Femoroacetabular Impingement Syndrome

– Outcomes of Arthroscopic Hip Surgery

Axel Öhlin

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

UNIVERSITY OF GOTHENBURG

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axel.ohlin@gmail.com

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Correspondence: axel.ohlin@gmail.com

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CONTENTS

ABSTRACT

Hip and groin problems are common among young, active individuals. Femoroacetabular impingement (FAI) syndrome is an important cause of hip pain and reduced hip function among these patients. Bony abnormalities at the femoral head and neck junction and/or the acetabular rim may result in abnormal contact between these structures. Recent advancements in hip arthroscopy have made it possible to treat this condition using a minimally invasive approach and this is currently the standard procedure. The initial results of the treatment have been promising and there is emerging scientific evidence of promising outcomes at long-term follow-ups.

The aim of this thesis is to evaluate medium- to long-term outcome, and predictors of outcome in patients undergoing arthroscopic treatment for FAI syndrome, and to evaluate the methodological quality of the current evidence for this treatment.

Study I is a prospective cohort study comprising 289 patients, evaluating the outcome of arthroscopic treatment for FAI syndrome at a two-year follow-up using patient-reported outcome measurements (PROMs). A significant and clinically relevant improvement was noted.

Study II is a retrospective cohort study comprising 198 patients, evaluating predictors of treatment outcome at a two-year follow-up using multiple linear regression analysis. Greater preoperative patient-reported hip function was associated with a higher postoperative patient-reported hip function.

Study III is a cross-cultural adaptation and validation of a PROM to evaluate the level of physical activity. The Swedish version was deemed to be a reliable and valid measurement to determine the level of physical activity in patients with FAI syndrome.

Study IV is a systematic review evaluating the methodological quality of prospective cohort studies of arthroscopic treatment for FAI syndrome. A total of 53 studies were included and the methodological quality of the included studies was deemed to be of moderate quality for both non-comparative and comparative studies.

Study V is a prospective cohort study comprising 184 patients, evaluating the outcome of arthroscopic treatment for FAI syndrome at a five-year follow-up using PROMs. A significant and clinically relevant improvement was noted.

Keywords: femoroacetabular impingement syndrome, hip arthroscopy, register, systematic review

SAMMANFATTNING PÅ SVENSKA

Höft och ljumskbesvär är vanligt bland unga och aktiva individer. Femoroacetabulärt impingment (FAI) syndrom är en viktig orsak till höftsmärta och nedsatt höftfunktion bland dessa unga patienter. Skelettförändringar vid övergången mellan lårbenshuvudet och lårbenshalsen och/eller höftledsgropen kan leda till onormal kontakt mellan dessa strukturer. Nya framsteg inom artroskopi i höftleden har gjort det möjligt att behandla detta tillstånd med ett minimal-invasivt tillvägagångsätt och är idag standardbehandlingen. De första resultaten av denna behandling har varit lovande och det har börjat komma vetenskaplig evidens som pekar på lovande långtidsresultat.

Denna avhandling har som mål att utvärdera utfallet på medellång- till lång sikt, samt prediktorer till utfallet för patienter som genomgår artroskopisk behandling för FAI syndrome, samt att utvärdera den metodologiska kvalitén på nuvarande evidens för denna behandling.

Studie I är en prospektiv kohortstudie om 289 patienter som utvärderar resultatet av artroskopisk behandling av FAI syndrom vid två-årsuppföljning med hjälp av patientrapporterade utfallsmått (PROMs). En signifikant och klinisk relevant förbättring noterades.

Studie II är en retrospektiv kohortstudie om 198 patienter, som utvärderar prediktorer till behandlingsresultatet vid två-årsuppföljning med hjälp av en multipel regressionsanalys. En högre preoperativ patientrapporterad höftfunktion var associerad med en högre postoperativ patientrapporterad höftfunktion.

Studie III är tvärkulturell adaption och validering av ett patient-rapporterat utfallsmått som mäter fysisk aktivitetsnivå. Den svenska versionen bedömdes vara ett reliabelt och valitt mått för att bedöma nivå av fysisk aktivitet hos patienter med FAI syndrom.

Studie IV är en systematisk översiktsartikel som bedömer den metodologiska kvalitén på prospektiva kohortstudier av artroskopisk behandling för FAI syndrom. Totalt inkluderades 53 studier och den metodologiska kvalitén av

inkluderade studier bedömdes vara av moderat kvalité för både icke-jämförande och jämförande studier.

Studie V är en prospektiv kohortstudie om 184 patienter som utvärderar resultatet av artroskopisk behandling vid fem-årsuppföljning med hjälp av PROMs. En signifikant och klinisk relevant förbättring noterades.

Nyckelord: femoroacetabulärt impingment syndrom, höftartroskopi, register, systematisk översikt

LIST OF PAPERS

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

I. Sansone M, Ahldén M, Jónasson P, Thomeé C, Swärd L, Öhlin A, Baranto A, Thomeé R.
Outcome after hip arthroscopy for femoroacetabular impingement in 289 patients with minimum 2-year follow-up.
Scand J Med Sci Sports. 2017;27(2):230-235.

II. Öhlin A, Sansone M, Ayeni OR, Swärd L, Ahldén M, Baranto A, Karlsson J.
Predictors of outcome at two-year follow-up after arthroscopic treatment of femoro-acetabular impingement.
J Hip Preserv Surg. 2017;4(3):224-230.

III. Öhlin A, Jónasson P, Ahldén M, Thomeé R, Baranto A, Karlsson J, Sansone M.
The Hip Sports Activity Scale (HSAS) for patients with femoroacetabular impingement syndrome – validation in Swedish.
Transl Sports Med. 2019;2:209-213.

IV. Öhlin A, Karlsson L, Hamrin Senorski E, Jónasson P, Ahldén M, Baranto A, Ayeni OR, Sansone M.
Quality assessment of prospective cohort studies evaluating arthroscopic treatment for femoroacetabular impingement syndrome – a systematic review. Orthop J Sports Med. 2019;7(5):2325967119838533.

V. Öhlin A, Ahldén M, Lindman I, Jónasson P, Desai N, Baranto A, Ayeni OR, Sansone M.
Good five-year outcomes after arthroscopic treatment for femoroacetabular impingement syndrome.
Knee Surg Sports Traumatol Arthrosc. 2019 https://doi.org/10.1007/s00167-019-05429-y.

ADDITIONAL PUBLICATIONS BY THE AUTHOR ON THE SAME TOPIC

Öhlin A, Ayeni OR, Swärd L, Karlsson J, Sansone M.
Bilateral femoroacetabular impingement syndrome managed with different approaches: a case report.
Open Access J Sports Med. 2018;9:215-220.

Öhlin A, Coughlin RP, Ahldén M, Samuelsson K, Malchau H, Safran MR, Ayeni OR, Sansone M.
The evolution of femoroacetabular impingement surgical management as a model for introducing new surgical techniques.
Knee Surg Sports Traumatol Arthrosc. 2019 https://doi.org/10.1007/s00167-019-05497-0.

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. in press.

ABBREVIATIONS

ADL:	Activity of Daily Living
ANOVA:	ANalysis Of VAriance
BMI:	Body Mass Index
CMS:	Coleman Methodology Score
CT:	Computed Tomography
DGEMRIC:	Delayed Gadolinium-Enhanced MRI of Cartilage
DHAR:	Danish Hip Arthroscopy Registry
EBM:	Evidence-Based Medicine
ES:	Cohen's Effect Size
EQ-5D:	EuroQoL-5 Dimension
FADIR:	Flexion ADduction Internal Rotation
FAI:	Femoroacetabular Impingement
FAIT:	Femoroacetabular impingement Trial
FIRST:	Femoroacetabular Impingement Randomized Controlled Trial
HAGOS:	Copenhagen Hip and Groin Outcome Score
HO:	Heterotopic Ossification
HOS:	Hip Outcome Score
HSAS:	Hip Sports Activity Scale
ICC:	Interclass Correlation Coefficient
iHOT:	international Hip Outcome Score
LCE angle:	Lateral Center Edge angle
mHHS:	modified Harris Hip Score
MIC:	Minimal Important Change
MINORS:	Methodological Index for Non-Randomized Studies
MRI:	Magnetic Resonance Imaging
NAHS:	Non-Arthritic Hip Score
NSAID:	Non-Steroidal Anti-Inflammatory Drugs
NFL:	National Football League
OA:	Osteoarthritis
PRISMA:	Preferred Reporting Items of Systematic reviews and Meta-Analyses
PROM:	Patient-Reported Outcome Measurement
QoL:	Quality of Life
RCT:	Randomized Controlled Trial
ROM:	Range Of Motion
SD:	Standard Deviation
SDC:	Smallest Detectable Change
SRM:	Standardized Response Mean
SCFE:	Slipped Capital Femoral Epiphysis
THA:	Total Hip Arthroplasty
UCLA:	activity scale: University of California Los Angeles activity scale
UK FASHIoN:	United Kingdom full randomized controlled trial of arthroscopic surgery for hip impingement versus best conventional
US MHS:	United States Military Health System
VAS:	Visual Analog Scale

BRIEF DEFINITIONS

Cam: abnormally shaped femoral head-neck junction, causing a non-spherical femoral head.

Ceiling effect: when patients obtain the highest possible score for a PROM.

Comparative study: a study design that compares a group of patients with a group of control subjects.

Construct validity: the degree to which a measurement relates in agreement with the hypothesis of the concept of interest.

Content validity: the degree to which a measurement represents the concept of interest.

Cohort study: a study design that follows a group of patients over time.

Cross-cultural adaptation: the adaptation of a PROM for use in another cultural setting.

Floor effect: when patients obtain the lowest possible score for a PROM.

Methodological quality: the degree to which a study design limits the risk of bias.

Mixed impingement: a combination of cam and pincer morphologies.

Multiple linear regression analysis: a statistical method that controls for confounding factors.

Pincer: focal or global overcoverage of the hip by a prominent acetabular rim.

Prospective study design: enrollment of patients begins prior to the development of the studied outcome.

Predictors: internal or external factors that predict the treatment outcome.

Reliability: the degree to which a measurement is free from measurement error.

Responsiveness: the ability of a measurement to detect changes over time.

Randomized controlled trial: a study design that randomly allocates patients to different treatment groups.

Survivorship: the rate of patients not receiving a THA (in this thesis).

Systematic review: a study design that involves a methodological search of the literature to select studies for inclusion.

CHAPTER 01

INTRODUCTION

1.1 ANATOMY

The hip joint is a synovial, ball-and-socket joint between the acetabulum of the pelvic bone and the head of the femur. With a deep socket and a strong ligamentous apparatus, the anatomy of the hip suggests that its function is mainly weight-bearing and stability. The combination of a wide head of the femur and a narrow neck enables a wide range of motion (ROM) in all planes, despite the deep socket (Figure 1).

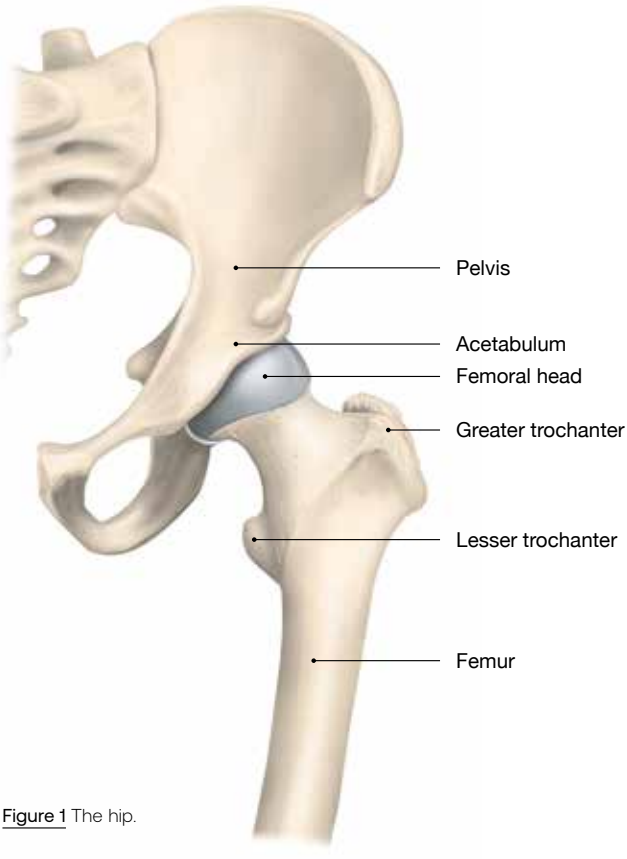

Figure 1 The hip.

The articular part of the acetabulum consists of a broad C-shaped hyaline cartilage, with its opening anteriorly and inferiorly. A fibro-cartilaginous collar along the rim of the acetabulum, the acetabular labrum, helps deepen the acetabulum. It has been suggested that the acetabular labrum contributes to stability[1] and to maintaining a synovial fluid seal which protects the cartilage layers of the hip during loading.[2] Over the acetabular notch, inferiorly in the acetabulum, the acetabular labrum passes over as the transverse acetabular ligament, making the notch a foramen. The non-articular part of the acetabulum is the acetabular fossa, where the ligamentum teres attaches. The ligament attaches to the femoral head at the fovea capitis femoris, which is located inferiorly and posteriorly to the center of the head. The fovea is the only part of the femoral head that is not covered by cartilage (Figure 2).

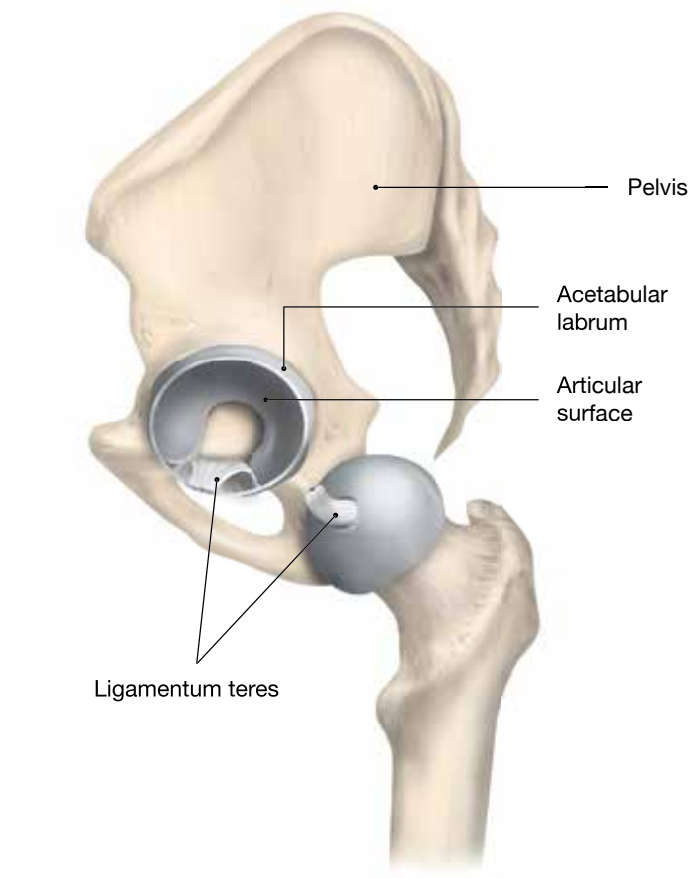

Figure 2 Lateral view of the left hip with the femoral head dislocated to display intraarticular structures.

The hip joint can be divided into the central and peripheral compartments, where the central compartment refers to the space between the femoral head and the acetabulum (Figure 3) and the peripheral compartment refers to the intracapsular space around the femoral neck.

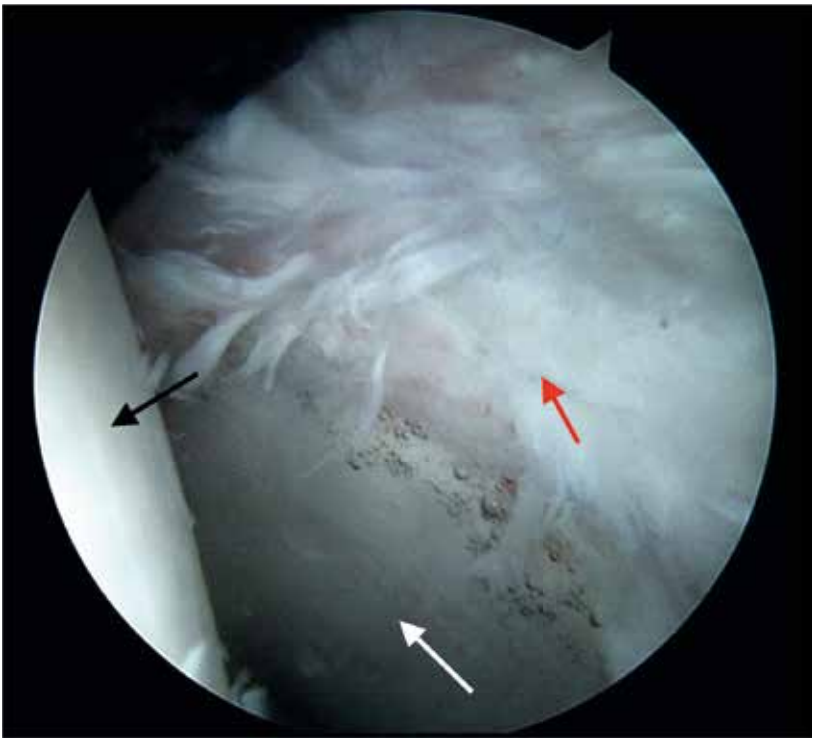

Figure 3 Arthroscopic view of the central compartment of the hip joint with cartilage of the femoral head (black arrow), cartilage of the acetabulum (white arrow) and chondrolabral damage (red arrow).

Three ligaments which stabilize the hip joint can be identified in the capsule. Proximally, these ligaments attach in a circle around the acetabulum. Distally, on the femur, they attach anteriorly onto the intertrochanteric line and posteriorly along the femoral neck. The ilio-femoral ligament is located anteriorly to the hip joint, the pubo-femoral ligament is located anterior-inferiorly to the hip joint and the ischio-femoral ligament is located posteriorly to the hip joint (Figure 4).

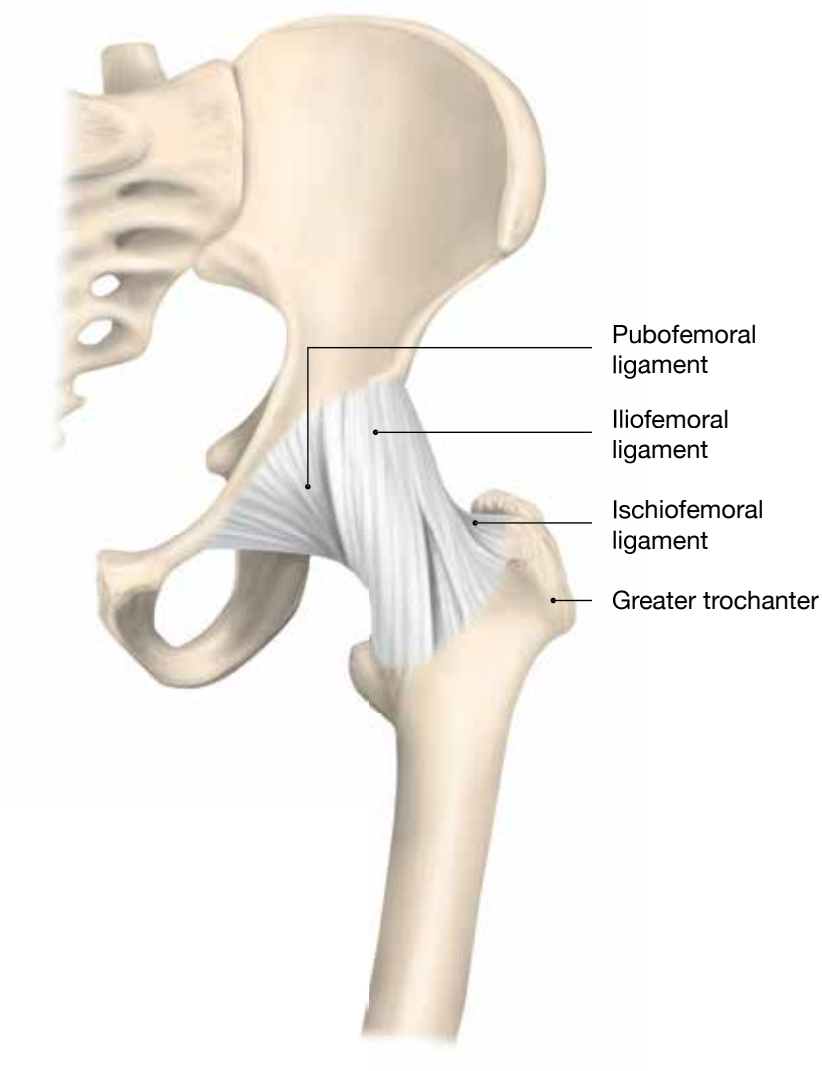

Figure 4 Ligaments of the hip joint.

