Lower extremity function in patients following hip arthroscopy and an asymptomatic control group. A cross-sectional comparison based on self-reported outcomes and performance based measures.

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Abstract

Background: This study aimed to evaluate physical function, measured with self-reported outcomes and performance-based measures (PBM), in patients 6-10 months following hip arthroscopy (HA) compared to an asymptomatic control group.

Methods: A cross-sectional comparison (21 patients, 22 controls) based on self-reported outcomes (HAGOS), range of motion (ROM), muscle strength and PBM (The Y-balance test (cm), medial and lateral triple hop test (cm) and Illinois agility test (s)). Independent sample t test was performed to assess between-group differences.

Results: HA-patients reported significantly worse self-reported outcomes in all HAGOS subscales, greatest difference was in QoL (-37.3 (95% CI -47.9; -26.8) p<0.001). HA-patients also reported significantly lower results (p<0.05) in active and passive flexion (ROM) and external rotation (strength). No significant differences were observed regarding PBM.

Conclusions: HA-patients reported significantly lower hip function following HA compared with the control group. Lower muscle strength and ROM were observed in patients however, few differences were significant. No significant differences were observed regarding PBM. This could indicate that physical function is re-established in patients 6-10 months after surgery or that tests were not sensitive enough to detect potential remaining functional limitations in this patient group.

Keywords: Hip arthroscopy, Femuroacetabular impingement, Performance-based measures, self-reported outcomes, Hip pain.
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2. Introduction
2.1 Background
Hip and groin pain is common in both the general and the athletic population (1). The prevalence of hip pain in the general population is 10% and increasing with age (2). In a four-year prospective study on Swedish elite ice hockey players of Pettersson M. et al (1993), 10% of all 376 injuries were to be localized in the hip and groin (3). In a prospective cohort study, over seven seasons, on professional European soccer players an injury incidence 1.1/1000h was registered for the hip and groin (4). Pain from the hip and groin region can be related to multiple anatomic structures, which makes the assessment and diagnosis of hip pain challenging (5).

Femuroacetabular impingement (FAI) is an intra-articular alteration within the hip joint (6) and is a common cause of pain in athletes (7). In an international consensus statement on Femuroacetabular impingement (FAI) from 2016, the terminology FAI syndrome was described as followed: "FAI syndrome is a motion-related clinical disorder of the hip with a triad of symptoms, clinical signs and imaging findings. It represents symptomatic premature contact between the proximal femur and the acetabulum" (8). There are three different types of FAI; CAM Morphology (a flattening or convexity at the femoral head junction), PINCHER Morphology (global or focal over coverage of the femoral head by acetabulum) or at combination of them both (8,9). Patients with FAI syndrome primarily describe motion-related or position-related pain in the hip or groin. Furthermore, patients may describe pain from the buttock, thigh or back. Clicking, catching, locking, stiffness, restricted range of motion or giving way are also symptoms the patient may describe (8). There are still uncertainties regarding the etiology of FAI (7). FAI is common in athletes within sports associated with high load on the hip joint in rotation, such as soccer, involving repeated change of direction and quick turns. FAI is also common in sports requiring high flexibility in the hip joint in flexion, adduction and internal rotation (e.g. ice hockey) as well as in sports requiring extreme range of motion (e.g. dance and gymnastics) (10).

Hip arthroscopy (HA) is a surgical treatment that gives an easy access to the hip joint and the ability to change anatomy. HA is the standard treatment of different hip pathologies, such as FAI (5,11). During the last decade, the number of hip arthroscopies has increased considerably (8, 12, 13). Hip arthroscopy as a treatment is often based on radiological findings, but it is important to differ between FAI morphology and pathology, since there many times presents
radiological findings in asymptomatic persons (11). To diagnose FAI syndrome the patient must present with symptoms, clinical signs and imaging findings (8). The surgical decision should be supplemented with anamnesis and clinical findings (11), even though the clinical measurements and assessments are not very specific enough and are mainly used for ruling out certain hip pathologies (14). In a systematic review by Ayien Or. et al. it was reported that the indications for surgical treatment of FAI are inconsistent and vary (15). Even tough hip arthroscopy has shown to reduce pain and improve function in the short term, patients may still feel remaining pain and reduced function after surgery (16). Persisting impairments may indicate that the postoperative rehabilitation after hip arthroscopy can be improved.

To achieve favorable outcomes after HA, thorough post-operative rehabilitation is required. Current research on post-operative rehabilitation following hip arthroscopy is limited to clinic experience and expert opinions (17). A systematic review by Grzybowski et al reported that current literature lacks high-quality evidence to support a specific rehabilitation protocol (18).

Integration of multiple body regions and systems is required from the athlete when performing different sport specific task. In order to objectively evaluate patients physical function prior to RTS, utilized measures should simulate the sport specific task. (19, 20, 21). Performance-based measures (PBM) usually aim to evaluate and challenge the patient on different functional levels, which may be an advantage over more traditional clinical measures (19). Range of motion, muscle strength, flexibility, endurance, coordination, balance and motor control are examples of components that could be observed through an patient-specific athletic movement pattern. (19,20,21). Common performance based measures are for example hop tests, balance tests and agility tests (19). PBM being able to reflect on patients’ normal athletic performance and environment but still can be performed in the clinic are warranted (19). In other populations such as knee and foot injuries, PBM are more frequently used to when evaluate athletes readiness to RTS (22, 23). Currently there is lack of evidence regarding PBM in patients with hip pain (19). A systematic review by Kivlan et al reported that there are only a few of the currently used PBMS that show reliability and validity when evaluating patients with hip pain (19). A study by Hegedus et al (2015) reported limitations in research on PBM regarding methods, execution and description of the test procedures. It creates imprecision around the tests and difficulties when trying to generalize results (24).
During a postoperative rehabilitation, there is a need for criteria based progression, to be able to assess when patients are ready for the next step in the rehabilitation or assess when patients are ready to RTS (25). Methods being used today in evaluation of patients following hip arthroscopy are often based on range of motion, isolated muscle strength and self-reported questionnaires. In self-reported questionnaires patients assess their own function before and after hip arthroscopy (26, 27, 28). Self-reported outcomes are a valuable and often used complement to the existing clinical assessment (29). There is strong evidence that reports that self-reported outcomes can be used to differentiate an athlete with or without pain from hip and/or groin (30). However, the evidence for performance based measures and their ability to differentiate an athlete with or without hip/groin pain is insufficient (30).

