- **Studies validating PROMs.**
- **Systematic reviews, conference papers, protocols, narratives and similar study designs.**

The search was performed in PubMed and Embase and was performed in collaboration with a librarian with proficiency in such searches at the Sahlgrenska University Hospital Library, Gothenburg, Sweden. The search covered the period from 1st of January 1999 to search day 7th of September 2020. Alterations to the words *hip impingement* OR *femoroacetabular impingement* OR *FAIS* in combination with alterations to the words *surgery* OR *arthroscopy* were applied.

The complete search strategy can be found in the Appendix for Study V.

To identify appropriate studies, two independent reviewers screened titles, abstracts and further full texts. Duplicates were detached. If the title or abstract did not provide satisfactory information to conclude qualification, it was automatically included in the next step of the screening. Any disagreement at full-text was resolved by consensus.

Data were extracted by one reviewer and included:

- **Information about the study such as: authors, title, year of publication, journal, country**
- **Type of study**
- **Level of evidence**
- **Type of surgery**
- **Characteristics of the patients (number of patients, gender and follow-up period)**
- **Information about included PROMs**
- **Inclusion of return to sport**
- **Inclusion of assessment of satisfaction**

No meta-analysis or quality assessment was conducted for two main reasons:

- **The heterogeneity of the included studies, which prevented a structured and correct assessment**
- **Since the aim of the study was to evaluate the trends in the literature and not the quality of the studies, it was decided that an assessment would not contribute**

As no meta-analysis was planned, studies with different purpose, yet covering the same group of patients were included in this systematic review.

STATISTICAL METHODS FOR STUDY V

The Microsoft Excel (version 16.40, Microsoft Corporation) was used to perform the statistical analyses. Agreement between reviewers was described as a percentage and assessed with Cohen's kappa[121]. Descriptive statistics were expressed for variables and the mean, standard deviation (SD), median and range values were expressed when suitable.

ETHICAL CONSIDERATIONS

Studies I-IV included data collected from the local Gothenburg hip arthroscopy registry containing personal data. Before undergoing surgery, the patients receive both written and oral information about the hip registry and its purpose of research. All patients have given informed consent prior to filling out the questionnaires. Studies I-IV have received ethical approval from the Swedish Ethical Review Authority (Table 2).

TABLE 2: The ethical approval for each study.

	NUMBER
Study I	071-12
Study II	071-12 with an additional number of 2019-02990
Study III	2019-06050
Study IV	2019-04682

As Study V was a systematic review, only including a literature search and no management or collection of personal data, no ethical approval was required.

The data collected from the patients were initially collected prior to the introduction of the General Data Protection Regulation (GDPR), yet all personal data have been safeguarded accordingly, both before and after the introduction of the law. Data are coded wherever possible and have been secured during the process. Published data are anonymized and cannot be traced to the individual. The patients can easily request their data to be deleted and are under no obligation to remain in the registry. Finally, all the studies have been executed according to the Declaration of Helsinki.

What are the ethical concerns about surgery and research in femoroacetabular impingement syndrome? There is always a risk when undergoing surgery, however, no patient in this thesis underwent any extra radiation, surgery or examination due to the research. Even if the research is performed according to the above-mentioned laws, there is always a risk relating to the integrity of the patients. In spite of this, considering the relatively large groups of patients, and no inclusion of sensitive data, the risk should be regarded as minimal. In Study II, we called the patients by telephone to remind them about filling out the forms, however, no personal questions were asked during this telephone call.

Further, when looking at a larger ethical perspective, the majority of the patients in the thesis are men. In Study III, only three women fulfilled the inclusion criteria. There was no prior intention to exclude women from this thesis. Several previous studies have concluded that FAIS, especially cam morphology, is more common in men. It has further been suggested that women have less satisfactory results after arthroscopic treatment than men. However, as mentioned in the introduction, diagnosis is important. One reason why women experience less satisfactory results after surgery than men might be the differential diagnostic difficulties and sometimes unclear indication for surgery. However, these are just speculations and further research comparing men and women from the time point of diagnosis to outcome after surgery is needed to confirm this.

STUDY I

Five-Year Outcomes After Arthroscopic Surgery for Femoroacetabular Impingement Syndrome in Elite Athletes

This study evaluates the outcome in elite athletes five years after arthroscopy for FAIS.

Sixty-four elite athletes, of which twenty underwent bilateral surgery, were included (mean age 24 (±6) years, 19% female) in the study. The mean duration of symptoms was 31 months. Of the 84 included hips, 43 had only cam morphology and 41 had mixed impingement, with a combination of cam and pincer. None of the included hips had isolated pincer morphology. Microfracture was performed in four hips and the labrum was repaired in eight hips (Table 3). Cartilage injury was reported in half of the included hips (Table 4).

There was a significant improvement in the HAGOS, EQ-5D, EQ VAS, iHOT-12 and VAS hip pain when comparing preoperative scores with the five-year follow-up scores (Table 5). The MIC value was exceeded for the HAGOS (73% for symptoms, 69% for pain, 55% for ADL, 73% for sports, 75% for physical activity and 86% for QoL) and the iHOT-12 in 73% of the patients. Satisfaction with surgery was confirmed in 90.5% of the athletes.

Soccer and ice hockey were the most frequently practiced sports (Figure 15). At the follow-up, 54% participated in competitive sports (defined as HSAS 5-8). A decrease in level was reported in 77% of the patients and 21% remained on the same level five years after surgery (Figure 16). Lower levels (defined as HSAS 0-4) were significantly correlated with higher age and longer symptom duration.

TABLE 3: Demographics and surgical data

BASELINE CHARACTERISTICS	
Age at time of surgery - years, mean (SD)	24 (6)
Male gender, n (%)	52 (81)
Symptom duration - months, mean (SD)	31.0 (32.7)
BMI, mean (SD)	23.7 (2.1)
Total number of hips	84
Cam/pincer/mixed, n (%)	43/0/41 (51/0/49)
Labral repair, n (%)	8 (9)
Labral resection, n (%)	1 (1.2)
Microfracture, n (%)	4 (4.8)

BMI, body mass index. n, numbers. SD, standard deviation.

TABLE 4: Classification of chondral injury according to Konan et al.[112] presented as numbers and percentages of hips.

CARTILAGE DAMAGE	HIPS, N (%)
0	36 (43)
1a	5 (6)
1b	0 (0)
1c	0 (0)
2	20 (24)
3a	14 (17)
3b	2 (2)
3c	0 (0)
4a	0 (0)
4b	1 (1)
4c	0 (0)
Not visualized	6 (7)

TABLE 5: Patient-reported outcome measures preoperatively and at the five-year follow-up (n=64)

	BEFORE SURGERY	FIVE-YEAR FOLLOW-UP	CHANGE	P-VALUE
HAGOS				
Symptoms	51.7 (19.9)	71.9 (21.9)	20.3 (22.2)	<.0001
Pain	61.0 (18.5)	81.1 (20.8)	20.1 (20.3)	<.0001
Function in daily living	67.1 (22.4)	83.6 (21.8)	16.5 (23.3)	<.0001
Sports and recreation	40.0 (21.8)	71.5 (27.0)	31.5 (30.2)	<.0001
Participation in PA	25.0 (25.7)	67.4 (32.2)	42.4 (39.0)	<.0001
Hip and groin related QoL	34.4 (21.4)	68.0 (28.0)	33.6 (27.5)	<.0001
iHOT				
iHOT-12	40.0 (18.5)	68.8 (29.3)	28.8 (27.0)	<.0001
EQ				
EQ-5D	0.60 (0.276)	0.83 (0.220)	0.23 (0.235)	<.0001
EQ VAS	66.1 (18.6)	76.7 (18.1)	10.6 (22.0)	0.0002
Other				
Hip function - VAS	49.2 (20.2)	74.4 (21.0)	25.6[a] (24.5)	<.0001
Satisfaction with surgery Satisfied Not satisfied	NA	 57 (90.5%)[a] 6 (9.5%)	NA	NA

Presented as the mean value and standard deviation and % for the satisfaction score. EQ-5D, European Quality of Life-5 Dimensions Questionnaire. HAGOS, Copenhagen Hip and Groin Outcome Score. iHOT-12, international Hip Outcome Tool (short version). NA, not applicable. PA, physical activities. QoL, quality of life. VAS, visual analogue scale. [a]The number of patients answering the question regarding hip function and satisfaction with surgery at the five-year follow-up was 63 patients.

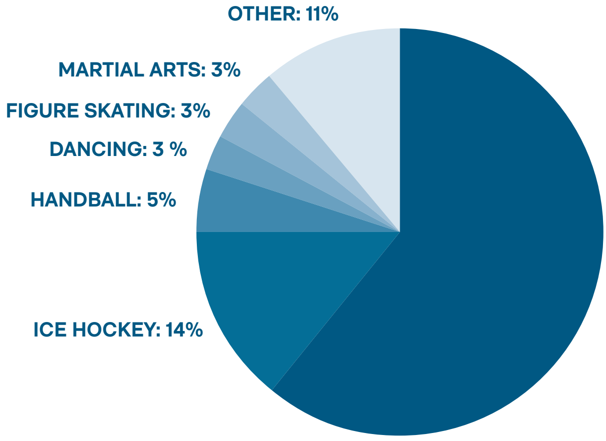

FIGURE 15: Sports participation before symptoms presented with percentages.

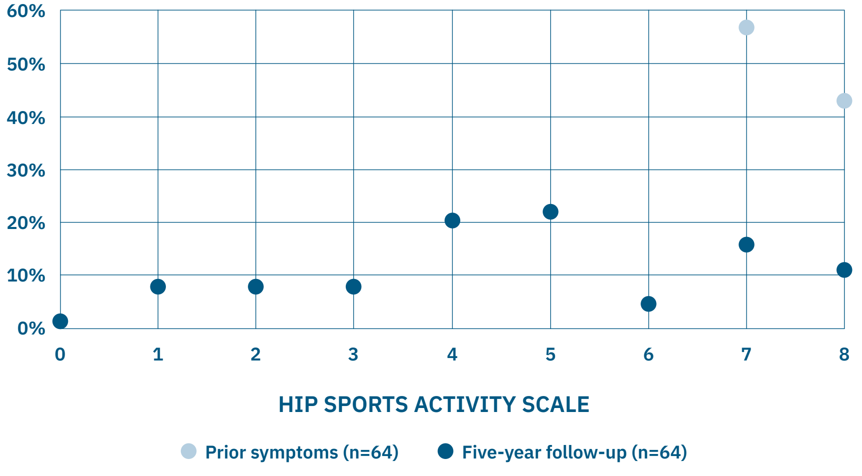

FIGURE 16: The Hip Sports Activity Scale before onset of symptoms and at the five-year follow-up presented as percentages.

CONCLUSION STUDY I

Five years after hip arthroscopic surgery elite athletes reported statistically significant and clinically relevant improvements in outcomes. More than 50% still remained at a competitive level, while 77% had reduced their level of activity. Nevertheless, over 90% reported satisfaction with surgery.

STUDY II

Loss to follow-up: initial non-responders do not differ from responders in terms of 2-year outcome in a hip arthroscopy registry

This study aims to assess the effect of dropouts in registry studies linked to hip arthroscopy.

Of the 536 eligible patients, 74% were included in the R-group and 20% were included in the INR-group, while the remaining 6% did not reply and were further excluded, contributing to a total cohort of 503 patients. The follow-up was 24.7 (±2.9) months and 42.5 (±7.0) months for the R- and INR-groups respectively. There was a significant difference in age between the two groups. No other differences were seen in terms of demographic data between the two groups (Table 6). The HAGOS with six subscales, iHOT-12, EQ-5D, EQ VAS and VAS for hip function yielded no significant differences, either at the two-year follow-up or in the change from preoperative status to the two-year follow-up (Table 7). There was a difference in terms of satisfaction between the two groups, where 86% of the R-group reported satisfaction with surgery compared with 70% of the INR-group (p=0.0003). Further, the HSAS during adolescence and prior to symptoms differed between the two groups (Table 8).

TABLE 6: Demographic data of included patients

	R-GROUP	INR-GROUP	P-VALUE
Age at time of surgery - years, mean (SD)	35.6 (12.7)	31.5 (12.5)	0.002
Male gender, n (%)	269 (68)	82 (77)	0.1
BMI - kg/m^2, mean (SD)	24.6 (3.2)	25.2 (4.0)	0.18
Symptom duration - months, mean (SD)	46.3 (48.4)	38.4 (45.4)	0.14
Bilateral procedure, n (%)	152 (38)	51 (48)	0.1

BMI, body mass index. INR, initial non-responders. n, numbers. R, responders. SD, standard deviation.

TABLE 7: Patient-reported outcome measures at the two-year follow-up and change between preoperative and follow-up.

	R-GROUP	INR-GROUP	P-VALUE	R-GROUP CHANGE	INR-GROUP CHANGE	P-VALUE
HAGOS						
Symptoms	69.7 (20.7)	69.3 (25.3)	0.87	17.4 (21.3)	17.9 (21.2)	0.77
Pain	75.5 (20.4)	76.0 (25.3)	0.87	19.1 (21.0)	19.8 (22.2)	0.74
Function in daily living	79.3 (21.6)	78.3 (26.5)	0.71	19.5 (22.9)	18.9 (26.0)	0.84
Sports and recreation	64.9 (27.4)	67.0 (30.0)	0.49	23.1 (27.1)	28.7 (28.3)	0.06
Participation in PA	58.5 (33.7)	58.7 (34.6)	0.96	30.1 (36.3)	33.8 (35.9)	0.37
Hip and groin related QoL	58.1 (26.4)	59.9 (30.0)	0.59	28.0 (25.5)	29.8 (27.8)	0.54
iHOT						
iHOT-12	66.6 (25.1)	68.0 (26.6)	0.61	22.0 (23.4)	24.5 (25.1)	0.36
EQ-5D						
EQ-5D	0.75(0.24)	0.74 (0.30)	0.54	0.19 (0.31)	0.18 (0.32)	0.72
EQ VAS	64.3 (18.8)	65.2 (19.9)	0.68	9.7 (19.4)	8.4 (23.6)	0.56
Hip function - VAS	69.5 (21.7)	65.1 (27.0)	0.08	21.7 (25.0)	19.5 (27.2)	0.46

Presented as the mean value and standard deviation. EQ-5D, European Quality of Life-5 Dimensions Questionnaire. HAGOS, Copenhagen Hip and Groin Outcome Score. iHOT-12, international Hip Outcome Tool (short version). INR, initial non-responders. PA, physical activities. QoL, quality of life. R, responders. VAS, visual analogue scale.

