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# Danish Hip Arthroscopy Registry (DHAR): the outcome of patients with femoroacetabular impingement (FAI)

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## ABSTRACT

The Danish Hip Arthroscopy Registry (DHAR) was initiated in January 2012 as a web-based prospective registry. The purpose of this study was to evaluate and report the first registry based outcome data of a national population with radiological and clinical femoroacetabular impingement (FAI) undergoing hip arthroscopic treatment. Our primary hypothesis was that patients undergoing hip arthroscopy would improve significantly in pain, quality of life and sports related outcome measurements in Patient Related Outcome Measures (PROM). Peri-operative data and Patient Reported Outcome Measures (PROM) data from DHAR between January 2012 and November 2015 were extracted. Radiological pincer-type FAI was defined as LCE  $> 35^\circ$  and cam FAI as alpha-angle  $> 55^\circ$ . These data were combined with FAI surgical data such as osteochondroplasty and labral repair or resection. PROMs consisting of HAGOS, EQ-5 D, HSAS and NRS pain scores were submitted online by the patients pre-operatively and at 1 and 2-years follow-up. 2054 FAI procedures in 1835 patients were included in this study (219 patients had bilateral procedures performed). HAGOS demonstrated significant improvement in all subscales at follow up. EQ-5 D demonstrated improvement after 1 and 2 years from 0.66 pre-op to 0.78 at 2 years. HSAS improved significantly from 2.5 to 3.3. Pain score data demonstrated improvement in NRS-rest 39 to 17 and NRS Walk 49 to 22 at follow-up. We conclude that patients with FAI undergoing hip arthroscopy experience improvement in pain, quality of life and also in function and sports related outcome measures during the first 2 years after surgery.

## INTRODUCTION

Hip arthroscopy procedures in Denmark have been registered in the Danish Hip Arthroscopy Registry (DHAR) since the beginning of 2012. This registry is a voluntary clinical registry for patients or surgeons and all centres performing hip arthroscopic procedures in Denmark report to the registry. The development of the DHAR and the baseline outcome data from the entire registry has been described in an

earlier study [1]. The present study will focus on the treatment outcome of patients with symptomatic hip pain and positive radiological findings indicating femoroacetabular impingement (FAI), by presenting data from the DHAR.

The definition of FAI is still debated. The generally accepted morphologies consist of cam-, pincer- or a mixed-type impingement [2, 3]. Several studies have demonstrated evidence supporting the theory that especially

cam-type FAI is a strong risk factor for the development of secondary osteoarthritis (OA) of the hip, whereas the correlation between pincer-type FAI and OA still remains controversial [2–9]. It is believed that the surgical treatment of FAI can delay the onset of osteoarthritis. In a systematic review from 2013 the current knowledge of the clinical outcome after FAI surgery is reported as a series of case studies and with a lack of consistency in outcome reporting after arthroscopic FAI surgery [10].

Data from a national registry represents potentially a large amount of population-based epidemiological information generated from multiple centres and surgeons. Thereby, outcome data might be more reliable for a specific surgical intervention. Assuming the surgeons and patients are compliant to the data entry process, a registry gives information on patient-related functional outcomes and on the impact of different surgical techniques and implants.

The purpose of this study was to evaluate and report the outcome data of a Danish population with radiological and clinical FAI undergoing hip arthroscopy. We hypothesized that patients undergoing hip arthroscopy would improve significantly in Patient Reported Outcome Measures (PROM), including pain, quality of life and sports related outcome measurements.

## MATERIALS AND METHODS

### Clinical registry

The DHAR was initiated in 2012. Surgeons as well as patients report data online in an ongoing prospective data registration. For this study, we extracted pre- and peri-operative data including PROMs from DHAR between January 2012 and November 2015. The post-operative patient reported data were extracted at 1 and 2-year follow-up. The registry is approved by the Danish Health Authorities, J.nr. 2012-58-0006.