PBMs could accordingly be of great value when evaluating physical function in patients following hip arthroscopy. The present study hope to contribute to the little information available regarding physical function in patients following hip arthroscopy. To optimize and improve postoperative rehabilitation after hip arthroscopy more knowledge is needed, for example, regarding which physical functions that still are ore could be reduced after a completed rehabilitation. Results of this study may provide more knowledge regarding possible limitations in physical function measured with both patient reported and performance based outcomes. It could also give increased knowledge of possible differences in results between patients and an asymptomatic control group, which could give guidance regarding how rehabilitations should be optimized for best possible result for patients following hip arthroscopy.

2.2 Purpose and objectives
The purpose was to evaluate physical function, measured with self-reported outcomes and performance based measures, in the lower extremities in patients 6-10 months following hip arthroscopy compared to an asymptomatic control group.

More specifically, the research questions were:

- Is there a difference regarding self-reported physical function (HAGOS) between patients 6-10 months post hip arthroscopy and an asymptomatic control group?
- Is there a difference regarding physical function measured as; hip range of motion (flexion, internal rotation, external rotation), hip muscle strength (abduction, adduction, flexion, extension, internal rotation, external rotation) or performance based measures (The Y-balance test, Medial and lateral triple hop test, Illinois agility test)
between patients 6-10 months post hip arthroscopy and an asymptomatic control group?

3. Materials and methods
3.1 Study design
A cross-sectional comparison of patients following hip arthroscopy for CAM and/or PINCER to an asymptomatic control group.

3.2 Study sample and recruitment
3.2.1 Sample
Hip arthroscopy (HA)-patients were identified through a follow-up registry at the clinic were all patients had completed their hip arthroscopy. Of the twenty-seven HA-patients that were identified and contacted, twenty-one HA-patients participated in the study (figure 1). Inclusion criteria for HA-patients were (1) hip arthroscopy for FAI within the last 6-10 months, (2) age >18 years and (3) living in Stockholm, Sweden. HA-Patients were excluded if they had previous hip surgery on the same hip or have had treatment for back pain and/or injuries in the lower extremities within the last six months.

Inclusion criteria for control participants were (1) non-history of hip surgery, (2) age >18 years and (3) no treatment for back pain and/or injuries in the lower extremities in the last six months. The control group was matched with HA-patients through gender, age, activity/sports and equivalent activity/sport level (before the debut of hip pain) according to the Hip Sport Activity Scale (HSAS) (31). Control participants were mainly contacted through local sports clubs that were a possible match to the HA-patients by the criteria described above. Some control participants were contacted after having showed interest after reading an information poster in the gym at the operating clinic.
3.2.2 Contact strategy

A physiotherapist working (and being involved in this study) at the operating clinic contacted the potential HA-patients initially to inform them about the study and to get permission to share their contact information with the main investigator. Information about the study (see attachment 1) and a consent form (were to be signed at the day of the test) (see attachment 2) was sent by email to those who showed interest in participating in the study. Two to three days after receiving the written information by email, the HA-patients were contacted by phone for more detailed information and given the possibility to ask questions. HA-patients being interested in participation were booked for measurement. Potential control participants showing interest in participation were contacted by phone for more detailed information about the study, and in a next step provided with written information (see attachment 3) and a consent form (see attachment 2) by email. Potentially eligible control participants wanting to participate in the control group and who passed the inclusion criteria were booked for a test appointment. An email was sent to confirm the time for the test appointment to all participants and they were all reminded about their time in a text message one to two days prior to the test appointment.

3.2.3 Participants characteristics

Forty-three participants (21 HA-patients and 22 control participants) participated in the study (Table 1). Among the HA-patients, 71% (n=15) had unilateral HA (right hip: 47% (n=7); left hip: 53% (n=8). Twenty-nine percent (n=6) underwent subsequent bilateral HA.

Table 1. Participants characteristics

<table>
<thead>
<tr>
<th></th>
<th>HA-Patients n=21</th>
<th>Controls n=22</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (y) Mean (SD)</td>
<td>31.6 (10.0)</td>
<td>28 (9.0)</td>
</tr>
<tr>
<td>Height (cm) Mean (SD)</td>
<td>178 (7.5)</td>
<td>179.3 (7.2)</td>
</tr>
<tr>
<td>Weight (kg) Mean (SD)</td>
<td>78.3 (7.3)</td>
<td>78.2 (10.8)</td>
</tr>
<tr>
<td>Male participants (n)</td>
<td>18</td>
<td>19</td>
</tr>
<tr>
<td>Training hours per week (h) Mean (SD)</td>
<td>7.9 (4.3)</td>
<td>7.1 (4.7)</td>
</tr>
<tr>
<td>HSAS * Mean (SD)</td>
<td>5.5 (2.4)</td>
<td>N/A</td>
</tr>
<tr>
<td>HSAS, Current level Mean(SD)</td>
<td>5.2 (2.0)</td>
<td>5.3 (2.0)</td>
</tr>
<tr>
<td>Leg dominance (Left/Right)</td>
<td>L: n=2 R: n=19</td>
<td>L: n=2 R: n=20</td>
</tr>
</tbody>
</table>

*HA-Patients activity level before hip pain.
Among the twenty-one HA-patients one didn’t complete the medial/lateral triple hop test and IAR due to an ankle sprain. All twenty-two control participants completed all tests.