TABLE 8: Hip Sports Activity Scale for both responders and initial non-responders at present time of follow-up, before onset of symptoms and in adolescence.

	R-GROUP	INR-GROUP	P-VALUE
HSAS at present time of follow-up	3.8 (2.1)	4.1 (2.3)	0.19
HSAS prior to symptoms	5.2 (1.9)	5.8 (2.0)	0.002
HSAS in the adolescence	5.7 (1.8)	6.2 (1.8)	0.009

Presented as the mean and standard deviation. HSAS, Hip Sports Activity Scale. INR, initial non-responders. R, responders.

CONCLUSION STUDY II

No differences were found in validated PROMs at follow-up for patients undergoing surgery for FAIS between those patients who had responded to the two-year follow-up evaluation compared with the patients who had not initially responded. The only outcome differing at follow-up was patient satisfaction. This suggests that the results from a hip arthroscopy registry are reliable and that patients lost to follow-up do not have to bias the outcomes.

STUDY III

Improvements After Arthroscopic Treatment for Femoroacetabular Impingement Syndrome in High-Level Ice Hockey Players: 2-Year Outcomes by Player Position

This study explores the outcomes two years after hip arthroscopy for FAIS and further compares the results between player position and stick handedness.

The 172 included ice hockey players had a mean age of 28 (±10) years and a mean duration of symptoms of 46.3 (±45.8) months. Of the 149 players with a registered position, there were 35% defensemen, 40% forwards and 25% goalkeepers (Table 9). During the two-year follow-up, 21 players were reoperated.

There were significant improvements in PROMs at follow-up (Table 10). The MIC value was exceeded in 77% of the players and the PASS value was exceeded in 57% of the players for the iHOT-12. The MIC values for the HAGOS were exceeded with the following frequencies; Symptoms: 70%, Pain: 65%, ADL: 63%, Sports participation: 68%, Physical activity: 56% and hip- and/or groin-related QoL: 71%.

At the follow-up, 53% reported an HSAS of 5-8, corresponding to a competitive level.

There was no significant correlation found with regards to the operated hip and stick handedness. No differences were reported in PROMs between defensemen, forwards or goalkeepers (Table 11).

TABLE 9: Demographic and hockey specific data for the included ice hockey players (n=172)

ICE HOCKEY PLAYERS' CHARACTERISTICS	
Age at time of surgery -years, mean (SD)	28 (10)
Male gender, n (%)	169 (98)
Symptom duration months - months, mean (SD)	46.3 (45.8)
BMI - kg/m², mean (SD)	25.6 (2.4)
Position (n=149)	
Defenseman, n (%)	52 (34.9)
Forward, n (%)	59 (39.6)
Goalkeeper, n (%)	38 (25.5)
Stick handedness (n=140)	
Right, n (%)	25 (18)
Left, n (%)	115 (82)
Surgery side (=172)	
Right, n (%)	25 (14.5)
Left, n (%)	37 (21.5)
Bilateral, n (%)	110 (64)

BMI, body mass index. n, numbers. SD, standard deviation.

TABLE 10: Patient-reported outcome measures before surgery and at the two-year follow-up (n=120).

	PREOPERATIVE	TWO-YEAR FOLLOW-UP	CHANGE (95% CI)	P-VALUE
HAGOS				
Symptoms	47.5 (17.2)	68.0 (21.2)	21.6 (21.9) (17.7; 25.6)	<0.0001
Pain	57.0 (17.0)	75.8 (20.9)	19.4 (20.0) (15.7; 23.0)	<0.0001
Function in daily living	62.5 (22.5)	81.0 (20.1)	19.0 (23.7) (14.8; 23.3)	<0.0001
Sports and recreation	40.0 (20.6)	64.7 (27.2)	26.1 (26.9) (21.2; 31.0)	<0.0001
Participation in PA	30.9 (26.0)	57.2 (33.8)	27.7 (34.8) (21.3; 34.1)	<0.0001
Hip- and groin related QoL	32.5 (16.8)	57.8 (28.2)	26.2 (26.4) (21.4; 31.1)	<0.0001
iHOT				
iHOT-12	45.2 (17.4)	66.7 (25.1)	22.8 (23.2) (18.3; 27.2)	<0.0001
EQ-5D				
EQ-5D	0.59 (0.26)	0.75 (0.26)	0.15 (0.28) (0.10; 0.20)	<0.0001
EQ VAS	68.3 (16.9)	73.2 (21.4)	4.43 (21.9) (0.39; 8.48)	<0.0001
Hip function - VAS	49.6 (22.8)	69.2 (21.6)	20.4 (26.7) (15.4; 25.4)	<0.0001
Satisfied with surgery, %	N/A	83	N/A	N/A

Presented as the mean value and standard deviation (SD) including confidence interval (CI) for the change, and % for the satisfaction score. EQ-5D, European Quality of Life-5 Dimensions Questionnaire. HAGOS, Copenhagen Hip and Groin Outcome Score. iHOT-12, international Hip Outcome Tool (short version). PA, physical activities. QoL, quality of life. NA, not applicable. VAS, visual analogue scale.

TABLE 11: Changes in patient-reported outcome measures from preoperatively to the two-year follow-up compared between player positions (n=104).

	DEFENSEMEN	FORWARDS	GOALKEEPERS	P-VALUE
HAGOS				
Symptom	19.9 (18.4) (14.0; 25.6)	16.8 (20.1) (10.7; 22.7)	22.8 (18.4) (15.4; 30.0)	0.50
Pain	22.2 (20.5) (15.8; 28.7)	20.8 (20.7) (14.6; 27.0)	24.4 (25.0) (14.1; 33.8)	0.54
Function in daily living	17.1 (23.1) (10.1; 24.5)	16.5 (24.0) (9.4; 23.7)	21.5 (21.5) (12.9; 30.0)	0.55
Sports and recreation	26.8 (27.2) (18.3; 35.4)	26.5 (25.9) (18.8; 34.5)	24.7 (27.1) (13.7; 35.3)	0.99
Participation in PA	24.0 (30.8) (14.2; 34.1)	33.1 (33.8) (22.9; 43.8)	25.5 (36.6) (10.7; 39.6)	0.50
Hip and groin related QoL	23.6 (26.4) (15.3; 32.3)	28.5 (24.5) (21.1; 36.1)	26.5 (27.9) (15.2; 37.5)	0.76
iHOT				
iHOT-12	22.3 (22.3) (14.9; 29.8)	22.5 (22.2) (15.4; 29.6)	24.7 (23.7) (15.1; 34.2)	0.91
EQ-5D				
EQ-5D	0.10 (0.31) (-0.002; 0.2)	0.20 (0.25) (0.12; 0.27)	0.16 (0.24) (0.08; 0.26)	0.23
EQ VAS	6.19 (19.94) (-0.3; 12.6)	4.28 (23.01) (-2.8; 11.3)	6.29 (22.48) (-2.7; 15.2)	0.96
Hip function- VAS	21.9 (26.8) (13.2; 30.8)	19.8 (26.2) (11.5; 27.8)	20.7 (26.6) (10.2; 31.3)	0.96

Presented as the mean value, standard deviation and 95% confidence interval (CI). EQ-5D, European Quality of Life-5 Dimensions Questionnaire. HAGOS, Copenhagen Hip and Groin Outcome Score. iHOT-12, international Hip Outcome Tool (short version). PA, physical activities. QoL, quality of life. VAS, visual analogue scale.

CONCLUSION STUDY III

High-level ice hockey players report good outcomes two years after hip arthroscopy for femoroacetabular syndrome for all player positions.

STUDY IV

Prior hip arthroscopy does not affect 1-year patient-reported outcomes following total hip arthroplasty: a register-based matched case-control study of 675 patients

This study evaluated whether a hip arthroscopy would affect the outcomes of a subsequent total hip arthroplasty.

A total of 135 patients had undergone a hip arthroscopy prior to receiving a THA, and fulfilled the inclusion criteria, and were further allocated to the treated group. Compared with the overall control group consisting of 71,891 patients, the treated group contained more men (62%) and were younger, 51 (±8) years old. (Table 12). The average time from arthroscopy to receiving a THA was 27 (±19) months.

All PROMs were compared between the treated group and the PSM-group. No statistically significant differences were found when comparing EQ-5D and EQ VAS between the treated group and the PSM-group (Table 13). In the EQ VAS, 68% of the treated group and 65% of the PSM-group reported an improvement of 15 points or more. No statistically significant differences in hip pain were found one year after surgery between the two groups. Satisfaction was reported by 87% of the treated group and 86% of the PSM-group. Only two (1.4%) patients and nineteen (3.5%) patients respectively underwent a reoperation in the treated and the PSM-group, and the difference in reoperation rate was not statistically significant (p=0.3).

TABLE 12: Demographic data for the overall control group, the treated group with a prior hip arthroscopy and the propensity-score matched control group.

VARIABLE	OVERALL CONTROL N=71,891	TREATED N=135	PROPENSITY MATCHED CONTROL N=540	SMD
Age at time of THA surgery - years, mean (SD)	68 (11)	51 (8)	52 (10)	3.0
BMI- kg/m^2, mean (SD)	27 (5)	27 (3)	27 (4)	0
Female/male - n (%)	40,341/31,550 (56/44)	51/84 (38/62)	188/352 (35/65)	6.2
ASA classification				
1, n (%)	17,703 (24)	95 (70)	384 (71)	
2, n (%)	43,079 (60)	36 (27)	137 (25)	4.1
3-4, n (%)	11,109 (16)	4 (3)	19 (4)	
Mode of fixation				
Cemented, n (%)	42,359 (59)	9 (7)	32 (6)	
Hybrid, n (%)	12,405 (17)	10 (7)	44 (8)	4.0
Uncemented, n (%)	17,127 (24)	116 (86)	464 (86)	

Presented as the mean value and standard deviation (SD) or numbers and percentages (%). The SMD, standardized mean difference is between the treated and the matched control group. n, numbers. THA, total hip arthroplasty.

TABLE 13: Patient-reported outcome measures both at preoperatively and at follow-up for the treated group and the propensity-matched control group.

VARIABLE	PROPENSITY MATCHED CONTROL	TREATED	DIFFERENCE 95 % CI	P-VALUE
EQ-5D				
Preoperative THA surgery	0.35	0.34	-0.05;0.07	0.8
One-year follow-up	0.82	0.81	-0.04;0.05	0.9
Difference between preoperative and one-year follow-up	0.47	0.47	-0.07;0.06	0.9
EQ VAS				
Preoperative THA surgery	51.9	52.4	-5;3.9	0.8
One-year follow-up	78.8	78.3	-3.2;4.2	0.8
Difference between preoperative and one-year follow-up	26.9	25.9	-4.1;6.1	0.7
Hip pain at one-year follow-up, %				
None	55	55		
Very mild	23	21		
Mild	14	15		0.7
Moderate	7	7		
Severe	1	2		
Satisfaction at one-year follow-up, %				
Not satisfied	14	13		0.9
Satisfied	86	87		

Presented as the mean value with 95% confidence interval and percentage for hip pain and satisfaction. CI, confidence interval. EQ-5D, European Quality of Life-5 Dimensions Questionnaire. THA, total hip arthroplasty. VAS, visual analogue scale

CONCLUSION STUDY IV

Patients undergoing a total hip arthroplasty after a prior hip arthroscopy are slightly younger and comprise more men than the average THA-patient. However, the one-year outcomes after THA surgery are not influenced by a previous arthroscopic treatment.

STUDY V

Evaluation of outcome reporting trends for femoroacetabular impingement syndrome- a systematic review

This systematic review explores the trends seen in the literature in terms of patient-reported outcomes after surgical treatment for FAIS.

The first literature search yielded a total of 2,559 studies of which 196 met the inclusion criteria. The percentage agreement between the reviewers was 97% for the inclusion of full-text and the Cohen kappa score was 0.82, which is regarded as an almost excellent agreement. The search included a range of twenty years, however, the first included study was published in 2004, with a large increase in published studies during the last five years (2016-2020). Of the 196 included studies, 135 (69%) were retrospective, 55 (28%) were prospective and 6 (3%) were RCTs. Most studies evaluated arthroscopic surgery and 58% of the studies were performed in the USA.

There were 39 different PROMs used in the included studies, and 15 of these were hip-specific. Each study included an average of three PROMs. The most reported PROM was the modified Harris Hip Score (mHHS), used in 61% of the studies, followed by the Hip Outcome Score (HOS), used in 41% of the studies. Return to sport was reported as a separate item in 13% of the studies and satisfaction with surgery was reported as a separate item in 40% of the studies.

At least one of the three PROMs recommended by the Warwick Agreement was reported in 91(64%) of the 143 published studies after 2016, where HOS was most commonly used followed by either iHOT-12 or iHOT-33 and the HAGOS.

CONCLUSION STUDY V

The number of published studies evaluating FAIS continue to increase. Although the Warwick Agreement in 2016 presented the recommendation of using either HOS, iHOT-12/33 or HAGOS as hip-specific PROMs being more suitable for the young and active population, the mHHS is still the most frequently included PROM.

The most important summarized finding in this thesis is that hip arthroscopy for FAIS is a reliable treatment with good outcomes in several patient categories. The thesis strengthens previous research in the area and concludes that patients suffering from FAIS benefit from surgical treatment. Until we have solved the question related to who develops symptomatic FAIS and further how to prevent its progress, we can conclude that arthroscopic treatment is a sound treatment option.

The knowledge and management of FAIS have increased explosively in recent years. In 2014, a survey among orthopaedic surgeons concluded that there was an absence of enough knowledge of the best evidence for FAIS[122]. Since then, a rapid increase in both awareness and published literature have occurred. Femoroacetabular impingement syndrome is now an established diagnosis with consensus meetings, tailor-made conferences and performed RCTs. Nevertheless, the evolution continues and several unanswered questions remain. It is time to take a step further and to customize the details to both provide the best possible treatment for the patients as well as to conduct the best possible research.