At inclusion in the outpatient clinic, the patient receives online access to the registry. Here, the patient submits the pre-operative subjective scores at inclusion consisting of various PROM and pain levels. At 1, 2 and 5 years post-operatively the patient will be notified to submit PROM scores at follow-up. Surgeons performing hip arthroscopies have access to the web-based registry. After surgery, the surgeon reports data from clinical examination, radiological characteristics and the peri-operative data. For each clinical examination test and radiological measurement, the registry has a standard definition and method description in order to minimize the interobserver variation.

### Patients in present study

This study includes patients operated for symptomatic FAI from January 2012 until November 2015. Data were extracted from DHAR on patients with radiological FAI, such as cam, pincer or mixed type FAI, based on the reported radiographic measurements from the surgeons. DHAR uses the three definitions of FAI types as described by Ganz [3]: cam type, a developed asphericity of the femoral head and widening of the femoral neck, pincer type, a developed global or focal over coverage on the acetabular side and mixed type, a combination of cam and pincer. We excluded data from patients diagnosed with other diseases than FAI, previous surgery in related hip or incomplete data registrations. These diseases include patients with developmental hip dysplasia or Legg-Calve-Perthes, among others (see Table 1).

### Registry data

#### *Radiological measurements*

The radiological measurements used in DHAR are determined from plain radiographs and as a standard a weight bearing anteroposterior pelvis is recommended as well as cross-table lateral or similar. The measured parameters are the Wibergs Lateral Centre Edge angle (LCE) [11] and joint space width (JSW) at the lateral sourcil, Tönnis acetabular index angle (AI) [12], alpha angle described by Nötzli [13]. The presence of posterior wall sign, crossover sign and prominent ischial spine are also reported [14].

#### *Surgical technique*

The surgical techniques represented in this registry vary since several surgeons and surgical centres participate in reporting data into the registry. The registry has no specific recommendations regarding surgical technique. The operative data reported are the surgical procedure times including traction times, cartilage injury assessment and depth of rim trimming in millimetre. The reported cam resection is measured in millimetre and the extent is measured in degrees with a maximum of 120°.

#### *Patient outcome measurements*

All PROMs used in DHAR are validated self-assessment scores and identified as suitable for patients undergoing hip arthroscopy. The used PROM questionnaires are the Copenhagen Hip and Groin Outcome Score (HAGOS), the EQ-5 D and the Hip Sports Activity Scale (HSAS). The pain score used is the numeric rating scale (NRS) [15]. The HAGOS consists of six subscales assessing symptoms, pain, function in daily living, function in sport and recreation, participation in physical activities and hip

**Table I. Exclusion criteria**

Characteristics	Number of procedures
Legg-Calve-Perthes	6
Developmental hip dysplasia (LCE angle < 25°)	110
Revision surgery	395
Periacetabular osteotomy	179
Total hip arthroplasty	33
Other earlier hip related operations	17
Missing data	228
Total	968

and/or groin-related quality of life, each scored separately [16, 17]. HAGOS is a questionnaire (37 questions in total) aimed for young to middle-aged adults undergoing non-surgical treatment or hip arthroscopy, but also patients presenting with groin pain. The EQ-5 D is used as a generic health-related quality of life instrument, which is translated and validated into many languages [18]. The HSAS is recommended as a reliable and valid activity measurement useful for patients with FAI [19]. Pain levels are measured using the NRS pain scores at rest and after 15 min of walking.

#### Statistical analysis

The student *t* test was used to analyse the differences between the pre-operative and post-operative PROM values. *P* values below 0.05 were considered statistically significant.

## RESULTS

#### Population characteristics

Data from a total of 3022 procedures from between January 2012 until November 2015 were extracted from DHAR. We excluded 968 procedures due to our exclusion criteria (see Table I). A total of 2054 FAI procedures in 1835 patients were included in this study (219 patients had bilateral procedures performed). 53% of the patients were female and 47% male. The average age at the time of surgery was 37.9 years (range 9–79 years). The majority of the patients were characterized as an isolated cam type FAI (52.4%). Isolated pincer type morphology consisted of only 9.1% whereas 38.5% were characterized as mixed type morphology.