The main blood supply to the femoral head comes from branches of the medial and lateral circumflex arteries, the retinacular arteries, which enter the femoral head through the medial and lateral retinacular fold of the synovial membrane (Figure 5).

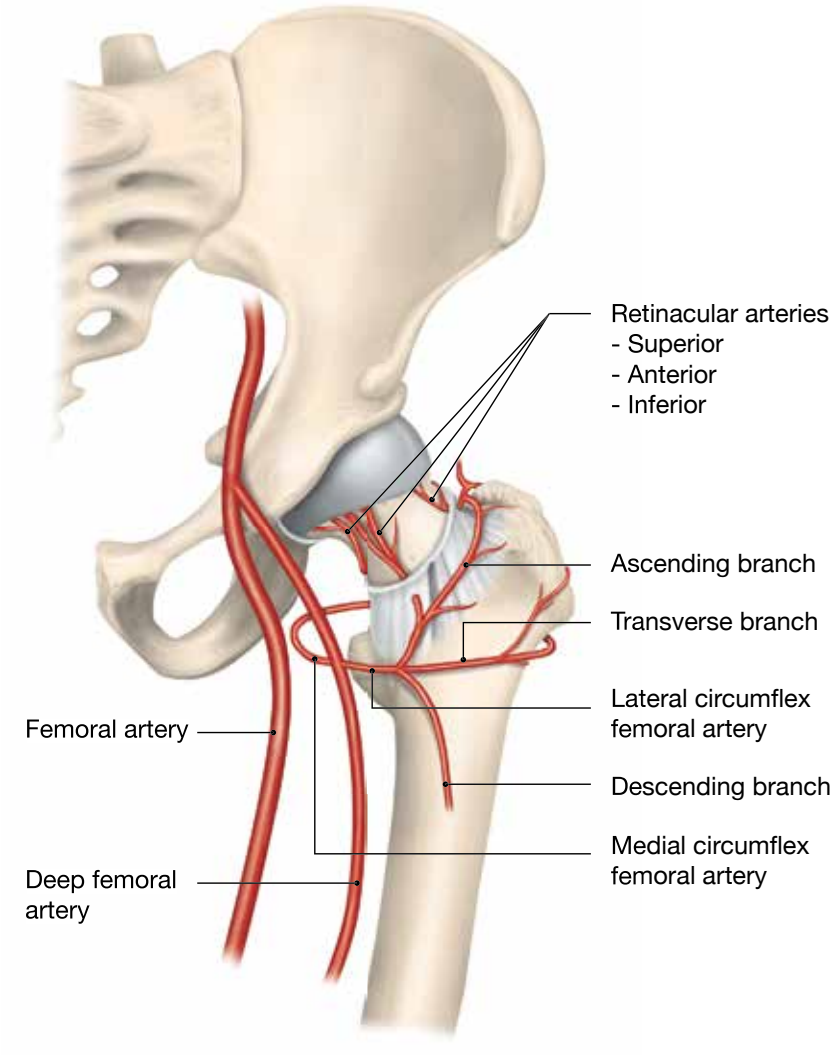

Figure 5 Vascular supply to the hip joint.

The main nerves that pass the hip joint are the sciatic nerve, which derives from the 4th lumbar spinal nerve to the 3rd sacral spinal nerve, and passes posteriorly to the hip joint, the lateral femoral cutaneous nerve, which derives from 2nd and the 3rd lumbar spinal nerves, and the femoral nerve, which derives from the 2nd to the 4th lumbar spinal nerves, and passes anteriorly to the hip joint (Figure 6).

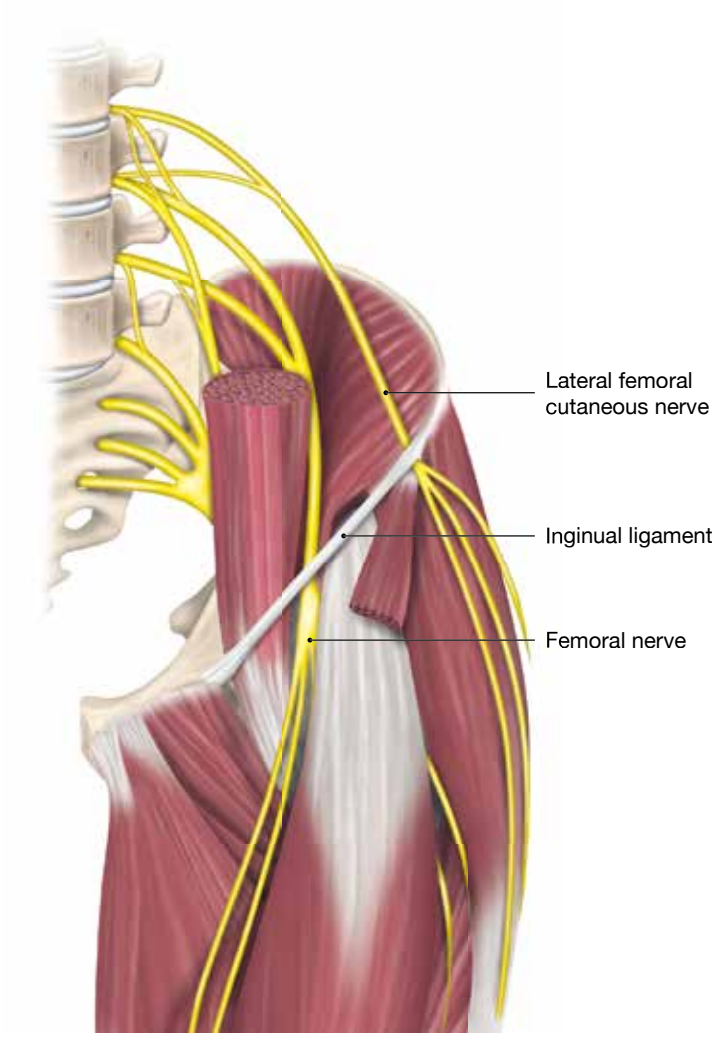

Figure 6 Nerves of the hip joint.

1.2 HISTORICAL BACKGROUND OF FAI SYNDROME

Femoroacetabular impingement (FAI) syndrome is an important cause of hip pain in the young, active patient.[3] It is associated with reduced ROM and diminished hip function. In 1933, Elmslie proposed that a pre-existing deformity of the joint will be found in many patients that develop osteoarthritis (OA) by the fourth and fifth decades.[4] The idea that impingement in the form of bone-on-bone contact in the moving hip causes pain and leads to a reduced ROM was later reported in 1936 by Smith-Pedersen, who performed

acetabular rim trimming and femoral neck osteoplasty in patients with acetabular protrusion and chronic slipped capital femoral epiphysis (SCFE).[5]

However, it was not until the 1990s that Ganz et al. presented the formal concept of FAI syndrome. They proposed that FAI syndrome, a factor not easily appreciated using the traditional diagnostic modalities, was present in many cases of what was previously considered idiopathic arthritis.[3, 6] Their findings were based on more than 600 surgical dislocations of the hip, which allowed the in-situ inspection of the damage pattern and the dynamic proof of its origin. The concept of FAI syndrome as a cause of OA of the hip focused more on motion than the widely accepted theory implicating axial loading as the mechanism for the onset of OA.

Initially, surgical treatment was performed via a dislocation of the hip, as described by Ganz et al., including a trochanteric flip approach.[7] Until the late 1990s, hip arthroscopy was mainly limited to diagnostics and the removal of loose bodies.[8] However, a less invasive approach for the treatment of FAI syndrome was desirable. As hip arthroscopy developed, the treatment of isolated labral pathology was made possible[9] and, in 2005, Sampson was the first to report on arthroscopic treatment for FAI syndrome.[10]

1.3 PATHOPHYSIOLOGY OF FAI SYNDROME

Femoroacetabular impingement syndrome is due to two distinct types of anatomical morphology, an abnormally shaped femoral head-neck junction, causing a non-spherical femoral head called cam morphology, and focal or global overcoverage of the hip by a prominent acetabular rim called pincer morphology (Figure 7). These osseous prominences can cause abnormal contact between the femoral head-neck junction and the acetabular rim in the moving hip. In the case of cam morphology, damage to the hip joint typically occurs when the non-spherical part of the femoral head at motion enters into the acetabulum and shear forces then cause the outside-in abrasion of the acetabular cartilage and/or its avulsion from the labrum and the subchondral bone (Figure 8, Figure 9). The labrum is not primarily affected by cam morphology, but chondral avulsion may secondarily lead to tear and ultimately detachment of the labrum. In contrast, pincer morphology primarily damages the labrum, when the labrum is pressed between the femoral neck, which may or may not have a normal form, and the prominent rim of the acetabulum. A combination of the two different morphologies is also frequently seen and is termed “mixed” impingement.[11] It is possible that cartilage

overload can cause the degeneration of the articular surface that leads to OA. How much stress the articular surface is able to tolerate and how rapidly OA may develop is, however, less well understood.[12] These unknown factors may explain why some individuals do not develop OA despite FAI morphology. Cartilage damage due to excessive motion in the outer ranges of the hip can be one factor that is difficult or impossible to measure and can explain the increased risk of OA in former athletes.[13] Despite this gap in knowledge, FAI syndrome has been suggested as a cause of OA[3, 14-16] and it has been shown that cam morphology of the femoral head rather than pincer morphology is strongly associated with the development of OA.[17, 18]

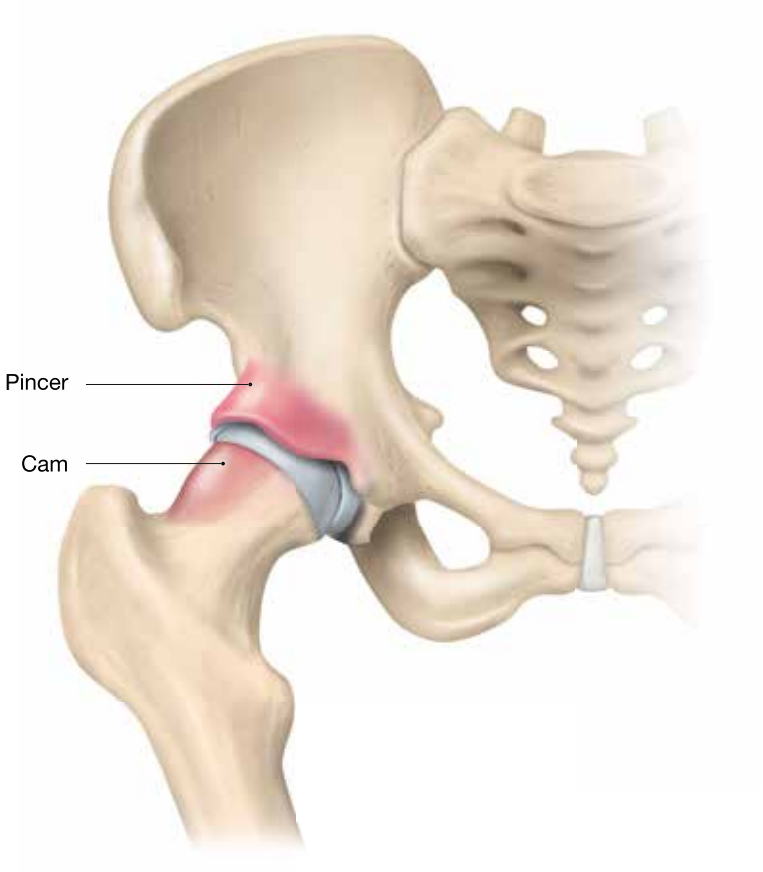

Figure 7 Anterior view of the hip joint with cam morphology at the femoral head-neck junction and pincer morphology at the acetabular rim.

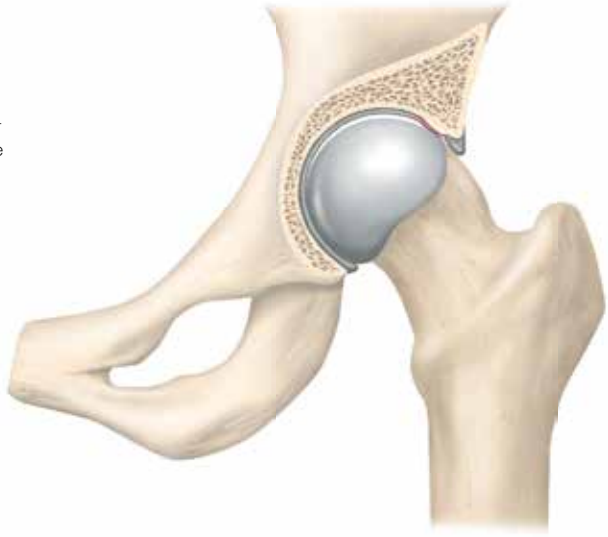

Figure 8 Cross-sectional view of the hip joint where cam morphology causes a mechanical conflict in the anterolateral part of the acetabulum, resulting in damage to the acetabular cartilage.

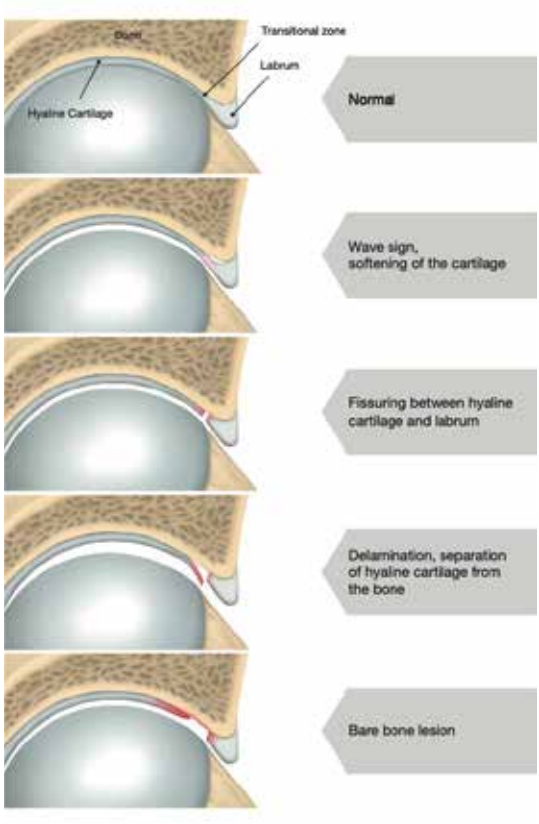

Figure 9 Development of cartilage damage in a hip with FAI syndrome. The first row describes an acetabulum with no cartilage damage. The following rows describe gradually more severe damage to the cartilage of the hip joint that starts with damage to the chondrolabral junction and continues with cartilage delamination and finally bare bone in the acetabulum.

1.4 EPIDEMIOLOGY

Hip pain is a fairly common disorder. A cross-sectional epidemiological study in Germany of 2,368 adolescents (age range, 13-18 years) noted a hip pain prevalence of 6.4%, while only 0.6% of the entire cohort had hip pain associated with objective findings of hip pathology.[19] Spahn et al. concluded that hip pain in adolescents should initially be seen as a psychosomatic disorder.[19] However, this study was published in 2005, before knowledge of FAI syndrome was widespread.

The prevalence of FAI syndrome is not yet well described in the population. However, several studies have evaluated the prevalence of cam and pincer morphologies. A population-based study of asymptomatic young adults reported that the prevalence of radiographic bilateral findings of cam and pincer morphologies was 24.7% and 21.7% respectively for males and 6.3% and 9.7% respectively for females.[20] Among asymptomatic elite soccer players, both with and without a history of groin pain, the prevalence of cam and pincer morphologies was 68% and 26.7% respectively for males and 50% and 10% respectively for females.[21] A high prevalence of cam morphologies and labral tears has also been reported for retired National Football League (NFL) players with persistent hip pain, 73% and 89% respectively.[22] A 20% prevalence of hip pain, together with a clinical sign of FAI syndrome, was, moreover, reported in a cross-sectional study of elite ice-hockey players.[23]

1.5 ETIOLOGY OF FAI SYNDROME

The underlying cause of cam and pincer morphologies is not yet well understood and several different causes of FAI syndrome have been proposed.

Cam morphology was previously thought to be due to a healed sub-clinical SCFE.[24] However, in a longitudinal study of young elite soccer players, Agricola et al. were not able to observe SCFE, even though the rate of cam morphology signs increased. Based on their findings, Agricola et al. presented an alternative explanation; that cam morphology is probably due to high-impact forces that biomechanically trigger a structural adaptation at the proximal femoral growth plate, the femoral neck isthmus and the growth plate of the greater trochanter in the adolescent growing bone (Figure 10).[25] A similar theory was also proposed by Siebenrock et al., who noted a larger alpha angle among basketball players with a closed physis compared with basketball players with an open physis.[26] This theory was, moreover, supported by the

finding that cam morphology did not increase over time in mid-adulthood.[27] Jónasson et al., studying young porcine hips, showed that cyclical loading on the proximal femoral bone caused histological injury in and adjacent to the physeal plate. They suggested that these injuries were likely to cause growth disturbances and could offer a plausible explanation for the development of cam morphology.[28] The association between physical activity and cam morphology was also reported by Ayeni et al., suggesting that cam morphology is more common in elite ice-hockey athletes in comparison with non-athletes.[29] Nepple et al.[30] stated that males participating in intensive impact sports run an increased risk of developing cam deformities, with a 10-fold risk in ice hockey and a four-fold risk in basketball. Running was not shown to be associated with the development of cam deformities.

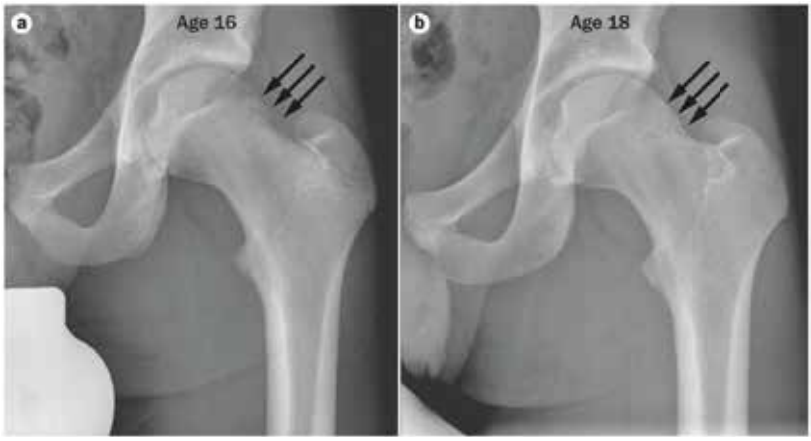

Figure 10 Development of cam morphology. The left radiograph shows the hip of a 16-year-old asymptomatic male elite soccer player and an extension of the growth plate into the femoral neck is present (arrows). The right radiograph is a follow-up radiograph of the same individual two years later, where cam morphology is present. Note that, at age 16, most of the physis is closed, except for the anterolateral part where the cam is seen at a later stage. Reprinted with the permission of Springer Nature, Nature Reviews Rheumatology, Cam impingement of the hip—a risk factor for hip osteoarthritis, Agricola et al., 2013.

