



University of Southern Denmark

Danish Hip Arthroscopy Registry

An epidemiologic and perioperative description of the first 2000 procedures

Mygind-Klavsen, Bjarne; Grønbech Nielsen, Torsten; Maagaard, Niels; Kraemer, Otto; Hölmich, Per; Winge, Søren; Lund, Bent; Lind, Martin

Published in:

Journal of hip preservation surgery

DOI:

[10.1093/jhps/hnw004](https://doi.org/10.1093/jhps/hnw004)

Publication date:

2016

Document version

Final published version

Document license

CC BY-NC

Citation for pulished version (APA):

Mygind-Klavsen, B., Grønbech Nielsen, T., Maagaard, N., Kraemer, O., Hölmich, P., Winge, S., ... Lind, M. (2016). Danish Hip Arthroscopy Registry: An epidemiologic and perioperative description of the first 2000 procedures. *Journal of hip preservation surgery*, 3(2), 138-145. <https://doi.org/10.1093/jhps/hnw004>

Terms of use

This work is brought to you by the University of Southern Denmark through the SDU Research Portal.

Unless otherwise specified it has been shared according to the terms for self-archiving.

If no other license is stated, these terms apply:

- You may download this work for personal use only.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying this open access version

If you believe that this document breaches copyright please contact us providing details and we will investigate your claim. Please direct all enquiries to puresupport@bib.sdu.dk

Danish Hip Arthroscopy Registry: an epidemiologic and perioperative description of the first 2000 procedures

Bjarne Mygind-Klavsen^{1,*}, Torsten Grønbech Nielsen¹, Niels Maagaard², Otto Kraemer³, Per Hölmich³, Søren Winge⁴, Bent Lund⁵ and Martin Lind¹

1. Department of Orthopaedics, Aarhus University Hospital THG, Aarhus C 8000, Denmark

2. Department of Orthopaedics, Odense University Hospital, Odense 5000, Denmark

3. Department of Orthopaedics, Copenhagen University Hospital, Amager-Hvidovre, Arthroscopic Center, Copenhagen S 2300, Denmark

4. Copenhagen Private Hospital, Kgs. Lyngby 2800 Copenhagen, Denmark and

5. Department of Orthopaedics, Horsens Regional Hospital, Horsens 8700, Denmark

*Correspondence to: B. Mygind-Klavsen, E-mail: bjarne@mygind-klavsen.dk

Submitted 6 July 2015; Revised 30 October 2015; revised version accepted 11 January 2016

ABSTRACT

Danish Hip Arthroscopy Registry (DHAR) was initiated in 2012 as a web-based prospective registry. The purpose of this study was to evaluate and report the epidemiologic and perioperative data of the first 2000 procedures in a Danish hip arthroscopy population and to describe the development of DHAR. We describe the use of various Patient Related Outcome Measures related to non-arthritic hip patients. The 2000 procedures consisted of 56% females and 44% males. Mean age 37.5 years, mean surgical time was 86.5 min and mean traction time 50.5 min. The most frequently performed procedure was CAM and Pincer resection in 93.5% of the cases. Labral refixation or repair was done in 70.3% of the cases. The most common type of acetabular chondral damage was grade II lesions (36.6%). Grade III and IV changes were seen in 36.1% of the cases. The preoperative iHOT12 was 45 (mean) based on all 12 items. EQ-5D was 0.65 and HAGOS sub-scores were 51 (pain), 49 (symptoms), 53 (ADL), 35 (sport), 20 (physical activity) and 29, respectively. We conclude that patients undergoing hip arthroscopy report considerable pain, loss of function, reduced level of activity and reduced quality-of-life prior to surgery. The problems with development and maintaining a large clinical registry are described and further studies are needed to validate data completeness. We consider the development of a national clinical registry for hip arthroscopy as a successful way of developing and maintaining a valuable clinical and scientific tool.