STUDY I

This study reported that elite athletes report good outcomes regarding the included PROMs and satisfaction five years after hip arthroscopy for FAIS. With the use of modern validated PROMs, suitable for the target population (young and active), the included athletes reported both statistically significant and clinically relevant improvements. Prior studies have shown similar results, with generally good results for athletes after FAIS surgery.

However, despite clinically relevant improvements, with regards to exceeding MIC values, it can be discussed whether the patients have really fully recovered. Relatively low values are displayed after surgery, especially for the subscales of “Participation in physical activity” and “Hip- and/or groin-related QoL”. While there is a considerably large positive change from baseline to the follow-up five years later, with a mean change of 42.2 points in physical activity, the patients still only report a mean value of 67.4 points at follow-up. This can be regarded as moderate on a scale where 100 is the highest score. It is doubtlessly a large improvement, yet a fairly moderate outcome score. Thorborg et al.[123] reported similar findings, with impairments in physical activity and QoL one year after surgery. The present study reveals that these two items are still reduced five years after surgery. Furthermore, in the same study, Thorborg et al.[123] presented values for a healthy population to use as reference values.

When comparing the data for the elite athletes in the present study with those values, the athletes do not reach the levels of a healthy individual.

It can be argued that improvements can be expected in other aspects in life, even though the patients still have reduced physical activity after surgery compared with prior to the onset of symptoms. This leads to the highly debated current discussion about RTS. While 54% of the elite athletes returned to a competitive level, 77% had reduced their activity level. The score used in this study, the HSAS, is a hip-specific activity score and is suitable for screening an individual's current activity level, yet it may not be the best tool to evaluate RTS. In this study, both symptom duration and age were correlated to lower levels of HSAS. Both these variables are well-studied factors correlating to inferior outcomes[124, 125]. A natural decrease in activity level is expected with increasing age, and the patient may have other reasons for not returning to sports despite optimal treatment results. Moreover, long symptom duration could be correlated to a higher degree of cartilage damage. It can be argued that FAIS behaves as a cartilage injury in several ways and, further, that the cartilage injury associated with the syndrome is an integral part. In line with all cartilage injuries, load is an important part of developing symptoms. Therefore, athletes reducing load may report fewer symptoms and return to sport despite suboptimal results. For a correct scientific assessment of RTS, it is important not only to record RTS and on what level, yet also take account of the load capacity and performance status before and after treatment. However, regardless of RTS and improvements in PROMs, more than 90% of the included athletes reported satisfaction with surgery.

There is currently no common recommendation for the best management of the labrum injuries in FAIS surgery[126]. It is suggested that labral repair or reconstruction is beneficial to optimize hip preservation when the labrum is injured[127, 128]. There were only 9% of labral repairs in this study, compared with other studies where more than 70% of the patients have received a labral repair[83]. This discrepancy appears to be due to the preferred surgical technique and traditions among hip surgeons. The surgeons in this study perform a labral repair when there is a clear separation between the labrum and the acetabular edge. It can be argued that the labrum itself is not the source of the pain and that there is little benefit in such a repair. Perhaps an RCT, blinded to the involved patient, and performed as a collaboration between several clinics, would be able to improve the understanding of the importance of labral repair.

STUDY II

Study II revealed that the outcomes for patients lost to follow-up in the hip arthroscopy registry do not differ from those participating in the follow-up in terms of the HAGOS, iHOT-12, EQ-5D, EQ VAS and hip function.

The development of registries such as the Gothenburg local hip arthroscopy registry enables prospectively collected data to be analyzed and observed longitudinally and further provide evidence to the current research. A registry is a great instrument for evaluating the proficiency of a surgical treatment and patient outcomes. Compared with an RCT, which is usually described as the highest level of evidence, registry studies are cheaper to conduct and have a more heterogeneous cohort with regard to less strict inclusion criteria, and they can be considered to represent more "real-world data"(129). However, a prerequisite for high validity is compliance and completeness. High compliance is considered a major contributor to the quality of registry studies, yet no clear consensus has been established on the rate of compliance that is regarded as sufficient to minimize bias(130). A response rate of >80% has been suggested as a threshold(131). A previous systematic review concluded that only a few national arthroscopy registries meet the recommended thresholds, and that there are discrepancies in the description of the missing data(129). For example, the systematic review reported that the completeness was only 40-61% at the two-year follow-up, which possibly could bias the results and conclusions drawn from studies conducted using data from these registries. Several reminders and personal phone calls increase the response rate, yet this is both time consuming and costly(131). If there is a scant difference between INR and NR, as seen in the current study, these resources might be better used elsewhere. However, a high response rate is still desirable and it is still important to properly calculate and report loss to follow-up and missing data.

It can be argued that the "true" loss to follow-up in this study is the "unavailable" group, the remaining 6% that either decided to not participate in the study or that we failed to reach. However, the 107 patients in the INR-group should be considered as representative of the loss to follow-up, since these patients would not have been further reminded if this study had not been conducted. Further, comparing initial non-responders (or late responders) with responders is an acceptable manner of evaluating differences in outcomes for non-responders in a study(130). Although the study includes all hip arthroscopies performed, the vast majority of the surgeries included FAIS, and the results from the study could better reflect a population of FAIS rather than overall hip arthroscopy.

It was not surprising that the INR were significantly younger than the responders, as this phenomenon has been previously found[132-134]. Previous studies have illustrated inferior outcomes after FAIS surgery for higher age groups[125]. This could theoretically imply poorer outcomes for the patients responding, however, no such difference was seen in this study. The HSAS before the onset of symptoms and in adolescence were significantly lower in the R-group. However, it could be argued if this is clinically relevant, as the differences were very small (for example, 5.7 in the adolescents in the R-group compared with 6.2 in the INR-group). It is noteworthy that the INR reported less satisfaction with surgery. There is an inconsistency in similar orthopaedic research concerning if patients lost to follow-up are less satisfied or not[133, 135]. However, no similar study has evaluated satisfaction with hip arthroscopy. Further, the question related to satisfaction has not yet been validated and, to confirm clinical relevance, this should be confirmed in future studies. Regardless of satisfaction, the remaining PROMs evaluating hip function and quality of life were similar between the patients, suggesting no differences in the validated PROMs.

With similar results between responders and initial non-responders, it seems that loss to follow-up does not compromise the results drawn from studies performed in hip arthroscopy registries. Although this study mainly confirms that the local hip arthroscopy is valid in terms of outcome and surgical data, registries with similar cohorts, such as the Danish Hip Arthroscopy Registry (DHAR), could definitively benefit from this finding.

STUDY III

This study concluded that high-level ice hockey players benefit from arthroscopic hip surgery and improve in PROMs at the two-year follow-up. Previous studies have shown high rate of return to ice hockey after hip arthroscopy for FAIS[92, 136]. However, there is a limited number of studies evaluating PROMs and only including ice hockey players. While the ice-hockey players revealed statistically significant improvements, as discussed in Study I, the question whether they recover fully is the subject of discussion. The MIC value was exceeded by 77% of the players, however, only 57% of the players exceeded the PASS value for the iHOT-12. In comparison with the results from Study I, the majority of the players exceeded the MIC value for HAGOS, yet only 56% exceeded the MIC-value in the subscale regarding "physical activity". As previously discussed in Study I, this could indicate that, in spite of statistical improvements, the ice hockey players may still have disabilities in physical activity two years after surgery.

Twenty-four percent of the players remained on an HSAS level of 7 or 8, and a little more than half of the players remained at a competitive level (HSAS 5-8) at follow-up. This is lower than previously reported RTS for ice hockey players[89, 136]. It is important to acknowledge that the HSAS included at baseline was prior to symptoms or in the adolescence, and with an average symptom duration of 46 months, this presumably does not mirror the true RTS after surgery. However, there are at least two possible explanations for the lower RTS in this study. It might reflect the anticipated transition in the sporting career, as increased age naturally is related to lower levels of sports. Or, on the contrary, as the players report significant improvements in terms of the other included PROMs, still lower in physical activity, they may not reach fully normalized hip function after surgery.

Groin injuries in ice hockey players is a widely discussed and well-known subject in sports medicine[137]. The prevalence of both symptomatic FAIS and asymptomatic radiographic findings are common in ice hockey players[138, 139]. It is suggested that, due to the repetitive and high demands imposed on their hips, there is a high degree of vulnerability to developing these morphological changes[140]. There was an equal distribution of player positions in this study. It has been suggested, however, that goalkeepers are more exposed to intra-articular hip injuries, due to the high force of extreme ROM of the hip joint, such as the butterfly save technique[141]. An ice hockey team usually has two goalkeepers on its roster in a squad of approximately twenty players, and the number of goalkeepers in this study strengthens the previous theory that they are more predisposed to FAIS than other positions. Although the butterfly technique appears extreme, a previous study revealed that the deceleration during skating yielded more internal rotation and might be the contributory movement to developing anterosuperior impingement[142]. In addition to the butterfly technique and the skating, a goalkeeper has several motions which theoretically contribute and explain why they are more predisposed to FAIS. Beyond splits and half butterfly, their resting pose causes a concomitant internal rotation, flexion and adduction possibly leading to impingement[142]. Nevertheless, the defensemen and forwards practice movements such as skating including quick stops and sprint starts, potentially leading to the development of FAIS, explaining why ice hockey players are generally more predisposed to FAIS[140]. However, there were no differences in reported functional outcomes between the three positions, advocating beneficial results from hip arthroscopy regardless of position.

We hypothesized that stick handedness could affect which hip turned symptomatic. Unfortunately, there were too many bilateral procedures and too many left-handed shooters to find any correlation.

Bilateral procedures were more common in this study than previously reported[143]. Symptoms in the contralateral hip are commonly reported for patients with FAIS and the majority do undergo subsequent surgery in the near future[144, 145]. Moreover, bilateral cam morphology has been shown to be common in ice hockey players[138]. It is important to elucidate that all players (and patients) in this thesis are symptomatic and no asymptomatic hips are treated in a preventive manner. With the presumable risk of FAI contributing to the development of OA[99], it has been discussed if the asymptomatic contralateral hip should be prophylactically treated[146]. Until we have solved the questions related to the natural course of asymptomatic morphologies and whether surgical intervention decelerates (or accelerates) the development of OA, we disagree with prophylactic surgery due to the current lack of evidence. However, *with* symptoms in both hips, bilateral surgery is a safe option with good outcomes[147].

How should we interpret the findings in this study, and previous research regarding ice hockey and FAIS? Should we prevent the children from playing on a frozen rink outside their home and discourage their dream of becoming a professional player at the big arenas? In this context, it is important to define the biomechanical circumstances, including both load and movement, and avoid the repetitive trauma to the hip joint instead of preventing them to play.

STUDY IV

This study demonstrated that a prior hip arthroscopy will not affect the outcomes of a subsequent total hip arthroplasty with regard to PROMs.

The majority of previous similar studies have found no inferior outcomes at follow-up for patients who had undergone prior hip arthroscopy[106, 148, 149]. Many of these previous studies have been reported to be underpowered and, to our knowledge, this study comprises the largest cohort of its kind so far. With underpowered cohorts, previous studies have claimed too few cases to draw any conclusions in terms of revision rate. In line with this, there were only a few revisions in the present study. The rationale for reporting reoperations in this study was to ensure that there was no trend pointing in the direction of an increased risk of reoperation in patients with a prior hip arthroscopy. Nevertheless, a prior arthroscopy did not appear to increase the risk of reoperation. Increased surgical time and perioperative complications were seen in a study was reported by Vovos et al.[150]. Unfortunately, the present study did not include surgical data and was therefore unable to confirm these results.

The propensity score matching enabled the estimation of the impact of hip arthroscopy by reducing selection bias. With the further inclusion of an overall THA group, baseline demographic data could be compared between a patient undergoing a prior hip arthroscopy and the “typical THA patient”. The group that had undergone hip arthroscopy was both younger and contained a higher proportion of men. Neither of these two findings is especially surprising. Men have been proposed to have a higher degree of cam morphology, including chondral injuries[50, 151]. The younger age could be explained by the theory that FAIS contributes to the development of degenerative disease[113], and consequently increases the risk of undergoing a THA at a fairly young age.

Of the 2,516 performed hip arthroscopies and found in the local hip arthroscopy registry between 2011-2018, 166 patients received a THA during the follow-up (135 included in this study, 31 excluded due to missing data). The conversion rate of 7% is in line with previous data[60]. Expectedly, both higher age and the severity of OA have been reported to increase the risk of undergoing a THA[152]. It is generally not recommended to perform hip arthroscopy in patients with OA[60]. The indication for arthroscopic surgery in all patients in this study was FAIS and not OA, yet unfortunately no information regarding chondral injuries were included for the patients. However, good midterm outcomes have been reported for patients with concomitant FAIS and OA after hip arthroscopy[102]. It is not known whether a hip arthroscopy prevents or, in fact, causes additional trauma to the hip joint and accelerates the development of OA. Careful patient selection is therefore warranted. Although a young person with concomitant OA and FAIS has been shown potentially to benefit from an arthroscopy[102], there is a theoretical risk of accelerating the OA. Our current philosophy is to promote non-surgical treatment in these cases with mild to moderate symptoms. On the other hand, a carefully selected middle-aged person with FAIS might benefit from a surgical procedure to postpone an inevitable THA surgery.

STUDY V

This study systematically screened the literature related to surgery for FAIS according to the PRISMA guidelines[120]. It revealed a rapid increase in the number of published articles in the field. This increase is expected, as both the incidence in the number of diagnosed FAIS and the surgical treatment of it have increased, with a subsequent escalation in the number of studies[51]. Since Ganz et al.[4] introduced the concept, FAIS has evolved and become a well-known etiology of hip pain.