Pincer morphology can, however, be due to several different malformations that deepen the acetabulum, either globally, such as coxa profunda and protrusion, or more focally, such as acetabular retroversion and ossification of the labrum.[31] In a review article of the etiology of FAI syndrome, Packer et al. concluded that there is a lack of research linking pincer impingement with athletic or other developmental stresses.[32]

The contribution of genetics has been discussed for both cam and pincer morphology, Pollard et al. reported that the siblings of patients with cam morphology had a 2.8 increased relative risk of also having cam morphology compared with a control group, while the increased relative risk of pincer morphology was 2.0.[33] Both the alpha angle and the center edge angle have been reported to be larger in white asymptomatic individuals compared with Chinese asymptomatic individuals.[34] However, to date, there is no firm evidence that genetic factors play a role in the development of FAI.[32]

1.6 MANAGEMENT OF FAI SYNDROME

1.6.1 DIAGNOSIS

According to the 2016 Warwick agreement on FAI syndrome, an international multidisciplinary consensus agreement, the diagnosis of FAI syndrome is dependent on several factors and there is no single test or symptom that confirms FAI syndrome independently. Instead, the diagnosis has to be based on a contexture of indicative symptoms, clinical signs and imaging findings.[35]

The symptoms related to FAI syndrome are similar to those seen in joint failure. In the patient history, the onset of symptoms is often insidious, but it can also be acute, after or without a trauma.[36] Pain can be motion related or position related and be felt in the hip, groin, back, buttock or thigh. The pain can be intermittent and, for example, only present after sitting for a long time or after athletic activities.[3] Clicking, catching, locking, stiffness, restricted ROM or giving way are other symptoms that may be described by the patient, in addition to pain.[35]

The clinical examination should include the Flexion-ADduction-Internal Rotation (FADIR) test, also called “the hip impingement test”. To perform this test, the patient is placed in the supine position, after which the hip is flexed at 90°and simultaneously adducted and internally rotated (Figure 11). In this position, the anterior femoral neck approximates the antero-superior acetabulum. The test is thought to be positive if the ROM is reduced and pain familiar to the patient occurs at the end position. The theory behind a positive test is that this position gives rise to impingement between the common cam location and the anterior part of the acetabulum, where chondrolabral damage is usually present. There is, however, some disagreement on the utility of this test. Ganz et al.[3] described the test as almost always being positive among patients suffering from FAI syndrome and Clohisy et al.[37] reported that the test sensitivity

was 88.6%. A meta-analysis by Reiman et al. revealed that the FADIR test only possesses screening accuracy when used for diagnosing FAI syndrome/labral tear.[38] However, the impingement test is interrater reliable, producing similar results when performed by different examiners.[39] It is important to remember that a reduced ROM is also common in patients with hip OA and OA may also produce a positive FADIR test.[40] It is therefore important to be cautious about using this test on hips with degenerative changes.

Figure 11 The Flexion-ADduction-Internal Rotation (FADIR) test is performed with the patient in the supine position. The hip is flexed at 90° and simultaneously adducted and internally rotated.

Imaging results may confirm the presence of cam and pincer morphologies and these can be visualized on plain radiographs, a computed tomography (CT) scan and magnetic resonance imaging (MRI). Cam morphology is defined as the loss of femoral head-neck offset quantified by an elevated alpha angle. The alpha angle is the angle between the interception of a line drawn from the center of the femoral head, parallel to the femoral shaft, and a line drawn from the center of the femoral head to the point where the curvature of the femoral head differs from that of a perfect circle (Figure 12).[41] An alpha angle above 50-55° is often regarded as positive for cam morphology.[42] However, it is difficult to determine a certain cut-off value for the alpha angle, since FAI syndrome is a multifactorial condition.[43] A large cam with an alpha angle of, for example, 70° does not have to lead to impingement if there also is an anterior undercoverage of the acetabulum and/or deviant femoral version. Furthermore, genetic predisposition and cartilage quality could affect the development of further cartilage damage and OA development.

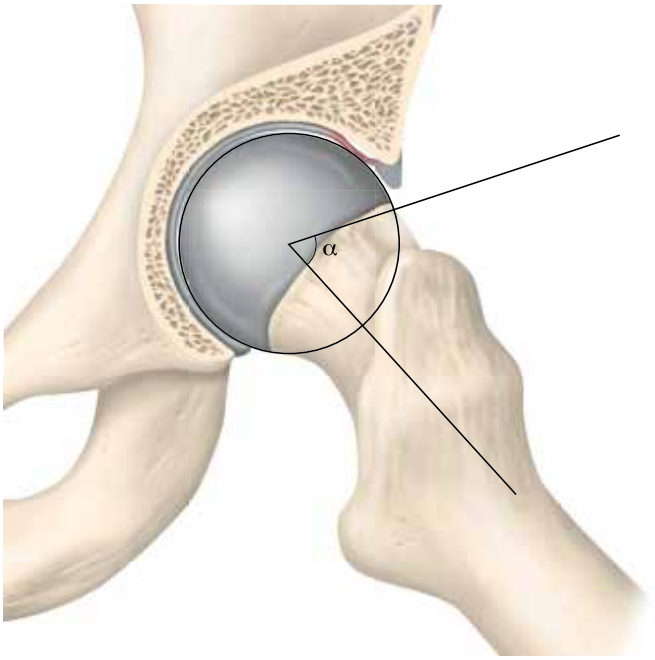

Figure 12 The alpha angle (66° in this example) is measured between the interception of a line drawn from the center of the femoral head, parallel to the femoral shaft, and a line drawn from the center of the femoral head to the point where the curvature of the femoral head differs from that of a perfect circle.

Pincer morphology can be determined in several different ways. An acetabulum medial to the ilioischial line indicates coxa profunda, while a femoral head medially to the ilioischial line indicates protrusion. A posterior rim of the acetabulum medially to the center of the femoral head indicates a deficient posterior wall of the acetabulum, often seen in acetabular retroversion.[44] Anterior acetabular overcoverage can be defined by the crossover sign, the proximal overlapping of the anterior rim of the acetabulum over its posterior rim (Figure 13).[45] In a study by Zaltz et al., the crossover sign, as measured on anterior-posterior plain radiographs, was, however, shown to overestimate acetabular retroversion when using three-dimensional CT as the golden standard.[46] Anterior acetabular overcoverage can also be quantified by the lateral center edge (LCE) angle, the angle between a vertical line and a line between the center of the femoral head and the lateral edge of the acetabulum (Figure 14). An LCE angle above 39° is considered positive for pincer morphology.[47] Other imaging results that may indicate a diagnosis of FAI syndrome are herniation pits on the femoral neck and os acetabuli at the acetabular rim.[3]

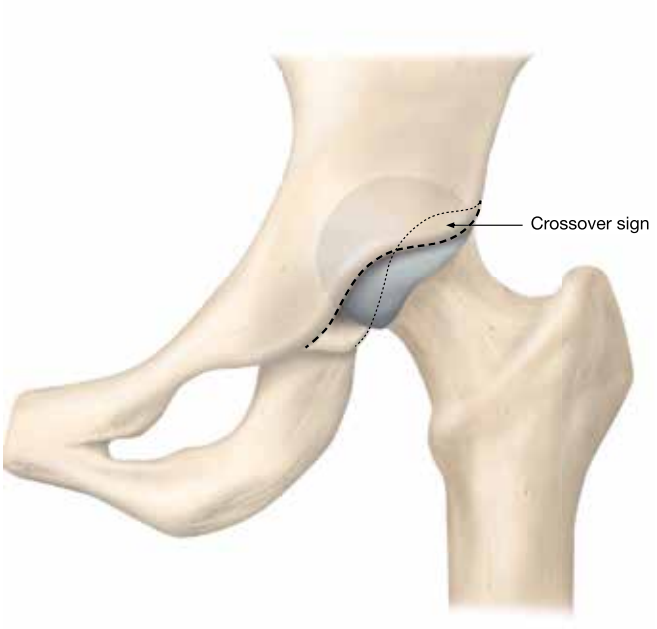

Figure 13 The crossover sign is measured on a frontal pelvic radiograph and is the proximal overlapping of the anterior rim of the acetabulum (thick dotted line) over its posterior rim (thin dotted line).

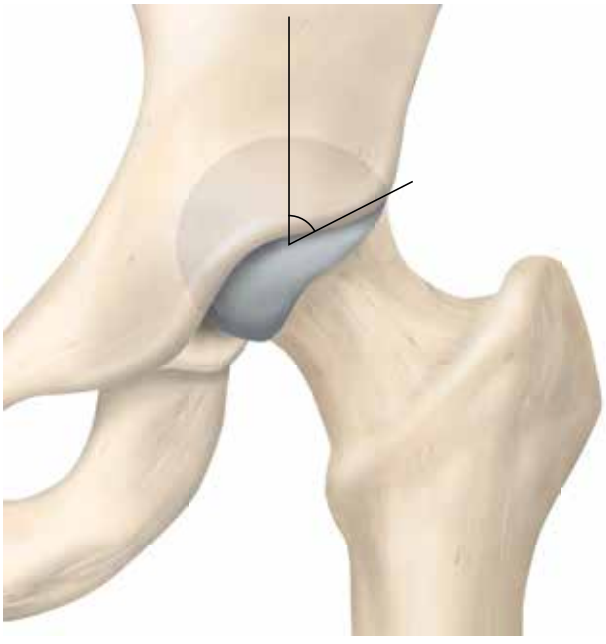

Figure 14 The lateral center edge (LCE) angle is measured on a frontal pelvic radiograph and is the angle between a vertical line representing the perpendicular axis of the pelvis and a line between the center of the femoral head and the lateral edge of the acetabulum.

Finally, fluoroscopically guided intra-articular hip injections of local anesthesia have been suggested as a useful test for diagnosing hip pain.[48] If the patient perceives less pain after injection, it may indicate an intra-articular pathology. Byrd et al. reported that the test was accurate in 90% of patients compared with arthroscopy in detecting intra-articular abnormality.[49]

1.6.2 DIFFERENTIAL DIAGNOSIS

Due to the complex anatomy of the hip joint and the phenomenon of referred pain, there are numerous differential diagnoses to consider when evaluating patients with hip and groin pain. Lumbar spine- and sacroiliac joint-related pathology are back pathologies that could cause hip pain.[50] When differentiating between different types of groin pain and hip pain, the specific pathology is challenging to assert clinically. The Doha agreement[51] therefore suggests categorizing patients into one of the following entities based on pain in the affected region that worsens on exercise and tenderness with palpation and pain on resistance testing; adductor-related groin pain, iliopsoas-related groin pain, inguinal-related groin pain and pubic-related groin pain. The location of the pain reported by the athlete on resistance testing should also correspond to the affected structure. Symptoms from more than one entity are not uncommon among athletes with groin pain.[52] Figure 15 describes the location of the pain for each entity. Mechanical symptoms such as catching, locking, clicking or giving way could indicate hip joint-specific pain and causes other than FAI syndrome that need to be considered include OA, dysplasia, instability and synovial chondromatosis. In addition, there are several other causes of hip and groin pain that cannot be classified into one of the above-mentioned clinical entities, such as an external snapping hip, trochanteritis, neuralgia and deep gluteal pain syndrome.[53, 54] Serious pathology that could cause groin pain and needs to be considered includes avascular necrosis, femoral neck fracture and femoral shaft stress fractures. Abdominal and pelvic organ disorders that mimic musculoskeletal-related groin pain and skeletal tumors are other serious causes of hip and groin pain that need to be considered.[50]

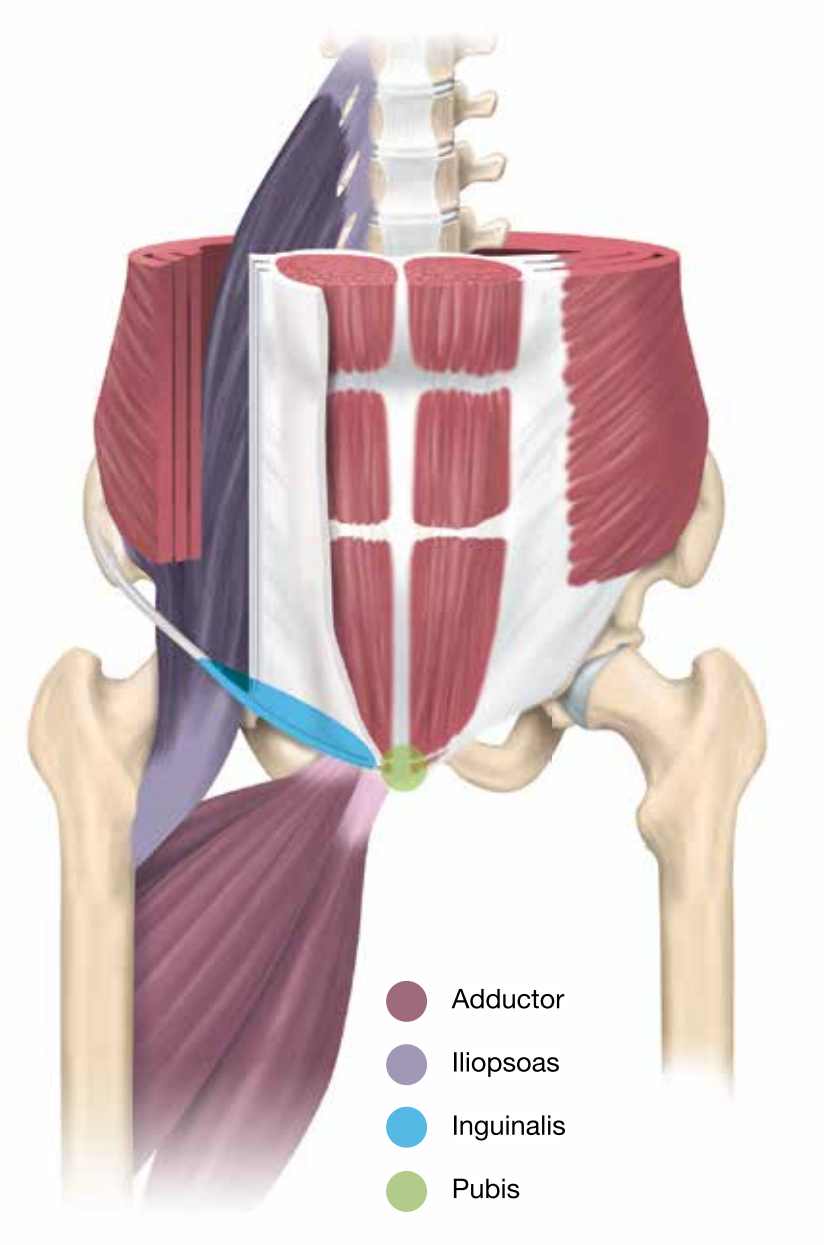

Figure 15 The Doha agreement categorizes patients into one of these four entities based on pain in the affected region that worsens on exercise and tenderness with palpation and pain on resistance testing.

1.6.3 TREATMENT

Femoroacetabular impingement syndrome can be managed by both surgical and non-surgical treatment. Non-surgical treatment consists of activity modification and physical therapy designed to adapt to a safe, and pain-free ROM and the strengthening of core, hip and thigh.[55, 56] There is currently no consensus in terms of the best or recommended non-surgical treatment. The surgical treatment of FAI syndrome aims to restore normal anatomy by resecting cam and pincer morphologies and treating possible intra-articular lesions such as labral tears and/or cartilage lesions.[57] Initially, surgical treatment was performed using an open technique including hip dislocation.[7] Sampson was the first to report on the arthroscopic treatment of FAI syndrome in 2005.[10] The arthroscopic technique has demonstrated outcomes equal to or better than those of open surgery for FAI syndrome patients.[58, 59] A systematic review by Botser et al.[59] reported a complication rate of 9.2% for the open technique compared with 1.7% for the arthroscopic approach. The most common complications with the open technique were those related to the greater trochanteric osteotomy, including fixation failure, non-union and persistent pain. For the arthroscopic approach, the most common complication was heterotopic ossification (HO), but the risk of HO was smaller after the arthroscopic approach than the open technique.

Our surgical technique used in the arthroscopic treatment of FAI syndrome has been described by Sansone et al.[57] Axial traction in the leg is used in order to gain access to the central compartment of the hip joint. Access to the peripheral compartment is achieved through a ligament-sparing interportal capsulotomy parallel to the fibers, with a minimal transverse cut in order to minimize the risk of iatrogenic laxity.[60, 61] The capsulotomy is longitudinal and is therefore not closed. Cartilage lesions are either debrided or treated by microfracture, depending on the lesion size and type. Cartilage lesions are handled with microfracture in cases of bare bone. Prominent acetabular rims (pincer morphology) are resected using a motorized burr. When possible, an “over-the-top” technique is used with the labrum left *in situ*. The “over-the-top” technique preserves the transitional zone between the chondral surface and labrum and has demonstrated good results.[62-64] Otherwise, for larger rim resections, the more traditional technique is used with labral take-down before the resection of the acetabular rim and subsequent re-fixation of the labrum using suture anchors. If present, labral tears can be treated with re-fixation and there are studies showing results superior to debridement.[65, 66] Cam morphologies are resected under the guidance of intra-operative fluoroscopy in order to assess the correct reshaping of the femoral head-neck junction (Figure 16, Figure 17).

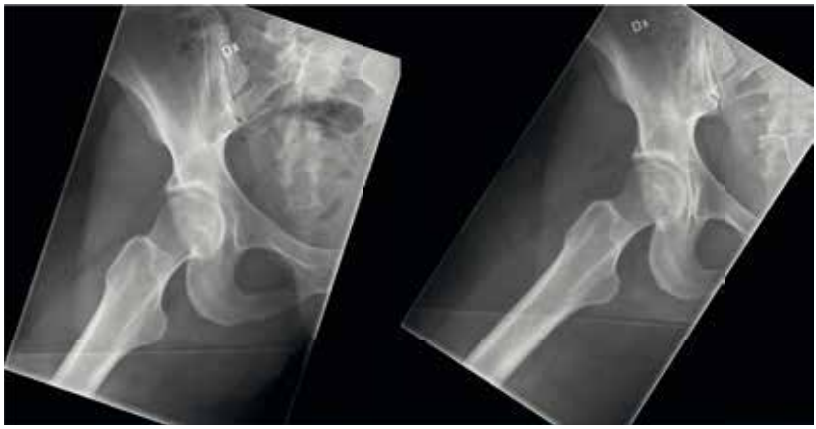

Figure 16 The left radiograph shows a hip with cam morphology and the right radiograph shows the same hip post cam resection. Used under the terms of the Creative Commons Attribution – Non Commercial (unported, v3.0) License (http://creativecommons.org/licenses/by-nc/3.0/). Öhlin et al. Bilateral femoroacetabular impingement syndrome managed with different approaches: a case report. Open Access J Sports Med. 2018:9 215-220. Dove Medical Press Limited.

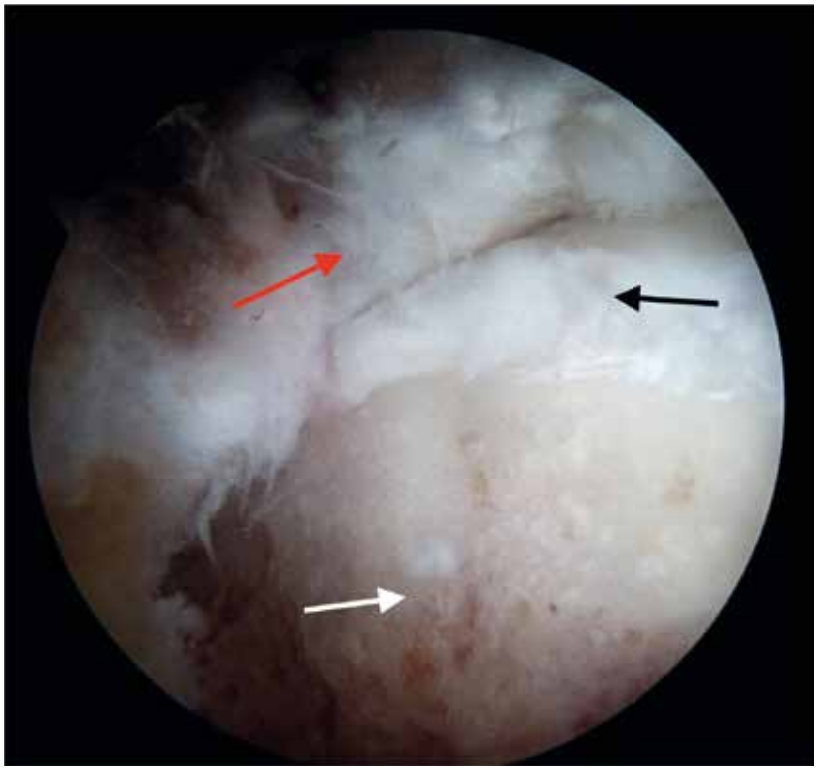

Figure 17 Femoral neck after cam resection (white arrow), acetabular labrum (red arrow) and cartilage of femoral head (black arrow).