**Table II. Pre-operative radiological findings**

Radiology parameters	Mean (SD)
LCE angle (degrees)	33 (6)
Alpha-angle (degrees)	67 (14)
Tönnis AI-angle (degrees)	6 (5.0)
JSW	Number of procedures
≤2.0 mm	6 (0.3%)
2.1–3.0 mm	97 (4.7%)
3.1–4.0 mm	683 (33.3%)
>4.0 mm	1268 (61.7%)

#### Radiological findings

The radiographic characteristics at the time of surgery are illustrated in Table II. The mean LCE in this FAI cohort was 33.4° (ranged from 25 to 68°). The mean Tönnis acetabular index angle was 5.9° and the mean alpha angle was 67.4°. The distribution of joint space width (JSW) measurements at the lateral sourcil at surgery time was ≤ 2 mm (0.3%), 2.1–3.0 mm (4.7%), 3.1–4.0 mm (33.3%) and >4 mm (61.7%), respectively. The majority of the patients (95%) had a JSW of more than 3 mm at the time of surgery.

#### Surgical findings

Mean surgery time was 86.9 min and mean hip traction time was 50.7 min. The most commonly reported hip joint pathology besides labral and cartilage injury during the hip arthroscopy was synovitis either as synovitis in the capsule or on the labrum due to pincer FAI (see Table III). The most common FAI surgical procedure consists of acetabular rim and femoral head neck junction corrections. Acetabular rim trimming was performed in 1762 cases (85.8%) and with a reported average depth of 4.1 mm (SD = 3.6). Femoral osteochondroplasty was performed in 1761 cases (85.7%) with an average circumferential area of 116° (SD = 24.5) and a mean depth of 3.8 mm (SD = 1.7). In 96% of the procedures antibiotics were administered pre-operatively.

Labral pathology and the performed surgical interventions on the labrum are shown in Table IV. In 89.5% of the procedures a labral lesion was reported. The most commonly performed procedure in case of a labral injury was reinsertion of the labrum using anchors. Labral resection either partially or full thickness resection was reported in a total of 12.5% of the procedures. In only eight procedures

**Table III. Commonly reported associated FAI hip joint pathology**

	<i>Number of procedures</i>
Synovitis	348 (16.9%)
Pincer synovitis	237 (11.5%)
Synovitis + pincer synovitis	445 (21.7%)
Ligamentum teres injury	15 (0.7%)
Os acetabuli	20 (1.0%)

a labrum reconstruction was performed. In three cases the labral injury was left unattended.

Cartilage injuries were found in 89% of cases and the degree of injury for both acetabulum and femoral head are shown in Table V. The majority of the injuries were located in the acetabulum (88.7%). Surgery due to cartilage injury was reported in 1465 procedures and the most commonly performed surgical intervention was resection and debridement with radiofrequency ablation technique. Acetabular microfracture was only reported in 110 procedures.

#### Patient Related Outcome Measures

PROM including pain scores improved significantly from pre-operative status to follow-up 1 year post-operatively as shown in Table VI. HAGOS demonstrated significant improvements in all subscales between the pre-operative and the post-operative scores at 1-year follow-up as shown in Fig. 1. 72% of the patients had more than a 10-point improvement in three or more HAGOS subscales and 64% of the patients had more than a 10-point improvement in four or more HAGOS subscales. Table VI summarizes scores from NRS, EQ-5 D and HSAS. The pain score data demonstrated significant improvement in NRS at rest from 39 before surgery to 17 at the 2-year follow-up. Also NRS during walking improved significantly from 49 to 22 at 1-year follow-up. We did not find any significant improvements in these parameters between 1 and 2-year follow-up except NRS pain score for walking. EQ-5 D demonstrated statistically significant improvement after one and 2 years from 0.66 pre-operatively to 0.78 at 2 years. The HSAS score improved from 2.5 before surgery to 3.3 at 2-year follow-up, which also was a statistically significant improvement.

#### Revision and survival rates

The number of revision hip arthroscopies in this population was 89 procedures (8.2%) in total. During the first year after the primary hip arthroscopy, the number of reported revision hip arthroscopy procedures was 78 (7.2%).