KEYWORDS: Hip arthroscopy, Registry, Sports

INTRODUCTION

In Denmark and internationally, hip arthroscopy has evolved rapidly over the last decade. This evolution is based on a new understanding of hip joint pathology and causes for hip-related symptoms [1–5]. Especially, the introduction of the concept of femoroacetabular impingement (FAI) [6–8] has led to an increase in the indications for arthroscopic hip preservation surgery. National clinical registries have a long tradition in Denmark and other Scandinavian countries. The arthroplasty registries have more than three decades of history for collecting data [9–11]. But also in the

field of sports traumatology, the anterior cruciate ligament reconstruction (ACL) registries are well known and numerous studies on patient and technique-related outcome studies originate from these registries [12–16].

Several academic centres have reported outcome studies after hip arthroscopy on different selected patient groups [3–11]. These data might be biased due to selection criteria and highly dedicated surgeons. Data from a national registry represent a large amount of population-based epidemiological information. Assuming the surgeons and patients is compliant to the data entry process, this registry information

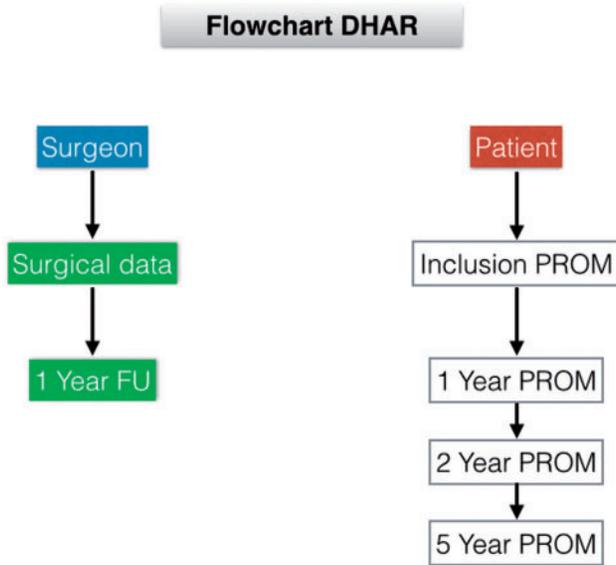


Fig. 1. The structure of the online database from the inclusion to 5-year follow up. The white boxes illustrate patient registration and the green boxes illustrate surgeon performs registration.

on patient-related functional outcome but also on the different surgical techniques and implant systems, etc. might be more representative for a specific surgical treatment.

Recently, the development and baseline data from a Swedish hip arthroscopy registry has been published [17]. Data were collected from one hospital with a large hip arthroscopic unit. They described the positive effects of a clinical registry as a practical way to collect, handle and follow large amount of information over time. It was also possible to evaluate different subpopulations. They concluded that careful registry design in form of outcome tool selection and logistical planning as well as optimizing quality of input data is of the utmost importance when creating a clinical registry [17].

The purpose of this study was to evaluate and report the development of The Danish Hip Arthroscopy Registry (DHAR) and present epidemiologic, preoperative status and operative data of the first 2000 procedures in a Danish patient population undergoing hip arthroscopy.

METHODS

Registry organization

In 2010, The Danish Board of Health stated that hip arthroscopies could only be performed at a limited number of hospitals with specific levels of expertise. Furthermore, they demanded registration of procedures performed at the individual hospitals. This gave the inspiration for a national hip arthroscopy registry. The DHAR was initiated in 2012,

Table I. The content of the patient reported data at inclusion and later follow up

<i>Web-based patient reported parameters and outcome measurements.</i>	
Inclusion	Patient accepts inclusion and data registration to DHAR
	Name
	Email
	Hospital or clinic name
	Index side
	Pre surgery PROM (EQ-5D, iHOT12, HAGOS, VAS, NRS)
FU registration at 1, 2 and 5 years	Post-surgery PROM (EQ-5D, iHOT12, HAGOS, VAS, NRS)

but previously a group of Scandinavian surgeons had attempted to make a Scandinavian registry. They agreed upon a common data structure, questionnaires and PROM. Due to strict national data laws and handling of patient data across the borders of these countries, the attempt to develop a Scandinavian Hip Arthroscopy Registry is failed.

The Danish group agreed to design a national registry and received a grant (€3.350) from the Danish Society of Arthroscopic Surgery and Sports Traumatology to establish the registry. The present yearly administration costs is ~€3.700, which is funded by the hospitals and clinics participating in DHAR.