3.3 Measurements
3.3.1 Self-reported outcomes
Background information was collected from both groups regarding; gender, age, profession, sport, training hours/week, dominant leg (based on which leg the person choose to kick a ball with (4). All participants were asked to report any previously surgery involving hip, knee or foot or if they have had any treatment for back pain or injuries in the lower extremities during the past six months.

Two self-reported outcome measures; Hip and Groin Outcome Score (HAGOS) and Hip Sport Activity Scale (HSAS) were used to measure hip related function sport/activity level. HAGOS consists of six subscales; Symptoms, Pain, Physical function in daily living (ADL), Physical function in sport and recreation, Participation in physical activities and hip and/or groin-related Quality of life (QoL). The questionnaire was answered considering the subjects hip and/or groin function during the past week. HAGOS has shown both reliability and validity in active, young to middle-aged patients with longstanding hip and/or groin pain (32).

HSAS is a reliable and valid tool to determine sports levels in patients with FAI. (31). On HSAS, patients self-select their activity level on an ordinal scale from zero to eight, where eight stands for the highest level of sport/activity. The grades are based on intensity, from recreational sport too competitive sport at elite level but also by the impact specifically on the hip. (31). HA-patients also graded their activity level before they had symptoms from the hip.

HA-patients also reported their current level of return to sport (RTS); whether they had categorized as (1) don’t participate in sport activities, (2) do sport activities, but have not returned to previous sport activity, (3) returned to previously sport activity but not at the same level (4) returned to previously sport activity at the same level or higher. All participants also reported whether they were satisfied with their current sport/activity level or not.

3.3.2 Leg length, range of motion (ROM) and muscle strength
Leg length was measured between Anterior Superior Iliac Spine to medial malleoli (33) and with the participant lying in a supine position. Hip flexion was measured with a goniometer and hip internal and external rotation was measured with an inclinometer. All measures regarding ROM were performed with the participant in a supine position.

A handhold dynamometer is shown to be a reliable instrument for measuring hip strength on healthy individuals (34). Hip-flexion, abduction, adduction and extension were measured according to routine protocol at the clinic, a modification of the protocol by Thorborg et al (34). Hip internal rotation and external rotation was measured by the protocol by Thorborg et al (34). All directions except for extension, internal- and external rotation were measured with the participant in supine position. All participants performed three trials in each direction with the best trial serving as outcome. If there were improvements more than ten percent between the two last trials, the participant performed additional trials. Randomization was done prior to the test, regarding start leg (right/left) and order of measurements.

3.3.3 Performance-based outcomes
3.3.3.1 The Y-Balance test
The Y-balance test is a dynamic balance test to assess postural stability through a combination of range of motion, neuromuscular control and strength in trunk and lower extremity. (35, 36, 37) The test is a modification of the star excursion balance test and has shown validity on a healthy population (19, 38, 39). It has also shown good intra-tester reliability on a healthy population but results regarding inter-reliability have varied. There is not yet enough evidence regarding validity and reliability in a patient population with hip pain (19, 35, 37).

The test was performed, without shoes, after description of Plisky et al (33, 40). The participant stood on one leg in the centre of the Y, with the most distal part of the big toe at the starting line. While maintaining single-leg stance the participant reached with the free limb in the anterior, posteriomedial and posteriolateral direction. The maximal reach distance was measured by reading the number at the edge (closest to the starting point) of the reach indicator. If the participant failed to maintain single-leg stance, lifted or moved the stance foot, touched down with the reach foot or failed to return to the starting position the trial was discarded and the participant repeated the trial. Three approved trials for each direction and leg were used for analysis. The testing order was three trials standing on one foot reaching in the anterior direction followed by three trials standing on the other foot also reaching in the ante-
rior direction. Same procedure was used for posteriomedial and posteriolateral direction (33, 40). To minimize the learning effect of the test the participant practice in each direction and on each leg before starting (41). If there were, during the test, more than ten percent improvement between the two last trials, the participant did additional trials (42).

3.3.3.2 Medial and lateral triple hop test
The medial and lateral triple hop test is a way of measuring muscle strength, power and muscle coordination (43). The test has shown good test-retest reliability. The medial triple hop test has also shown validity in a study done on female dancers with unilateral hip pain (44).

Execution was based on the description done by Kivlan et al (2013). Start position was standing on one leg and with the foot placed perpendicular to the starting line. The participant then hopped on the same leg as far as possible three continuous hops in the medial direction. For the trial to count the participant had to land with control after the third and last jump. If the participant put down the other leg or hands on the floor the hop was not approved and the participant hopped additional trials. The distance between the starting line and the part of the foot closes to the starting line after the third hop was measured and recorded in centimetres. Rest time between each trial was 10-30 seconds. The lateral triple hop test was completed in the same way as described for the medial triple hop test but in the lateral direction. After completed both the medial and lateral triple hop test, the participant hopped as described above but on the other leg. Three completed trials were recorded on each leg and on each direction (44), if the last hop increased with more than ten percent the participant got additional trials.