Postoperatively, patients are allowed free ROM and full weight-bearing with the use of crutches for four weeks. Patients are prescribed non-steroidal anti-inflammatory drugs (NSAID) for the first three weeks postoperatively to minimize the risk of HO.[67] Antibiotic prophylaxis is not routinely used. Physical therapy is initiated directly postoperatively and the protocol includes exercises focusing on ROM, strength, endurance, balance and coordination. The intensity is gradually increased as tolerated by the patient under the guidance of a physical therapist.

1.7 RESULTS OF TREATMENT FOR FAI SYNDROME

Several studies have reported good results following the arthroscopic treatment of FAI syndrome at the medium term.[68-76] Despite good results at group level, studies have reported large individual differences (Figure 18) and several different factors have been suggested as predictors of treatment outcome, in some cases with contrasting results between studies.

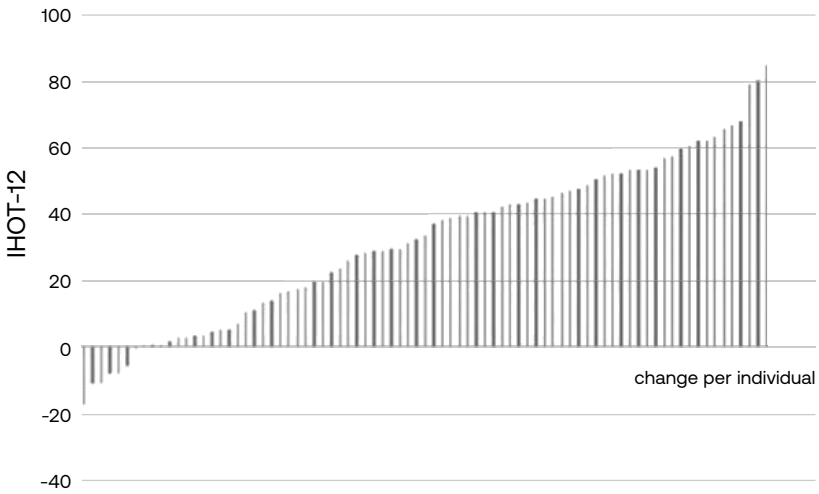

Figure 18 The individual change in the International Hip Outcome Tool (iHOT-12) score at the 12-month follow-up for 81 patients treated with arthroscopic surgery for femoroacetabular impingement. A few patients became worse following treatment, the patients to the left in the diagram, while most patients improved following treatment and some patients improved by around 80 points, the patients to the right in the diagram. Used under the terms of the Creative Commons Attribution - NonCommercial - No Derivatives License (http://creativecommons.org/licenses/by-nc-nd/3.0/). Sansone et al. Good Results After Hip Arthroscopy for Femoroacetabular Impingement in Top-Level Athletes. Orthop J Sports Med. 2015:10;3(2):2325967115569691. SAGE Publishing.

Less cartilage damage[70, 72] and younger age[70] have been noted among patients with better treatment outcomes. Both these factors and duration of symptoms until surgery have also been reported not to predict treatment outcomes.[72] Moreover, male gender has been reported not only as being associated with a better treatment outcome[75] but also as not affecting it.[76] The understanding of predicting factors provides patients with realistic expectations of treatment and thereby guides decision-making. When evaluating potential predicting factors, it is of the utmost importance to account for confounding factors. A multiple linear regression analysis with backward elimination is a statistical method that controls for confounding factors and can preferably be used for this type of evaluation. The long-term results of arthroscopic treatment for FAI syndrome are less well understood due to the novelty of the field. Kaldau et al. reported a five-year survival rate of 83.9% (conversion to total hip arthroplasty (THA) as the endpoint).[77] Haefeli et al. reported an 81% survivorship of hips at the mean seven-year follow-up (conversion to THA, progression of OA or poor clinical outcome as endpoints) and Comba et al. reported a similar joint preservation rate of 83.3% at a minimum seven-year follow-up (conversion to THA as the endpoint).[78, 79] Moreover, Menge et al. reported a significant patient-reported improvement at the 10-year follow-up for both the Hip Outcome Score-Activity of Daily Living (HOS-ADL) and HOS-Sport.[80] Radiographic signs of OA and more severe cartilage lesions at surgery appear to be associated with a greater risk of requiring THA.[77, 79, 80] While long-term results are invaluable, they must be interpreted with caution in the rapidly developing field of clinical research on the FAI syndrome, as the results might not be applicable to patients treated today.

In a systematic review of 1,405 patients, Harris et al. reported that the most common complication following arthroscopic treatment for FAI syndrome was temporary nerve palsy. Further complications and rates are described in Table 1.[81]

Table 1 Complications following arthroscopic treatment for FAI syndrome (Harris et al.)

Temporary nerve palsy	1.7%
Heterotopic ossification	0.4%
Infection	0.07%
Skin damage	0.07%
Thromboembolic disease	0.07%

Contrasting results have been reported in terms of the efficacy of non-surgical treatment for FAI syndrome ranging from favorable[55, 82] to less favorable.[83, 84]

Less is known about the effect of the different treatment regimens on the development and prevention of OA. In a study by Steppacher et al.[85], the under-treatment of acetabular rim trimming was reported as a predictor of failure at the 10-year follow-up after open surgery for FAI syndrome, indicating that surgery may have a favorable impact on preventing the development of OA. This relationship was not, however, seen at the five-year follow-up reported earlier for the same cohort.[86] There is currently no evidence that the treatment of patients with pain-free cam or pincer morphology will alter the risk of developing FAI syndrome or OA.[35]

1.8 EVALUATION

Patient-reported outcome measurements (PROMs) are currently regarded as the gold standard when evaluating the subjective aspects of FAI syndrome. In the early era of hip arthroscopy, pre-existing PROMs, primarily developed for use in patients with advanced OA undergoing THA, were predominantly used. Compared with patients with advanced OA undergoing THA, patients with FAI syndrome have a higher level of physical activity and are mostly limited from participating in sports rather than activities of daily living. One of the early more commonly used PROMs, the modified Harris Hip Score (mHHS), is based on a score initially constructed for use in elderly patients who had undergone THA.[87] When used for young, active patients undergoing arthroscopic hip surgery, a non-negligible ceiling effect is seen, which impairs the opportunity to detect improvement.[88] The need for more accurate PROMs has driven the development of PROMs aimed specifically at young, active patients undergoing hip arthroscopy. The PROMs, the international Hip Outcome score (iHOT)[89] and the Copenhagen Hip and Groin Outcome Score (HAGOS),[90] are scores with sound psychometric properties and are recommended when evaluating patients with FAI syndrome.[35]

The iHOT-12, a short version of the iHOT-33, is a visual analog scale (VAS) and consists of 12 questions, covering symptoms and functional limitations; sport and recreational activities; job-related concerns; and social, emotional and lifestyle concerns as well. A total score is calculated for the 12 questions, range 0-100, where 100 points is the best score. The validation of the Swedish version of the iHOT-12 demonstrated a minimal important change

(MIC) of nine points and no ceiling or floor effect when used for young, active patients undergoing hip arthroscopy.[91] The HAGOS is a Likert scale and consists of six sub-scales; symptoms; pain; physical function in daily living; function in sports and recreational activities; participation in physical activities; and quality of life. A total score is calculated for each sub-scale, range 0-100, where 100 points is the best possible score. The validation of the Swedish version of the HAGOS demonstrated a MIC of 9-17 points for the different sub-scales, a floor effect for the sub-scale participation in physical activity and a ceiling effect for the sub-scale function in daily living when used for young, active patients undergoing hip arthroscopy.[92] With a separate score for each domain, the HAGOS provides a more detailed perception of hip function, compared with the single score for the iHOT-12. However, with several sub-scales, a comparison between patients, or groups of patients, can be less intuitive.

As symptoms are related to the level of activity and that level of activity may affect the patient's expectations and satisfaction, this factor is essential to consider when interpreting PROMs. The Hip Sports Activity Scale (HSAS) is a hip joint-specific activity scale, developed to measure the level of physical activity in patients suffering from FAI syndrome.[93] The HSAS is based on the Tegner activity scale[94] and ranges from *no recreational or competitive sport to competitive sports (disciplines with high hip joint forces) at national and international elite level.* The use of the HSAS is preferred ahead of earlier activity scales such as the University of California Los Angeles (UCLA) activity scale, which, in accordance with the mHHS, has demonstrated a larger ceiling effect when used for young, active patients.[93]

1.8.1 CROSS-CULTURAL ADAPTATION AND VALIDATION OF PROMs

With today's growing trend towards international multicenter research projects and a desire to compare studies performed in different countries in systematic reviews, for example, there is a need for homogeneous outcomes and thus a need to translate and adapt PROMs between different countries and cultures. This process should be performed in a standardized manner. Beaton at al. presented guidelines for a cross-cultural adaptation process including translation and back-translation by multiple translators and the involvement of a multiprofessional expert committee.[95] However, the translated version does not automatically have the same psychometric properties as the original version and it is thus important to evaluate the reliability, validity and responsiveness of the translated version as well.

1.9 STATE OF THE EVIDENCE

Since the conceptualization of the FAI syndrome by Ganz et al.[3] in 2003, the level of scientific evidence has gradually increased over the years. The field has since expanded dramatically and Ayeni et al.[96] noted a five-fold increase in publications related to FAI syndrome between 2005 and 2010. In contrast to earlier single-surgeon case reports, the Gothenburg Hip Arthroscopy Registry[57] and the Danish Hip Arthroscopy Registry (DHAR)[97] were initiated in 2011 and 2012 respectively, in an attempt to obtain more generalizable results. By 2018, a considerable number of prospective cohort studies evaluating arthroscopic treatment for FAI syndrome had been published.[98]

1.9.1 RANDOMIZED CONTROLLED TRIALS

In the pursuit of high-level evidence, Mansell et al.[99] published the first randomized controlled trial (RCT) comparing arthroscopic treatment for FAI syndrome with physical therapy in 2018 (the United States Military Health System (US MHS) FAI trial). Including patients from an American military hospital, this single-surgeon study revealed no significant differences in terms of outcome between the groups. However, this study had a very high cross-over rate; 70% of the patients in the physical therapy group ended up undergoing surgery. The "as-treated" analysis was also underpowered, and therefore unable to exclude a type-2 error. The results of this study should therefore be interpreted with caution, despite the initial rigorous randomized controlled design.[100] Later the same year, Griffin et al.[101] published the second RCT comparing arthroscopic treatment for FAI syndrome with physical therapy (the United Kingdom full randomized controlled trial of arthroscopic surgery for hip impingement versus best conventional (UK FASHIoN)). This national multi-center study revealed a significant and clinically relevant improvement in hip function for the surgical intervention as measured by the patient-reported outcome, the iHOT-33. In 2019, Palmer et al.[102] published the third RCT, comparing hip arthroscopy with a combination of physical therapy and activity modification (the Femoroacetabular Impingement Trial (FAIT)). This national multi-center study also revealed a significant improvement in hip function after surgical intervention. Despite significant differences in outcome between arthroscopic treatment and non-surgical treatment in the studies by Griffin et al. and Palmer et al., it should be mentioned that the differences were only moderate. There is a risk of bias in the results of these three studies, as the included patients were not blinded to the given treatment. The femoroacetabular impingement randomized controlled trial (FIRST) is an ongoing international multi-center RCT that compares arthroscopic treatment

for FAI syndrome with arthroscopic lavage of the hip joint, which involves blinding the patients to the given treatment, consequently limiting bias. The results of this trial will be published in the near future.[103]

1.10 RATIONALE FOR THIS THESIS

There is a relatively wide body of cohort studies reporting favorable outcome following arthroscopic surgery at medium term. However, despite overall good results, the studies have demonstrated large individual differences and predictors of treatment outcome are less well understood, with partly contrasting results.[70, 72, 75, 76] The PROMs used for evaluation in previous studies are also frequently not developed for a young, active population with high demands, which is often the case in patients with FAI syndrome. Beyond hip-specific PROMs, there is currently no activity level scale for FAI syndrome validated for use in a Swedish population, thereby limiting the interpretation of the outcome. Finally, as awareness of FAI syndrome and the treatment of FAI syndrome are fairly new entities, there is a lack of large studies with longer follow-up times for natural reasons. A long follow-up time is, however, especially interesting for FAI syndrome, as it has been suggested that FAI syndrome is one possible factor contributing to OA[3, 14-16] and that the treatment of FAI syndrome could have the potential to delay or even prevent this development in some patients.[56, 85]

CHAPTER 02

AIMS

Study I

To report outcome in a large cohort two years after the arthroscopic treatment of FAI syndrome using validated outcome measurements adapted for young, active patients.

Study II

To identify predictors of treatment outcome at a two-year follow-up in a large cohort undergoing arthroscopic treatment for FAI syndrome, using PROMs validated for use in a young, active population.

Study III

To translate and culturally adapt the HSAS to Swedish and validate the Swedish version in patients with FAI syndrome.

Study IV

To assess the methodological quality of prospective cohort studies evaluating arthroscopic surgery for FAI syndrome and to determine whether there has been an improvement in methodological quality over time.

Study V

To report outcomes at the five-year follow-up after arthroscopic treatment for FAI syndrome, using PROMs developed for a young, active population.

CHAPTER 03

3 METHODS

Ethical approval for Studies I-III and V was granted by the Regional Ethical Review Board in Gothenburg at the Sahlgrenska Academy, Gothenburg University, Gothenburg, Sweden (registration number EPN 071-12).

Study I

Between November 2011 and February 2013, 289 patients (males = 190, females = 99, total hips = 359) underwent arthroscopic surgery for FAI syndrome and were prospectively included in the study. The follow-up was performed two years postoperatively. The inclusion criterion was arthroscopic surgery for suspected FAI syndrome. The number of eligible patients was 425, of which 22 were excluded due to prior hip surgery and 83 did not complete the follow-up. Patient inclusion and follow-up are described in Figure 19.

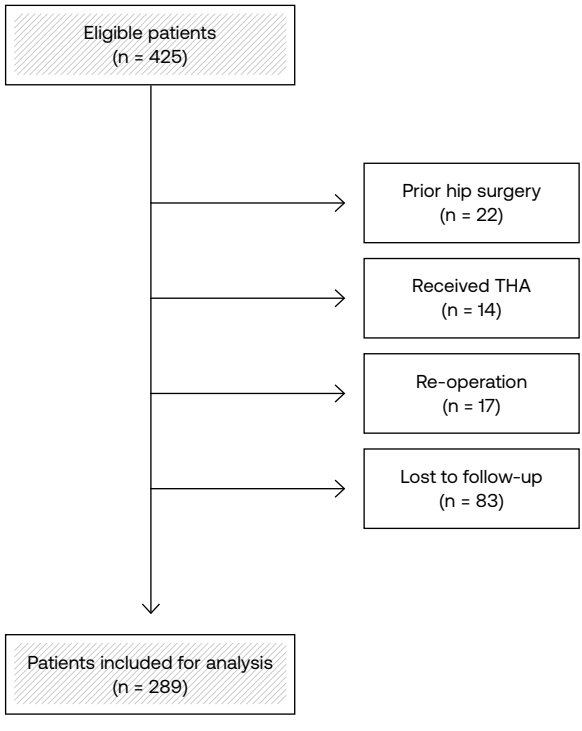

Figure 19 Outline describing patient inclusion and follow-up. THA, total hip arthroplasty.

All hip arthroscopies were performed at two centers by three surgeons. The indication for surgery was an established diagnosis of FAI syndrome and failed non-surgical treatment. Contraindications for surgery included advanced OA, with joint space below 2 mm, and severe dysplasia. The diagnosis of FAI syndrome was made from patient history, physical examination and radiological findings consistent with FAI syndrome of cam type, pincer type, or mixed. A radiographic evaluation was performed on all patients. Perioperative data were registered at the time of surgery. A description of cartilage status was made according to the classification by Konan et al.[104] The classification by Konan et al. is shown in Table 2. All procedures were performed in an out-patient setting. The number of re-operations, including THA, was assessed from patient files and documented. The surgical technique used has been described previously.[57]

Table 2 Classification system for acetabular chondral lesions according to Konan et al.

Cartilage damage classification	Description
0	Normal cartilage
1	Wave sign
2	Cleavage tear between labrum and articular cartilage
3	Delamination of articular cartilage
4	Exposed bone in the acetabulum
A	< one-third of the distance from the acetabular rim to the cotyloid fossa
B	One-third to two-thirds of distance above
C	> two-thirds of distance above

All the patients completed self-administered web-based PROMs, including the iHOT-12, the HAGOS six sub-scales, the HSAS, a VAS for overall hip function and the EuroQoL-5 dimension (EQ-5D) (two sub-scales) for use as a measurement of health outcome. (See Appendix) Moreover, the patients reported whether or not they were satisfied with the surgery. The questionnaires were completed preoperatively and at a minimum of 24 months postoperatively.

Descriptive data were reported as the mean, median, standard deviation (SD) and range. The Wilcoxon signed rank test was used to compare all PROM values used preoperatively with those obtained at follow-up. Age and symptom duration were correlated with the iHOT-12 and HAGOS-Quality of Life (QoL) using Spearman's rank correlation test. The iHOT-12 and HAGOS-QoL score for the different types of cartilage status was compared using analysis of variance (ANOVA). The level of significance was set at $p < 0.05$.

Study II

Between January 2012 and January 2014, all the patients at a single center meeting the inclusion criteria were consecutively included. A total of 315 patients were included. Patient inclusion and follow-up are described in Figure 20. The inclusion criterion was a diagnosis of symptomatic cam-type, pincer-type or mixed-type FAI syndrome.

The clinical diagnostic criteria were a positive FADIR test and painful hip rotation. The radiologic diagnostic criteria consisted of a crossover sign, pistol grip deformity and alpha angle. As no consensus has been reached on the cut-off value for the alpha angle, this was left to individual surgeons to decide and was not further recorded in the study. The indication for surgery was failed non-surgical treatment. The exclusion criteria included previous surgery on the affected hip, advanced OA (joint space < 2 mm) and surgery on the contralateral hip prior to or during the study period. Moreover, patients undergoing THA during the study period were excluded. The demographic data including gender, age and duration of symptoms were collected preoperatively. Preoperatively and at the two-year follow-up, patients were asked to complete the self-administered web-based PROM, the iHOT-12. At the two-year follow-up, the patients were also asked to report whether or not they were satisfied with the surgery. Perioperative data were registered at the time of surgery and included the type of surgical procedure and a description of cartilage status according to Konan et al.[104] The surgical technique that was used has been described previously.[57]

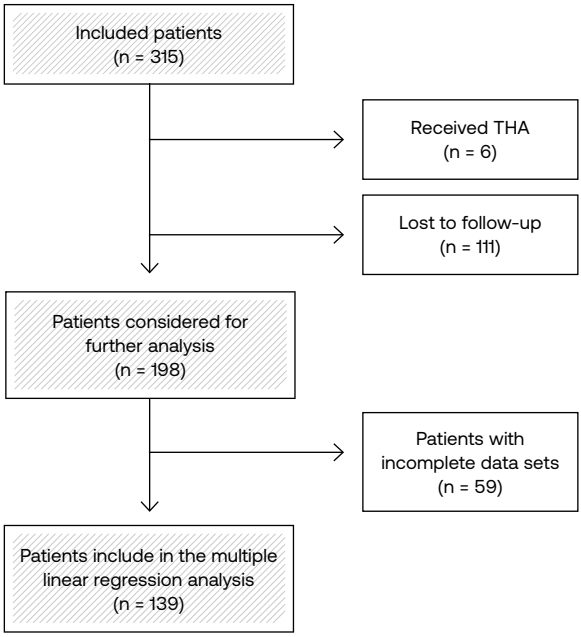

Figure 20 Outline describing patient inclusion and follow-up. THA, total hip arthroplasty.

Potential predictors of treatment outcome chosen for analysis were age, gender, duration of symptoms until surgery, level of cartilage damage, preoperative score and FAI type.