The data collection is web-based (www.hipjoint.dk) and is an ongoing prospective registration of all procedures of hip arthroscopy performed in Denmark at the participating centres. There are presently 11 centres performing hip arthroscopy. These centres include six public hospitals and five private clinics. The registration of patients and surgical procedures in the registry is not mandatory.

DHAR has a steering committee responsible for database management and future developments. An annual report is published including department and total epidemiological, surgical and patient reported outcome data. This report is published on the Internet at The Danish Society of Arthroscopy and Sports Traumatology (www.saks.nu). All participating surgeons have access to their own registered data and might extract and present data using a CSV-file. DHAR is approved by The Danish Data Protection Agency.

DATABASE CONTENT

The database content is collected prospectively and follows a certain flowchart (Fig. 1). By the time of inclusion at the treating clinic, the patient receives online access to the database. The patient submits the preoperative subjective scores at inclusion consisting of various PROM and pain levels (see Table I). These PROMs are validated self-assessment scores and identified as suitable for patients undergoing hip arthroscopy. The patients submit these data at inclusion time in the outpatient clinic. The registry automatically sends out PROM questionnaires at 1, 2 and 5 years postoperatively to the patients.

The used PROM questionnaires are the International Hip Outcome Tool (iHOT), Copenhagen Hip and Groin Outcome Score (HAGOS), The EQ-5D, The Hip Sports Activity Scale (HSAS) and the pain scores used are the visual analogue scale (VAS) and numeric rating scale (NRS). The iHOT is used in the registry as the short validated version with 12 questions (iHOT12) for initial patient assessment and as postoperative follow-up. The iHOT12 is validated to measure health-related quality-of-life and to identify changes after treatment in young and active patient with hip disorders. The total score is calculated as a simple mean of these 12 item responses ranging from 0 to 100, with a higher score representing a better overall quality-of-life score [18]. The HAGOS consists of six sub-scales assessing symptoms, pain, function in daily living, function in sport and recreation, participation in physical activities and hip and/or groin-related quality-of-life, each scored separately [19, 20]. 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-5D is a widely used generic health-related quality-of-life instrument now translated and validated into many languages [21]. The HSAS is also used and recommended as a reliable and valid activity measurement useful for patients with FAI [22]. Pain levels are measured using the VAS and NRS pain scores at rest and after 15 min of walking.

Each surgeon performing hip arthroscopies has access to the web-based registry. At the time of surgery, the surgeon reports both data from clinical examination, radiological parameters and perioperative data (Table II). The clinical examination includes hip range of motion (ROM), palpable psoas pain, palpable gluteus medius pain, hip flexion strength test and walking gait analyses. The radiological data consist of the following radiological measurements; Wibergs Lateral Centre Edge angle (LCE), joint space width (JSW), Tönnis acetabular index angle (AI), Alpha angle and the presence of posterior wall sign, crossover sign and prominent ischial spine [23, 24]. The operative

data reported are the surgical procedure time including traction times, cartilage injury and surgical technique characteristics such as anchor type, number of anchors used, depth of rim trimming in mm. The reported CAM resection is measured in millimetre and the extent is measured in degrees with 120° as maximum. Any perioperative complications are also reported. The registry has for each clinical test and radiological procedure a standard definition and description to minimize the interobserver variation. There are also guides on how to measure the different radiological angles.

SURGICAL TECHNIQUE

The surgical techniques represented in this registry vary since several surgeons and surgical centres report data into the registry. These procedures are most commonly performed under general anaesthesia with patients in supine position. The registry has no specific input regarding surgical technique. As an example, some surgeons might advocate refixation of labral tears after rimtrimming, while other surgeons will perform a rimtrimming and leave the labrum alone. The registry is not set-up to look into details on how the specific surgical procedure was carried out.

RESULTS

From January 2012 through December 2014, the 2000 procedures were included in the registry. All patients undergoing hip arthroscopy are included and the data collected at the time of surgery are presented here. For this study population, we collected data from a total of 1678 patients. A total of 124 patients had bilateral hip arthroscopy procedures performed. The remaining 198 procedures are composed of several surgical interventions e.g. revision surgery in the follow-up period.