3.3.3.3 Illinois Agility Run test (IAR)
IAR is a change of direction speed test first described by Hoffman et al (45). The test has shown good test-retest reliability and validity, not on a specific movement pattern but more on the general athletic ability to effectively shift direction (46). So far, the test hasn’t previously been tested on a patient population.

The participant started lying on the floor in a prone position, forehead right behind the start line and hands by the shoulders. On the commando “Go”, the participant got up as quickly as possible and sprinted the course as described on the picture bellow (a). The participant had to touch the cones placed on the opposite side to the start and finish line and run slalom thru the cones in the middle of the course (46). In this study, the participant that started on the right
side had to touch the two cones opposite to the start and finish line and on the contrary for participant starting on the left side. Results were measured in seconds and each subject had three trials, with three-minute rest in between. The participant was instructed to run as fast as possible (46). Before starting the test, participant ran the course in their speed of choice, with the purpose to learn the course.

![Course diagram]

3.4 Test procedure
All participants started by filling in the background information followed by the self-reported outcomes, in a web-based survey. Body weight and height were measured before warm-up that consisted of five minutes on a stationary cycle ergometer in optional speed. Participants were asked to wear training shoes, shorts and t-shirt/tank top to allow visualization of anatomic landmarks during measurements. Following the warm up measurement of leg length, hip ROM and hip strength were performed, all tests with the participants lying on a treatment bench. Finally, all participants did three performance based tests according to the following order; The Y-balance test, Medial and lateral triple hop test and IAR. Randomization for which leg the participant was to start with in the Y-balance test and medial and lateral trip hop test, was done prior to the measurements. In IAR the group of HA-patients started on the same side as of the latest hip arthroscopy, so if the HA-patient has had a hip arthroscopy in the right hip they started the IAR from the right side. Control participants started from alternating sides (left/right), based on randomization on the first participant in the control group. In each test, maximal experienced pain was noted for each limb based on a numerical rating scale (NRS), zero stands for no pain and ten for worse imaginable pain. Physiotherapists did all parts of the measurement and the total test time was around 90 minutes.

3.5 Data management
Each HAGOS subscale score was computed and converted into percentages of the total score,
with 0% representing the maximum and 100% the minimum amount of symptoms and pain (47). Best result of three trials was used in analysis regarding muscle strength, Y-balance test, medial and lateral triple hop test. Results of the Y-balance test were normalized with leg length according to direct reach distance divided with leg length then multiplied with 100 (33). Best of three trials were also used in analysis of IAR.

3.5 Statistical methods
All data was entered into a statistical software program (SPSS) for data analysis. Descriptive data were computed to describe participants characteristics and reported as mean, standard deviation (SD) or percentage. Based on visual examination, all outcome data was judged as approximately normally distributed and contained no extreme outliers. Hence, independent sample t tests were performed to test between-group differences. All analyses of strength, ROM and PBMs were based on comparisons of mean values for participants right and left side/leg. Results are presented as mean differences with accompanying 95% confidence intervals. Significance level was set to ≤0.05.

4. Ethical stance
The regional ethics committee, Lund, Sweden, approved this study, Dnr 2016/472. All participants received both written and verbal information of the study including risks and benefits of participation. Written informed consent was obtained from all participants prior entering the study. All participants were informed that they could, without giving a reason, exclude themselves anytime during the study.

During the performance based measures, just as during all types of physical activities, there was a small risk of injury, for both HA-patients and control participants. To reduce the risk all tests were done according to standard measures and under observation of physiotherapists with several years of experience. Medical supply relevant for taking care of an acute musculoskeletal injury was at hand if needed.

According to literature (17, 48) the time of RTS varied and is described up to six months after surgery. Measures in this study were done six to ten months’ post-surgery, so the majority should have RTS and therefore be able to perform all tests. Making sure that the HA-patients have returned to the level of physical activity that the tests in this study requires, the answer
of activity level according to HSAS were taking in to consideration. If participants reported a level of two or lower on HSAS they were asked an additional question regarding if they felt comfortable doing the IAR after they had been giving all of the instructions regarding the test.

The participants were informed that they could anytime without giving a reason skip one or several tests if feeling unsecure performing the test/tests. If participants felt pain that was perceived uncomfortable the test was cancelled.

5. Results
All HA-patients had return to sport at different levels (table 2). Among the HA-patients 33% (n=7) reported to be satisfied with their current sport/activity level.

<table>
<thead>
<tr>
<th>Table 2: Return to sport (RTS) 6-10 months following hip arthroscopy</th>
</tr>
</thead>
<tbody>
<tr>
<td>HA-Patients n=21</td>
</tr>
<tr>
<td>1. No participation in sports. 0%(n=0)</td>
</tr>
<tr>
<td>2. Participation in some kind of sport or physical activity, 33%(n=7)</td>
</tr>
<tr>
<td>but not in previously sport activity.</td>
</tr>
<tr>
<td>3. Participation in previously form of sport activity, 48%(n=10)</td>
</tr>
<tr>
<td>but at a lower level.</td>
</tr>
<tr>
<td>4. Participation in previously form of sport activity, 19%(n=4)</td>
</tr>
<tr>
<td>at same level or higher.</td>
</tr>
</tbody>
</table>

HA-patients reported significantly worse self-reported outcomes in all HAGOS subscales compared with control participants (Figure 2). The biggest difference was observed in the subscale QoL (-37,3 (95% CI -47,9; -26,8) p<0,001), followed by Sports and recreation (-20,7 (95% CI -29,1; -2,4) p<0,001), Symptoms (-16,5 (95% CI -23,3; -9,7) p<0,001), Physical activity (PA) (-15,7 (95% CI -22,2 t; -9,2) p<0,001), Pain (-11,5 (95% CI -16,7; -6,2) p<0,001) and ADL (-8,7 (95% CI -14,7; -2,7) p=0,006).
**Figure 2:** The Copenhagen Hip and Groin Outcome Score (HAGOS). Between-group comparison.