Descriptive data were reported as the mean, SD, median and range. The paired Wilcoxon sign rank test was used to calculate the difference between preoperative and postoperative iHOT-12 scores. The preoperative factors were correlated to the iHOT-12 score at the two-year follow-up. Age (years), symptom duration (months) and the preoperative iHOT-12 score were correlated to the iHOT-12 at follow-up using Pearson's correlation. Spearman's rho was used to correlate gender, FAI type and cartilage status with the iHOT-12 at follow-up. A multivariable analysis was used to examine potential predictors of the iHOT-12 score at the two-year follow-up. A multiple linear regression analysis with backward elimination with α to remove at 0.08 was performed.

Study III

The adaptation of the HSAS to Swedish was performed in several steps. The German version was translated and back-translated to Swedish by two

different native German-speaking individuals who are fluent in Swedish. The translated version was compared with the original version and was deemed acceptable, according to consensus on the expert panel. See Study III Appendix 1 for the Swedish version of the HSAS.

To determine reliability, validity, floor and ceiling effects, 30 patients (cohort 1) requiring arthroscopic treatment for FAI syndrome were recruited. For all patients, FAI syndrome was diagnosed by patient history, clinical examination and radiographs by experienced hip arthroscopic surgeons. The indication for surgery was an established diagnosis of FAI syndrome and failed non-surgical treatment. When the decision to undergo surgical treatment was taken, a questionnaire set consisting of the HSAS, the iHOT-12, the HAGOS and the Tegner score was handed to the patient. For the reliability assessment, the patients were asked to complete the HSAS again about two weeks later (mean 15.9 days, SD = ±5.3).[105] To determine responsiveness, data from 30 patients (cohort 2) who had undergone arthroscopic treatment for FAI syndrome were collected from a prospective register. The HSAS levels before surgery and at a minimum 12-month follow-up (mean 498.9 days, SD = ±287.6) were compared.

Reliability was evaluated by assessing test-retest reliability. The interclass correlation coefficient (ICC) (two-way random effects model with single measurements (absolute agreement)) was calculated.[106] An ICC of > 0.70 was deemed acceptable.[105] To assess whether there were significant differences in scores between test occasions, Wilcoxon's paired test was performed.

The strength of the correlation between the HSAS and the Tegner score was calculated using Spearman's correlation coefficient for non-parametric data in order to determine construct validity. To calculate content validity (hip specificity), the strength of the correlation between the HSAS and the iHOT-12 and the HAGOS respectively was calculated using Spearman's correlation coefficient for non-parametric data.

Cohen's effect size (ES) and the standardized response mean (SRM) were calculated to determine responsiveness. The ES was calculated as the mean change in score divided by the SD of the baseline score. The SRM was calculated as the mean change in score divided by the SD of the change.[107]

The floor effect, when patients rate their physical activity level as the lowest possible, and the ceiling effect, when patients rate their physical activity level as the highest possible, were calculated as a percentage of all patients. Floor

and ceiling effects were calculated for both the HSAS and the Tegner score for comparison.

Descriptive data were reported as the mean and SD. A comparison between cohort 1 and cohort 2 was made using the Mann-Whitney U-test for all parameters except gender, where Pearson's chi-square test was used. The significance level was defined as $p < 0.05$ for all tests.

Study IV

This systematic review was conducted in accordance with the preferred reporting items of systematic reviews and meta-analyses (PRISMA) guidelines.[108]

The inclusion criteria were clinical prospective cohort studies of primary arthroscopic surgery for cam and/or pincer type FAI syndrome. Only studies with clinical outcomes, patient-reported outcomes and/or evaluating complications were included. Studies with only radiographic outcomes were not included and nor were studies that comprised fewer than eight patients. Further exclusion criteria were cohorts described as adolescent and/or with open physes, retrospective reviews of prospectively collected data and studies relating to the validation of outcome scores. Comparative studies for which the main aim was to evaluate diagnoses other than FAI syndrome, only including patients with FAI syndrome as a control group, were also excluded.

A systematic literature search was performed in PubMed, EMBASE (OvidSP) and the Cochrane Library in January 2018. Searches were conducted using controlled vocabulary and title/abstract words. Variations of the words *hip impingement OR CAM impingement OR femoroacetabular impingement OR FAI* were used, together with variations of the word arthroscopy. The searches were performed and validated by a librarian at the Sahlgrenska University Hospital Library, Gothenburg, Sweden. Detailed search strategies for all databases can be found in Study IV Appendix.

All studies yielded by the electronic search were sorted by two reviewers based on abstracts and both reviewers sorted all three databases. Separate studies of the same cohort were all included, as no meta-analysis of data was planned. The included studies were then categorized as a cohort study, non-randomized comparative study or RCT. Studies were analyzed

in full text if the abstract did not provide enough data to make a decision in terms of the fulfillment of inclusion criteria. The researchers were not blinded to the author, year and journal of publication. Disagreement between the reviewers was resolved by consensus or by discussion with the senior author when consensus was not reached. Interobserver agreement for the reviewers' assessment of study eligibility was calculated with the Cohen κ coefficient.

For studies that lacked any data, an attempt to contact the corresponding author of the respective study was made via email.

The data extracted from the included studies were as follows: year, country, study size, age, patient gender ratio and follow-up time and outcome measurements. If reported, demographic data including patients lost to follow-up were always presented in favor of demographic data excluding patients lost to follow-up. For comparative studies, if both groups matched the inclusion criteria in Study IV, the presented study size was the total study size of both groups. If only one group matched the inclusion criteria, only the size of the group that matched the inclusion criteria was presented as the study size. For age and patient gender ratio, if both groups in a comparative study matched the inclusion criteria, the mean age and patient gender ratio for each group were presented, if reported. Regarding the follow-up time, if both the mean follow-up time and minimum follow-up time were reported, only the mean follow-up time was presented. If the mean follow-up time was not reported, the minimum follow-up time was presented. Only clinical outcome scores are presented. For studies with several outcome scores, a maximum of three outcome scores per study were presented.

No meta-analysis was performed due to the heterogeneity of outcome reporting.

The risk of bias was evaluated using the methodological index for non-randomized studies (MINORS).[109] The MINORS is a validated instrument used to determine the methodological quality of non-randomized surgical studies, both comparative and non-comparative. The MINORS consists of eight items for non-comparative studies and an additional four items for comparative studies. The maximum score is 16 for non-comparative studies and 24 for comparative studies. For non-comparative studies, the scores can be understood as: 0-4, very low quality; 5-8, low quality; 9-12, moderate quality; and 13-16, high quality. For comparative studies, the scores can

be understood as: 0-6, very low quality; 7-12, low quality; 13-18, moderate quality; and 19-24, high quality.[51] The scoring method is described in Study IV Appendix. To study the development of methodological quality over time, papers published during the first five years of the period were compared with papers published during the last five years of the period. Non-comparative and comparative studies were analyzed separately. In addition, the methodological quality of RCTs was assessed using the Coleman Methodology Score (CMS).[110] Ten criteria are used to compute the CMS, which ranges between 0-100, with 100 being a perfect score that represents a study design that largely avoids the influence of chance, different biases and confounding factors.

Descriptive data are presented as the mean and SD. Comparisons between papers were made using the Mann-Whitney U-test. All significance tests were two-sided and conducted at the 5% significance level.

Study V

A total of 184 patients treated between 2011 and 2013 were included in this prospective cohort study. The follow-up took place five years postoperatively. The inclusion criterion was arthroscopic surgery for cam-, pincer- or mixed-type FAI syndrome. The diagnosis of FAI syndrome was based on patient history, physical examination and radiological findings consistent with FAI syndrome. The indication for surgery was an established diagnosis of FAI syndrome and failed non-surgical treatment. The contraindications for surgery included advanced OA (joint space < 2mm) and severe dysplasia (LCE angle ≤ 20 degrees). The exclusion criterion was prior hip surgery. All the hip arthroscopies were performed at two centers by three orthopedic surgeons. The surgical technique that was used has been described previously.[57]

There were 408 eligible patients, of which 47 patients were excluded due to prior hip surgery and 148 patients did not complete the five-year follow-up. Twenty-nine patients (13.6%) who were converted to THA for one or both hips during the follow-up period were excluded. As a result, 184 patients were included for further analysis, 225 hips in total. Patient inclusion and follow-up are described in Figure 21.

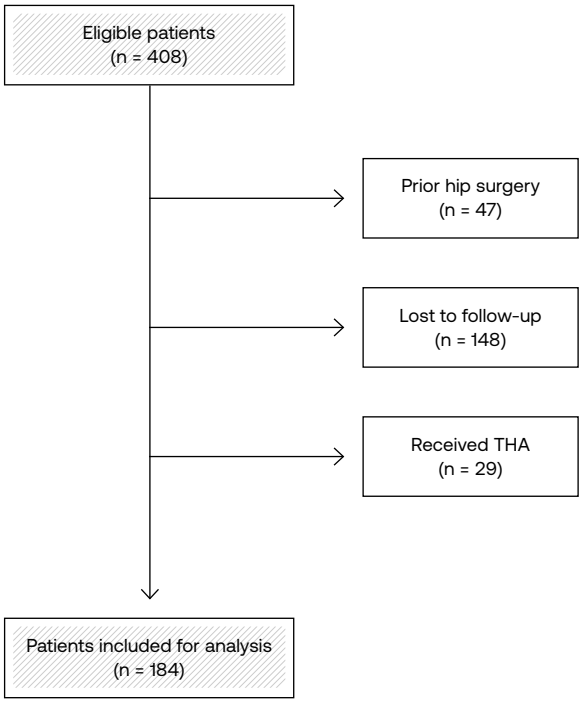

Figure 21 Outline describing patient inclusion and follow-up. THA, total hip arthroplasty.

Perioperative data were recorded at the time of surgery and included age, symptom duration, a description of cartilage status according to the classification by Konan et al.[104] and procedures performed. Preoperatively and at the five-year follow-up, the patients completed a set of self-administered web-based PROMs consisting of the iHOT-12, the HAGOS, the HSAS, the EQ-5D, the EQ-VAS and the VAS for overall hip function. At the five-year follow-up, the set of self-administered, web-based PROMs also included a question asking whether or not the patients were satisfied with surgery. Information regarding re-operations, including conversion to THA, was recorded by the author from patient journals.

With a clinically relevant change in the iHOT-12 score of 10 points, an SD of 21 points (based on data from a previous study[91]) and an α-value of 0.05, the sample size calculation revealed that a power of > 90% would be reached with 75 patients. Descriptive data were reported as the mean, median, SD and range. Categorical variables were tabulated with absolute and relative frequencies. The Wilcoxon signed rank test was used to compare preoperative PROM values with those obtained at the five-year follow-up. Survivorship

was calculated as the number of patients not undergoing THA for one or both hips divided by the number of included patients that completed the five-year follow-up. All significance tests were two-sided and conducted at the 5% significance level.

CHAPTER 04

SUMMARY OF STUDIES AND RESULTS

Study I

This study reports the outcome of arthroscopic treatment for FAI syndrome at the two-year follow-up in a large cohort of 289 patients (359 hips).

Femoroacetabular impingement syndrome is an important cause of hip pain and dysfunction among young, active individuals. Initial studies have reported good results; however, outcomes have often been evaluated by PROMs not primarily developed to measure the unique demands of these patients.

This prospective cohort study used the following PROMs to evaluate the outcome; the iHOT-12, the HAGOS, the HSAS, the EQ-5D, the EQ-VAS, the VAS-overall hip function and single question regarding satisfaction.

The mean age was 37 years (SD: 13), the mean time to follow-up was 25 months (SD: 2) and the median time of symptom duration prior to surgery per hip was 24 months (range: 2-252) (Table 3). There were 149 isolated cam resections, 201 cam and pincer combined procedures and nine isolated pincer resections. The labrum was re-attached in 26 hips and microfracture was performed in 19 hips (Table 4). Reoperations were performed in 17 patients (6%) after index surgery. At the two-year follow-up, fourteen patients (5%) had received a THA. Chondral damage was reported in 202 of 359 hips (56%). The incidence and distribution of chondral damage are shown in Table 5.

The most common type of cartilage damage, as classified by Konan el al.[104], was type 2 (34%), followed by type 3a (20%). Twenty-four (11%) hips had bare bone in the acetabulum and, for the majority of these hips (19 hips), the lesion expanded less than 1/3 of the distance from the acetabular rim to the cotyloid fossa. Preoperative scores compared with those obtained at the two-year follow-up revealed statistically and clinically significant improvements ($p<0.05$) for all measured outcomes; the iHOT-12 (43 vs 66), EQ-5D index (0.58 vs 0.75), the EQ-VAS (67 vs 75), the HAGOS different sub-scales

(56 vs 76, 51 vs 69, 60 vs 78, 40 vs 65, 29 vs 57, 33 vs 58), the VAS for overall hip function (50 vs 71) and the HSAS (2.9 vs 3.6) (Table 6). Of the 289 patients, two hundred and thirty-six (82%) reported that they were satisfied with the outcome of their surgery. Thirty-eight (13%) patients reported dissatisfaction, one (0.3%) was undecided and 14 (5%) did not report. Two of the dissatisfied patients had undergone a re-operation. Symptom duration correlated significantly and negatively with the iHOT-12 and the HAGOS-QoL (r=-0.189 and -0.209, p=0.012 and 0.004 respectively).

Table 3 Patient demographics and perioperative data

Demographics	Total
Total number of patients	289
Total number of hips	359
Operated side - R/L/bilateral, %	42/32/26
Male/female, %	66/34
Symptom duration/hip, median/range/IQR months	24/2-252/12-60
Day surgery, %	100
Age, mean (SD) years	37 (13)
Operation time/hip, mean (SD) minutes	73 (17)
Traction time/hip, mean (SD) minutes	10 (7)
Joint could not be distracted – hips, %	10

IQR, interquartile range; SD, standard deviation

Table 4 Arthroscopic procedures performed on 289 patients and a total of 359 hips

Surgical procedure	Number of hips
Cam	149
Pincer	9
Cam + pincer (combined)	201
Labral suture	26
Microfracture	19
Labral resection	22
Teres ligament resection	2

Table 5 Hips with cartilage damage classified according to the classification system of acetabular chondral lesions according to Konan et al.

Classification	Number of hips (%)
0	3 (1)
1a	18 (9)
1b	2 (1)
1c	0 (0)
2	69 (34)
3a	40 (20)
3b	8 (4)
3c	1 (0.5)
4a	19 (9)
4b	3 (1)
4c	2 (1)
Joint not distractible	18 (10)
Total	202 (100)

Table 6 Mean and standard deviation (SD) for the outcome scores for the entire group (n=289) preoperatively and at the 24-month follow-up

Outcome	Preoperative	24 months	Change (Δ)	P-value
iHOT-12, mean (SD)	43 (17)	66 (27)	23	<0.05
EQ-5D, mean (SD	0.58 (28)	0.75 (26)	0.17	<0.05
EQ-VAS, mean (SD)	67 (20)	75 (20)	0.08	<0.05
HAGOS - pain, mean (SD)	56 (18)	76 (21)	20	<0.05
HAGOS - symptoms, mean (SD)	51 (19)	69 (22)	18	<0.05
HAGOS - daily activity, mean (SD)	60 (22)	78 (22)	18	<0.05
HAGOS - sports, mean (SD)	40 (20)	65 (29)	25	<0.05
HAGOS - physical activity, mean (SD)	29 (26)	57 (34)	28	<0.05
HAGOS - quality of life, mean (SD)	33 (18)	58 (29)	25	<0.05
VAS - overall hip function, mean (SD)	50 (20)	71 (23)	21	<0.05
HSAS, mean (SD)	2.9 (2.2)	3.6 (2.1)	0.7	<0.05
Satisfied with surgery, %	NA	82	NA	NA

iHOT-12, short version of the international hip outcome score; EQ-5D, EuroQoL-5 dimension; VAS, visual analog scale; HAGOS, Copenhagen hip and groin outcome score; HSAS, hip sports activity scale; SD, standard deviation; NA, not applicable

Conclusions

The two-year outcome for arthroscopic treatment for FAI syndrome was favorable. Significant and clinically relevant improvements were noted for all the included PROMs, which cover pain, symptoms, function, physical activity level and quality of life.

Study II

The purpose of this study was to evaluate factors for their potential to predict treatment outcome.

Despite good results at group level following arthroscopic treatment for FAI syndrome, studies have demonstrated large individual differences among patients and several different factors have been suggested as predictors of treatment outcome, in some cases with contrasting results between studies.

A multiple linear regression analysis was used to control for confounding factors. The postoperative iHOT-12 score was the dependent factor and age, gender, duration of symptoms until surgery, level of cartilage damage, preoperative score and FAI type were chosen as independent factors.

Three hundred and fifteen patients meet the inclusion criteria. Two hundred and four patients completed the self-administered web-based PROM, the iHOT-12, at the two-year follow-up (64.8%). Six of these patients (3%) received a THA within the two-year follow-up period and were therefore excluded from the study. A total of 198 patients were thus analyzed. The mean age was 41.0 (SD 12.1) years, with 122 males and 76 females (61.6% males). The mean duration of symptoms prior to surgery was 37.0 (SD 38.1) months. Patient demographics are shown in Table 7. The distribution of cartilage damage type according to Konan et al. is shown in Table 8, with type 0 being the most common type. Of the procedures performed, 60 (30.3%) were isolated cam resections, none was an isolated pincer resection and 138 (69.7%) were combined cam and pincer resections. Two re-operations were performed after the index surgery. The arthroscopic procedures performed are reported in Table 9.

A comparison of the preoperative iHOT-12 score with the postoperative iHOT-12 score obtained at the two-year follow-up revealed statistically significant and clinically relevant improvements, 44.2 versus 65.5 ($p<0.001$) (Table

10). Correlations between preoperative factors and the postoperative iHOT-12 score at the two-year follow-up revealed a statistically significant correlation only for the preoperative iHOT-12 score (Table 11). The multiple linear regression model, after the elimination of non-significant independent variables, contained only the iHOT-12 preoperative score and had an R^2 of 0.19. Based on the multiple linear regression model, the postoperative iHOT-12 score increases by 0.65 points for every additional preoperative iHOT-12 score (Table 12).

Table 7 Patient demographics

Demographics	Total
Total number of patients	198
Operated side - R/L, %	60.4/39.6
Gender - male/female, %	61.6/38.4
Symptom duration, mean (SD) months	37.0 (38.1)
Age, mean (SD years	41.0 (12.1)
BMI, mean (SD)	25.1 (3.5)

R, right; L, left; SD, standard deviation; BMI, body mass index

Table 8 Hips with cartilage damage classified according to the classification system of acetabular chondral lesions according to Konan et al.

Classification	Number of patients (%)
0	40 (20.2)
1a	12 (6.1)
1b	2 (1)
1c	0 (0)
2	32 (16.1)
3a	19 (9.6)
3b	6 (3)
3c	3 (1.5)
4a	12 (6.1)
4b	13 (6.6)
4c	7 (3.5)
Not visualized	30 (15.2)
No data	22 (11.1)

Table 9 Arthroscopic procedures performed

Surgical procedures	Number of patients (%)
Cam	60 (30.3)
Pincer	0 (0)
Cam + pincer	138 (69.7)
Re-operation	2 (1)

Table 10 Outcome data

Score	Preoperative, mean (SD)	Two-year follow-up, mean (SD)	Change, mean (SD)	P-value
iHOT-12 total	44.2 (18.7)	65.5 (27.0)	21.3 (25.5)	<0.001
Q1	35.8 (22.2)	62.4 (31.3)	26.6 (34.1)	<0.001
Q2	56.1 (28.7)	73.6 (28.1)	17.5 (28.9)	<0.001
Q3	46.4 (31.0)	65.0 (32.7)	18.6 (33.6)	<0.001
Q4	62.5 (31.2)	73.9 (29.2)	11.4 (33.7)	<0.001
Q5	51.7 (29.1)	67.6 (31.6)	15.9 (32.7)	<0.001
Q6	41.9 (29.0)	60.5 (33.3)	18.6 (37.4)	<0.001
Q7	33.7 (25.9)	61.9 (31.1)	28.2 (35.4)	<0.001
Q8	66.6 (30.2)	78.5 (29.1)	11.9 (30.0)	<0.001
Q9	61.5 (32.0)	75.6 (29.5)	14.1 (28.9)	<0.001
Q10	22.9 (22.0)	53.2 (35.8)	30.3 (35.9)	<0.001
Q11	27.0 (21.5)	57.7 (34.1)	30.7 (34.7)	<0.001
Q12	24.2 (20.3)	56.2 (34.7)	32.0 (36.6)	<0.001

SD = standard deviation, Q = question number

Table 11 Correlations between preoperative factors and the iHOT-12 score at the two-year follow-up

Factor	N	Correlation	P-value
Age	198	-0.010	n.s.
Symptom duration	183	0.021	n.s.
Preop iHOT-12	198	0.427	0.000
Gender	198	-0.106	n.s.
Cartilage damage	146	-0.052	n.s.
FAI type	198	-0.042	n.s.