Table III shows the preoperative demographic variables based on the DHAR protocol at the time of surgery. In the patient cohort, 56% were females and the median age was 37.5 years, range 9–80 years. ~15% of the cases were revision hip arthroscopies and almost 9% had a history of hip dysplasia previously treated with periacetabular osteotomy.

Table IV illustrates the surgeon reported radiological parameters and signs from x-ray. The mean LCE angle in this study was 33° and the mean Alpha angle was 67°. The majority of the cases (99%) had a JSW measured at the lateral sourcil above 2 mm. About two-third of the patients (60.8%) had a JSW of 4 mm and above.

Table V summarizes the operative data. Mean operation time was 86.5 min (12–445 min) and mean traction time was 50.5 min (2–180 min). Femoral head–neck osteochondroplasty is the most commonly performed procedure performed in 1725 hips (86.3%) in total and labral refixation

Table II. Data related to both the clinical examination before surgery, radiological parameters and the peri-operative data collection reported by the surgeon

<i>Surgeon reported data</i>	
Previous surgery at affected hip joint	Periacetabular osteotomy or hip arthroscopy, other
Hip ROM	Internal rotation, external rotation, abduction, flexion.
Palpation pain in various muscle groups	Psoas prox. and distal to inguinal ligament, gluteus medius, hip flexion strength and gait (limp).
Radiology parameters	Lateral centre edge angle, alpha angle, joint space width, prominent ischial spine. Cross over sign
<i>Peri-operative data</i>	
Cartilage (classification and treatment)	Femoral head according to ICRS classification Acetabulum according to Becks classification.
Other pathology	Loose bodies, lig. teres tear, synovial disease
Surgical time and traction time	
Type of anaesthesia	GA, spinal, use of local anaesthetics, nerve blocks, etc
Use of antibiotics and DVT prophylaxis	Type of antibiotic, type of DVT prophylactic
Extra articular surgery	Psoastenotomy and level, peri-trochanteric surgery
Peri-operative complications	Iatrogenic cartilage and labral damage, suture and anchor breakage, instrument breakage and loss of traction

or repair as the second most performed procedure in 1406 hips (70.3%). In 8.3% of the cases a psoastenotomy was performed. The level for psoastenotomy in the majority of these cases was at the acetabular rim. The distribution of reported surgical FAI pathology in this cohort was 13.9% as isolated CAM-type morphology. The CAM-type morphology in this register is defined as a characteristic osseous bump at the femoral head–neck junction. The severity of this deformity is here measured in either plain or radial radiographic sequences as described by Notzli *et al.* [25] as an Alpha angle above 55°. The cut-off value 55° was chosen based on the article by Tannast *et al.* [26]. In 7.2% of the cases, an isolated Pincer-type morphology was found. Pincer-type morphology is here defined as over coverage on the acetabular side, either as global or focal over coverage. These deformities are recognizable on anteroposterior pelvic radiograph. The generally accepted LCE angle is in normal individuals between 25 and 39. An LCE angle above 39 is in this register considered as a possible Pincer deformity. Crossover sign might indicate focal over coverage pincer deformity, but the surgeons have to be aware of the artefact caused by the orientation of the anterior inferior iliac spine and also the possibility of acetabular retroversion in combination with the presence of

posterior wall sign [27]. The majority of the cases (72.4%) had a combination of CAM and Pincer-type morphology.

Table VI shows the distribution of cartilage damage found in the acetabulum and on the femoral head. The most common type of acetabular chondral damage was wave sign (grade II) (36.6%), and additional delamination of the cartilage (grade III) (25.6%). In 209 patients (10.5%), the acetabular cartilage was classified as grade IV damage, with bare bone in the acetabulum. There was less cartilage damage reported on the femoral head and in this study, 74.7% had no damage at all on the femoral side and only 2.5% had grade IV loss of cartilage compared with 10.5% on the acetabular side.

Table VII summarizes the preoperative PROM data including VAS, NRS, EQ-5D, HSAS and all subscales of HAGOS at inclusion time. The iHOT12 is here presented as a mean value based on all 12 items.

In DHAR, we found completeness in PROM data at inclusion-time, based on patient response, of 51.7%.