Randomized controlled trials are considered the highest level of evidence, yet performing a study of this kind in a surgical environment is challenging. With the inherent difficulties of conducting an RCT, the idea of the superiority of an RCT could result in poorly performed studies when the basic knowledge has not yet been acquired. Instead, starting from scratch, with a step-wise introduction from case-reports and cohort studies, when introducing a new concept, is warranted. This systematic review confirmed that retrospective studies are still the most commonly performed studies. However, the research on FAIS has reached the level of evidence where well-designed RCTs are starting to be introduced[53, 57, 64].

Patient-reported outcome measures are commonly used to evaluate the patient's reflection on the outcome[66]. Fifteen different, hip-specific PROMs were found in the studies included in this systematic review. Since the statement of the Warwick Agreement, the HOS, iHOT or HAGOS are recommended for use when evaluating these kinds of young and active patient groups[6, 153]. Nonetheless, the mHHS remains being the most commonly used PROM, even though there is a well-known risk of ceiling effect for this questionnaire. It has even been described that the newly introduced MIC values may be difficult to achieve for PROMs such as the mHHS, as the patients' baseline scores are too high[154]. As mentioned in the introduction, it is desirable that the same PROMs are used worldwide to facilitate comparisons between studies and collaborations between centers. We therefore strongly suggest that the recommended modern and valid/reliable PROMs suitable for the target population should be used.

There was an average of three PROMs per study, with a slight increase over the years. There is a fine line between including as many items as possible without compromising compliance. It is of major concern to use validated and user-friendly PROMs while avoiding increasing the patient-burden. In the registry included in this thesis, there are four overall PROMs and two additional questions (covering satisfaction and hip pain). When the registry was introduced in 2011, it was thought that these covered several properties of the patients' issues regarding FAIS[108]. It could be argued that the registry, with 60 items at follow-up, might be too extensive. While both the iHOT-12 and HAGOS are covering similar aspects of hip and groin pain, it is still beneficial to keep both of them. The HAGOS with six subscales would solely give a good cover in general, yet as seen in this systematic review, only a few studies included the HAGOS and it is therefore beneficial to keep the iHOT-12 in our registry to enable comparisons between studies.

STUDIES I and III

The absence of a control group is a major limitation. The possibility to draw conclusions is weakened due to the risk of placebo effect or that improvements may have occurred regardless of surgery. The latter is minimized as only patients who have failed with non-surgical treatment undergo surgery. Recent RCTs have also showed superior results for patients undergoing hip arthroscopy compared with conservative care(53, 57) and they have further showed a high cross-over rate to later undergo surgery, for patients initially allocated to conservative care(64).

None of the studies included radiographic measurements, such as the alpha angle or LCEA. It was up to the decision of the individual surgeon to assess each radiograph; hence no measurements are included in the registry. This limits the comparison to similar studies and might prevent evaluation if different alpha angles correlate with inferior results. However, in line with the complex diagnostics of OA, the radiographic measurements correlate poorly with the patients' symptoms.

Both Studies I and III used the HSAS as a measurement of RTS and included the HSAS before symptoms or in adolescence. The definition of physical activity was based on the patient's own subjective interpretation of the PROM, possibly generating both a recall bias and a risk of both over- and underestimating the activity level. In addition to this, with a fairly high mean age, including a wide range and long symptom duration, it is not the optimal reflection of RTS.

Unfortunately, the subgroup analyses in Study III were underpowered to enable any analysis of correlations related to stick handedness and affected hip and, as a result, a type 2-error could not be excluded.

STUDY II

The main limitation of this study is the difference in the length of follow-up. However, we attempted to limit this without compromising the quality of the study. In order to use a follow-up length of two years and include a decent number of patients, the years 2015-2016 were included. Improvements after hip surgery can already be detected after six months (and probably even earlier), yet can continue to improve until at least two years[155]. It would have been preferable for the non-responders to have been contacted immediately after failed responsiveness. On the other hand, the fact that they did not reply during the time that had elapsed strengthens the conclusion that they could be considered as true non-responders. It would be interesting to follow these two groups until the five-year follow-up to discover any dissimilarities between them.

STUDY IV

The main limitation of this study was that no sample size analysis was conducted a priori. However, all consecutive patients in the local hip arthroscopy registry with a subsequent THA meeting the inclusion criteria were included in the study. This study included a larger cohort than previous similar studies, nevertheless there is still a risk of a type 2-error. With a fairly small cohort, the uncertainty in estimated effects can be compensated for to some extent by a larger control group. There is no consensus in the literature on which ratio is preferable when using a propensity score matching and some claim that a larger cohort would entail greater variance and an increased risk of confounding bias. We believe that the contrary is true; the meticulous matching instead reduced the risk of confounding.

The reoperations were low in both groups and no proper conclusion can be drawn about whether there are differences in terms of revisions.

This study only includes outcomes one year after THA surgery and it would be interesting to follow this cohort for an additional time to evaluate the long-term results.

No intraoperative findings or recordings of surgical procedures were included. The aim of the study was to evaluate the PROMs after THA and not possible technical difficulties during surgery or the level of OA.

STUDY V

The PRISMA checklist was applied when conducting this systematic review in order to elucidate any strengths and weaknesses of the review. A subsequent consequence of the heterogenicity in the studies was the impossibility of including a meta-analysis. Moreover, the search included studies exclusively in the English language, possibly generating a language bias and causing a possible erroneous conclusion about a field where the majority of publications were conducted in the USA and Europe. The decision to not include studies with patients <18 years of age excluded several studies which otherwise fulfilled all inclusion criteria. This could theoretically influence the outcome of the systematic review.

OVERALL CONCLUSION

Hip arthroscopy for FAIS is a successful and beneficial treatment yielding improved outcomes compared to preoperative measurements, up to five years after the procedure. However, it gives no warranty for returning to the same level of athletic performance as before symptoms arose.

STUDY I

At the five-year follow-up, elite athletes reported both statistically significant and clinically relevant improvements in outcomes after hip arthroscopic surgery for FAIS, where more than 90% stated that they were satisfied with surgery. Regarding return to sport, more than 50% were at a competitive level, while 77% had reduced their level of activity five years after surgery.

STUDY II

There were no significant differences in validated patient-reported outcomes between patients responding compared with patients not responding at the two-year follow-up. The patients who had not responded reported slightly less satisfaction and were slightly younger than those who responded. The results from this study confirm that conclusions drawn from the hip arthroscopy registry are reliable and that drop-outs do not have to bias the outcomes.

STUDY III

High-level ice hockey players undergoing hip arthroscopy for FAIS report good outcomes two years after surgery, regardless of playing position. While they report good results in term of patient-reported outcomes, their return to sport and level of physical activity might not be as high as previously reported.

STUDY IV

The patient-reported outcomes one year after undergoing THA surgery are not affected by a previous arthroscopic treatment. These results indicate that patients who have undergone a previous arthroscopy do not need to be concerned about the potential risks of inferior results with a THA.

STUDY V

There is a continuous increase in the number of published studies evaluating FAIS and retrospective studies remain being the most common type of study. Despite the recommendation to include PROMs that are more suitable for the young and active population, the mHHS is nevertheless the most frequently used.

FUTURE PERSPECTIVES

FUTURE PERSPECTIVES

Hip arthroscopy is without doubt an efficient and optional treatment for FAIS, and it will reduce pain and improve function in the majority of the patients. We have a solid knowledge base in terms of FAIS and we now need to take one step further to reach a higher level of evidence in this category of research. The next natural step is to investigate predictors of the individuals that become symptomatic, the specific natural causes of FAIS, ways of preventing its development, and the individuals that will benefit the most from surgery.

Short- and midterm results have been shown to be good, and it will be interesting to monitor the long-term effects of the treatment. The natural cause of cam and pincer morphology is still not fully understood. There is strong evidence of cam being a contributor to OA, yet it is not understood whether the correction of the abnormal morphology prevents or potentially increases the progression of OA. Longitudinal studies, from youth until people in their 60s (or at least their 30s,) would be extremely interesting to follow in the future.

Moreover, evidence suggests that the development of cam morphology depend on load and types of sport. Athletes participating in certain sports, especially ice hockey and soccer run an increased risk of developing FAIS. These sports result in forceful impacts and impose heavy demands on the hip joint. However, this must be interpreted cautiously, as there are several sports not yet well evaluated. For example, do bandy players with on-ice movements similar to those of ice hockey players develop FAIS to the same extent and, if not, why? We need to further determine which movements and the quantity and load on the hip joint increase the risk of FAIS to help preventing its emergence. By following cohorts with diverse training routines, preferably in a variety of sports and in patients of different ages, this can be further investigated. It is increasingly common for adolescents to specialize in one sport at an early age, with specific training and repetitious movements potentially causing overuse injury. It is important for young people to keep participating in sports and, if we obtain additional knowledge of the movements and loads that make the joint most vulnerable, we shall be able to educate coaches and underline the importance of being all-around well trained without sacrificing the greatness of training in general. Moreover, consensus in terms of the definition of return to sport is warranted for FAIS after arthroscopic surgery.

During the work with this thesis, it has become increasingly apparent that FAIS should not be regarded as one entity, yet instead as an overall syndrome with various of subgroups. As has been discussed throughout this thesis, there is a discrepancy between cam and pincer, both in terms of etiology, epidemiology and the risk of developing OA. Cam morphology has, for example, been shown to be more common in men and women report inferior outcomes after corrective surgery. This is only briefly discussed in this thesis, as the majority of the included patients and players were men. However, depending on morphology, gender, age, symptoms, physical activity, type of sport and degree of cartilage injury, each individual should probably be treated differently.

The management of the labrum and the capsule are briefly discussed in this thesis. The question of the different aspects of labrum and capsule treatment appears to be a frequently debated question in international literature, with strong opinions about the best treatment. A multicenter RCT across countries could play an important role in acquiring deeper knowledge.

The Warwick Agreement is mentioned throughout this thesis, however, this meeting was held five years ago, and to unite surgeons and other healthcare providers, future consensus meeting(s) on new, updated knowledge are warranted.

Mikael Sansone, Il capo! I could not have asked for a better supervisor. Thank you for all your help and for being a great mentor throughout this process. Thank you for always replying quickly and being optimistic and encouraging. Looking forward to future projects and continuing to be a part of "the team".

Jón Karlsson, Co-supervisor. A legend in orthopaedic research. Thank you for sharing your tremendous knowledge of the art of conducting research. Always extremely fast replies and great comments and help.

Axel Öhlin, My "unofficial" supervisor. Always willing to discuss research. You have been a great support from the first day. I am looking forward to many exciting projects together in the future.

Eric Hamrin Senorski, Co-supervisor. Thank you for great input and comments. You are phenomenal at finding a detail or suggesting a figure that will improve the manuscripts. Special thanks for helping me healing my "runner's knee" after my marathon.

Olufemi Ayeni, Professor at McMaster in Canada and co-supervisor. Thanks for all your skilled inputs and extremely fast replies.

Josefin Abrahamson, Thanks for your help with Study III and for great talks about running. I hope we get to work more together in the future.

Louise Karlsson, Thanks for your help with Study IV. I am sorry for being the worst roommate when I got laryngitis and lost my voice when I was one of the speakers at ISHA in Madrid. Good luck with your own PhD-project.

Neel Desai, Thanks for letting me join you in the OR, for the help with the arthroscopic pictures and for the contribution to Study I.

Ola Rolfson, Current head of the Departments of Orthopaedics. Thank you for the opportunity to conduct this research and thanks for the collaboration and great help with Study IV.

Helena Brisby, Former head of the Departments of Orthopaedics. Thank you for the opportunity to conduct this research.

Monica Bengtsson, Thank you for all your practical help at Orthocenter.

Bengt Bengtsson, Thank you for your statistical help with Studies I-III.

Cina Holmer, Thank you for all your fantastic help. What you do not know about the administration related to the Sahlgrenska Academy is not worth knowing. Your help is irreplaceable.

Christoffer Thomeé, Thanks for all the help with the registry.

Sarantos Nikou, Thank you for your help with reading all those 2,600 articles in Study V. Good luck with your own PhD-project.

Roy Tranberg, Thank you for all your help with computers, data programs and for a great job at my half-time seminar.

Jonatan Nåtman, Thank you for your statistical help with Study IV and for teaching me everything about propensity score matching.

Erik Thurin, Thank you for your superb help with proofreading this thesis.

Göteborgs läkaresällskap, Thank you for financial support.

Guðni Ólafsson, Thanks for the great help with the layout of this thesis.

Pontus Andersson, Thank you for the excellent illustrations throughout this thesis.

Jeanette Kliger, Thank you for your brilliant help with the language review.

Anders Stålman, Thanks for your contribution to Study II.

Kristian Samuelsson, Thanks for your contribution to Study I

Harald Olsson, Thanks for your help with calling the patients and your help with Study II.

Karin Svensson Malchau, Thanks for your contribution to Study IV. I hope we get to work on more projects together in the future.

Maziar Mohaddes, Thanks for your contribution and great inputs to Study IV.

Frida Eek, Thanks for your contribution and input on the statistics in Study III.

Tobias Wörner, Thanks for your contribution and great figures for Study III.

Lasse Weidenhielm, Former professor at the Karolinska Institute. A dear friend who left us too early. Thank you for your support throughout my career.

My colleagues at my "real" work, **Säröledens Familjeläkare** for being the best work place I could ask for.

Lena Neumann, my clinical supervisor during my residency. Thank you for both looking out for me in clinics and for being a friend.

Friends and relatives, supporting me outside the medical field - you know who you are! I am thankful to have so many lovely people around me. I promise I will have more time for hanging out now.

Maria Åkerberg Morin, I am so glad we met first day at medical school. We have spent countless of hours talking about medicine and pretty much everything worth talking about. You are a friend for life.

Mathilda Lissel, My friend from medical school and colleague. Thank you for being my friend and letting me be a part of your fantastic family.

Grandpa and grandmas, I know you would have been proud!

Ylva, Karl and Hedda, My brother's family - I am so happy to have you in my life.

Pennie, Thanks for reminding me of what is most important in life and for always making your auntie smile.

Matilda and Gustaf, My siblings and best friends! The two kindest and most positive people I know. Thank you for being the best siblings and for always being there. Bro - thanks for teaching me everything I know about ice hockey. Lil sis - thank you for coming up with the idea for the front page. Love you both!