Between the 1 and 2-year follow-up only 11 revision procedures (1%) were reported. The rate of conversion to total hip arthroplasty (THA) was 0.8% in a total of 1088 reported procedures. These nine THA conversion procedures were all reported during the first year after the primary hip arthroscopy.

#### Registration completeness

The completeness of PROM registrations pre-operatively was 57% and the follow-up completeness at 1 and 2 years was 57% and 56%, respectively. There is an ongoing study looking at data completeness comparing data from DHAR to the National Registry for Hospital Procedures.

#### DISCUSSION

Key findings in the present study are that patients with symptomatic FAI in a large national cohort during the first 2 years after surgery do benefit from hip arthroscopic procedures involving labral reinsertion and removal of pincer and cam bone deformities. These procedures resulted in significant improvements in all HAGOS subscales, EQ-5 D, HSAS and NRS at 1 year post-operatively. Between 1 and 2-year follow-up further improvements were not recognized.

A recently published systematic review by Schairer *et al.* [20] illustrated a large variation in the use of PROM for evaluation of clinical outcome after hip arthroscopic procedures. The most frequently used PROMs were the modified Harris Hip Score (mHHS), Non-Arthritic Hip Score (NAHS), Hip Outcome Score-Activities of Daily Living (HOS-ADL) and Hip Outcome Score-Sport Specific Subscale (HOS-SSS). Some of these scores (mHHS, HOS) were originally designed to evaluate outcome in patients with advanced osteoarthritis in older people. Newer outcome scores such as HAGOS, International Hip Outcome Tool (iHOT) and the NAHS were developed and validated for use in young and active patients with hip related symptoms [16, 17]. So far, not many studies have used HAGOS for evaluating patients undergoing surgery for FAI. A Swedish study by Sansone *et al.* [21] of top-level athletes (85 patients, 115 procedures) undergoing arthroscopic FAI surgery found significant increase in all six subscales of HAGOS at 12-month follow-up. Significant improvements were also found in Hip Sports Activity Scale (HSAS) and iHOT-12.

In the DHAR cohort, we have reported data from a large FAI population with much greater variety of pathologies, older age and physically less active than the Swedish study. In comparison with the Swedish study, we found that all HAGOS subscales both pre-operatively and post-operatively at 1 and 2-year follow-up were lower compared

**Table IV. Labral pathology and related surgical procedures**

Labral pathology	Number of procedures
Labral injury (yes/no)	1838 (89.5%)/188 (10.5%)
Labral flap tear/fibrillation	55 (3.0%)
Longitudinal injury at labral insertion site	1216 (66.2%)
Bucket handle lesion	67 (3.6%)
Degenerative lesion	427 (23.2%)
Labral ossification	73 (4.0%)
Labral procedures	
Labral reinsertion	1561 (76.0%)
Partial labral resection	176 (8.6%)
Full thickness labral resection	80 (3.9%)
Labral reconstruction	8 (0.4%)

with the group of top-level athletes. Several other studies have reported high rates of success in outcomes after FAI surgery [22, 23]. A recent study by Gupta et al from a single surgical centre consisting of a large group of hip arthroscopy patients ( $n = 595$ ) mainly with FAI pathology patients, they found significant improvements in the modified Harris Hip Score (mHHS), Non-Arthritic Hip Score (NAHS), Hip Outcome Score-Activities of Daily Living (HOS-ADL) and Hip Outcome Score-Sport Specific Subscale (HOS-SSS) at 2-year follow-up. Also Visual Analogue Scale (VAS) pain scores decreased from 5.86 pre-operatively to 2.94 post-operatively. The cumulative risk of failure with conversion to THA was 8.6% [24].