DISCUSSION

The establishment of a national clinical registry for hip arthroscopy treatments demonstrates that it is possible to create a viable and successful method for national data collection for

Table III. The preoperative variables including previous performed surgery

<i>Patient demographics and previous surgical history extracted from all procedures (n = 2000)</i>	
Male	872
Female	1128
Ratio m/f (%)	44/56
Age mean	37.5
Labral tears	0.7%
CAM resection	2.0%
Pincer resection	4.5%
Cartilage injury	4.9%
Loose bodies/chondromatosis	0.2%
Lig. teres rupture	0.2%
Infection	0.1%
Peri-acetabular osteotomy	8.8%
THR	0.6%
Osteosynthesis of SCFE	0.3%
Trochanteric Z-plasty	0.1%
Other open hip surgery	0.4%
Revisions	15.3%
Other	0.1%

124 patients had bilateral procedures performed.

Table IV. The reported radiological measurements and signs from all the procedures (n = 2000)

<i>Radiology parameters</i>	<i>Mean (SD)</i>	
LCE-angle (degrees)	33 (7)	
Alpha-angle (degrees)	67 (15)	
Tönnis AI-angle (degrees)	6 (5)	
<i>Joint space width</i>	<i>Number of procedures</i>	<i>%</i>
<2.0 mm	19	1.0
2.1–3.0 mm	102	5.1
3.1–4.0 mm	662	33.1
>4.0 mm	1217	60.8

Table V. The surgeon reported operation data and treatments in all procedures (n = 2000)

<i>Surgical data</i>		
Mean OR time (min)	86.5 (12–445)	
Mean traction time (min)	50.5 (2–180)	
<i>Surgical procedure</i>	<i>Number of procedures</i>	<i>%</i>
Femoral head–neck osteochondroplasty	1725	86.3
Labral refixation/repair	1406	70.3
Labral resection	278	13.9
Labral reconstruction	13	0.65
Isolated Cam resection	277	13.9
Isolated Pincer resection	144	7.2
Combined cam + Pincer resection	1448	72.4
Psoastenotomy	166	8.3
Microfracture	86	4.3
Trochanteric bursectomy	18	0.9
Other	189	9.5

Other includes removal of capsular calcifications, os acetabuli and removal of screws after PAO and cysts decompression.

patients undergoing hip arthroscopy. A national hip arthroscopy registry provides detailed epidemiological data, radiological description of hip joint disorders and the possibility of monitoring development of surgical treatment strategies can be used to improve the quality of care, by supporting surgical decision-making and by linking patient and surgical data to outcome parameters collected by the registry.

This is especially important in a relatively new field such as hip arthroscopy, where indications and surgical techniques may vary considerably between surgical centres and surgeons. This gives rise to questions about validity and problems collecting data from multiple centres and surgeons. Future data collection over the coming years with clinical follow-up and validation studies will even further provide valuable information. We think that the development of a national Danish registry has been successful and that the registry is able to provide useful data in this patient population undergoing hip arthroscopy. It is however very important in the planning process of a national registry to carefully select outcome measurement tools, etc.

Table VI. The cartilage damage on the acetabular side and the femoral head

<i>Cartilage damage classification in all procedures (n = 2000)</i>					
<i>Acetabulum</i>	<i>N</i>	<i>%</i>	<i>Femoral head</i>	<i>N</i>	<i>%</i>
Grade 0: normal cartilage	270	13.5	Grade 0: Normal cartilage	1494	74.7
Grade I: Fibrillation	277	13.9	Grade I: Nearly normal	157	7.9
Grade II: Wave sign	732	36.6	Grade II: Abnormal	229	11.5
Grade III: Cleavage tear between labrum and articular cartilage	512	25.6	Grade III: Partial loss of cartilage	71	3.6
Grade IV: Exposed bone in the acetabulum	209	10.5	Grade IV: Exposed bone	49	2.5

It is also of great importance in the planning process of an online registry to invite technological expertise in the preparation to avoid technical errors.