Mum and Dad, There are no words to describe how much you mean to me. My biggest role models and daily support in life. Thank you for giving me the best childhood and for always being there for me. I love you more than words can say. Thank you for everything!

FUNDING SUPPORT

This thesis has been financially supported by:

• Grants from "Göteborgs Läkaresällskap" including grants from "Elin o Carl Linders fond".
• The ALF agreement regional research grants (ALFGBG-75100 and ALFGBG-74020)
• Grants from Dr Felix Neubergh's Foundation.

METHODS

SUMMARY OF STUDIES AND RESULTS

DISCUSSION

LIMITATIONS

CONCLUSION

FUTURE PERSPECTIVES

ACKNOWLEDGEMENTS

REFERENCES

APPENDIX

PAPERS

1. Matsumoto K, Ganz R, Khanduja V. The history of femoroacetabular impingement. Bone Joint Res. 2020;9(9):572-7.
2. Smith-Petersen MN. The classic: Treatment of malum coxae senilis, old slipped upper femoral epiphysis, intrapelvic protrusion of the acetabulum, and coxa plana by means of acetabuloplasty. 1936. Clin Orthop Relat Res. 2009;467(3):608-15.
3. Myers SR, Eijer H, Ganz R. Anterior femoroacetabular impingement after periacetabular osteotomy. Clin Orthop Relat Res. 1999(363):93-9.
4. Ganz R, Parvizi J, Beck M, Leunig M, Notzli H, Siebenrock KA. Femoroacetabular impingement: a cause for osteoarthritis of the hip. Clin Orthop Relat Res. 2003(417):112-20.
5. Ganz R, Gill TJ, Gautier E, Ganz K, Krugel N, Berlemann U. Surgical dislocation of the adult hip a technique with full access to the femoral head and acetabulum without the risk of avascular necrosis. J Bone Joint Surg Br. 2001;83(8):1119-24.
6. Griffin DR, Dickenson EJ, O'Donnell J, Agricola R, Awan T, Beck M, et al. The Warwick Agreement on femoroacetabular impingement syndrome (FAI syndrome): an international consensus statement. Br J Sports Med. 2016;50(19):1169-76.
7. Ross JR, Larson CM, Bedi A. Indications for Hip Arthroscopy. Sports Health. 2017;9(5):402-13.
8. Kandil A, Safran MR. Hip Arthroscopy: A Brief History. Clin Sports Med. 2016;35(3):321-9.
9. Colvin AC, Harrast J, Harner C. Trends in hip arthroscopy. J Bone Joint Surg Am. 2012;94(4):e23.
10. Maradit Kremers H, Schilz SR, Van Houten HK, Herrin J, Koenig KM, Bozic KJ, et al. Trends in Utilization and Outcomes of Hip Arthroscopy in the United States Between 2005 and 2013. J Arthroplasty. 2017;32(3):750-5.
11. Zhang D, Chen L, Wang G. Hip arthroscopy versus open surgical dislocation for femoroacetabular impingement: A systematic review and meta-analysis. Medicine (Baltimore). 2016;95(41):e5122.
12. Campoamor Gonzalez M, Martinez Aznar C, Martin Martinez A, Martin Hernandez C, Mateo Agudo JJ, Panisello Sebastia JJ. Comparison of the open versus the arthroscopic approach in the treatment of femoroacetabular shock. Rev Esp Cir Ortop Traumatol. 2020.
13. Nwachukwu BU, Rebolledo BJ, McCormick F, Rosas S, Harris JD, Kelly BT. Arthroscopic Versus Open Treatment of Femoroacetabular Impingement: A Systematic Review of Medium- to Long-Term Outcomes. Am J Sports Med. 2016;44(4):1062-8.
14. Bozic KJ, Chan V, Valone FH, 3rd, Feeley BT, Vail TP. Trends in hip arthroscopy utilization in the United States. J Arthroplasty. 2013;28(8 Suppl):140-3.
15. Bsat S, Frei H, Beaule PE. The acetabular labrum: a review of its function. Bone Joint J. 2016;98-B(6):730-5.
16. Wylie JD, Kim YJ. The Natural History of Femoroacetabular Impingement. J Pediatr Orthop. 2019;39(Issue 6, Supplement 1 Suppl 1):S28-S32.
17. Keogh MJ, Batt ME. A review of femoroacetabular impingement in athletes. Sports Med. 2008;38(10):863-78.
18. Kuhns BD, Weber AE, Levy DM, Wuerz TH. The Natural History of Femoroacetabular Impingement. Front Surg. 2015;2:58.
19. Clohisy JC, Knaus ER, Hunt DM, Lesher JM, Harris-Hayes M, Prather H. Clinical presentation of patients with symptomatic anterior hip impingement. Clin Orthop Relat Res. 2009;467(3):638-44.
20. Gaitonde DY, Ericksen A, Robbins RC. Patellofemoral Pain Syndrome. Am Fam Physician. 2019;99(2):88-94.
21. Shanmugaraj A, Shell JR, Horner NS, Duong A, Simunovic N, Uchida S, et al. How Useful Is the Flexion-Adduction-Internal Rotation Test for Diagnosing Femoroacetabular Impingement: A Systematic Review. Clin J Sport Med. 2020;30(1):76-82.

22. Reiman MP, Goode AP, Cook CE, Holmich P, Thorborg K. Diagnostic accuracy of clinical tests for the diagnosis of hip femoroacetabular impingement/labral tear: a systematic review with meta-analysis. Br J Sports Med. 2015;49(12):811.

23. Casartelli NC, Brunner R, Maffiuletti NA, Bizzini M, Leunig M, Pfirrmann CW, et al. The FADIR test accuracy for screening cam and pincer morphology in youth ice hockey players. J Sci Med Sport. 2018;21(2):134-8.

24. Trindade CAC, Briggs KK, Fagotti L, Fukui K, Philippon MJ. Positive FABER distance test is associated with higher alpha angle in symptomatic patients. Knee Surg Sports Traumatol Arthrosc. 2019;27(10):3158-61.

25. Pacheco-Carrillo A, Medina-Porqueres I. Physical examination tests for the diagnosis of femoroacetabular impingement. A systematic review. Phys Ther Sport. 2016;21:87-93.

26. Bagwell JJ, Bauer L, Gradoz M, Grindstaff TL. The Reliability of Faber Test Hip Range of Motion Measurements. Int J Sports Phys Ther. 2016;11(7):1101-5.

27. Tannast M, Siebenrock KA, Anderson SE. Femoroacetabular impingement: radiographic diagnosis--what the radiologist should know. AJR Am J Roentgenol. 2007;188(6):1540-52.

28. Zhou J, Melugin HP, Hale RF, Leland DP, Bernard CD, Levy BA, et al. The Prevalence of Radiographic Findings of Structural Hip Deformities for Femoroacetabular Impingement in Patients With Hip Pain. Am J Sports Med. 2020:363546519896355.

29. Jamali AA, Mladenov K, Meyer DC, Martinez A, Beck M, Ganz R, et al. Anteroposterior pelvic radiographs to assess acetabular retroversion: high validity of the "cross-over-sign". J Orthop Res. 2007;25(6):758-65.

30. Notzli HP, Wyss TF, Stoecklin CH, Schmid MR, Treiber K, Hodler J. The contour of the femoral head-neck junction as a predictor for the risk of anterior impingement. J Bone Joint Surg Br. 2002;84(4):556-60.

31. Gollwitzer H, Suren C, Struwind C, Gottschling H, Schroder M, Gerdesmeyer L, et al. The natural alpha angle of the femoral head-neck junction: a cross-sectional CT study in 1312 femurs. Bone Joint J. 2018;100-B(5):570-8.

32. Laborie LB, Lehmann TG, Engesaeter IO, Sera F, Engesaeter LB, Rosendahl K. The alpha angle in cam-type femoroacetabular impingement: new reference intervals based on 2038 healthy young adults. Bone Joint J. 2014;96-B(4):449-54.

33. Roling MA, Mathijssen NMC, Bloem RM. Diagnostic sensitivity and specificity of dynamic three-dimensional CT analysis in detection of cam and pincer type femoroacetabular impingement. BMC Musculoskelet Disord. 2020;21(1):37.

34. Kalberer F, Sierra RJ, Madan SS, Ganz R, Leunig M. Ischial spine projection into the pelvis : a new sign for acetabular retroversion. Clin Orthop Relat Res. 2008;466(3):677-83.

35. Philippon MJ, Ho CP, Briggs KK, Stull J, LaPrade RF. Prevalence of increased alpha angles as a measure of cam-type femoroacetabular impingement in youth ice hockey players. Am J Sports Med. 2013;41(6):1357-62.

36. Pollard TC, Villar RN, Norton MR, Fern ED, Williams MR, Murray DW, et al. Genetic influences in the aetiology of femoroacetabular impingement: a sibling study. J Bone Joint Surg Br. 2010;92(2):209-16.

37. Sekimoto T, Kurogi S, Funamoto T, Ota T, Watanabe S, Sakamoto T, et al. Possible association of single nucleotide polymorphisms in the 3' untranslated region of HOXB9 with acetabular overcoverage. Bone Joint Res. 2015;4(4):50-5.

38. Grantham WJ, Philippon MJ. Etiology and Pathomechanics of Femoroacetabular Impingement. Curr Rev Musculoskelet Med. 2019:253-9.

39. Packer JD, Safran MR. The etiology of primary femoroacetabular impingement: genetics or acquired deformity? J Hip Preserv Surg. 2015;2(3):249-57.

40. Agricola R, Bessems JH, Ginai AZ, Heijboer MP, van der Heijden RA, Verhaar JA, et al. The development of Cam-type deformity in adolescent and young male soccer players. Am J Sports Med. 2012;40(5):1099-106.

41. Siebenrock KA, Kaschka I, Frauchiger L, Werlen S, Schwab JM. Prevalence of cam-type deformity and hip pain in elite ice hockey players before and after the end of growth. Am J Sports Med. 2013;41(10):2308-13.

42. Zadpoor AA. Etiology of Femoroacetabular Impingement in Athletes: A Review of Recent Findings. Sports Med. 2015;45(8):1097-106.

43. Erridge S, Goh EL, Chidambaram S. Subclinical developmental dysplasia of the hip could predispose to femoroacetabular impingement. Med Hypotheses. 2017;102:144-5.

44. Monazzam S, Bomar JD, Dwek JR, Hosalkar HS, Pennock AT. Development and prevalence of femoroacetabular impingement-associated morphology in a paediatric and adolescent population: a CT study of 225 patients. Bone Joint J. 2013;95-B(5):598-604.

45. Agricola R, Heijboer MP, Ginai AZ, Roels P, Zadpoor AA, Verhaar JA, et al. A cam deformity is gradually acquired during skeletal maturation in adolescent and young male soccer players: a prospective study with minimum 2-year follow-up. Am J Sports Med. 2014;42(4):798-806.

46. Tak I, Weir A, Langhout R, Waarsing JH, Stubbe J, Kerkhoffs G, et al. The relationship between the frequency of football practice during skeletal growth and the presence of a cam deformity in adult elite football players. Br J Sports Med. 2015;49(9):630-4.

47. Mascarenhas VV, Rego P, Dantas P, Morais F, McWilliams J, Collado D, et al. Imaging prevalence of femoroacetabular impingement in symptomatic patients, athletes, and asymptomatic individuals: A systematic review. Eur J Radiol. 2016;85(1):73-95.

48. Frank JM, Harris JD, Erickson BJ, Slikker W, 3rd, Bush-Joseph CA, Salata MJ, et al. Prevalence of Femoroacetabular Impingement Imaging Findings in Asymptomatic Volunteers: A Systematic Review. Arthroscopy. 2015;31(6):1199-204.

49. Zhou J, Melugin HP, Hale RF, Leland DP, Bernard CD, Levy BA, et al. The Prevalence of Radiographic Findings of Structural Hip Deformities for Femoroacetabular Impingement in Patients With Hip Pain. Am J Sports Med. 2020;48(3):647-53.

50. Nepple JJ, Riggs CN, Ross JR, Clohisy JC. Clinical presentation and disease characteristics of femoroacetabular impingement are sex-dependent. J Bone Joint Surg Am. 2014;96(20):1683-9.

51. Hale RF, Melugin HP, Zhou J, LaPrade MD, Bernard C, Leland D, et al. Incidence of Femoroacetabular Impingement and Surgical Management Trends Over Time. Am J Sports Med. 2021;49(1):35-41.

52. Emara K, Samir W, Motasem el H, Ghafar KA. Conservative treatment for mild femoroacetabular impingement. J Orthop Surg (Hong Kong). 2011;19(1):41-5.

53. Palmer AJR, Ayyar Gupta V, Fernquest S, Rombach I, Dutton SJ, Mansour R, et al. Arthroscopic hip surgery compared with physiotherapy and activity modification for the treatment of symptomatic femoroacetabular impingement: multicentre randomised controlled trial. BMJ. 2019;364:l185.

54. Hoit G, Whelan DB, Dwyer T, Ajrawat P, Chahal J. Physiotherapy as an Initial Treatment Option for Femoroacetabular Impingement: A Systematic Review of the Literature and Meta-analysis of 5 Randomized Controlled Trials. Am J Sports Med. 2019:363546519882668.

55. Khan W, Khan M, Alradwan H, Williams R, Simunovic N, Ayeni OR. Utility of Intra-articular Hip Injections for Femoroacetabular Impingement: A Systematic Review. Orthop J Sports Med. 2015;3(9):2325967115601030.

56. Skowronek P, Synder M, Polguj M, Marczak D, Sibinski M. Treatment of Femoroacetabular Impingement with a Mini-open Direct Anterior Approach. Indian J Orthop. 2017;51(6):677-80.

57. Griffin DR, Dickenson EJ, Wall PDH, Achana F, Donovan JL, Griffin J, et al. Hip arthroscopy versus best conservative care for the treatment of femoroacetabular impingement syndrome (UK FASHIoN): a multicentre randomised controlled trial. Lancet. 2018;391(10136):2225-35.

58. Matsuda DK, Carlisle JC, Arthurs SC, Wierks CH, Philippon MJ. Comparative systematic review of the open dislocation, mini-open, and arthroscopic surgeries for femoroacetabular impingement. Arthroscopy. 2011;27(2):252-69.