N, number of patients with data; n.s., non-significant

Table 12 Multiple linear regression model with the iHOT-12 score at the two-year follow-up as the dependent variable. Model R^2 = 0.19

Variable	Coefficient	Standard error	P-value	95% CI
Intercept iHOT-12 pre-op score	35.20 0.65	5.50 0.10	- <0.001	- 0.45-0.85

CI, confidence interval

Conclusions

The preoperative iHOT-12 score correlates with the postoperative iHOT-12 score at the two-year follow-up. This study implies that the preoperative iHOT-12 score is a predictor of the postoperative result.

Study III

The aim of Study III was to translate the original HSAS from German to Swedish and culturally adapt and validate the Swedish version for patients suffering from FAI syndrome.

The HSAS measures the level of physical activity in patients suffering from FAI syndrome and consists of nine different sports activity levels, ranging from "No Recreational or Competitive Sports" to "Competitive Sports (elite level)".

A questionnaire set consisting of the HSAS, the iHOT-12, the HAGOS and the Tegner score was handed to the patients to assess reliability, construct validity, content validity, responsiveness and floor and ceiling effect. Demographic data and PROM score values are shown in Table 13.

For test-retest reliability, the ICC was 0.930 (95% CI: 0.858 to 0.966). No statistically significant differences were found between the test and retest values. There was a statistically significant high correlation between the HSAS and the Tegner score and a statistically significant low correlation between the HSAS and the HAGOS sub-scale of "physical activity". No further correlations were found. All correlations are shown in Table 14. At a minimum 12-month follow-up, a small to moderate change was noted, with an ES of 0.25 and an SRM of 0.28. The mean HSAS level at follow-up after surgery was 3.2 +/- 2.0. For the HSAS, ceiling effects were observed in 7-10% in the two cohorts respectively, while floor effects were observed in 7% in both cohorts. In comparison, for the Tegner score, both ceiling effects and floor effects were observed in 7%.

Table 13 Demographics and score values

Parameter/score	Cohort 1	Cohort 2	P-value
Number of patients	30	30	NA
Age, mean (SD) years	30.6 (11.3)	36.2 (10.8)	0.047
Males, %	70	66.7	n.s.
HSAS, mean (SD)	4.1 (2.8)	2.6 (2.3)	n.s.
Tegner, mean (SD)	4.7 (3.1)	-	NA
iHOT-12, mean (SD)	38.0 (15.9)	42.4 (19.2)	n.s.
HAGOS - symptoms, mean (SD)	47.4 (17.6)	47.0 (15.6)	n.s.
HAGOS - pain, mean (SD)	52.3 (18.6)	53.6 (17.0)	n.s.
HAGOS - daily activity, mean (SD)	60.2 (23.5)	57.8 (20.0)	n.s.
HAGOS - sports, mean (SD)	33.9 (20.5)	42.6 (23.7)	n.s.
HAGOS - physical activity, mean (SD)	23.9 (26.8)	29.8 (28.1)	n.s.
HAGOS - quality of life, mean (SD)	26.5 (17.7)	29.8 (16.3)	n.s.

HSAS, Hip Sports Activity Scale; iHOT-12, short version of the International Hip Outcome Tool; HAGOS, Copenhagen Hip and Groin Outcome Score; NA, not applicable; n.s., non-significant; SD, standard deviation

Table 14 Correlations between the HSAS and the other PROMs

PROM	HSAS	P-value
Tegner	0.794	<0.01
iHOT-12	-0.020	n.s.
HAGOS - symptoms	-0.142	n.s.
HAGOS - pain	-0.020	n.s.
HAGOS - daily activity	0.135	n.s.
HAGOS - sports	0.120	n.s.
HAGOS - physical activity	0.436	<0.05
HAGOS - quality of life	0.181	n.s.

HSAS, Hip Sports Activity Scale; iHOT-12, short version of the International Hip Outcome Tool; HAGOS, Copenhagen Hip and Groin Outcome Score; n.s., non-significant

Conclusions

The translation was deemed acceptable, according to consensus on the expert panel. The Swedish version of the HSAS demonstrated good reliability, good construct validity and low content validity, small to moderate responsiveness and low floor and ceiling effects. The Swedish version of the HSAS is a reliable and valid measurement, albeit with limited responsiveness, to determine sports-activity levels in patients with FAI syndrome.

Study IV

The aim of Study IV was to evaluate the methodological quality of available evidence for prospective cohort studies following arthroscopic treatment for FAI syndrome and to determine whether there has been an improvement in methodological quality over time.

Prospective cohort studies constitute the dominant part of the available prospective evidence evaluating clinical outcome following arthroscopic treatment for FAI syndrome.

A systematic literature search was performed in PubMed, EMBASE (Ovid-SP) and the Cochrane Library in January 2018. Variations of the words *hip impingement OR cam impingement OR femoroacetabular impingement OR FAI* were used, together with variations of the word *arthroscopy*.

The electronic search yielded 891 studies in EMBASE, 65 studies in the Cochrane Library and 866 studies in PubMed. A total of 636 duplicates were removed, leaving 1,186 unique studies. Of these 1,186 studies, 1,001 were excluded based on the abstract and 132 were excluded based on a full-text assessment. A total of 53 studies were included. A flow-chart of the included and excluded studies is presented in Figure 22. The percentage agreement between reviewers was 93.5% (n=173/185), while the kappa for agreement between reviewers for full-text screening was 0.83 (95% CI 0.74-0.92), indicating excellent agreement.[111]

Of the 53 studies included, 34 were non-comparative studies, 15 non-randomized comparative studies and four were RCTs. The included studies were published between 2008 and 2017 in 26 different journals. Most studies came from the USA (n=16), followed by Switzerland (n=8) and the UK (n=7). Of the patient-reported outcome scores recommended by the Warwick agreement,[35] the HOS was the most frequently reported outcome (n=13), followed by the iHOT (n=7) and the HAGOS (n=6). Demographic data for each study are presented in Table 15.

None of the included studies received a full score according to the MINORS. The best non-comparative study received a global score of 14. The mean global score for all non-comparative studies was 10.4 (SD=1.4). The areas of weakest reporting for non-comparative studies were an unbiased assessment of the study endpoint and a prospective calculation of study size and endpoints appropriate to the aim of the study. The best comparative

studies received a global score of 21 (three studies received this score). The mean global score for all comparative studies was 18.7 (SD=2.0). The areas of weakest reporting for comparative studies were an unbiased assessment of the study endpoint, a prospective calculation of study size and loss to follow-up of less than 5%. Apart from the prospective collection of data, which was an inclusion criterion, the area of strongest reporting for both non-comparative studies and comparative studies was a clearly stated aim. For non-comparative studies, an adequate control group was an area of equally strong reporting. The MINORS score for each study is presented in Table 15. More studies were published during the last five years of the period (n=37) compared with the first five years (n=16). There were no significant differences when comparing the MINORS score for studies published during the first five years of the period with studies published during the last five years, either for non-comparative studies or for comparative studies, 10.3 (SD=1.2) vs. 10.4 (SD=1.5) (p=1.00) and 17.7 (SD=1.5) vs. 18.9 (SD=2.0) (p=0.21) respectively. The mean CMS for RCTs were 79.0 (SD=7.0). Weak areas of methodological quality for RCTs were short follow-up time and description of postoperative rehabilitation.

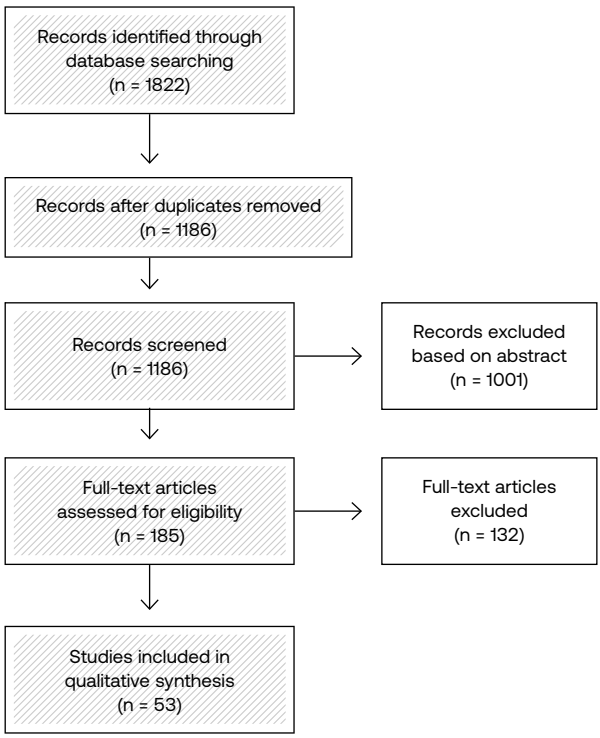

Figure 22 Outline of systematic search strategy used.

Table 15 Demographic data and MINORS score

First author (year)	No. of patients	Follow-up time	Age, y	% male	Country	Outcome	MINORS score, total/max	CMS, total/max
Ayeni (2014)	52	6 mo	37 (median)	42	Canada	mHHS	10/16	NA
Becker (2015)	156	1 y	31.2	25	USA	iHOT-33, HOS-ADL	18/24	NA
Bennell (2017)	30	24 wk	31.0/28.6	86/75	Australia	iHOT-33, HOS (ADL+Sport), HAGOS	20/24	87/100
Bennett (2016)	101	1 y	33	74	UK	VAS pain, NAHS, FAA	11/16	NA
Botser (2014)	18	14.3 mo	20.1	0	USA	mHHS, NAHS, HOS (Sport+ADL)	20/24	NA
Brunner (2009)	50	26.5 mo	42.9	78	Switzerland	VAS pain, ROM, NAHS	20/24	NA
Brunner (2009)	53	2.4 y	42	77	Switzerland	SFS, VAS pain, NAHS	11/16	NA
Byrd (2009)	200	Mean 16 mo	33	69	USA	mHHS	11/16	NA
Byrd (2011)	200	Mean 19 mo	28.6	74	USA	mHHS	11/16	NA
Casartelli (2014)	8	2.5 y	29	38	Switzerland	MS, HOS (ADL+Sport), VAS pain	19/24	NA
Classen (2016)	177	6 mo	48.2	46	Germany	NAHS, WOMAC	6/16	NA
Clement (2014)	58	1 y	33.9	43	UK	SF-12, OHS	10/16	NA
Cvetanovich (2017)	386	Mean 2.6 y	33.3	39 (hips)	USA	HOS (ADL+Sport), mHHS	12/16	NA
Dall'Oca (2016)	40	Mean 20 mo	47	55	Italy	mHSS, LEFS	10/16	NA
Davis (2016)	42	180 d	24.9	45?	USA	HOS (ADL+Sport)	10/16	NA
Di Benedetto (2016)	65	Mean 26 mo	29	54	Italy	ROM, mHHS, iHOT-33	15/24	NA
Dippmann (2014)	87	12 mo	38	37	Denmark	mHHS, VAS pain	10/16	NA
Farkas (2016)	16	6 mo	28.4	25	USA	VPT, VAS pain, HOS (ADL+Sport)	15/24	NA
Fiorentino (2015)	38	Mean 36 mo	44.4	58	Italy	mHHS	11/16	NA
Frank (2016)	150	Mean 33.6 mo	37.9	50	USA	HOS (ADL+Sport), mHHS	21/24	NA
Gedouin (2010)	110	Mean 10 mo	31	71	France	WOMAC	10/16	NA
Gicquel (2014)	51	Mean 4.6 y	31	37	France	WOMAC	10/16	NA
Grant (2017)	16	12 wk	37.5/41.75	100/88	UK	MS, EQ-5D-5L, NAHS	20/24	79/100
Haefeli (2017)	50	Mean 7 y	35	8	Switzerland	Merle d'Aubigné	11/16	NA
Horisberger (2010)	88	Mean 2.3 y	40.9	68	Switzerland	NAHS, VAS pain	11/16	NA
Ilizaliturri (2008)	19	Min 2 y	34	58	Mexico	WOMAC	10/16	NA
Ilizaliturri (2015)	50	Mean 41.24 mo	30.86	40	Mexico	WOMAC	9/16	NA
Joseph (2016)	229	24 mo	31.1/31.6	32	USA	iHOT-33, HOS-ADL	20/24	NA
Krych (2013)	36	Mean 32 mo	38/39	0/0	USA	HOS (ADL+Sport)	21/24	80/100
Larson (2008)	96	Mean 9.9 mo	34.7	56	USA	mHHS, SF-12, VAS pain	9/16	NA
Larson (2011)	210	Mean 25/30 mo	31.8/44.7	52/78 (hips)	USA	mHHS, SF-12, VAS pain	18/24	NA
Lerch (2015)	40	Mean 13 wk	39	X	Germany	HOOS, WOMAC	8/16	NA
Lund (2017)	1835	2 y	37.9	47	Denmark	HAGOS, EQ-5D, HSAS	11/16	NA
Lund (2017)	1082	Min 2 y	38.5	52	Denmark	HAGOS, EQ-5D, HSAS	11/16	NA
Malviya (2012)	122	Min 1 y	35.7/34.9	63/57	UK	mHHS, NAHS	16/24	NA
Malviya (2012)	612	Mean 3.2 y	36.7	58	UK	mHHS	11/16	NA
Malviya (2013)	80	Mean 1.4 y	(36/35)	65/60	UK	RTS, mHHS, NAHS	21/24	NA
Mardones (2010)	15	Mean 34.6 mo	63.3	X	Chile	HHS	9/16	NA
Nielsen (2014)	117	Mean 40 mo	37	41	Denmark	mHHS, HOS, NRS pain	11/16	NA
Nossa (2014)	360	Mean 6 mo	40.4	40.6 (hips)	Colombia	Complications	18/24	NA
Philippon (2009)	112	Mean 2.3 y	40.6	45	USA	mHHS, HOS (ADL+Sport), NAHS	11/16	NA
Rafols (2015)	57	Min 2 y	34.18/36.5	53	Chile	mHHS, VAS pain	20/24	70/100
Rylander (2011)	11	1 y	33.1	73	USA	ROM, Tegner	8/16	NA
Sansone (2015)	85	Mean 12.3 mo	25	82	Sweden	iHOT-12, HAGOS, HSAS	11/16	NA
Sansone (2016)	75	Mean 26 mo	47	79	Sweden	iHOT-12, HAGOS, HSAS	14/16	NA
Sansone (2017)	289	Mean 25 mo	37	66	Sweden	iHOT-12, HAGOS, HSAS	11/16	NA
Schmaranzer (2017)	8	1 y	31	75	Switzerland	WOMAC, HOOS, mHHS	16/24	NA
Seijas (2017)	22	12 mo	40.2	59	Spain	TMG, VAS pain, mHHS	11/16	NA
Shaw (2017)	11	Mean 6 mo	33.5	73	USA	mHHS, HOS	11/16	NA
Stahelin (2008)	22	6 mo	42	68	Switzerland	ROM, VAS pain, NAHS	12/16	NA
Trompeter (2013)	118	Min 1 y	37.3	49	UK	NAHS	9/16	NA
Vera (2017)	19	8 wk	35	47	USA	BRT, STST	19/24	NA
Zingg[7] (2013)	23	1 y	27.6	78	Switzerland	WOMAC, HHS, MS	20/24	NA

ADL, Activity of Daily Living; BRT, Break Reaction Time; CMS, Coleman Methodology Score; HAGOS, Copenhagen Hip and Groin Outcome Score; HHS, Harris Hip Score; HOS, Hip Outcome Score; HOOS, Hip disability and Osteoarthritis Outcome Score; iHOT, international Hip Outcome Tool; LEFS, Lower Extremities Functional Scale; mHHS, modified Harris Hip Score; mo, months; MS, Muscle Strength; NA, not applicable; NAHS, Non-Arthritic Hip Score; NRS, Numeric Rating Scale; OHS, Oxford Hip Score; ROM, Range Of Motion; RTS, Return To Sport; SFS, Sports Frequency Score; SF-12 Short form 12; STST, Sit-To-Stand Test; TMG, Tensiomyography; VAS, Visual Analog Scale; VPT, Vibratory Perception Threshold; wk, weeks; WOMAC, Western Ontario and McMaster Universities Osteoarthritis Index, X; no data

Conclusions

The methodological quality of prospective cohort studies evaluating arthroscopic surgery for FAI syndrome is moderate for both comparative and non-comparative studies. Despite an increase in the number of published studies, no improvement in methodological quality over time was observed.

Study V

The aim of this study was to report outcomes at the five-year follow-up after arthroscopic treatment for FAI syndrome, using PROMs developed for a young, active population.

There is a lack of studies evaluating the long-term outcome after arthroscopic treatment for FAI syndrome.

This prospective cohort study used the following PROMs to evaluate the outcome; the iHOT-12, the HAGOS, the HSAS, the EQ-5D, the EQ-VAS, VAS-overall hip function and single question regarding satisfaction. Survivorship was calculated as the number of patients not undergoing THA divided by the number of included patients that completed the five-year follow-up.

The mean age was 38.0 (standard deviation (SD) ± 12.7) years and the youngest patient was 15 years of age. Demographic data are shown in Table 16. Of the included hips, 74 were isolated cam morphology (41.1%), two were isolated pincer morphology (1.1%) and 104 had both cam and pincer morphology (57.8%). During the follow-up period, four patients (2.2%) underwent re-operation other than conversion to THA following index surgery. The performed procedures are shown in Table 17. Chondral damage was observed in 87 hips (65.4% of the visualized hips). The most common type of chondral damage was Konan type 2, a tear between the labrum and the acetabular cartilage. Sixteen hips had bare bone in the acetabulum (12.0% of the visualized hips). The incidence of cartilage damage is shown in Table 18. Figure 23 depicts Konan 3a cartilage damage.

Table 16 Patient demographics

Demographics	
Total number of patients	184
Total number of hips	225
Age, mean (SD) years	38.0 (12.7)
Male/female, n (%)	110/74 (59.8/40.2)
Symptom duration/hip, median (min-max) months	24 (2-240)
Operated side, right/left (%)	101/85 (54.3/45.7)

n, numbers; SD, standard deviation

Table 17 Arthroscopic procedures performed

Procedure	Hips (%)
Cam	74 (41.1)
Pincer	2 (1.1)
Cam + pincer (combined)	104 (57.8)
Labral suture	19 (10.6)
Microfracture	13 (7.2)
Labral resection	13 (7,2)
Teres ligament resection	1 (0.6)

Table 18 Incidence of cartilage damage, classification according to Konan et al.

Cartilage damage classification	Hips (% of visualized hips)
0	46 (34.6)
1a	10 (7.5)
1b	2 (1.5)
1c	0 (0.0)
2	33 (24.8)
3a	21 (15.8)
3b	4 (3.0)
3c	1 (0.8)
4a	9 (6.8)
4b	4 (3.0)
4c	3 (2.3)
Not visualized	21 (13.6% of hips)

Table 19 Outcome scores

Outcome	Preoperative, mean (SD)	60 months, mean (SD)	Change	P-value
iHOT-12	42.9 (18.3)	67.2 (27.5)	24.6 (25.7)	<0.0001
HAGOS – symptoms	50.2 (17.8)	69.6 (24.0)	19.3 (22.6)	<0.0001
HAGOS – pain	55.7 (19.5)	76.1 (23.4)	20.3 (24.0)	<0.0001
HAGOS – daily activity	59.2 (24.7)	72.3 (31.1)	13.0 (30.6)	<0.0001
HAGOS – sport	41.1 (22.1)	66.4 (29.9)	25.3 (30.5)	<0.0001
HAGOS – physical activity	30.8 (28.2)	60.2 (33.1)	29.2 (38.6)	<0.0001
HAGOS – quality of life	31.6 (18.4)	60.4 (29.6)	28.9 (28.7)	<0.0001
EQ-5D	0.570 (0.296)	0.742 (0.292)	0.174 (0.354)	<0.0001
EQ-VAS	66.6 (19.7)	74.4 (18.1)	8.03 (22.09)	<0.0001
HSAS	3.13 (2.99)	3.17 (1.90)	-0.053 (3.021)	n.s.
VAS – overall hip function	47.9 (20.6)	69.2 (25.6)	21.4 (28.0)	<0.0001

iHOT-12, short version of the international hip outcome score; HAGOS, Copenhagen hip and groin outcome score; EQ-5D, EuroQoL-5 dimension; VAS, visual analog scale; HSAS, hip sports activity scale; SD, standard deviation; n.s., non-significant

A comparison between preoperative PROM scores and those obtained at the five-year follow-up revealed statistically significant improvements for all outcome scores ($p<0.05$), apart from the HSAS that was unchanged. Results and statistics are described in Table 19. At the five-year-follow-up, 154 patients reported that they were satisfied with the surgery (84.6%). Survivorship at the five-year follow-up was 86.4%.

