Knee Surg Sports Traumatol Arthrosc (2017) 25:31–35
DOI 10.1007/s00167-016-4266-z

HIP

Arthroscopic treatment of global pincer-type femoroacetabular impingement

Thomas L. Sanders[1] · Patrick Reardon[1] · Bruce A. Levy[1] · Aaron J. Krych[1]

Received: 5 April 2016 / Accepted: 2 August 2016 / Published online: 9 August 2016

Abstract
Purpose Few studies have evaluated the role of hip arthroscopy in patients with coxa profunda. The purposes of this study are to (1) report functional hip outcomes after arthroscopic treatment of patients with femoroacetabular impingement (FAI) associated with radiographic coxa profunda and (2) evaluate factors associated with poor hip function at minimum 2 years following surgery in this specific cohort.
Methods This retrospective review included patients with radiographic sign of coxa profunda who underwent hip arthroscopy to treat FAI. Preoperative and post-operative radiographs were reviewed to determine changes in lateral centre-edge angle (CEA), the presence and correction of Cam deformity, and Tönnis grade of osteoarthritis. Hip functional scores, including modified Harris Hip Score, Hip Outcome Score, and IHOT score, were obtained at a minimum of 2 years following surgery.
Results The study cohort included 46 patients with a mean preoperative CEA of 39.9 (±2.4)° which decreased to a mean of 30.8 (±1.8)° post-operatively. At a mean follow-up of 2.5 years (±0.5), the mean mHHS and IHOT scores were 79.5 (±20.2) and of 69.7 (±28.3), respectively. Increased preoperative ($p = 0.02$) and post-operative ($p = 0.001$) Tönnis Osteoarthritis Grade was associated with a lower mHHS.
Conclusions Patients with coxa profunda can achieve similar functional scores to more traditional FAI cohorts after arthroscopic treatment. Baseline osteoarthritis is predictive of lower hip function after hip arthroscopy. This study demonstrates that patients with global over-coverage can benefit from hip arthroscopy and may influence surgeons to treat these patients with less invasive arthroscopic techniques which avoid the morbidity of open surgical procedures.
Level of evidence Retrospective case series, Level IV.

Keywords Femoroacetabular impingement · Pincer · Coxa profunda · Center edge angle

Introduction

Femoroacetabular impingement (FAI) is a structural abnormality of the hip joint which can predispose patients to chondrolabral damage and osteoarthritis [5, 8, 11, 15]. While isolated acetabular (Pincer) or femoral head/neck (Cam) deformities can exist, most patients with FAI present with a combination of both acetabular and femoral abnormalities [8]. Arthroscopic techniques have been recommended as a treatment for FAI, and initial reports have demonstrated increased functional hip scores and decreased pain at intermediate-term follow-up [1, 2, 4, 12, 13, 18].

Among patients with pincer-type deformity, over-coverage can exist focally in the anterior portion of the acetabulum or more globally affecting both the anterior and posterior acetabulum [10]. Global over-coverage is often associated with radiographic signs of coxa profunda or acetabular protrusion [8]. While the indications for hip arthroscopy continue to evolve, it is generally accepted that focal anterior acetabular over-coverage can be effectively exposed and treated with arthroscopic techniques [8]. However, for patients with global pincer FAI, open surgical techniques have traditionally been recommended due

✉ Aaron J. Krych
krych.aaron@mayo.edu

[1] Departments of Orthopedic Surgery and Sports Medicine, Mayo Clinic, 200 First Street SW, Rochester, MN 55905, USA

Fig. 1 Preoperative radiograph of a patient with global acetabular over-coverage

Fig. 2 Post-operative radiograph of a patient with global acetabular over-coverage

to difficulty with joint distraction, decreased access to the central compartment, and insufficient access to the posterior acetabulum [8, 10, 11].

Few clinical studies have evaluated the role of hip arthroscopy in patients with global pincer FAI [10, 16]. A case series of three patients with lateral centre-edge angle (CEA) of 50° or more reported improvement in functional hip scores at minimum 2.5 year follow-up after arthroscopic acetabuloplasty [16]. Although this study provides valuable information to the hip arthroscopy literature, the benefit of arthroscopic treatment in patients with global over-coverage is largely unknown. Therefore, the purposes of this study are to (1) report functional hip outcomes after arthroscopic treatment of patients with FAI associated with radiographic coxa profunda and (2) evaluate factors associated with poor hip function at minimum 2 years following surgery. Patients with global pincer FAI can likely achieve acceptable hip functional scores after arthroscopic treatment. The use of arthroscopic techniques in treating global pincer FAI may avoid the morbidity of open surgical treatment in these patients.