In a large cross-sectional study of a North American FAI cohort reported by Clohisy *et al.* the most common surgical technique during FAI surgery was femoral head-neck osteochondroplasty in 91.6% of the 1130 procedures. In their cohort labral refixation/repair was performed in 47.8% of the cases and a partial labral resection in 27.7%. The percentage of acetabular microfracture interventions in this study was similar to the reported number in DHAR, respectively 5.6% and 5.4% [25]. Bony resections such as acetabular rim trimming and femoral osteochondroplasty was performed in 85% of the cases in our study. Labral surgical procedures were performed in 88.9% of cases and the most frequent were labral reinsertion (76.0%) and labral resection (12.5%). A large proportion (90.0%) of our FAI

cohort had chondral damage at the time of surgery. The most common site of cartilage injury was in the acetabulum and to a minor degree on the femoral head. Although many of these injuries were described as full thickness cartilage damage, microfracture was not performed very often, similar to the Clohisy study

A recent systematic review by Nwachukwu compared open versus arthroscopic FAI surgery and demonstrated excellent and comparable hip survival rates at medium to long-term follow-up. Hip arthroscopy showed a statistically significant improvement in general health-related quality of life, when compared with open procedures [26]. In the study with THA as an outcome endpoint, there was an overall survival rate of 93% for open and 90.5% for arthroscopic procedures. A recent retrospective population based analysis ( $n = 7351$ ) showed an overall conversion rate of 12.4% within 2 years of hip arthroscopic surgery [20]. The lowest rate of conversion was found in the age group younger than 40 years, at 3%. The highest risk of conversion was seen in the age group 60–69 years, at 35%. This material was based on hip arthroscopy procedures performed between 2005 and 2012. They also found decreased conversion rates from 2005 to 2010, which might illustrate changes in indications for surgery and changes in surgical procedures during hip arthroscopy. A systematic review by Weber *et al* described a 6.3% re-operation rate after hip arthroscopy in a cohort consisting of more than 6000 from 92 studies [27]. The majority of these re-operations were, respectively, revision hip arthroscopies in 1.9% and conversion to THA in 2.9% of the patients. In the study presented here revision hip arthroscopy was performed in 8.2% of cases and conversion to THA was reported in 0.8% of the cases. The low conversion rate to THA compared with other studies might be attributed to the short term follow-up in the present study.

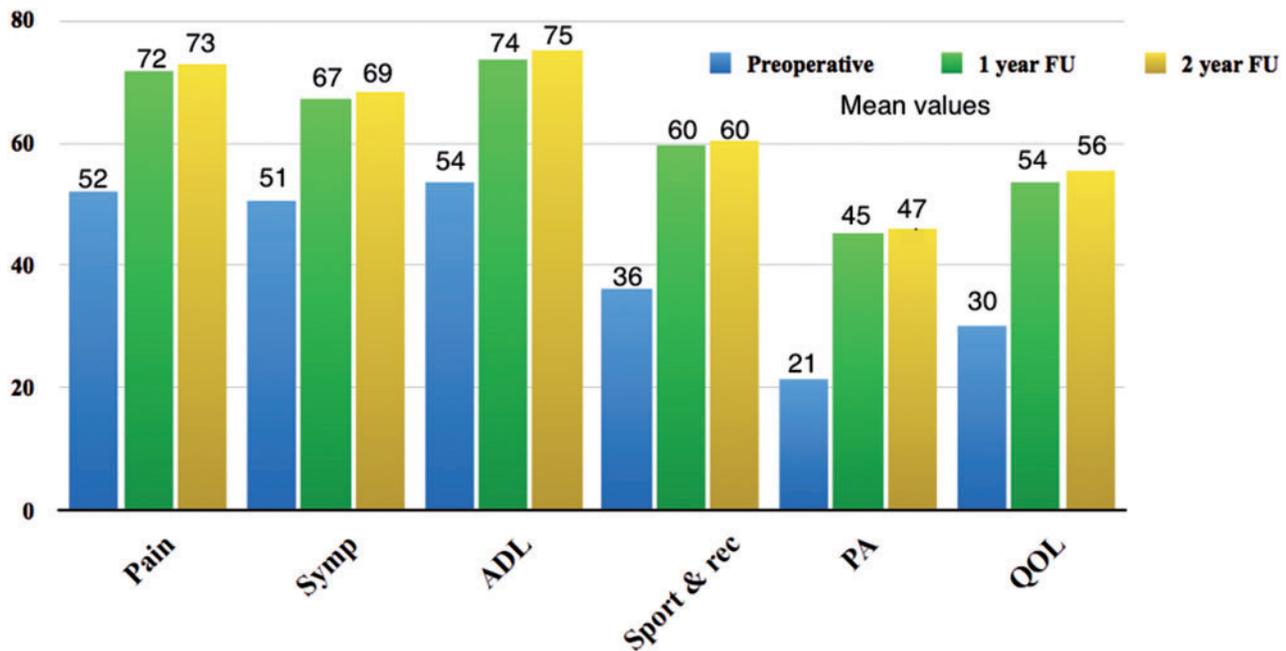
The present study and studies previously mentioned show consistent improved clinical outcomes, especially regarding patients' quality of life and pain related outcome measures. Revision rates and conversion to THA are low and data suggests that hip arthroscopy is recommendable for FAI surgery. There is still a need for good level I studies on the correct treatment of FAI and we still need high level studies about the natural history of asymptomatic FAI. There are several RCTs on the way and hopefully they will give us further insight into the treatment of this clinical entity [28–32].