59. Harris JD, McCormick FM, Abrams GD, Gupta AK, Ellis TJ, Bach BR, Jr., et al. Complications and reoperations during and after hip arthroscopy: a systematic review of 92 studies and more than 6,000 patients. Arthroscopy. 2013;29(3):589-95.

60. Yao JJ, Cook SB, Gee AO, Kweon CY, Hagen MS. What Is the Survivorship After Hip Arthroscopy for Femoroacetabular Impingement? A Large-database Study. Clin Orthop Relat Res. 2020;478(10):2266-73.

61. Kaldau NC, Brorson S, Holmich P, Lund B. Good midterm results of hip arthroscopy for femoroacetabular impingement. Dan Med J. 2018;65(6).

62. Menge TJ, Briggs KK, Dornan GJ, McNamara SC, Philippon MJ. Survivorship and Outcomes 10 Years Following Hip Arthroscopy for Femoroacetabular Impingement: Labral Debridement Compared with Labral Repair. J Bone Joint Surg Am. 2017;99(12):997-1004.

63. Perets I, Chaharbakhshi EO, Mu B, Ashberg L, Battaglia MR, Yuen LC, et al. Hip Arthroscopy in Patients Ages 50 Years or Older: Minimum 5-Year Outcomes, Survivorship, and Risk Factors for Conversion to Total Hip Replacement. Arthroscopy. 2018;34(11):3001-9.

64. Mansell NS, Rhon DI, Meyer J, Slevin JM, Marchant BG. Arthroscopic Surgery or Physical Therapy for Patients With Femoroacetabular Impingement Syndrome: A Randomized Controlled Trial With 2-Year Follow-up. Am J Sports Med. 2018;46(6):1306-14.

65. Femoroacetabular Impingement Randomized Controlled Trial I, Ayeni OR, Karlsson J, Heels-Ansdell D, Thabane L, Musahl V, et al. Osteochondroplasty and Labral Repair for the Treatment of Young Adults With Femoroacetabular Impingement: A Randomized Controlled Trial. Am J Sports Med. 2021;49(1):25-34.

66. Reiman MP, Peters S, Sylvain J, Hagymasi S, Ayeni OR. Prevalence and Consistency in Surgical Outcome Reporting for Femoroacetabular Impingement Syndrome: A Scoping Review. Arthroscopy. 2018;34(4):1319-28 e9.

67. Renouf J, Pergaminelis N, Tran P, Tirosh O, Fary C. Prevalence and Trends of Patient-Reported Outcome Measures Used in Hip Arthroscopy. Orthopedics. 2019;42(3):e305-e8.

68. Kemp JL, Collins NJ, Roos EM, Crossley KM. Psychometric properties of patient-reported outcome measures for hip arthroscopic surgery. Am J Sports Med. 2013;41(9):2065-73.

69. Lim CR, Harris K, Dawson J, Beard DJ, Fitzpatrick R, Price AJ. Floor and ceiling effects in the OHS: an analysis of the NHS PROMs data set. BMJ Open. 2015;5(7):e007765.

70. Griffin DR, Parsons N, Mohtadi NG, Safran MR, Multicenter Arthroscopy of the Hip Outcomes Research N. A short version of the International Hip Outcome Tool (iHOT-12) for use in routine clinical practice. Arthroscopy. 2012;28(5):611-6; quiz 6-8.

71. Thorborg K, Holmich P, Christensen R, Petersen J, Roos EM. The Copenhagen Hip and Groin Outcome Score (HAGOS): development and validation according to the COSMIN checklist. Br J Sports Med. 2011;45(6):478-91.

72. Nwachukwu BU, Runyon RS, Kahlenberg CA, Gausden EB, Schairer WW, Allen AA. How are we measuring clinically important outcome for operative treatments in sports medicine? Phys Sportsmed. 2017;45(2):159-64.

73. Coster MC, Nilsdotter A, Brudin L, Bremander A. Minimally important change, measurement error, and responsiveness for the Self-Reported Foot and Ankle Score. Acta Orthop. 2017;88(3):300-4.

74. Nwachukwu BU, Chang B, Beck EC, Neal WH, Movassaghi K, Ranawat AS, et al. How Should We Define Clinically Significant Outcome Improvement on the iHOT-12? HSS J. 2019;15(2):103-8.

75. Rabin R, de Charro F. EQ-5D: a measure of health status from the EuroQol Group. Ann Med. 2001;33(5):337-43.

76. Naal FD, Miozzari HH, Kelly BT, Magennis EM, Leunig M, Noetzli HP. The Hip Sports Activity Scale (HSAS) for patients with femoroacetabular impingement. Hip Int. 2013;23(2):204-11.

77. Ayeni OR, Banga K, Bhandari M, Maizlin Z, de Sa D, Golev D, et al. Femoroacetabular impingement in elite ice hockey players. Knee Surg Sports Traumatol Arthrosc. 2014;22(4):920-5.

78. Larson CM, Ross JR, Kuhn AW, Fuller D, Rowley DM, Giveans MR, et al. Radiographic Hip Anatomy Correlates With Range of Motion and Symptoms in National Hockey League Players. Am J Sports Med. 2017;45(7):1633-9.

79. Nepple JJ, Vigdorchik JM, Clohisy JC. What Is the Association Between Sports Participation and the Development of Proximal Femoral Cam Deformity? A Systematic Review and Meta-analysis. Am J Sports Med. 2015;43(11):2833-40.

80. Knapik DM, Gaudiani MA, Camilleri BE, Nho SJ, Voos JE, Salata MJ. Reported Prevalence of Radiographic Cam Deformity Based on Sport: A Systematic Review of the Current Literature. Orthop J Sports Med. 2019;7(3):2325967119830873.

81. Clapp IM, Nwachukwu BU, Beck EC, Jan K, Gowd AK, Nho SJ. Comparing Outcomes of Competitive Athletes Versus Nonathletes Undergoing Hip Arthroscopy for Treatment of Femoroacetabular Impingement Syndrome. Am J Sports Med. 2019:363546519885359.

82. Ishoi L, Thorborg K, Kraemer O, Holmich P. Return to Sport and Performance After Hip Arthroscopy for Femoroacetabular Impingement in 18- to 30-Year-Old Athletes: A Cross-sectional Cohort Study of 189 Athletes. Am J Sports Med. 2018;46(11):2578-87.

83. Perets I, Craig MJ, Mu BH, Maldonado DR, Litrenta JM, Domb BG. Midterm Outcomes and Return to Sports Among Athletes Undergoing Hip Arthroscopy. Am J Sports Med. 2018;46(7):1661-7.

84. Rosinsky PJ, Kyin C, Lall AC, Shapira J, Maldonado DR, Domb BG. Rate of Return to Sport and Functional Outcomes After Bilateral Hip Arthroscopy in High-Level Athletes. Am J Sports Med. 2019:363546519885354.

85. Sansone M, Ahlden M, Jonasson P, Thomee C, Sward L, Baranto A, et al. Good Results After Hip Arthroscopy for Femoroacetabular Impingement in Top-Level Athletes. Orthop J Sports Med. 2015;3(2):2325967115569691.

86. Shibata KR, Matsuda S, Safran MR. Arthroscopic Hip Surgery in the Elite Athlete: Comparison of Female and Male Competitive Athletes. Am J Sports Med. 2017;45(8):1730-9.

87. Frank RM, Ukwuani G, Allison B, Clapp I, Nho SJ. High Rate of Return to Yoga for Athletes After Hip Arthroscopy for Femoroacetabular Impingement Syndrome. Sports Health. 2018;10(5):434-40.

88. Waterman BR, Ukwuani G, Clapp I, Malloy P, Neal WH, Nho SJ. Return to Golf After Arthroscopic Management of Femoroacetabular Impingement Syndrome. Arthroscopy. 2018;34(12):3187-93 e1.

89. Schallmo MS, Fitzpatrick TH, Yancey HB, Marquez-Lara A, Luo TD, Stubbs AJ. Return-to-Play and Performance Outcomes of Professional Athletes in North America After Hip Arthroscopy From 1999 to 2016. Am J Sports Med. 2018;46(8):1959-69.

90. Reiman MP, Peters S, Sylvain J, Hagymasi S, Mather RC, Goode AP. Femoroacetabular impingement surgery allows 74% of athletes to return to the same competitive level of sports participation but their level of performance remains unreported: a systematic review with meta-analysis. Br J Sports Med. 2018;52(15):972-81.

91. Levy DM, Kuhns BD, Frank RM, Grzybowski JS, Campbell KA, Brown S, et al. High Rate of Return to Running for Athletes After Hip Arthroscopy for the Treatment of Femoroacetabular Impingement and Capsular Plication. Am J Sports Med. 2017;45(1):127-34.

92. Jack RA, 2nd, Sochacki KR, Hirase T, Vickery JW, Harris JD. Performance and Return to Sport After Hip Arthroscopy for Femoroacetabular Impingement in Professional Athletes Differs Between Sports. Arthroscopy. 2019;35(5):1422-8.

93. Casartelli NC, Leunig M, Maffiuletti NA, Bizzini M. Return to sport after hip surgery for femoroacetabular impingement: a systematic review. Br J Sports Med. 2015;49(12):819-24.

94. Worner T, Thorborg K, Stalman A, Webster KE, Momatz Olsson H, Eek F. High or low return to sport rates following hip arthroscopy is a matter of definition? Br J Sports Med. 2018;52(22):1475-6.

95. Begly JP, Buckley PS, Utsunomiya H, Briggs KK, Philippon MJ. Femoroacetabular Impingement in Professional Basketball Players: Return to Play, Career Length, and Performance After Hip Arthroscopy. Am J Sports Med. 2018;46(13):3090-6.

96. Ardern CL, Glasgow P, Schneiders A, Witvrouw E, Clarsen B, Cools A, et al. 2016 Consensus statement on return to sport from the First World Congress in Sports Physical Therapy, Bern. Br J Sports Med. 2016;50(14):853-64.

97. Memon M, Kay J, Hache P, Simunovic N, Harris JD, O'Donnell J, et al. Athletes experience a high rate of return to sport following hip arthroscopy. Knee Surg Sports Traumatol Arthrosc. 2019;27(10):3066-104.

98. Ko SJ, Terry MA, Tjong VK. Return to Sport After Hip Arthroscopy for Femoroacetabular Impingement Syndrome: a Comprehensive Review of Qualitative Considerations. Curr Rev Musculoskelet Med. 2020;13(4):435-41.

99. van Klij P, Heerey J, Waarsing JH, Agricola R. The Prevalence of Cam and Pincer Morphology and Its Association With Development of Hip Osteoarthritis. J Orthop Sports Phys Ther. 2018;48(4):230-8.

100. Agricola R, Heijboer MP, Bierma-Zeinstra SM, Verhaar JA, Weinans H, Waarsing JH. Cam impingement causes osteoarthritis of the hip: a nationwide prospective cohort study (CHECK). Ann Rheum Dis. 2013;72(6):918-23.

101. Wyles CC, Heidenreich MJ, Jeng J, Larson DR, Trousdale RT, Sierra RJ. The John Charnley Award: Redefining the Natural History of Osteoarthritis in Patients With Hip Dysplasia and Impingement. Clin Orthop Relat Res. 2017;475(2):336-50.

102. Sansone M, Ahlden M, Jonasson P, Thomee C, Sward L, Collin D, et al. Outcome of hip arthroscopy in patients with mild to moderate osteoarthritis-A prospective study. J Hip Preserv Surg. 2016;3(1):61-7.

103. Domb BG, Chaharbakhshi EO, Rybalko D, Close MR, Litrenta J, Perets I. Outcomes of Hip Arthroscopic Surgery in Patients With Tonnis Grade 1 Osteoarthritis at a Minimum 5-Year Follow-up: A Matched-Pair Comparison With a Tonnis Grade 0 Control Group. Am J Sports Med. 2017;45(10):2294-302.

104. Hunter DJ, Bierma-Zeinstra S. Osteoarthritis. Lancet. 2019;393(10182):1745-59.

105. Piuzzi NS, Slullitel PA, Bertona A, Onativia JI, Albergo I, Zanotti G, et al. Hip arthroscopy in osteoarthritis: a systematic review of the literature. Hip Int. 2016;26(1):8-14.

106. Haughom BD, Plummer DR, Hellman MD, Nho SJ, Rosenberg AG, Della Valle CJ. Does Hip Arthroscopy Affect the Outcomes of a Subsequent Total Hip Arthroplasty? J Arthroplasty. 2016;31(7):1516-8.

107. Spencer-Gardner LS, Camp CL, Martin JR, Sierra RJ, Trousdale RT, Krych AJ. Does Prior Surgery for Femoroacetabular Impingement Compromise Hip Arthroplasty Outcomes? J Arthroplasty. 2016;31(9):1899-903.

108. Sansone M, Ahlden M, Jonasson P, Thomee C, Sward L, Baranto A, et al. A Swedish hip arthroscopy registry: demographics and development. Knee Surg Sports Traumatol Arthrosc. 2014;22(4):774-80.

109. Ohlin A, Ahlden M, Lindman I, Jonasson P, Desai N, Baranto A, et al. Good 5-year outcomes after arthroscopic treatment for femoroacetabular impingement syndrome. Knee Surg Sports Traumatol Arthrosc. 2019.

110. Sansone M, Ahlden M, Jonasson P, Thomee C, Sward L, Ohlin A, et al. Outcome after hip arthroscopy for femoroacetabular impingement in 289 patients with minimum 2-year follow-up. Scand J Med Sci Sports. 2017;27(2):230-5.

111. Riff AJ, Kunze KN, Movassaghi K, Hijji F, Beck EC, Harris JD, et al. Systematic Review of Hip Arthroscopy for Femoroacetabular Impingement: The Importance of Labral Repair and Capsular Closure. Arthroscopy. 2019;35(2):646-56 e3.

112. Konan S, Rayan F, Meermans G, Witt J, Haddad FS. Validation of the classification system for acetabular chondral lesions identified at arthroscopy in patients with femoroacetabular impingement. J Bone Joint Surg Br. 2011;93(3):332-6.