Materials and methods

This retrospective series included patients who underwent hip arthroscopy at a single institution between 2007 and 2013. Patient information was retrieved from a prospectively gathered surgical database of all patients undergoing arthroscopic treatment of FAI during this time period. Patients were included if they had a lateral centre-edge angle (CEA) $\geq$35°, [8, 9] radiographic coxa profunda, and had a minimum follow-up of 2 years. Patients were excluded if they received hip arthroscopy for a reason other than FAI, had less than 2 year follow-up, had a CEA of <35°, or did not have preoperative radiographic signs of coxa profunda.

All patients underwent preoperative and post-operative radiographic imaging which included an anterior–posterior (AP) pelvis and either a cross table lateral or frog leg lateral view. The AP pelvis radiograph was determined to be acceptable if the coccyx was located 3–4 cm superior to the pubic symphysis and was centred over the symphysis [8]. Preoperative radiographs were assessed for various radiographic signs of FAI and acetabular retroversion including: crossover sign, posterior wall sign, ischial spine sign, Tönnis angle, CEA, Tönnis osteoarthritis grade, coxa profunda, and acetabular protrusion. Coxa profunda was identified when the acetabular subchondral bone crossed over the ilioischial line on an AP pelvis. Acetabular protrusion was identified when the medial border of the femoral head crossed over the ilioischial line on an AP pelvis. An MRI was obtained in all patients preoperatively to assess the status of the articular cartilage and labrum. Additionally, the details of the articular cartilage at the time of surgery were recorded. The operative notes were reviewed for the presence and treatment of Cam deformity in conjunction with acetabuloplasty. Additionally, Cam lesions were assessed based on alpha angle on preoperative radiographs. Post-operative AP pelvis radiograph was reviewed to determine the changes in CEA, crossover sign, Tönnis angle, alpha angle, and Tönnis osteoarthritis grade from preoperative measurements.

Surgical technique

All procedures were performed with patients in the supine position on a modified traction table. Two or three standard arthroscopy portals were used and included: the anterolateral, midanterior, and distal anterolateral accessory portals based on surgeon preference. Landmarks established for safe portal placement were used [14]. Diagnostic arthroscopy was then performed to evaluate the status of the articular cartilage and labrum. An inter-portal capsulotomy was established between the anterolateral and midanterior portals. To treat pincer FAI, the soft tissue and capsule were elevated using a cautery device to expose the bony deformity and if possible, the labrum was left attached to the acetabular chondrolabral junction. In select cases where labral detachment was necessary for cartilage treatment, the labrum was subsequently repaired. A 5.5-mm arthroscopic burr was used to remove the prominent portion of the acetabulum using fluoroscopic guidance with the goal of eliminating the radiographic crossover sign (Figs. 1 and 2). The labrum was then repaired to the rim of the acetabulum using multiple suture anchors with either an intrasubstance or simple stitch technique, depending on tissue quality. The suture ends were then placed in a knotless anchor (Arthrex Push-Lock 2.9-mm anchor, Naples, FL) and tensioned appropriately to maintain the suction seal effect of the labrum. Once the repair was finished, traction was then released and the hip positioned in 40° of hip flexion. If necessary, a longitudinal capsulotomy was made to treat extensive Cam lesions using a 5.5-mm burr under fluoroscopic guidance.

Post-operative care

All patients in the cohort received the same post-operative rehabilitation protocol. Patients were restricted from passive hip rotation for 4 weeks. Additionally, patients were kept partial weight-bearing for 4 weeks. A specific hip rehabilitation protocol was started between post-operative days 7 and 10 [20].

Functional outcomes

Functional hip scores were gathered prospectively and included: modified Harris Hip Score (mHHS), Activity of Daily Living Score (ADL), Activity of Daily Living Rating (ADLR), Sport Score, Sport Rating, International Hip Outcome Tool (IHOT), and subjective level of function (normal, nearly normal, abnormal, severely abnormal). Additionally, factors predictive of lower post-operative functional scores were assessed and included: age, gender, preoperative/post-operative CEA, and preoperative/post-operative Tönnis Osteoarthritis Grade. This study was conducted after IRB approval from Mayo Clinic (08-002259).

Statistical analysis

Descriptive analyses of patient characteristics were performed with use of means and standard deviations for continuous variables, and frequencies and percentages for discrete variables. All patients who met the study inclusion criteria were included in analysis. Multivariate analysis using standard least squares was performed to evaluate the effect of patient and radiographic factors on final functional outcome scores. Significance was determined using an alpha level of 0.05. All statistical analyses were performed using SAS Statistical Discovery JMP version 7.0 (SAS, Inc, Cary, NC).