#### LIMITATIONS

There are limitations in this study in regard to data quality due to the potential diversity in interpretation of radiology and pathology and due to completeness of data in the

**Table V. Cartilage pathology and surgical procedures**

Cartilage damage classification	Acetabulum (Becks classification)	Femoral head (ICRS)
Grade 0	27 (1.5%)	1385 (74.9%)
Grade 1	277 (15.0%)	155 (8.4%)
Grade 2	819 (44.2%)	204 (11.1%)
Grade 3	524 (28.4%)	68 (3.7%)
Grade 4	201 (10.9%)	36 (1.9%)
Cartilage surgical procedures		Number of procedures
Cartilage debridement		725 (35.3%)
Cartilage resection (acetabulum)		543 (26.4%)
Microfracture (acetabulum)		110 (5.4%)



**Fig. 1.** Development in HAGOS scores from before surgery until 2-year follow-up. HAGOS subscales: pain; Symp, symptoms; ADL, activities of daily living; Sport and rec, sport and recreation; PA, physical activities; QOL, quality of life.

DHAR. All data input is voluntary, both for surgeons and patients. We know from the Danish National ACL Registry that patient inputs are as low as 35%, where surgeon inputs are much higher, at 85% [33]. The hip arthroscopy procedure is regulated by the Danish Board of Health and is therefore limited to the 11 centres which have a permission to perform the procedure. The actual number of hip arthroscopic procedures during this time period in Denmark is not known, but is being studied in an ongoing

validation study. There are no data in the registry available on radiographic measurements post-operatively on the FAI correction. This possibility has been added to the registry at a later date, and therefore these data are not available at the present time, but will be available in future studies.

There is also a likelihood of variations in the report of intra-operative findings and the measurement of cam and pincer resections from the participating surgeons. These

**Table VI. Development in HAGOS, NRS, EQ-5 D and HSAS**

HAGOS	Preoperative mean	1-year FU mean	2-year FU mean	P value Preop—1 year FU	P value 1 year FU – 2 year FU
HAGOS					
Pain	52	72	73	<0.001	0.39
Symptoms	51	67	69	<0.001	0.31
ADL	54	74	75	<0.001	0.28
Sport	36	60	60	<0.001	0.72
PA	21	45	47	<0.001	0.43
QoL	30	54	56	<0.001	0.26
NRS rest	39	19	17	<0.001	0.24
NRS walk	49	27	22	<0.001	<0.05
EQ-5D	0.66	0.77	0.78	<0.001	0.26
HSAS	2.5	3.1	3.3	<0.001	0.20

variations might give this study a benefit since this reflects natural variation and then data can be more generalizable.

### CONCLUSION

We conclude that patients from the DHAR with FAI undergoing hip arthroscopy experience improvement in pain, quality of life and in function and sports related outcome measures.

### CONFLICT OF INTEREST STATEMENT

None declared.

### FUNDING

None.

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