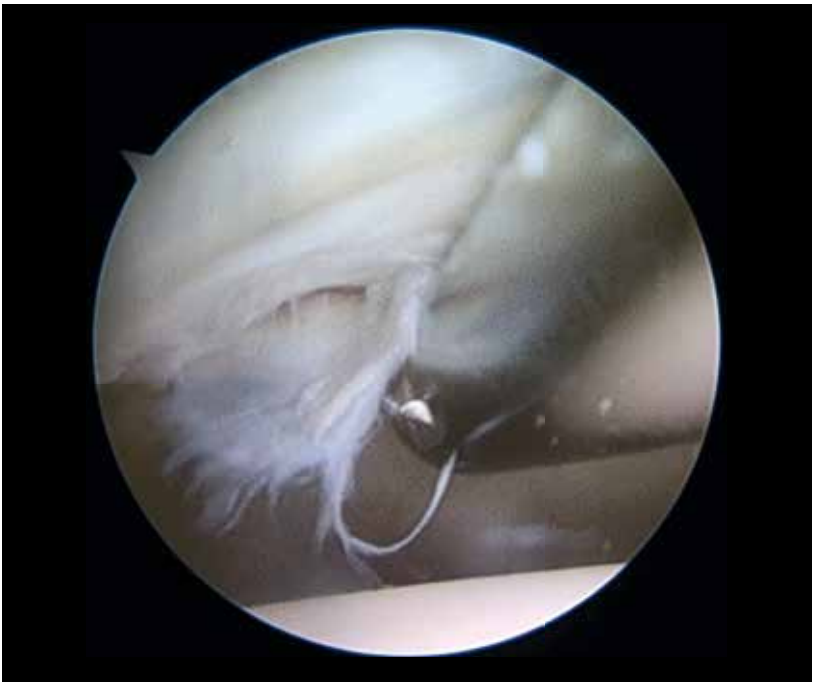

Figure 23 Example of Konan type 3a cartilage damage to the left hip, delamination of cartilage less than one-third of the distance from the acetabular rim to the cotyloid fossa. Used under the terms of the Creative Commons Attribution 4.0 International license (http://creativecommons.org/licenses/by/4.0/). Öhlin et al. Good 5-year outcomes after arthroscopic treatment for femoro-acetabular impingement syndrome. KSSTA. 2019. https://doi.org/10.1007/s00167-019-05429-y. Springer Nature.

Conclusions

At the five-year follow-up, arthroscopic treatment for FAI syndrome demonstrated good patient-reported outcome. Survivorship at the five-year follow-up, defined as not receiving THA, was 86.4%.

CHAPTER 05

DISCUSSION

GENERAL DISCUSSION

Since the introduction of evidence-based medicine (EBM), there has been a growing awareness of the need for scientific evidence to support both current and new practices. Unfortunately, the majority of orthopedic procedures that are being used today lack high-level evidence for their use. Randomized controlled trials are regarded as the highest level of evidence, but they require a common scientific language, a common accepted technique and valid outcome measurements. For a new field, such as hip arthroscopy in general, and FAI syndrome in particular, it is not possible to perform an RCT of good quality before these conditions are met. As RCTs of poor scientific quality create a potential negative bias towards new techniques, a more appropriate development for a new field is instead a stepwise introduction, with a gradually increasing level of evidence. Beginning with a cadaveric study, moving on to case report(s) and cohort studies before performing an RCT is an effective approach to protect patients from unnecessary risks, both the risk of changing treatment and the risk of not changing treatment.[112] The field of FAI syndrome has evolved from the first conceptual paper by Ganz et al.[3], in 2003, to groundbreaking cohort studies, such as the introduction of arthroscopic treatment for FAI syndrome by Sampson[10], the development of the national DHAR[113], the Warwick Consensus Agreement[35] and the first RCTs of good scientific quality.[101, 102]

Two key topics that need to be addressed are the relationship of FAI syndrome to OA and the definition of a significant cam and pincer morphology.

The hypothesis that FAI syndrome is a cause of OA is essential to understanding the diagnosis and treatment of FAI syndrome. If FAI syndrome causes OA, there must be a transition zone between solely impingement symptoms and impingement symptoms paired with OA symptoms. Today, our knowledge of OA is limited; it is uncertain how and why OA begins and develops and it is consequently impossible to value when a hip with FAI syndrome begins to develop pre-arthritic changes. FAI syndrome and OA must therefore be regarded as two different entities that partially overlap. This overlapping in pathology results in a complexity when it comes to the diagnosis and treatment of FAI syndrome. Moreover, other entities, such as possible microinstability of

the hip,[114] make diagnostics and treatment even more difficult.

The second dilemma when it comes to the diagnosis and treatment of FAI syndrome is what constitutes a significant cam or pincer morphology and, consequently, how much of the cam or pincer morphology should be removed. The mechanical conflict present in the FAI syndrome is highly dependent on the hip ROM being repeatedly utilized by the patient and with which force. Cam and pincer morphology is therefore not easy to define using a standardized cut-off value, but it could instead be more accurately defined by simultaneously considering each patient's unique demands, such as hip ROM and load. Correspondingly, these factors must also be considered in the treatment of FAI syndrome in order to be able to perform a sufficient resection of cam and/or pincer morphologies. This individual approach could also prevent excessive surgical trauma or surgical effects affecting hip laxity.

The core question in any treatment of FAI syndrome is what the effects are here and now and what the effects will be in the future. The long-term effects are of special interest, since FAI syndrome mainly affects young individuals. Providing patients and physicians with an idea of what to expect from arthroscopic treatment for FAI syndrome is the core aim of this thesis.

Study I

The main finding in Study I was that the outcome at two years following the arthroscopic treatment for FAI syndrome was favorable, with significant and clinically relevant improvements as measured by PROMs validated for young, active patients with hip pain (Figure 24). Eighty-two percent of patients were satisfied with surgery.

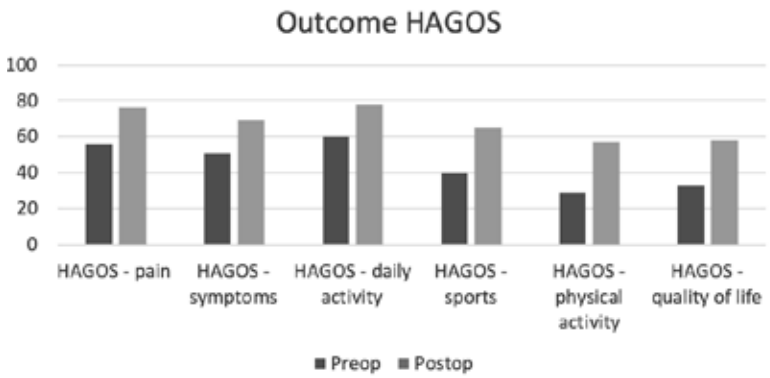

Figure 24 Visualization of the pre- and postoperative Copenhagen Hip and Groin Outcome Score (HAGOS), demonstrating statistically significant and clinically relevant improvements for all subscales.

This study is one of the largest prospective cohort studies, published so far, using PROMs with psychometric properties appropriate for young, active individuals with hip pain. Prospective cohort studies have the benefit of low selection bias, which increases the general applicability of their results. The use of PROMs to evaluate outcome has several advantages compared with a surgeon-reported outcome, as it mirrors the patients' own experiences of pain and function. The result will, however, be influenced by patients' expectations, which is a factor that is important to consider when interpreting outcomes based on PROMs. The next step in evaluating outcome following surgical treatment for orthopedic injuries is most likely a combination of PROMs and objective functional test instruments. There is currently no consensus in terms of the functional test that best mirrors the outcome following arthroscopic treatment for FAI syndrome. The Warwick agreement recommends the iHOT and HAGOS PROMs when evaluating patients with FAI syndrome.[35] The use of several PROMs provides an opportunity to evaluate as many aspects as possible. Too many questions presented to the patient might, however, reduce compliance. To reduce this effect in Study I, the short version of the iHOT, the iHOT-12, was chosen in favor of the longer iHOT-33. The iHOT-12 has been shown to have characteristics that are very similar to those of the iHOT-33.[89] The Swedish versions of the iHOT-12[91] and the HAGOS[92] have been validated in previous studies and the MIC at group level, 9 and 9-17 points respectively, has been reported to be larger than the smallest detectable change (SDC), indicating that an improvement above the MIC is to be regarded as a clinically relevant improvement. A floor effect for the sub-scale "participating in physical activity" and a ceiling effect for the sub-scale "function of daily living" were present in both the Swedish and the original validation of the HAGOS.[90, 92] Thorborg et al.[90] argued that the floor effect for the sub-scale "participating in physical activity" did not appear to be problematic because a further deterioration from "never" is not possible and, moreover, they also argued that the sub-scale "function of daily living" may still be relevant for patients with severe hip and groin pain.

Favorable results at two years following arthroscopic treatment for FAI syndrome have also been reported in previous studies, but these studies have mainly used PROMs not developed for young, active individuals, which impairs the opportunity for comparison between studies. At the two-year follow-up, Byrd et al.[68] reported an improvement of 21 points as measured by the mHHS and several studies have reported similar results[69, 73]. Brunner et al.[71] and Horisberger et al.[74] reported an improvement of 31 and 28 points respectively, using the Non-Arthritic Hip Score (NAHS).

The preoperative score was low for the iHOT-12 and the HAGOS sub-scales "physical activity" and "sports", indicating disabling degrees of symptoms in the present study group. Despite a significant improvement in hip function, the improvement in physical activity level as measured by the HSAS was relatively modest. The reason why patients maintain a similar physical activity level despite an improvement in hip function could be due to social reasons, such as a change of lifestyle. Long symptom duration, as noted in Study I, median 24 months, could contribute to this. It is also common for the population in general to tend towards reducing their level of physical activity over time and the mean age of this cohort was 37 years. To evaluate the reasons why patients did not improve their physical activity level, a qualitative approach could have been used. However, this was not the aim of Study I and was thus not performed.

Thirteen percent of patients were dissatisfied with the surgical treatment. As dissatisfaction might be due to more than hip function, a qualitative study design would be necessary to perform a thorough analysis of why some patients were dissatisfied. An analysis of this kind was, however, outside the scope of Study I.

In Study I, long symptom duration correlated with inferior outcome. No correlation was confirmed between age and outcome and no significant differences in outcome score were present for the different levels of cartilage damage. These analyses were not controlled for confounding factors and, due to the study design, it is also possible that the outcome for patients with bilateral FAI syndrome was influenced by the status of the contralateral hip.

Chondral damage can also be underestimated using the classification proposed by Konan et al.[104] and rarely the opposite. Because of these conditions, results related to the influence of these factors on the outcome should be interpreted with caution in Study I. In addition, the recordings of cartilage status were low, only 56%, which could affect the results. The low recording rate of cartilage status could be due to difficulties using the classification proposed by Konan et al. in a stressful operating room environment. The DHAR also uses the classification formulated by Konan et al. and a lower rate of missing data has been reported for the DHAR compared with Study I, indicating that the low recording rate in Study I might be due to organizational reasons rather than difficulties with the classification per se.[113]

The patients included in Study I were treated between November 2011 and February 2013. Since then, surgical indications have changed towards a more

conservative attitude to the treatment of hips with pre-arthritic changes, as these patients have demonstrated inferior outcomes.[72] There is currently also a more conservative attitude to the treatment of patients with unrealistically high expectations of treatment outcome, as we now better understand the potential of the surgery. These aspects need to be considered when applying the results of the Study I to patients being treated today.

Study II

The most important finding in Study II is that the preoperative iHOT-12 score correlates with the postoperative iHOT-12 score at the two-year follow-up. To control for confounding factors in prospective cohort studies, a multiple regression analysis should preferably be used. The results of the multiple linear regression model in Study II suggest that a patient with a one point higher preoperative iHOT-12 score will have a 0.65 point higher postoperative iHOT-12 score at the two-year follow-up compared with a patient with a one point lower preoperative iHOT-12 score. These findings imply that it can be beneficial to treat a symptomatic patient before a further decline in hip function occurs. Based on the MIC of nine points for the iHOT-12 reported in a previous study[91], there must, however, be a difference of approximately 14 points in the preoperative iHOT-12 score to expect a clinically significant difference in the postoperative iHOT-12 score.

Factors chosen for analysis were based on reports from previous studies. In the Study II no correlation was, however, noted between the postoperative iHOT-12 score and age, symptom duration, gender, degree of cartilage damage or FAI type.

Results similar to those in Study II were reported by Philippon et al.[72], controlling for confounding factors, a higher preoperative score, together with a joint space of ≥ 2mm and labral repair rather than debridement, were suggested as predictors of a higher postoperative mHHS at the two-year follow-up. Other factors analyzed by Philippon et al.[72] that were not found to be statistically significant were age, symptom duration, alpha angle, overall cartilage condition and the use of micro-fracture. In Study II, joint space height was not recorded, although it was always ≥ 2mm due to the inclusion/exclusion criteria. Results corresponding to those in Study II were also reported by Byrd and Jones, who noted a correlation between a higher preoperative mHHS and a higher postoperative iHOT-12 score at the two-year follow-up.[70] This study did not, however, control for confounding factors. Moreover, the results from Study II were also in accordance with those reported by Joseph

et al.[76], in their study, specifically evaluating gender differences in outcome, where no difference in postoperative iHOT-33 score was observed between males and females. Malviya et al.[75], on the other hand, reported that the QoL score was higher for males at follow-up and that gender was a predictor of changes in the QoL score.

Results contrasting to those in Study II were reported by Philippon et al.[72] and Byrd and Jones[70], who reported that patients with poor overall cartilage status had a lower postoperative mHHS compared with patients with moderate or mild changes, and a higher prevalence of more severe cartilage damage and older age among patients with fair/poor results compared with patients with excellent results, as measured by the mHHS respectively. The data reported by Philippon et al.[72] and Byrd and Jones[70] were not controlled for confounders and this might be an explanation for the conflicting results compared with Study II. The above studies also use other PROMs and classifications for cartilage damage than Study II, which limits the opportunity to make comparisons between the studies. The different pattern of damage caused by the cam type and the pincer type suggest there might be a difference in treatment outcome[31]. However, no such difference was found in Study II and similar results were also presented by Malviya et al.[75]

The multiple linear regression model in Study II, including the preoperative iHOT-12 score as an independent variable, was only able to explain 19% of the postoperative iHOT-12 score, indicating there are most likely other factors that also affect the treatment outcome. More factors, such as pain and/or BMI, could have been included in the analysis. However, to reduce the problem of data dragging and mass significance, only a limited number of factors, based on reports from previous studies, were analyzed.

A type-2 error could explain the missing correlation between the postoperative iHOT-12 score and age, symptom duration, gender, level of cartilage damage and FAI type. However, this was one of the largest studies evaluating predictors of treatment outcome, limiting the risk of a type-2 error.

Little is known today about the microstructure of the cartilage in hips with FAI syndrome, but it is possible that a better understanding of the damage to the cartilage at microlevel could help to predict treatment outcome. For predictors of treatment outcome, it is also important to consider the possibility of co-morbidity related to currently unknown diagnoses, which may affect the outcome, or unknown diagnoses that mimic the symptoms of FAI syndrome. For example, the proposed microinstability of the hip joint has recently

emerged as a possible cause of hip pain in young, active individuals.[115-119] It is thus possible that patients with FAI syndrome might also have microinstability in the hip joint and, by only treating the FAI syndrome, some parts of the patient's problem are not addressed. This could be one explanation of why, following treatment, the results differ in patients with FAI syndrome.[120]

Study III

The main finding in Study III is that the Swedish version of the HSAS is a reliable and valid measurement, albeit with limited responsiveness, to determine sports activity levels in patients with FAI syndrome, comprising characteristics similar to those in the original version. When evaluating treatment outcome in patients with FAI syndrome, it is important not only to use joint-specific scores, such as the iHOT-12 or the HAGOS, but also to evaluate physical activity levels, as this may affect the results of the joint-specific scores.

The decision to include 30 patients in each cohort was based on the study size in the original study, which comprised 30 patients. For inter-class correlation, a study size of 30 patients generated a power of > 95% for Study III, indicating that the study size was appropriate. Compared with the original study, the patients in Study III were fairly similar in age and gender distribution, but none of these factors has previously been described as affecting the outcome.[121] The ICC in Study III was 0.93, which is well above the acceptable 0.70[105] and similar to the 0.94 and 0.96 in the original study, indicating good test-retest reliability. In addition, Wilcoxon's paired test was not able to show a statistically significant difference between test-retest occasions.

As assumed, there was a high and significant correlation between the HSAS and the Tegner scores (r=0.794), indicating good construct validity. The fact that the HSAS is a modified version of the Tegner score could account for some of this correlation. The high, but not perfect correlation to the Tegner score, however, indicates that the HSAS relates to different difficulties in performing sports activity compared with the Tegner score. There was no significant correlation between the HSAS and the iHOT-12 or any of the HAGOS sub-scales, except for the HAGOS "physical activity", indicating low content validity. As the HSAS measures other aspects of hip function compared with the iHOT-12 and the HAGOS, a perfect correlation was not expected. The original study showed a moderate to high and significant correlation between the HSAS and the HOS, which is also an outcome tool recommended for use in FAI syndrome patients, for the German-speaking cohort but not for

their North-American English-speaking cohort.[93] The original study suggested that the missing correlation could be due to the fact that patients in the USA tended to stay more active, despite symptoms, and the same explanation could apply to the Swedish patients, thereby being dependent on the selection of patients. In a young population, it is important to consider social factors and a change of lifestyle as important factors for physical activity level, in addition to hip function. Professional athletes might, for example, have economic reasons to stay at a high level of physical activity before treatment or a return to a higher level of physical activity, regardless of experiencing pain or not, while recreational athletes might be satisfied with a lower level of physical activity. The population in general also tends to reduce its level of physical activity over time.

Compared with the original study by Naal et al.[93], the ES and the SRM were smaller in Study III, 0.25 and 0.28 respectively versus 0.41 and 0.69 respectively. There is no well-defined interpretation of ES and SRM values, but it has been suggested that a value of 0.20 or less should be considered small, a value of 0.50 moderate and a value of 0.80 or more should be considered large.[107] Comparisons of the ES and SRM between studies are, however, difficult, as a calculation of the statistics is specific to each study. The small response for the HSAS could be due to a small effect by the treatment. Although, as numerous previous studies have demonstrated an improvement in patient-reported hip function following arthroscopic treatment, a more likely explanation for the small response is a change in lifestyle, as mentioned above. If the study had exclusively included young individuals with short symptom durations, greater responsiveness might have been noted. The follow-up time was at least 12 months in Study III compared with six months in the original study. This difference is most probably negligible, as Joseph et al.[76] reported no improvement in self-reported hip function between six and 24 months after arthroscopic surgery for FAI syndrome.

Naal et al.[93] reported ceiling effects and floor effects in 0-10% and 7-10% respectively in the original study and the proportion of ceiling and floor effects was similar for the two cohorts in Study III. The amount of ceiling and floor effects for the HSAS in Study III was also comparable, but not superior, to the amount of ceiling and floor effects for the Tegner score. Floor and ceiling effects of ≤ 15% have been suggested as acceptable.[122]

The UCLA activity scale is another tool that is used to evaluate physical activity levels in patients with hip disorders and it has been suggested that it is appropriate for patients undergoing arthroplasty.[123] However, when used

for patients with FAI syndrome, the ceiling effects have been reported to be above 20%, thereby limiting the opportunity to measure any further improvement.[93] Its usefulness could therefore be questioned in this specific patient population.