Greater range of motion and muscle strength was observed in control participants; however the differences were significantly only regarding active flexion (ROM), passive flexion (ROM) and external rotation (muscle strength) compared to HA-patients (Table 3).

**Table 3: Range of motion and muscle strength in HA-patients and control participants; Between group comparisons based on mean values of participants right and left leg.**

<table>
<thead>
<tr>
<th></th>
<th>HA-Patients</th>
<th>Control participants</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n=21</td>
<td>n=22</td>
</tr>
<tr>
<td><strong>ROM:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Active flexion</td>
<td>115.4 (6.6)</td>
<td>120 (7.2)</td>
</tr>
<tr>
<td>Passive flexion</td>
<td>130.2 (7.4)</td>
<td>136.3 (7.7)</td>
</tr>
<tr>
<td>IR</td>
<td>30.6 (6.6)</td>
<td>35.0 (8.8)</td>
</tr>
<tr>
<td>ER</td>
<td>40.0 (7.9)</td>
<td>43.9 (5.7)</td>
</tr>
<tr>
<td><strong>Muscle Strength</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Abduction</td>
<td>2.28(0.39)</td>
<td>2.40(0.26)</td>
</tr>
<tr>
<td>Adduction</td>
<td>2.21(0.40)</td>
<td>2.34(0.36)</td>
</tr>
<tr>
<td>Flexion</td>
<td>2.75(0.70)</td>
<td>3.08(0.51)</td>
</tr>
<tr>
<td>IR</td>
<td>1.79(0.40)</td>
<td>1.95(0.31)</td>
</tr>
<tr>
<td>ER</td>
<td>1.95(0.42)</td>
<td>2.18(0.35)</td>
</tr>
<tr>
<td>Extension</td>
<td>3.39(0.61)</td>
<td>3.56(0.51)</td>
</tr>
</tbody>
</table>

**ROM:** Range of Motion, presented in degrees, **Muscle Strength:** presented in Nm/Kg. **IR:** Internal rotation, **ER:** External rotation

**Significant values**

The participating HA-patients performed worse results in all performance-based measures, however the differences were not significant (Table 4). In the Y-balance test 19% (n=4) of HA-patients and 5% (n=1) of control participants reported pain during performance. Among the twenty HA-patients that performed the medial and lateral triple hop test 20% (n=2) and 15% (n=3) reported pain performing the test and during IAR 30% (n=6) reported pain during performance. Five percent (n=1) of the control participant reported pain during lateral triple hop test, but none reported pain performing medial triple hop test or IAR.

**Table 4: Performance based measures**

<table>
<thead>
<tr>
<th></th>
<th>HA-Patients</th>
<th>Controls</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n=21</td>
<td>n=22</td>
</tr>
<tr>
<td><strong>Y-Balance test (Y)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Y-Anterior(%)</td>
<td>66.58(6.39)</td>
<td>68.45(6.87)</td>
</tr>
<tr>
<td>Y-Postmed(%)</td>
<td>112.36(11.70)</td>
<td>117.45(9.64)</td>
</tr>
</tbody>
</table>

**Y-Balance test (Y), Medial and Lateral triple hop test, Illinois Agility Test (IAR)**
Y-Postlat(%) & 107.89(13.64) & 110.92(11.31) & -3.03 & -10.74; 4.67 & 0.431 \\
Medial triple hop test* (cm) & 337.6(119.3) & 367.2(83.1) & -29.5 & -93.2; 34.1 & 0.354 \\
Lateral triple hop test* (cm) & 308.3(96.1) & 337.2(67.4) & -29.0 & -80.3; 22.4 & 0.261 \\
IAR* (s) & 18.71(3.02) & 17.71(1.08) & 0.99 & -0.40; 2.38 & 0.156 \\

% =Percentage of leg length. cm= Centimetres. s= seconds. * Patients n= 20.

6. Discussion
The aim with the present study was to evaluate physical function, measured with self-reported outcomes and performance based measures, in the lower extremities in patients 6-10 months following hip arthroscopy compared to an asymptomatic control group. Patients following hip arthroscopy showed significantly worse self-reported outcomes in all HAGOS subscales compared with a control group. Inferior results were observed for the HA-patients regarding range of motion, muscle strength and performance based measures compared to an asymptomatic control group. The differences were however significantly only regarding active and passive flexion ROM and external rotation muscle strength. No significant differences were found regarding PBM.

At the time of the measurements, 48% (n=10) of the HA-patients in the present study had returned to previous sport activity although at a lower level than before hip surgery, and 19% (n=4) had returned to previous sport activity at same, or higher, level. Remaining 33%(n=7) reported that they had return to some kind of sport or physical activity, but not to their previous form of sport activity. The level of that participation was not defined. In a systematic review by Casartelli et al 2015 they reported an average RTS rate of 87% on patients following hip arthroscopy. The mean time of evaluation was 2.3 years (range 0.5-5.0) after hip surgery (49). HA-patients in the present study report a lower RTS rate compared to Casartelli et al, which may due to that all HA-patients may not yet have completed their full rehabilitation program at the 6-10months follow up, and therefore have not yet return to previously sport activity.