With this registry, we are able to demonstrate and extract data from a national population undergoing hip arthroscopic procedures. We can describe their initial status before the surgical procedure and at every follow up with validated PROMs and radiological parameters. Furthermore, it is possible to follow the evolution of this surgical procedure and the development of new techniques. In this study, we have presented the baseline data of this population and their status at the time of surgery. In the future, we can present outcome data at follow up (ongoing studies) from this population after surgery.

In Denmark, surgical registries are common and known from various surgical procedures such as ACL surgery and total joint arthroplasty [12, 14, 28]. These registries have led to focus on patient management and to increased scientific activity, which further have strengthened the impact of clinical registries. The work on the new hip arthroscopy registry was started up with the emphasis on collecting data that could be used for monitoring clinical activity and treatment strategies, but also to provide scientific data for future investigations in the outcome of hip arthroscopic treatments. Care was taken to include data for evaluation of these surgical procedures and their outcomes. The registry was initially planned to use paper-based registrations, but was changed early on to a complete online registration system. Adjustments have been made all along as we got experience from collecting data.

The degree of patient compliance and participation in DHAR during these first years might not seem high. Difficulties in setting up an online access at the participating centres account for parts of the low baseline PROMs. These technical issues are now solved. The registry automatically generates an e-mail notification to the patient at 1, 2 and 5-year follow up. If the patient does not complete

the PROM questionnaire, a reminder is e-mailed. There is at the time an ongoing study investigating the degree of completeness on both patient and surgeon side. In the future, we might consider developing other data collecting tools such as mobile apps that might be easier to use for the patient.

In a survey of the general population of western Sweden, the mean EQ-5D was 0.54, compared with 0.65 in the present study [17]. For the HAGOS score, a validation study demonstrated in a group of soccer players without hip or groin symptoms a score of 100, or close to it, on all the subscales [29]. This can be compared with the preoperative HAGOS scores ranging from 20 to 53 in this study, indicating significant hip-related symptoms and function impairment for hip arthroscopy patients prior to surgery.

The hip arthroscopy patients included in the DHAR presented in this study reported considerable pain, function loss, decreased activity level and reduced quality-of-life preoperatively measured by different PROMs and as shown in Table VII. We report that 56% of the patients are females. This is somewhat higher than in the Swedish study. Our data were collected from 11 centres, where the Swedish material is based on a single centre and therefore might have some selection bias. There were 124 bilateral cases (12%) compared with 30% in the Swedish study.

The cartilage injury classification chosen was first described by Beck, and is later modified and validated by Konan [30]. We have chosen to use the classification originally described by Beck, which is based on the Outerbridge classification [7, 31]. The extent of cartilage damage registered was mostly on the acetabular side and only 13.5% of the patients were reported to have no chondral damage. Even though the cartilage damage pattern is mixed, the most severe type of damage was described on the acetabular side with grade IV changes and bare bone in 10.5% of the patients. This supports the theory that FAI

Table VII. The results of the various PROMs. iHOT12 is presented as a mean of the 12 items

PROM	Preoperative status Mean (SD)
iHOT-12	45 (31)
EQ-5D	0.65 (0.18)
HAGOS Pain	51 (19)
HAGOS symptoms	49 (18)
HAGOS daily activity	53 (24)
HAGOS sports	35 (23)
HAGOS physical activity	20 (24)
HAGOS quality-of-life	29 (16)
VAS	58 (19)
NRS pain at rest	39 (25)
NRS pain at walking	51 (27)
HSAS	2.4 (1.8)

plays a role in the development of secondary osteoarthritis of the hip joint as described in the literature [6, 32]. Development of secondary osteoarthritis could be due to the abutment of a CAM deformity onto the anterior rim of the acetabulum, leading to progressive cartilage delamination and subsequent cartilage loss in the joint [6].

To our knowledge, this is the first study to report demographic, radiological and operative data from a national registration of hip arthroscopy.

Limitations

The limitations in this study are that data input is voluntary, both for surgeons and patients. We have not yet studied completeness of input from the contributing surgeons. We know from the Danish National ACL Registry that patients input are as low as 35% but more than 85% from surgeons [12]. The procedure is regulated by the Danish Board of Health and is therefore limited to the 11 centres with the permission to perform it. The actual numbers of hip arthroscopic procedures during this time period in Denmark is not known, but will be studied in a validation study.