113. Beck M, Kalhor M, Leunig M, Ganz R. Hip morphology influences the pattern of damage to the acetabular cartilage: femoroacetabular impingement as a cause of early osteoarthritis of the hip. J Bone Joint Surg Br. 2005;87(7):1012-8.

114. Jonasson P, Baranto A, Karlsson J, Sward L, Sansone M, Thomee C, et al. A standardised outcome measure of pain, symptoms and physical function in patients with hip and groin disability due to femoro-acetabular impingement: cross-cultural adaptation and validation of the international Hip Outcome Tool (iHOT12) in Swedish. Knee Surg Sports Traumatol Arthrosc. 2014;22(4):826-34.

115. Thomee R, Jonasson P, Thorborg K, Sansone M, Ahlden M, Thomee C, et al. Cross-cultural adaptation to Swedish and validation of the Copenhagen Hip and Groin Outcome Score (HAGOS) for pain, symptoms and physical function in patients with hip and groin disability due to femoro-acetabular impingement. Knee Surg Sports Traumatol Arthrosc. 2014;22(4):835-42.

116. Tegner Y, Lysholm J. Rating systems in the evaluation of knee ligament injuries. Clin Orthop Relat Res. 1985(198):43-9.

117. Ohlin A, Jónasson P, Ahldén M, Thomée R, Baranto A, Karlsson J, et al. The Hip Sports Activity Scale for patients with femoroacetabular impingement syndrome—Validation in Swedish. Translational Sports Medicine 2019;2(4).

118. Rolfson O, Karrholm J, Dahlberg LE, Garellick G. Patient-reported outcomes in the Swedish Hip Arthroplasty Register: results of a nationwide prospective observational study. J Bone Joint Surg Br. 2011;93(7):867-75.

119. King MT. A point of minimal important difference (MID): a critique of terminology and methods. Expert Rev Pharmacoecon Outcomes Res. 2011;11(2):171-84.

120. Moher D, Shamseer L, Clarke M, Ghersi D, Liberati A, Petticrew M, et al. Preferred reporting items for systematic review and meta-analysis protocols (PRISMA-P) 2015 statement. Syst Rev. 2015;4:1.

121. Landis JR, Koch GG. An application of hierarchical kappa-type statistics in the assessment of majority agreement among multiple observers. Biometrics. 1977;33(2):363-74.

122. Ayeni OR, Belzile EL, Musahl V, Naudie D, Crouch S, Sprague S, et al. Results of the PeRception of femOroaCetabular impingEment by Surgeons Survey (PROCESS). Knee Surg Sports Traumatol Arthrosc. 2014;22(4):906-10.

123. Thorborg K, Kraemer O, Madsen A-D, Hölmich P. Patient-Reported Outcomes Within the First Year After Hip Arthroscopy and Rehabilitation for Femoroacetabular Impingement and/or Labral Injury: The Difference Between Getting Better and Getting Back to Normal. The American Journal of Sports Medicine. 2018;46(11):2607-14.

124. Nwachukwu BU, Beck EC, Lee EK, Cancienne JM, Waterman BR, Paul K, et al. Application of Machine Learning for Predicting Clinically Meaningful Outcome After Arthroscopic Femoroacetabular Impingement Surgery. Am J Sports Med. 2020;48(2):415-23.

125. Mygind-Klavsen B, Lund B, Nielsen TG, Maagaard N, Kraemer O, Holmich P, et al. Danish Hip Arthroscopy Registry: predictors of outcome in patients with femoroacetabular impingement (FAI). Knee Surg Sports Traumatol Arthrosc. 2019;27(10):3110-20.

126. Trivedi NN, Sivasundaram L, Su CA, Knapik D, Nho SJ, Mather RC, 3rd, et al. Indications and Outcomes of Arthroscopic Labral Reconstruction of the Hip: A Systematic Review. Arthroscopy. 2019;35(7):2175-86.

127. Ayeni OR, Alradwan H, de Sa D, Philippon MJ. The hip labrum reconstruction: indications and outcomes--a systematic review. Knee Surg Sports Traumatol Arthrosc. 2014;22(4):737-43.

128. Chandrasekaran S, Darwish N, Mu BH, Rybalko DA, Perets I, Suarez-Ahedo C, et al. Arthroscopic Reconstruction of the Irreparable Acetabular Labrum: A Match-controlled Study. Arthroscopy. 2019;35(2):480-8.

129. Ueland TE, Carreira DS, Martin RL. Substantial Loss to Follow-Up and Missing Data in National Arthroscopy Registries: A Systematic Review. Arthroscopy. 2021;37(2):761-70 e3.

130. Phillips AW, Reddy S, Durning SJ. Improving response rates and evaluating nonresponse bias in surveys: AMEE Guide No. 102. Med Teach. 2016;38(3):217-28.

131. Hendra R, Hill A. Rethinking Response Rates: New Evidence of Little Relationship Between Survey Response Rates and Nonresponse Bias. Eval Rev. 2018:193841X18807719.

132. Hojmark K, Stottrup C, Carreon L, Andersen MO. Patient-reported outcome measures unbiased by loss of follow-up. Single-center study based on DaneSpine, the Danish spine surgery registry. Eur Spine J. 2016;25(1):282-6.

133. Reinholdsson J, Kraus-Schmitz J, Forssblad M, Edman G, Byttner M, Stalman A. A non-response analysis of 2-year data in the Swedish Knee Ligament Register. Knee Surg Sports Traumatol Arthrosc. 2017;25(8):2481-7.

134. Poulsen E, Lund B, Roos EM. The Danish Hip Arthroscopy Registry: Registration Completeness and Patient Characteristics Between Responders and Non-Responders. Clin Epidemiol. 2020;12:825-33.

135. Kim J, Lonner JH, Nelson CL, Lotke PA. Response bias: effect on outcomes evaluation by mail surveys after total knee arthroplasty. J Bone Joint Surg Am. 2004;86(1):15-21.

136. Philippon MJ, Weiss DR, Kuppersmith DA, Briggs KK, Hay CJ. Arthroscopic labral repair and treatment of femoroacetabular impingement in professional hockey players. Am J Sports Med. 2010;38(1):99-104.

137. Worner T, Thorborg K, Eek F. High prevalence of hip and groin problems in professional ice hockey players, regardless of playing position. Knee Surg Sports Traumatol Arthrosc. 2019.

138. Lerebours F, Robertson W, Neri B, Schulz B, Youm T, Limpisvasti O. Prevalence of Cam-Type Morphology in Elite Ice Hockey Players. Am J Sports Med. 2016;44(4):1024-30.

139. Brunner R, Maffiuletti NA, Casartelli NC, Bizzini M, Sutter R, Pfirrmann CW, et al. Prevalence and Functional Consequences of Femoroacetabular Impingement in Young Male Ice Hockey Players. Am J Sports Med. 2016;44(1):46-53.

140. Stull JD, Philippon MJ, LaPrade RF. “At-risk” positioning and hip biomechanics of the Peewee ice hockey sprint start. Am J Sports Med. 2011;39 Suppl:29S-35S.

141. Worner T, Clarsen B, Thorborg K, Eek F. Elite Ice Hockey Goalkeepers Have a High Prevalence of Hip and Groin Problems Associated With Decreased Sporting Function: A Single-Season Prospective Cohort Study. Orthop J Sports Med. 2019;7(12):2325967119892586.

142. Whiteside D, Deneweth JM, Bedi A, Zernicke RF, Goulet GC. Femoroacetabular Impingement in Elite Ice Hockey Goaltenders: Etiological Implications of On-Ice Hip Mechanics. Am J Sports Med. 2015;43(7):1689-97.

143. Klingenstein GG, Zbeda RM, Bedi A, Magennis E, Kelly BT. Prevalence and preoperative demographic and radiographic predictors of bilateral femoroacetabular impingement. Am J Sports Med. 2013;41(4):762-8.

144. Louer CR, Pashos G, Clohisy JC, Nepple JJ. A Prospective Analysis of the Contralateral Hip Among Patients With Femoroacetabular Impingement: What Are the Risk Factors for Disease Progression? Am J Sports Med. 2018;46(10):2486-91.

145. Azboy I, Ceylan HH, Groff H, Vahedi H, Parvizi J. Bilateral Femoroacetabular Impingement: What is the Fate of the Asymptomatic Hip? Clin Orthop Relat Res. 2019;477(5):983-9.

146. Collins JA, Ward JP, Youm T. Is prophylactic surgery for femoroacetabular impingement indicated? A systematic review. Am J Sports Med. 2014;42(12):3009-15.

147. McConkey MO, Chadayammuri V, Garabekyan T, Mayer SW, Kraeutler MJ, Mei-Dan O. Simultaneous Bilateral Hip Arthroscopy in Adolescent Athletes With Symptomatic Femoroacetabular Impingement. J Pediatr Orthop. 2019;39(4):193-7.

148. Rosinsky PJ, Kyin C, Shapira J, Maldonado DR, Lall AC, Domb BG. Hip Arthroplasty After Hip Arthroscopy: Are Short-term Outcomes Affected? A Systematic Review of the Literature. Arthroscopy. 2019;35(9):2736-46.

149. Hoeltzermann M, Sobau C, Miehlke W, Zimmerer A. Prior arthroscopic treatment for femoro-acetabular impingement does not compromise hip arthroplasty outcomes: a matched-controlled study with minimum two-year follow-up. Int Orthop. 2019;43(7):1591-6.

150. Vovos TJ, Lazarides AL, Ryan SP, Kildow BJ, Wellman SS, Seyler TM. Prior Hip Arthroscopy Increases Risk for Perioperative Total Hip Arthroplasty Complications: A Matched-Controlled Study. J Arthroplasty. 2019;34(8):1707-10.

151. Hooper P, Oak SR, Lynch TS, Ibrahim G, Goodwin R, Rosneck J. Adolescent Femoroacetabular Impingement: Gender Differences in Hip Morphology. Arthroscopy. 2016;32(12):2495-502.

152. Kemp JL, MacDonald D, Collins NJ, Hatton AL, Crossley KM. Hip arthroscopy in the setting of hip osteoarthritis: systematic review of outcomes and progression to hip arthroplasty. Clin Orthop Relat Res. 2015;473(3):1055-73.

153. Impellizzeri FM, Jones DM, Griffin D, Harris-Hayes M, Thorborg K, Crossley KM, et al. Patient-reported outcome measures for hip-related pain: a review of the available evidence and a consensus statement from the International Hip-related Pain Research Network, Zurich 2018. Br J Sports Med. 2020;54(14):848-57.

154. Carton P, Filan D. Defining the Minimal Clinically Important Difference in Athletes Undergoing Arthroscopic Correction of Sports-Related Femoroacetabular Impingement: The Percentage of Possible Improvement. Orthop J Sports Med. 2020;8(1):2325967119894747.

155. Nwachukwu BU, Chang B, Adjei J, Schairer WW, Ranawat AS, Kelly BT, et al. Time Required to Achieve Minimal Clinically Important Difference and Substantial Clinical Benefit After Arthroscopic Treatment of Femoroacetabular Impingement. Am J Sports Med. 2018;46(11):2601-6.

SUMMARY OF STUDIES AND RESULTS

DISCUSSION

LIMITATIONS

CONCLUSION

FUTURE PERSPECTIVES

ACKNOWLEDGEMENTS

REFERENCES

APPENDIX

PAPERS

This appendix includes the form filled out by the surgeon prior to surgery and the questions from the local hip arthroscopy registry in Gothenburg for the HAGOS, the HSAS, VAS hip function, satisfaction with surgery and iHOT-12.

Höftregisterparametrar

Dagens datum ☐☐☐☐☐☐

Personnummer ☐☐☐☐☐☐ -- ☐☐☐☐

Namn ______________________ ☐ Hö ☐ Vä

Ev idrott ______________________

Symtomduration: ☐☐ år ☐☐ mån

Re-operation:

☐ Ja
☐ Nej

Diagnos:

☐ CAM
☐ Pincer
☐ Mixed
☐ Chondromatos
☐ Psoastendinos
☐ Teres
☐ Fri kropp
☐ Labrumskada
☐ Artros
☐ Annan orsak______________________
☐ Intern snapping hip
☐ Extern snapping hip
☐ Cystor acetabulum
☐ Cystor caput/collum

Broskskada: ☐ **Ingen broskskada**

Lokal:

☐ **ACETABULUM**

Orsak:
☐ Impingement ☐ Trauma ☐ OA ☐ OCD ☐ Iatrogen ☐ Annat............

Konans broskklassifikation:
☐ 0 Normal ☐ 1 Softening or wave sign ☐ 2 Cleavage lesion ☐3 Delamination ☐4 Exposed bone

1 Softening or wave sign: ☐a ☐b ☐c
3 Delamination: ☐a ☐b ☐c
4 Exposed bone: ☐a ☐b ☐c

a = < 1/3 av avståndet mellan labrum och fossan.
b = > 1/3 av avståndet mellan labrum och fossan
c = > 2/3 av avståndet mellan labrum och fossan.

Lokal:

☐ **CAPUT**

Orsak:

☐ Impingement ☐ Trauma ☐ OA ☐ OCD ☐ Iatrogen ☐ Annat............

ICRS:

☐ 0 Normal ☐ 1 Nearly normal ☐ 2 Ab-normal ☐ 3 Sverely abnormal >50% djup ☐ 4 Seveverely abnormal, ned till ben

Åtgärder:

Resektion:	☐ CAM	☐ Pincer	☐ Mediala osteofyter
Labrum:	☐ Sutur	☐ Debridering	☐ Resektion
Psoas:	☐ Debridering	☐ Tenotomi	
Teres:	☐ Resektion	☐ Debridering	
Excision :	☐ Fri kropp	☐ Lat plica	

☐ Mikrofrakturering

☐ Synovektomi

☐ Trochanterbursektomi

☐ Annat ....

Op-datum ☐☐☐☐☐☐ Längd.................. Vikt........................

Op-tid:......................................

Sträcktid:...................................

Dagkir: ☐ Ja ☐ Nej

Avvikelse: ☐ Mycket blödning ☐ Leden gick ej att se ☐ Annat

Komplikationer: beskriv..

....

....

Operatör:..................................

Assistent:..................................

Övrigt:..