In the present study, HA-patients reported significantly worse self-reported outcomes in all HAGOS subscales compared with control participants. Similar results were shown by Kemp et al 2013 (29). This may indicate that the HA-patients haven’t recovered fully regarding experienced subjective physical function after hip arthroscopy. The biggest differences between groups in the present study were observed in the subscale QoL and smallest difference were
observed in the subscale ADL. Patients often have a long period of time with hip pain before hip arthroscopy (50). An adaption of physical level and lifestyle may occur in patients with longstanding hip pain that could affect patients experience of quality of life. A pre-operatively adapted lifestyle and limited self-experienced physical function, may take longer time to change following hip arthroscopy compared to rehabilitation of physical functions such as muscle strength.

In the present study, inferior results were observed for the HA-patients regarding range of motion and muscle strength compared to the asymptomatic control group. The differences were however statistically significant only regarding active and passive flexion ROM and external rotation muscle strength. Kemp et al 2014 also observed differences in range of motion and muscle strength in a cross-sectional comparison between patients following hip arthroscopy and a healthy control group. This study showed significantly greater hip extension and significantly less internal rotation ROM in patients following hip arthroscopy compared to the healthy control group. Regarding muscle strength, the healthy control group had significantly greater strength in adduction, extension, flexion and external rotation compared to patients following hip arthroscopy (51). Kemp et al included patients based on the presence of chondralabral pathology, not FAI morphology that was used in the present study. The population in the study by Kemp et al also consisted of 50% (n=42) female within the group of patients compared to the present study with 14% (n=3) female HA-patients. These differences potentially explain the divergences with results in the present study. The observed results found in the present study may indicate that patients had been rehabilitated and re-established well after hip arthroscopy regarding physical functions such as range of motion and muscle strength compared to the asymptomatic control group. It may also indicate that factors other than muscle strength are the reason for patients perceived functional limitations described in the self-reported outcomes (52). A further notion is the relatively low power in the present study, increasing the risk for type 2 error in case of relatively small differences in the population.

Even tough self-reported outcomes (HAGOS) showed significant differences between groups there was no significant difference between groups regarding PBM in the present study. This could be an indication of re-established objective functional capacity in the patient group, at the time of measurement. However, it may also indicate that PBMs being used weren’t sensi-
tive enough. Functional impairments of relevance in this group of patients may not be reflected in performance in these specific PBMs.

To the best of our knowledge, this is the first study to use the y-balance test, medial and lateral triple hop test and IAR in evaluation of patients following hip arthroscopy. Most of the measurements included in the present study have been found reliable and validly but not on a patient population following hip arthroscopy. Which may influence the possibility to find functional impairments of relevance in this specific group of patients.

Balance and hop tests have prior to the present study been used by Tjissen et al 2016, when evaluating patients following hip arthroscopy. Study by Tjissen et al did a comparison regarding single leg balance test, single leg squat test, single leg hop for distance, single leg vertical jump and single leg side hop between the operated leg and the non-operated leg. Observed results were slightly better in all test for the operated side compared to the non-operated side. Only single-leg side hop showed significantly differences (53). In a cross-sectional study on patients 1-2years after hip arthroscopy Charlton et al observed deficits in single leg squat performance when comparing to a matched control group. Significant greater hip adduction and knee valgus were shown in patients following hip arthroscopy (28). The present study, describes a higher percentage of men and a higher activity level (HSAS current activity level mean 5.2) in the group of HA-patients compared to Charlton et al that describes that 83% were women and the primary physical activity was walking. This may indicate that HA-patients in the present study didn’t present any functional impairments hip arthroscopy based on PBMs compared to the asymptomatic control group.

Inclusion criterions for HA-patients in the present study didn’t address if the surgery involved surgical actions besides FAI, for example labrum repair, which potentially may influence both on the rehabilitation duration and subjective and objective physical function following hip arthroscopy, compared to patients only correcting FAI morphology. The present study, does not either describe level of cartilage damage, which may affect outcomes after hip arthroscopy negatively. Sansone et al reports chondral damage in 202 of 359 hips (56%), assessed during hip arthroscopy (50). A study by Larson et al showed a failure rate on 12% on patients following hip arthroscopy with no or only slight preoperative radio-graphic joint space narrowing (54).
In the present study, HA-patients were matched with control participants on a group level. Individual matching was not practical feasible due to lack of time and access to potential control participants to choose from. Case specific individual matching would have enabled direct comparison of operated limb to corresponding side at the matched controls. One thing to consider in matching based on type of sport, is the actual position within each sport. An ice-hockey player has different tasks compared to the goalkeeper when playing ice hockey, which may indicate that the hip is exposed in different ways. A HA-patient ice-hockey player may therefore not be match to control participants that has the position of a goalkeeper, even though they both play ice hockey at the same HSAS level.

HSAS were used when matching the groups in the present study. Instead of using the current activity level according to HSAS, HA-patients were match with control participants based on activity level before experienced hip symptom. Reason for that, is trying to compare HA-patients with control participants with an activity level of HA-patients previous level and probably the same activity level they want to return to after surgery. In a study by Wörner et al they compared patients with longstanding hip pain with a healthy control group based on patients’ current activity level and reporting no differences in PBMs. Potential explanation were said to be an underestimation of limitation for PBMs in patients compared to controls (55).

In the present study results are based on mean value of the right and left leg, that may dilutes a potential difference if that is presenting in the involved side only. Lower or equal results have previously been observed in the involved side regarding range of motion, muscle strength and PBMs compared to the uninvolved side in patients following hip arthroscopy (28, 44, 53). One limitation to the present study was that no consideration was taken to that 28,5% (n=6) of HA-patients had done a hip arthroscopy prior to this study in the other leg. Which may influence the results negative when looking at previously studies observing inferior results in range of motion, muscle strength and PBMs in patients following hip arthroscopy compared to a healthy control group (28, 51). Therefore, future studies should take under considerations patients with bilateral hip arthroscopy when comparing with a healthy control group.