To improve the response rates, the DHAR forwards online reminders to patients. Non-responders get an additional reminding letter. Further studies based on central healthcare registries are needed to document the degree of completeness for surgical data.

Furthermore, there is a great possibility of a wide difference in interpretation of both clinical tests and radiological measurements due to interobserver variation between surgeons. This is also influenced by the quality of the radiological procedures. There is also a likelihood of variations in the report of intraoperative findings and the measurement of CAM and Pincer resections from the participating surgeons. There have been changes made to the registry as we have discovered errors in the questionnaires.

CONCLUSION

We conclude that patients undergoing hip arthroscopy report considerable pain, loss of function, reduced level of activity and reduced quality-of-life prior to surgery. The problems with development and maintaining a large clinical registry are described and further studies are needed to validate data completeness. We consider the development of a national clinical registry for hip arthroscopy as a successful way of developing and maintaining a valuable clinical and scientific tool.

CONFLICT OF INTEREST STATEMENT

None declared.

REFERENCES

1. Martin RL, Enseki KR, Draovitch P, et al. Acetabular labral tears of the hip: examination and diagnostic challenges. *J Orthop Sport Phys Ther* 2006;**36**:503–15.
2. Schilders E, Dimitrakopoulou A, Bismil Q, et al. Arthroscopic treatment of labral tears in femoroacetabular impingement: a comparative study of refixation and resection with a minimum two-year follow-up. *J Bone Joint Surg Br* 2011;**93**:1027–32.
3. Kelly BT, Williams RJ 3rd, Philippon MJ. Hip arthroscopy: current indications, treatment options, and management issues. *Am J Sport Med* 2003;**31**:1020–37.
4. Kelly BT, Weiland DE, Schenker ML, et al. Arthroscopic labral repair in the hip: surgical technique and review of the literature. *Arthroscopy* 2005;**21**:1496–504.
5. Robertson WJ, Kadrmaz WR, Kelly BT. Arthroscopic management of labral tears in the hip: a systematic review of the literature. *Clin Orthop Relat Res* 2007;**455**:88–92.
6. Ganz R, Parvizi J, Beck M, et al. Femoroacetabular impingement: a cause for osteoarthritis of the hip. *Clin Orthop Relat Res* 2003;**417**:112–20.
7. Beck M, Kalhor M, Leunig M, et al. Hip morphology influences the pattern of damage to the acetabular cartilage: femoroacetabular impingement as a cause of early osteoarthritis of the hip. *J Bone Joint Surg Br* 2005;**87**:1012–8.
8. Leunig M, Beck M, Dora C, et al. Femoroacetabular impingement: trigger for the development of coxarthrosis. *Orthopade* 2006;**35**:77–84.
9. Havelin LI, Engesaeter LB, Espehaug B, et al. The Norwegian Arthroplasty Register: 11 years and 73,000 arthroplasties. *Acta Orthop Scand* 2000;**71**:337–53.
10. Herberts P, Malchau H. Long-term registration has improved the quality of hip replacement: a review of the Swedish THR Register comparing 160,000 cases. *Acta Orthop Scand* 2000;**71**:111–21.