Höftenkät

Basdata

Förnamn

Efternamn

Telefonnummer

E-Mail

Skadad sida

- Höger
- Vänster
- Båda

Nästa

HAGOS

Frågeformulär om höft- och/eller ljumskproblem

VÄGLEDNING: Detta frågeformulär innehåller frågor om hur din höft och/eller ljumske fungerar. Du skall ange hur din höft och/eller ljumske har fungerat under den **senaste veckan**.

Svaren skall hjälpa oss att kunna förstå hur du har det och hur bra du klarar dig i vardagen.

Du skall besvara frågorna genom att markera det alternativ som passar dig bäst.

Om en fråga inte gäller dig eller om du inte upplevt besväret under den senaste veckan, så ange det alternativ som passar bäst in och som du känner dig mest nöjd med.

Symptom

Tänk på de **symptom** och besvär du har haft i din höft och/eller ljumske under den **senaste veckan** när du svarar på följande frågor.

S1. Har du malande/obehag i höften och/eller ljumsken?

Aldrig	Sällan	Ibland	Ofta	Alltid
○	○	○	○	○

S2. Har du hört klickande eller andra ljud från höften och/eller ljumsken?

Aldrig	Sällan	Ibland	Ofta	Hela tiden
○	○	○	○	○

S3. Har du problem med att få benen långt ut åt sidan?

Inga	Lite	Måttliga	Stora	Mycket stora
○	○	○	○	○

S4. Har du problem med att ta steget fullt ut när du går?

Inga	Lite	Måttliga	Stora	Mycket stora
○	○	○	○	○

S5. Får du plötsliga stickande/pirrande förnimmelser i höften och/eller ljumsken?

Aldrig	Sällan	Ibland	Ofta	Hela tiden
○	○	○	○	○

Stelhet

Följande frågor handlar om stelhet i höften och/eller ljumsken. Stelhet medför besvär att komma igång eller ett ökat motstånd när du böjer höften och/eller ljumsken.

Ange i hur stor grad du har upplevt stelhet i höften och/eller ljumsken under den **senaste veckan**.

S6. Hur stel är du i din höft och/eller ljumske när du just har vaknat på morgonen?

Inte alls	Lite	Måttligt	Mycket	Extremt
○	○	○	○	○

S7. Hur stel är du i din höft och/eller ljumske senare på dagen, efter att du har suttit eller legat och vilat dig?

Inte alls	Lite	Måttligt	Mycket	Extremt
○	○	○	○	○

Nästa

HAGOS

Smärtor

P1. Hur ofta har du ont i höften och/eller ljumsken?

Aldrig	Varje månad	Varje vecka	Varje dag	Alltid
○	○	○	○	○

P2. Hur ofta har du ont på andra ställen än i höften och/eller ljumsken som du tycker hänger ihop med dina höft- och/eller ljumskproblem?

Aldrig	Varje månad	Varje vecka	Varje dag	Alltid
○	○	○	○	○

Följande frågor handlar om hur mycket smärta i höften och/eller ljumsken under den **senaste veckan**. Ange graden av höft- och/eller ljumsksmärta du har upplevt i följande situationer.

P3. Sträcka ut höften helt och hållet

Ingen	Lätt	Måttlig	Svår	Mycket svår
○	○	○	○	○

P4. Böja höften helt och hållet

Ingen	Lätt	Måttlig	Svår	Mycket svår
○	○	○	○	○

P5. Gå upp- eller nedför trappor

Ingen	Lätt	Måttlig	Svår	Mycket svår
○	○	○	○	○

P6. Om natten när du ligger ned (smärtor som förstör din sömn)

Ingen	Lätt	Måttlig	Svår	Mycket svår
○	○	○	○	○

P7. Sitta eller ligga

Ingen	Lätt	Måttlig	Svår	Mycket svår
○	○	○	○	○

P8. Stående

Ingen	Lätt	Måttlig	Svår	Mycket svår
○	○	○	○	○

P9. Gå på hårt underlag, på asfalt eller sten

Ingen	Lätt	Måttlig	Svår	Mycket svår
○	○	○	○	○

P10. Gå på ojämnt underlag

Ingen	Lätt	Måttlig	Svår	Mycket svår
○	○	○	○	○

Tillbaka Nästa

HAGOS

Fysisk funktion, dagliga aktiviteter

Följande frågor handlar om din fysiska funktion. **Ange graden av besvär du har haft i följande situationer under den senaste veckan, på grund av din höft och/eller ljumske.**

A1. Gå uppför trappor

Inga	Lätta	Måttliga	Stora	Mycket stora
◯	◯	◯	◯	◯

A2. Böja dig ner, tex för att plocka upp något från golvet

Inga	Lätta	Måttliga	Stora	Mycket stora
◯	◯	◯	◯	◯

A3. Kliva i/ur bil

Inga	Lätta	Måttliga	Stora	Mycket stora
◯	◯	◯	◯	◯

A4. Ligga i sängen (vända dig eller hålla höften i samma läge under lång tid)

Inga	Lätta	Måttliga	Stora	Mycket stora
◯	◯	◯	◯	◯

A5. Utföra tungt hushållsarbete (tvätta golv, dammsuga, flytta tunga lådor eller liknande)

Inga	Lätta	Måttliga	Stora	Mycket stora
◯	◯	◯	◯	◯

Tillbaka Nästa

HAGOS

Funktion, sport och fritid

Följande frågor handlar om din fysiska förmåga. Om en fråga inte gäller dig eller om du inte upplevt besväret under den senaste veckan, så ange det alternativ som passar bäst in och som du känner dig mest nöjd med.

Ange vilken grad av besvär du har haft i följande aktiviteter under den senaste veckan, på grund av problem med din höft och/eller ljumske.

SP1. Sitta på huk

Inga	Lätta	Måttliga	Stora	Mycket stora
○	○	○	○	○

SP2. Springa

Inga	Lätta	Måttliga	Stora	Mycket stora
○	○	○	○	○

SP3. Vrida/snurra kroppen när du står på benet

Inga	Lätta	Måttliga	Stora	Mycket stora
○	○	○	○	○

SP4. Gå på ojämnt underlag

Inga	Lätta	Måttliga	Stora	Mycket stora
○	○	○	○	○

SP5. Springa så snabbt du kan

Inga	Lätta	Måttliga	Stora	Mycket stora
○	○	○	○	○

SP6. Föra benet framåt kraftigt och/eller till sidan, exempelvis som vid en spark, skridskosteg eller liknande

Inga	Lätta	Måttliga	Stora	Mycket stora
○	○	○	○	○

SP7. Plötsliga, explosiva rörelser som involverar snabba fotrörelser, exempelvis accelerationer, uppbromsningar, riktningsförändringar eller liknande

Inga	Lätta	Måttliga	Stora	Mycket stora
○	○	○	○	○

SP8. Situationer där benet rör sig helt ut i ytterläge (med ytterläge menas så långt ut från kroppen som möjligt

Inga	Lätta	Måttliga	Stora	Mycket stora
○	○	○	○	○

Tillbaka

Nästa

APPENDIX

HAGOS

Delta i fysisk aktivitet

Följande frågor handlar om din förmåga att delta i fysiska aktiviteter. Med fysiska aktiviteter menas idrottsaktiviteter, men även andra aktiviteter, där man blir lätt andfådd.

Ange i vilken grad din förmåga att delta i önskade fysiska aktiviteter har varit påverkade under senaste veckan, på grund av dina problem med din höft och/eller ljumske.

PA1. Kan du delta i dina önskade fysiska aktiviteter så länge du vill?

Alltid	Ofta	Ibland	Sällan	Aldrig
○	○	○	○	○

PA2. Kan du delta i dina önskade fysiska aktiviteter på din normala prestationsnivå?

Alltid	Ofta	Ibland	Sällan	Aldrig
○	○	○	○	○

Livskvalitet

Q1. Hur ofta blir du påmind om dina problem med höften och/eller ljumsken?

Aldrig	Varje månad	Varje vecka	Varje dag	Alltid
○	○	○	○	○

Q2. Har du ändrat ditt sätt att leva för att undgå att påfresta höften och/eller ljumsken?

Inget alls	Något	Måttligt	I stor utsträckning	Totalt
○	○	○	○	○

Q3. Hur stora problem har du generellt med din höft och/eller ljumske?

Inga	Lätta	Måttliga	Stora	Mycket stora
○	○	○	○	○

Q4. Påverkar dina problem med höften och/eller ljumsken ditt humör i en negativ riktning?

Aldrig	Sällan	Ibland	Ofta	Alltid
○	○	○	○	○

Q5. Känner du dig begränsad på grund av problem med din höft och/eller ljumske?

Aldrig	Sällan	Ibland	Ofta	Alltid
○	○	○	○	○

Tillbaka Nästa

HSAS

Hip Sports Activity Scale - Swedish

Uppskatta din aktivitetsnivå vid olika tidpunkter enligt skalan nedan. Fyll i den siffra som stämmer bäst.

Uppskatta din nuvarande aktivitetsnivå (oavsett om du är opererad eller inte). (0-8)
Uppskatta din aktivitetsnivå som den var innan du fick symptom från höften. (0-8)
Uppskatta din aktivitetsnivå som den var i yngre tonåren (10-15 års ålder). (0-8)

Tillbaka Nästa

8	Tävlingsidrott (nationell och internationell elitnivå) Fotboll, Ishockey, Innebandy, Kampsport, Tennis, Friidrott, Inomhusaktiviteter, Beachvolleyboll
7	Tävlingsidrott (nationell och internationell elitnivå) Alpin skidåkning, Snowboard, Konståkning, Skridsko, Dans Tävlingsidrott (lägre divisioner) Fotboll, Ishockey, Innebandy, Kampsport, Tennis, Friidrott, Inomhusaktiviteter, Beachvolleyboll
6	Tävlingsidrott (nationell och internationell elitnivå) Golf, Cykel, Mountainbike, Simning, Rodd, Längdskidåkning, Ridning Tävlingsidrott (lägre divisioner) Alpin skidåkning, Snowboard, Konståkning, Skridsko, Dans
5	Tävlingsidrott (lägre divisioner) Golf, Cykel, Mountainbike, Simning, Rodd, Längdskidåkning, Ridning Motionsidrott Ishockey, Innebandy, Kampsport, Fotboll, Friidrott, Beachvolleyboll
4	Motionsidrott Tennis, Alpin skidåkning, Snowboard, Inomhusaktiviteter
3	Motionsidrott Jympa/Aerobics, Jogging, Styrketräning av benen, Ridning
2	Motionsidrott Cykel, Mountainbike, Längdskidåkning, skridsko, Golf, Dans, Inlines
1	Motionsidrott Simning, Promenader, Gång
0	Ingen motions- eller tävingsidrott

APPENDIX

Höftenkät

Hur skulle du skatta din höftfunktion på en skala 0 - 100?
0 = extremt dålig funktion och 100 = perfekt funktion.

Skulle du göra om operationen om du var i samma situation igen?

- ◯ Ja
- ◯ Nej
- ◯ Ej opererad

Tillbaka

Nästa

iHOT12

INTERNATIONAL
HIP OUTCOME TOOL

FORMULÄR OM LIVSKVALITÉ HOS UNGA AKTIVA MÄNNISKOR MED HÖFTPROBLEM

Instruktioner

- Nedan följer 12 frågor om de besvär som du kan uppleva i din höft, hur dessa besvär påverkar ditt liv och de känslor du känner som följd av dessa besvär.

- På varje fråga skall du flytta markören till det läge på skalan som du anser bäst överensstämmer med dina besvär.

  - Om du markerar längst ut till vänster betyder det att du känner dig påtagligt begränsad.

  PÅTAGLIGT BEGRÄNSAD — INGA PROBLEM ALLS

  - Om du markerar längst ut till höger betyder det att du inte har några problem alls.

  PÅTAGLIGT BEGRÄNSAD — INGA PROBLEM ALLS

  - Om markeringen placeras mitt på skalan betyder det att du är måttligt begränsad, eller med andra ord, mitt emellan 'påtagligt begränsad' och 'inga problem alls'. Det är viktigt att du markerar ända ut i kanten av skalan om det är ytterligheten som bäst beskriver din situation.

- Vänligen låt dina svar beskriva den typiska situationen **senaste månaden.**

  - **TIPS** Om du inte utför en aktivitet, föreställ dig hur det skulle kännas i din höft om du var tvungen att utföra aktiviteten.

Totalt sett, hur mycket smärta har du i din höft/ljumske?

PÅTAGLIGT BEGRÄNSAD — INGA PROBLEM ALLS

Hur svårt är det för dig att ta dig ner på och upp från golvet/marken?

EXTREMT SVÅRT — INTE SVÅRT ALLS

Hur svårt är det för dig att gå långa distanser?

EXTREMT SVÅRT — INTE SVÅRT ALLS

Hur mycket besvär har du av krasningar, upphakningar eller klickande i din höft?

PÅTAGLIGA BESVÄR — INGA BESVÄR ALLS

Hur mycket besvär har du av att knuffa, dra, lyfta eller bära tunga föremål?

PÅTAGLIGA BESVÄR — INGA BESVÄR ALLS

Hur oroad är du över riktningsförändringar när du idrottar eller motionerar?

EXTREMT OROAD — INTE OROAD ALLS

Hur mycket smärta har du i din höft efter fysisk aktivitet?

EXTREM SMÄRTA — INGEN SMÄRTA ALLS

Hur oroad är du över att lyfta upp eller bära barn på grund av din höft?

EXTREMT OROAD — INTE OROAD ALLS

Hur mycket besvär har du med sexuella aktiviteter på grund av din höft?

PÅTAGLIGA BESVÄR — INGA BESVÄR ALLS

Hur mycket tid är du medveten om dina besvär med din höft?

KONSTANT MEDVETEN — INTE MEDVETEN ALLS

Hur oroad är du över din möjlighet att upprätthålla din önskade fysiska nivå?

EXTREMT OROAD — INTE OROAD ALLS

Hur distraherande/störande är dina höftproblem?

EXTREMT DISTRAHERANDE/ STÖRANDE — INTE DISTRAHERANDI STÖRANDE ALLS

Tillbaka   Avsluta

APPENDIX