The present study comprises a subsample of participants in a larger planned study were the intention, based on a power calculation prior to the study, is to have at least 34 participants in
each group in order to have sufficient power to detect group differences of about 10%. Therefore, lacking significance of observed differences may potentially be due to insufficient power of the present study, rather than actual support for the null hypothesis.

**Conclusion**

Patients reported significantly lower hip function at 6-10 months following hip arthroscopy, compared with an asymptomatic control group. Lower range of motion and hip muscle strength were observed in patients compared with controls, however only few differences were significant. No significant differences were observed regarding performance based measures. This could indicate that physical function is re-established after 6-10 months rehabilitation in patients following hip arthroscopy. It could also indicate that tests were not sensitive enough to detect potential remaining functional limitations in this group of patients.
7. References


8. Attachments
Attachment 1: Study information; HA-patients

Information till forskningsperson (patienter)

"Fysisk funktion i nedre extremiteten hos personer som genomgått höftartroskopi, jämfört med en grupp utan muskuloskeletala besvär från nedre extremiteten, baserat på subjektiv funktionsskattning och prestationsbaserade tester."

Hej,

Mitt namn är Johanna Nilsson, Leg fysioterapeut samt magisterstudent på Linnéuniversitetet. Som en del av min magisterutbildning planerar jag att genomföra en studie på personer som har genomgått en höftartroskopi och jämföra de resultaten med en grupp av personer som inte har några aktuella besvär från ryggen eller nedre extremiteten (höft, knä, fot).

Syftet med studien är att jämföra fysisk funktion i nedre extremiteten hos personer som genomgått en höftartroskopi med en jämförelsegrupp som inte har några muskuloskeletala besvär från ryggen eller nedre extremiteten (höft, knä, fot). Dessutom kommer en jämförelse mellan det opererade benet och icke-opererade benet att göras hos de personer som genomgått en höftartroskopi. Studiens resultat kommer att baseras på varje persons subjektiva uppfattning av sin egna fysiska funktion och aktivitetsnivå samt objektiva mätningar i form av test av rörelseomfång, höftmuskelstyrka och prestationsbaserade tester.

Anledningen till att du har blivit kontaktad för förfrågan om att delta i denna studie är för att du har gjort en höftartroskopi på Capio Artro Clinic för 6-10 månader sedan. Information om dig har tagits fram genom klinikens uppföljningsregister. Om du önskar att delta i denna studie som forskningsperson kommer du att bokas in för ett testtillfälle på Capio Artro Clinic. Vid testtillfället kommer du att få fylla i ett internetbaserade frågeformulär om din fysiska funktion och
aktivitetsnivå. Utöver det kommer du att få göra en rörelsemätning (höft), test av höftmuskelstyrka samt fyra prestationsbaserade tester; enbensknäböj, dynamiskt balanstest, hopptest och ett agilitytest. Även en benlängdsmätning med måttband, ryggliggandes på barts, kommer att göras i samband med de prestationsbaserade testerna. Utöver det kommer inga fysiska undersökningar att göras.

I samband med ett av testerna kommer en videoupptagning göras för att möjliggöra analys efter testtillfället. Tre markörer kommer att placeras på överkroppen; en strax nedanför nyckelbenen samt två stycken på framsidan av höftbenen. För att möjliggöra analysen behöver dessa markörer synas i samband med videoupptagningen. Om du inte känner dig bekväm med detta har du rätt att avstå från detta test. Du kommer att behöva vara ombytt under testtillfället.


För dig som forskningsperson erbjuds du en utökad kontakt med en fysioterapeut, där eventuella problem kan diskuteras och vid behov kan tid för klinisk uppföljning bokas in. De individuella testresultaten kan användas för att se till eventuella funktionsnedsättningar, vilket kan ge möjlighet till att vidare rikta in fortsatt rehabilitering eller träning. Framtida patienter kan komma att gynnas av den ökade kunskap som projektet syftar till att bidra med.

Alla personuppgifter kommer att hanteras enligt personuppgiftslagen (1998:204), för att få ytterligare information kring personuppgiftslagen hänvisas du till Riksdagens hemsida. Du som forskningsperson har rätt att ansöka om information från personuppgiftsbehandling enligt Pul 26 och detta gör man genom att skriva till personuppgiftsombudet, Lunds universitet, Box 117, 221 00 Lund. Sådan ansökan måste vara egenhändigt undertecknad. Ansvarig för dina per-

Alla forskningspersoner kommer att aidentifieras genom att varje deltagare får ett kodnummer, kopplat till sin identitet. Endast studieansvarig kommer att hantera dina personuppgifter i samband med aidentifiering och kodning. All insamlad data kommer att vara datoriserad och sparas i förhållande till aktuellt kodnummer. Kodnyckeln som kopplar kodnummer till personidentitet är nödvändig för att kunna inhämta journaldata och kommer att förvaras inläst på ett separat ställe, med studieansvarig som ansvarig för hanteringen. All insamlad data kommer att hanteras konfidentiellt och enligt gällande sekretessbestämmelser. 


Deltagandet i forskningsprojektet är frivilligt och du kan när som helst, utan särskild anledning, avbryta din medverkan i studien. Om du väljer att avbryta din medverkan i studien kommer alla resultat att raderas och eventuellt sedanlig behandling/ omhändertagande kommer inte att påverkas. Om du önskar att ändra ditt samtycke av personuppgifter samt resultat vänligen kontakta Johanna Nilsson. Se kontaktuppgifter nedan.