11. Robertsson O, Dunbar MJ, Knutson K, *et al.* The Swedish Knee Arthroplasty Register. 25 years experience. *Bull Hosp Joint Dis* 1999;**58**:133–8.
12. Lind M, Menhert F, Pedersen AB. The first results from the Danish ACL reconstruction registry: epidemiologic and 2 year follow-up results from 5,818 knee ligament reconstructions. *Knee Surg Sport Traumatol Arthrosc* 2009;**17**:117–24.
13. Granan L-P, Forssblad M, Lind M, *et al.* The Scandinavian ACL registries 2004–2007: baseline epidemiology. *Acta Orthop* 2009;**80**:563–7.
14. Rahr-Wagner L, Thillemann TM, Pedersen AB, *et al.* Increased risk of revision after anteromedial compared with transtibial drilling of the femoral tunnel during primary anterior cruciate ligament reconstruction: results from the Danish Knee Ligament Reconstruction Register. *Arthroscopy* 2013;**29**:98–105.
15. Persson A, Fjeldsgaard K, Gjertsen JE, *et al.* Increased risk of revision with hamstring tendon grafts compared with patellar tendon grafts after anterior cruciate ligament reconstruction: a study of 12,643 patients from the Norwegian Cruciate Ligament Registry, 2004–2012. *Am J Sports Med* 2014;**42**:285–91.
16. Andernord D, Björnsson H, Petzold M, *et al.* Surgical predictors of early revision surgery after anterior cruciate ligament reconstruction: results from the Swedish National Knee Ligament Register on 13,102 patients. *Am J Sports Med* 2014;**42**:1574–82.
17. Sansone M, Ahlden M, Jonasson P, *et al.* A Swedish hip arthroscopy registry: demographics and development. *Knee Surg Sport Traumatol Arthrosc* 2014;**22**:774–80.
18. Griffin DR, Parsons N, Mohtadi NGH, *et al.* A short version of the International Hip Outcome Tool (iHOT-12) for use in routine clinical practice. *Arthroscopy* 2012;**28**:611–6.
19. Thorborg K, Hölmich P, Christensen R, *et al.* The Copenhagen Hip and Groin Outcome Score (HAGOS): development and validation according to the COSMIN checklist. *Br J Sports Med* 2011;**45**:478–91.
20. Thorborg K, Tjissen M, Habets B, *et al.* Patient-reported outcome (PRO) questionnaires for young to middle-aged adults with hip and groin disability: a systematic review of the clinimetric evidence. *Br J Sport Med* 2015;**49**:812.
21. Zampelis V, Ornstein E, Franzén H, *et al.* A simple visual analog scale for pain is as responsive as the WOMAC, the SF-36, and the EQ-5D in measuring outcomes of revision hip arthroplasty. *Acta Orthop* 2014;**85**:128–32.
22. Naal FD, Miozzari HH, Kelly BT, *et al.* The Hip Sports Activity Scale (HSAS) for patients with femoroacetabular impingement. *Hip Int* 2013;**23**:204–11.
23. Wiberg G. Studies on dysplastic acetabula and congenital subluxation of the hip joint with special reference to the complication of osteo-arthritis. *JAMA J Am Med Assoc* 1940;**115**:81.
24. Kalberer F, Sierra RJ, Madan SS, *et al.* Ischial spine projection into the pelvis: a new sign for acetabular retroversion. *Clin Orthop Relat Res* 2008;**466**:677–83.
25. Notzli H, Wyss TF, Stoecklin CH, *et al.* The contour of the femoral head-neck junction as a predictor for the risk of anterior impingement. *J Bone Joint Surg Br* 2002;**4**:556–60.
26. Tannast M, Siebenrock KA, Anderson SE. Femoroacetabular impingement: a radiographic diagnosis—what the radiologist should know. *AJR Am J Roentgenol* 2007;**188**:1540–52.
27. Sankar WN, Matheney TH, Zaltz I. Femoroacetabular impingement. Current concepts and controversies. *Orthop Clin N Am* 2013;**44**:575–89.
28. Pedersen AB, Baron JA, Overgaard S, *et al.* Short- and long-term mortality following primary total hip replacement for osteoarthritis: a Danish nationwide epidemiological study. *J Bone Joint Surg Br* 2011;**93**:172–7.
29. Thorborg K, Branci S, Stensbirk F, *et al.* Copenhagen hip and groin outcome score (HAGOS) in male soccer: reference values for hip and groin injury-free players. *Br J Sports Med* 2014;**48**:557–9.
30. Konan S, Rayan F, Meermans G, *et al.* Validation of the classification system for acetabular chondral lesions identified at arthroscopy in patients with femoroacetabular impingement. *J Bone Joint Surg Br* 2011;**93**:332–6.
31. Beck M, Leunig M, Parvizi J, *et al.* Anterior femoroacetabular impingement: part II. Midterm results of surgical treatment. *Clin Orthop Relat Res* 2004;**418**:67–73.
32. Ganz R, Leunig M, Leunig-Ganz K, *et al.* The etiology of osteoarthritis of the hip: an integrated mechanical concept. *Clin Orthop Relat Res* 2008;**466**:264–72.