Study IV

The most important finding in Study IV is that the method of available prospective cohort studies is of overall moderate quality for both comparative and non-comparative studies, with only a few studies of low quality. Despite an increase in the number of studies published during the last five years of the period, an improvement in methodological quality was not observed.

The results in Study IV are similar to those reported by Khan et al.[51], who, in a systematic review of the utility of hip injections for FAI syndrome, reported that the methodological quality according to the MINORS was 11 for non-comparative studies (moderate quality) and 17.3 for comparative studies (moderate quality). Similar results were also reported by Sim et al.[124] in a systematic review of non-hip score outcomes following surgery for FAI syndrome.

Overall, most studies failed to use an unbiased assessment of study endpoint, or to report reasons for not blinding. Double-blind evaluations of subjective endpoints, such as PROM scores, are inherently challenging in cohort studies. However, an assessor-blinded evaluation should be made and the reasons for not blinding should always be meticulously described. With a lack of assessor-blinded evaluation, there is a risk that the current scientific evidence in terms of the outcome of arthroscopic treatment for FAI syndrome is biased. Moreover, a prospective calculation of study size was also lacking in most of the included studies. In order not to expose patients to unnecessary risks, while still avoiding a type-2 error, the use of a power analysis is crucial and the lack of this kind of calculation in many studies is a reason for concern. For RCTs, weak areas of methodological quality were short follow-up times and descriptions of postoperative rehabilitation. Not all studies failed in the above areas, proving that improvements in methodological quality are possible in future studies. The use of endpoints appropriate to the aim of the study was lacking in several non-comparative studies. With the introduction of the Warwick agreement in 2016, which includes recommendations for PROMs, this area will hopefully improve in the near future.

The degree of bias in a single study is not easily captured in a score such as

the MINORS. For example, two studies can have the same score according to the MINORS, even though they receive their points from widely different items, such as “A clearly stated aim” or “Unbiased assessment of the study endpoint”. There is currently no evidence to prioritize one item over another, but it is possible to imagine that some items might be more important than others. However, a score provides an indication of the collected level of methodological quality, as well as facilitating a comprehensive comparison between studies. Another score to assess the methodological quality of randomized- and non-randomized studies was presented by Downs and Black[125]. Their checklist comprised 27 items and used different scoring systems for the different items, thereby increasing the complexity and user burden compared with the MINORS.

The first two RCTs comparing arthroscopic treatment and non-surgical treatment for FAI syndrome were published in 2018[99, 101]. Nonetheless, because of the inherent weaknesses of RCTs, with often narrow inclusion criteria and selection bias, and consequently less generalizable results, there will still be a need for observational studies and it is therefore important also to improve the methodological quality of prospective cohort studies.[126]

Study IV appears to be the first systematic review assessing the methodological quality of prospective cohort studies that evaluate arthroscopic surgery for FAI syndrome. An extensive and comprehensive database search was performed in Study IV. The quality of a systematic review is dependent on a thorough literature search in order not to miss any study in accordance with the inclusion criteria. With a growing body of literature, a thorough literature search, however, also needs to be feasible. The use of search terms is often essential to reach this compromise, although the choice of search terms needs to be made carefully. In Study IV, the inclusion of the search term “prospective” would have generated a search result omitting studies that failed to include the word “prospective” in the title, abstract or key words, although a prospective study design was actually used, like the studies by Becker et al.[127] and Farkas et al.[128]

During the study assessment in Study IV, some confusion was noted in the literature related to definitions of study design. It is important to remember that a prospective study design requires the research question to be formulated prior to the enrollment of patients. If the research question is formulated after the enrollment of patients has begun, the study should be regarded as a retrospective study, albeit with prospectively collected data. A prospective study design is regarded as a higher level of scientific evidence compared

with a retrospective study design, due to the opportunity to perform the study in such a way that it more accurately targets the research question.

Study V

The key finding in Study V is that outcomes five years after arthroscopic treatment for FAI syndrome demonstrated a significant improvement for all PROMs except the HSAS. In addition, 84.6% of patients reported that they were satisfied with the surgery. Survivorship at the five-year follow-up, defined as not receiving THA, was 86.4%.

The five-year outcome following arthroscopic treatment for FAI syndrome was recently reported by Hufeland et al.[129], where the mHHS improved from 67.2 points to 86.4 points, with a 10.8% conversion rate to THA. A study by Degen et al.[130], including, but not limited to, patients with a five-year follow-up, revealed comparable improvements in the mHHS, the HOS and the iHOT-33 following the arthroscopic treatment of FAI syndrome. The results were similar for both adolescents and non-adolescents. For patients with preserved joint space (> 2mm), Skendzel et al.[131] reported a 16% conversion rate to THA within five years following arthroscopic surgery for FAI syndrome. The use of different outcome scores in Study V limits the opportunity for comparison with earlier studies. Nevertheless, the conversion rate to THA in Study V was comparable to previous studies.

The two-year outcome for the present cohort was reported in Study I and the patient-reported outcomes were similar to those obtained at the five-year follow-up, indicating stability in outcomes over time.[132] The five-year patient-reported outcomes in Study V are also similar to the two-year outcomes reported from the DHAR, which uses the same PROMs as in Study V.[113] Contrary to Study V, both the two-year data from the present cohort and from the DHAR, showed a small, yet significant improvement in physical activity level measured by the HSAS. As the population in general tends to reduce its level of physical activity over time and the mean age of this cohort was 38 years, a lower level of physical activity at the five-year follow-up could thus be expected. In some cases, there could also be a recommendation from the treating physician to reduce the patients' physical demands on the hip. Moreover, the conversion rate to THA was also considerably lower at the two-year follow-up both for the present cohort and in the DHAR compared with Study V, 5% and 0.8% vs. 13.6%, and this difference is most likely due to the longer follow-up period in Study V.

In Study V, as well as in Study I, only PROMs were used to evaluate outcome. Historically, surgeon-reported outcome scores have been used to evaluate treatment outcome. These are, however, less clinically relevant as it is the patient's opinion that matters. The inclusion of imaging evaluation at follow-up could have been used in order to assess the progression of cartilage damage. Imaging evaluations compared with PROMs are, however, more resource intense and logistically challenging and we did not have this opportunity in Study V. There are currently no established functional outcome tests and these were therefore not included in Study V.

The long-term outcomes are essential, especially since FAI syndrome has been suggested as a cause of OA. Conducting prospective cohort studies with a long follow-up time is, however, challenging. First of all, patients tend to lose interest in participating in studies over time, as indicated by a substantially lower follow-up rate at five years compared with two years for the present cohort, 55% vs 78% respectively. Educating patients in the importance of the study, as well as providing patients with feedback from their answers, could help to maintain a higher follow-up rate. In order to minimize the number of patients lost to follow-up in Study V, non-responders were reminded several times via email. It was not possible to contact patients via phone for the five-year follow-up due to limited resources, but this might have improved the follow-up rate. An analysis of non-responders was not performed in Study V, as patients were assumed to be lost at random in terms of their outcome, as seen in the Swedish Knee Ligament Register.[133] A worst-case analysis was not performed, as that type of analysis has the potential to bias the results, especially if patients are assumed to be lost at random. Secondly, the maintenance of registers requires funding that stretches over several years, preferably decades. Another aspect of long-term studies that needs to be considered is the development of indications for surgery, as well as the development of surgical techniques. Consequently, the results from a cohort treated several years ago might not be as relevant. This is an aspect that is especially important to consider for a fast-developing scientific field such as FAI syndrome. For example, in recent years, a more conservative attitude has evolved towards the treatment of hips with FAI syndrome and pre-arthritic changes.

Figure 25 Isaiah Thomas was diagnosed with femoroacetabular hip impingement when he was playing in the National Basketball Association (NBA). By Mike - Flickr: (2013-12-21) Kings at Magic 64, CC BY-SA 2.0, https://commons.wikimedia.org/w/index.php?curid=30421910.

LIMITATIONS

Studies I and V

The main limitation of Studies I and V is the lack of a control group. Consequently, it is not possible to disregard the possibility that patients would improve independently of treatment, or to account for any placebo effect. The methodological design, however, partly compensates for the fact that patients would improve independently of treatment, by only including patients in whom non-surgical treatment had failed and, with a fairly long symptom duration, the patients could be regarded as their own controls. A double-blind study design utilizing sham surgery for the control group, like the FIRST trial, would minimize the placebo effect, but it is also possible to argue that an additional placebo effect is part of the treatment, affecting our minds and bodies in a way that is not as yet fully understood.[134] Another limitation to Studies I and V is that the number of re-operations and conversions to THA was assessed from patient journals at the clinic at which the primary surgery was performed. As a result, re-operations and conversions to THA performed at other clinics were not accounted for. However, the clinic at which primary surgery is performed provides its patients with a thorough follow-up. Data extraction from the Swedish hip arthroplasty register would have improved the accuracy of the conversion rate to THA, but this was not part of the ethical approval for Studies I and V.

Another limitation of Studies I and V is the lack of recording of objective radiographic values, such as the alpha angle for cam morphology and the LCE angle or crossover sign for pincer morphology. This reduces the opportunity for comparisons with other studies. However, beyond confirming the presence of cam morphology, it is rarely clinically relevant to measure the exact alpha angle in a clinical setting and pincer morphology is difficult to define radiographically.[46] Radiographic evaluation at follow-up was not included in Studies I and V, limiting the possibility to evaluate radiographic signs of OA. However, it is important to remember that the diagnosis of OA is not solely based on radiographic signs. It is primarily a clinical diagnosis, based on pain and hip function, aspects well covered by the PROM evaluation.

When applying the results from Studies I and V, it is important to remember that the surgical indications have changed towards a more conservative attitude to the treatment of hips with pre-arthritic changes since the inclusion of these patients between 2011 and 2013.

Study II

The main limitation of Study II is that it is not possible to exclude a type-2 statistical error when rejecting a correlation of age, gender, symptom duration before surgery, level of cartilage damage and FAI type to the postoperative iHOT-12 score. It should be noted that the sub-groups related to cartilage damage were small and no patients had only pincer morphology. However, this is one of the largest studies of its kind. Another limitation of Study II is the fairly high drop-out rate. This might be due to the young, mobile population, changing contact information and lacking the motivation to follow up once treated successfully. For the patients that did not complete the web-based follow-up protocol, further contact by phone and e-mail was attempted before they were regarded as drop-outs. Despite being low, the follow-up rate was still above the 60% threshold regarded as acceptable.[135] A recent analysis of the present register, however, revealed that there were no major differences between responders and patients lost to follow-up (unpublished data). Moreover, the incomplete documentation of cartilage classification status, with 52 (26.3%) patients having no documentation, is also a limitation. In 22 (11.1%) of these patients, there was no documentation of cartilage status and in 30 (15.2%) patients the cartilage was never visualized. This has several possible explanations. For the patients in whom the cartilage was not visualized, this could be due to the inability to distract the hip or the fact that there was no cartilage damage and no entry may therefore have been made. For the remaining patients lacking documentation of cartilage status, this was likely due in most cases to difficulties using the classification system and, as a result, no status was recorded.

Study III

In accordance with the original study by Naal et al.[93], the definition of the different physical activity levels for the HSAS was based on a subjective interpretation of the stresses experienced in and around the joint, which must be regarded as a limitation. As scientific data are lacking in this area, an expert opinion is, however, the best possible solution at the moment. Another limitation of the HSAS is that it does not consider the frequency of the physical activity, which is an important factor when it comes to determining the physical activity load. For practical reasons, a retrospective cohort had to be used for the responsiveness analysis and the patients in this cohort were approximately six years older than the primary cohort. As age has not yet been described as affecting the outcome following arthroscopic treatment for FAI syndrome, this difference may not have a major effect on the results.

Study IV

The rigorous PRISMA approach was used when completing this systematic review. Nonetheless, the restriction to studies published in English may be a source of bias and must be regarded as a limitation to Study IV. Another limitation to Study IV is that not all data were available, despite efforts to contact the authors. The limited number of studies also impaired the opportunity for a more robust statistical analysis or the pooling of data. As the Study IV sought to evaluate the available research with the highest possible level of evidence, retrospective studies were excluded. This might have influenced the results.

CHAPTER 06

CONCLUSIONS

Study I

At the two-year follow-up, arthroscopic treatment for FAI syndrome resulted in statistically significant and clinically relevant improvements in all outcomes for pain, symptoms, function, physical activity level and QoL.

Study II

The preoperative iHOT-12 score correlated with the postoperative iHOT-12 score at the two-year follow-up. This study implies that the preoperative iHOT-12 score is a predictor of the postoperative result. However, the preoperative score only explained 19% of the postoperative score, indicating that other factors might predict the outcome.

Study III

The Swedish version of the HSAS is a reliable and valid measurement, albeit with limited responsiveness, to determine physical activity levels in patients with FAI syndrome.

Study IV

The methodological quality of prospective cohort studies evaluating arthroscopic surgery for FAI syndrome is moderate for both comparative and non-comparative studies. Common areas for improvement include unbiased assessments of study endpoints and prospective sample size calculations. Despite an increase in the number of published studies, no improvement in methodological quality over time was observed.

Study V

At the five-year follow-up, arthroscopic treatment for FAI syndrome demonstrated good patient-reported outcome. Survivorship at the five-year follow-up, defined as not receiving THA, was 86.4%.

Overall conclusion

The overall conclusions from the five studies is that the outcomes after arthroscopic surgery for FAI syndrome are favorable at both two and five years following treatment and that the level of preoperative hip function appears to be a potential predictor of treatment outcome. The overall methodological quality of prospective cohort studies of arthroscopic treatment for FAI syndrome published so far is moderate. Finally, the Swedish version of the HSAS is a reliable and valid measurement to determine sports activity levels in patients with FAI syndrome.

CHAPTER 07

FUTURE PERSPECTIVES

There is fairly solid evidence that hip arthroscopy for FAI syndrome reduces pain and improves hip function. Due to the novelty of the field, there is less knowledge of the effect of treatment in the long run. While surgical treatment aims to normalize cam and pincer morphology, it is still unknown whether this correction will be enough to stop, or slow down, the development of OA in a hip where cartilage is already damaged. There is even a risk that a higher level of activity, as made possible by the treatment, will increase the development of OA.

In the future, long-term results from register data and RCTs will make it possible to determine the effect the treatment of FAI syndrome has on OA development. Modalities such as delayed gadolinium-enhanced MRI of cartilage (DGEMRIC) and/or biomarkers of cartilage damage could enhance the evaluation of results, possibly also with a limited follow-up time. These modalities could also help in the diagnostic process by identifying patients at risk of sub-clinical disease and pre-arthritic changes.

Future research should also focus on the etiology of FAI syndrome to evaluate possible preventive actions to limit the development of FAI syndrome and OA. As of today, there is strong evidence that high loads during adolescence lead to cam formation. The next logical step is to examine the type of load that drives the development of cam, or the eventual thresholds for these loads.

CHAPTER 08

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CHAPTER 09

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CHAPTER 10

APPENDIX

iHOT12

INTERNATIONAL
HIP OUTCOME TOOL

FORMULÄR OM LIVSKVALITÉ HOS UNGA AKTIVA MÄNNISKOR MED HÖFTPROBLEM

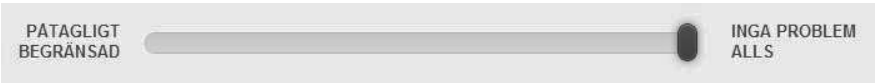
Instruktioner

- 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.

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



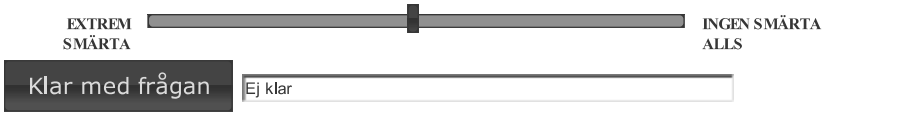
  - Om markeringen placeras mitt på skalan betyder det att du är måttligt begränsad, eller med andra ord, mitt emellan 'påtagligt begränsad' och 'inga problem alls'. Det är viktigt att du markerar ända ut i kanten av skalan om det är ytterligheten som bäst beskriver din situation.

- 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.

När du ställt in markören för en fråga i önskat läge, tryck på "Klar med frågan" så att det står "Klar!" i rutan bredvid.

F1. Totalt sett, hur mycket smärta har du i din höft/ljumske?



F2. Hur svårt är det för dig att ta dig ner på och upp från golvet/marken?

Klar med frågan | Ej klar

F3. Hur svårt är det för dig att gå långa distanser?

Klar med frågan | Ej klar

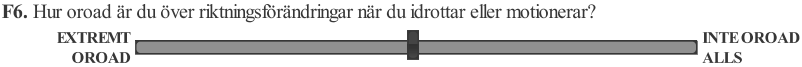
F4. Hur mycket besvär har du av krasningar, upphakningar eller klickande i din höft?

Klar med frågan | Ej klar

F5. Hur mycket besvär har du av att knuffa, dra, lyfta eller bära tunga föremål?

Klar med frågan | Ej klar

F6. Hur oroad är du över riktningsförändringar när du idrottar eller motionerar?



Klar med frågan | Ej klar

F7. Hur mycket smärta har du i din höft **efter** fysisk aktivitet?

Klar med frågan | Ej klar

F8. Hur oroad är du över att lyfta upp eller bära barn på grund av din höft?

Klar med frågan | Ej klar

F9. Hur mycket besvär har du med sexuella aktiviteter på grund av din höft?

Klar med frågan Ej klar

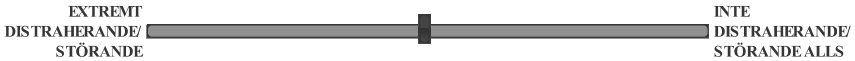
F10. Hur mycket tid är du medveten om dina besvär med din höft?

Klar med frågan Ej klar

F11. Hur oroad är du över din möjlighet att upprätthålla din önskade fysiska nivå?

Klar med frågan Ej klar

F12. Hur distraherande/störande är dina höftproblem?



Klar med frågan Ej klar

OBS! Kolla att det står **"Klar!"** på varje fråga innan du klickar på **"Skicka"-**knappen, så slipper du besvara alla frågorna igen.

Skicka

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
○	○	○	○	○

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
○	○	○	○	○

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
○	○	○	○	○

Nästa

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
○	○	○	○	○

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)

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

EQ-5D

Hälsoenkät

Svensk version

(Swedish version)

Markera, genom att klicka i ett alternativ i varje nedanstående grupp vilket påstående som bäst beskriver Ditt hälsotillstånd i dag.

1. Rörlighet

- Jag går utan svårigheter
- Jag kan gå men med viss svårighet
- Jag är sängliggande

2. Hygien

- Jag behöver ingen hjälp med min dagliga hygien, mat eller påklädning
- Jag har vissa problem att tvätta eller klä mig själv
- Jag kan inte tvätta eller klä mig själv

3. Huvudsakliga aktiviteter (t ex arbete, studier, hushållssysslor, familje- och fritidsaktiviteter)

- Jag klarar av mina huvudsakliga aktiviteter
- Jag har vissa problem med att klara av mina huvudsakliga aktiviteter
- Jag klarar inte av mina huvudsakliga aktiviteter

4. Smärtor/besvär

- Jag har varken smärtor eller besvär
- Jag har måttliga smärtor eller besvär
- Jag har svåra smärtor eller besvär

5. Oro/nedstämdhet

- Jag är inte orolig eller nedstämd
- Jag är orolig eller nedstämd i viss utsträckning
- Jag är i högsta grad orolig eller nedstämd

Till hjälp för att avgöra hur bra eller dåligt Ert hälsotillstånd är, finns den termometer-liknande skalan till höger. På denna har Ditt bästa tänkbara hälsotillstånd markerats med 100 och Ditt sämsta tänkbara hälsotillstånd med 0.

Vi vill att Du använder denna skala för att bedöma hur bra eller dåligt Ditt hälsotillstånd är, som Du själv bedömer det. Gör detta genom att skriva in motsvarande siffra (0-100) i nedanstående ruta.

Skicka