**Ansvariga**

Kontaktpersoner

Tobias Wörner, Leg Fysioterapeut, Capio Artro Clinic; Mejl: tobias.worner@capio.se
Johanna Nilsson, Leg Fysioterapeut; Mejl: i_ohannanilsson@hotmail.com, Mobil: 0737-594786

Studieansvarig och handledare:

Frida Eek, Leg Sjukgymnast, Docent. Lunds Universitet.
Mejl: Frida.eek@med.lu.se, Mobil:0736-744 834

Forskningshuvudman: Lunds Universitet

Magisterutbildning: Linnéuniversitetet
Attachment 2: Consent form

Samtyckesformulär

"Fysisk funktion i nedre extremiteten hos personer som genomgått höftartroskopi, jämfört med en grupp utan muskuloskeletala besvär från nedre extremiteten, baserat på subjektiv funktionsskattning och prestationsbaserade tester."

Informerat samtycke

- Jag bekräftar att jag har tagit del utav denna skriffliga samt annan muntlig information om forskningsstudien.

- Jag bekräftar att jag har fått tillfälle att ställa frågor gällande forskningsstudie samt fått frågorna besvarade.

- Jag ger mitt samtycke till att delta i studien och vet att mitt deltagande är helt frivilligt.

- Jag är medveten om att jag när som helst och utan förklaring kan avsluta mitt deltagande.

- Jag tillåter att mina personuppgifter registreras enligt den information jag tagit del av och att insamlad data om mig förvaras och hanteras elektroniskt av studieansvariga.

Datum
Forskningspersonens namnteckning
Namnförtydligande

Forskningspersonens födelsedatum (XXXX-XX-XX)

Undertecknad har gått igenom och förklarat studiens syfte för ovanstående forskningsperson samt erhållit forskningspersonens samtycke. Forskningspersonen har även fått en kopia av forskningspersonsinformationen.

Datum
Namnteckning
Namnförtydligande
Information till forskningsperson (jämförelsegrupp)
"Fysisk funktion i nedre extremiteten hos personer som genomgått höftartroskopi, jämfört med en grupp utan muskuloskeletala besvär från nedre extremiteten, baserat på subjektiv funktionsskattnng och prestationsbaserade tester."

Hej,
Mitt namn är Johanna Nilsson, Leg fysioterapeut samt magisterstudent på Linnéuniversitetet.
Som en del av min magisterutbildning planerar jag att genomföra en studie på personer som har genomgått en höftartroskopi och jämföra de resultaten med en grupp av personer som inte har några aktuella besvär från ryggen eller nedre extremiteten (höft,knä,fot).

Syftet med studien är att jämföra fysisk funktion i nedre extremiteten hos personer som genomgått en höftartroskopi med en jämförelsegrupp som inte har några muskuloskeletala besvär från ryggen eller nedre extremiteten (höft, knä, fot). Dessutom kommer en jämförelse mellan det opererade benet och icke-opererade benet att göras hos de personer som genomgått en höftartroskopi. Studiens resultat kommer att baseras på varje persons subjektiva uppfattning av sin egna fysiska funktion och aktivitetsnivå samt objektiva mätningar i form av test av rörelseomfång, höftmuskelstyrka och prestationsbaserade tester.

Anledningen till att du har blivit kontaktad för förfrågan om att delta i denna studie är för att du faller inom kriterierna att kunna delta i denna studie som referensperson, dvs ingå i jämförelsegruppen. Om du önskar att delta i denna studie som forskningsperson kommer du att bokas in för ett testtillfälle på Capio Artro Clinic. Vid testtillfället kommer du att få fylla i ett internetbaserade frågeformulär om din fysiska funktion och aktivitetsnivå. Utöver det kommer du att få göra en rörelsemätning (höft), test av höftmuskelstyrka samt fyra prestationsbaserade tester;
enbensknäböj, dynamiskt balanståst, hopptest och ett agilitytest. Även en benlängdsmätning med mätband, ryggliggandes på brits, kommer att göras i samband med de prestationsbaserade testerna. Utöver det kommer inga fysiska undersökningar att göras.


Nedsatt styrka och motorisk kontroll är välkänt som riskfaktorer för idrottsskador. För dig som forskningsperson erbjuds du en kontakt med en fysioterapeut, där eventuella sådana funktionsnedsättningar kan identifieras och diskuteras och vid behov kan tid för klinisk uppföljning bokas in. De individuella testresultaten kan användas för att rikta åtgärder för att förbättra eventuella funktionsnedsättningar.

Alla forskningspersoner kommer att avidentifieras genom att varje deltagare får ett kodnummer, kopplat till sin identitet. Endast studieansvarig kommer att hantera dina personuppgifter i samband med avidentifiering och kodning. All insamlad data kommer att vara datoriserad och sparas i förhållande till aktuellt kodnummer. Kodnyckeln som kopplar kodnummer till personidentitet är nödvändig för att kunna inhämta data och kommer att förvaras inlåst på ett separat ställe, med studieansvarig som ansvarig av hanteringen. All insamlad data kommer att hanteras konfidentiellt och enligt gällande sekretessbestämmelser.


Deltagandet i forskningsprojektet är frivilligt och man kan när som helst, utan särskild anledning, avbryta sin medverkan i studien. Om du väljer att avbryta din medverkan i studien kommer alla resultat att raderas och eventuellt sedvanlig(t) behandling/ omhändertagande kommer inte att påverkas. Om du önskar att ändra ditt samtycke av personuppgifter samt resultat vänligen kontakta Johanna Nilsson. Se kontaktuppgifter nedan.

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