Results

The final study cohort included 46 patients with a mean age (±SD) of 42.4 years (±13.9), and 67 % were female (Table 1). The mean preoperative CEA was 39.9 (±2.4)° and decreased to a mean of 30.8 (±1.8)° post-operatively. Among all subjects in the cohort, 24 patients (52.2 %) had a preoperative CEA greater than 40°. Similarly, the mean preoperative Tönnis angle was 0.5 (±2.9) and increased to a mean post-operative value of 2.3 (±2.8)°. Twenty-five patients (54.3 %) had a preoperative radiographic crossover sign which remained in only five patients (10.9 %) post-operatively. Similarly, 20 patients (43.4 %) had preoperative radiographic evidence of an ischial spine sign. All patients had evidence

Table 1 Demographic factors and radiographic factors of the hip arthroscopy cohort

Patient demographics	
Gender (% female)	67.4 %
Age at surgery	42.4 (±13.9)
Preoperative CEA	39.9 (±2.4)
Post-operative CEA	30.8 (±1.8)
Preoperative Tonnis angle	0.5 (±2.9)
Post-operative Tonnis angle	2.3 (±2.7)
Preoperative Tonnis OA grade	1.0
Post-operative Tonnis OA grade	1.0

Table 2 Postoperative functional scores in hip arthroscopy cohort

Post-operative functional scores	
mHHS	79.5 (±20.2)
ADL score	81.5 (±19.0)
ADL rating	81.8 (±19.4)
Sport score	65.3 (±31.9)
Sport rating	65.9 (±34.1)
Level of function	14.0 (±12.0)
IHOT	69.7 (±28.3)

of coxa profunda, and none had evidence of acetabular protrusion. Eleven patients (23.9 %) had isolated pincer-type FAI, while the remaining 35 patients (76.1 %) had a mix of pincer and cam-type FAI; of which all received osteochondroplasty of the femoral head/neck junction. The mean preoperative alpha angle was 60.8° [range: 52–73] and decreased to 51.5° [range: 43–63] post-operatively. Only three patients had alpha angles greater than 55° post-operatively. The mean preoperative Tönnis Osteoarthritis Grade was 1.0 and remained unchanged post-operatively.

At a mean follow-up of 2.5 years, (±0.5), the mean mHHS and IHOT scores were 79.5 (±20.2) and 69.7 (±28.3), respectively (Table 2). Similarly, the mean ADL score and ADL rating were 81.5 (±19.0) and 81.8 (±19.5), respectively. Likewise, the mean Sport Score and Sport Rating were 65.3 (±31.8) and 65.9 (±34.1). At final follow-up, 17 patients rated their hip function as normal, 12 patients as nearly normal, 14 patients as abnormal, and 3 patients as severely abnormal.

Factors predictive of lower post-operative functional hip scores were then assessed (Table 3). Increased preoperative and post-operative Tönnis Osteoarthritis Grade was associated with lower mHHS ($p = 0.02$, $p = 0.001$), ADL scores (n.s., $p = 0.006$), and Sport Scores (n.s., $p = 0.003$). Increased post-operative CEA was associated with lower Sport Rating Scores ($p = 0.03$). Neither age, gender, nor post-operative alpha angle was associated with lower post-operative function scores.

Discussion

The most important finding of the present study was that patients with global pincer-type FAI can achieve hip function similar to other patients with FAI after arthroscopic treatment. Arthroscopic treatment of FAI has demonstrated significant improvements in functional scores and pain level at mid-term follow-up [1, 4, 18]. However, few studies have evaluated the role of hip arthroscopy in patients with coxa profunda.

The post-operative mHHS score in this cohort was similar to previously reported scores for more traditional FAI cohorts [1, 2, 4, 13, 17]. For example, Gupta et al. [4] reported a mean mHHS of 83 points at 2-year follow-up in a large cohort of patients treated with hip arthroscopy for FAI. Similarly, Philippon et al. [13] reported a mean mHHS of 84 points following arthroscopic treatment of 122 patients with FAI. Likewise, the post-operative IHOT score in this cohort is similar to preceding studies. For example, Sansone et al. [17, 18] reported IHOT scores between 66 and 73 in patients treated arthroscopically for FAI with a follow-up between 1 and 2 years. Together, these data indicate that arthroscopic treatment of patients with global over-coverage can result in hip function similar to more traditional FAI surgical cohorts.

In this cohort, both preoperative and post-operative Tönnis Osteoarthritis Grade was predictive of lower post-operative functional hip scores and is consistent with previous studies [3, 6, 19]. For example, a systematic review of 22 studies demonstrated that patients with osteoarthritis had lower functional hip scores after hip arthroscopy than patients without arthritis [6]. Similarly, Domb et al. [3] reported that patients with a Tönnis Osteoarthritis Grade of 1 or more were more likely to progress to total hip arthroplasty following hip arthroscopy than patients with no arthritis. While patients with baseline arthritis can still benefit from hip arthroscopy [3], they likely also have lower baseline hip function and a greater amount of baseline labral and articular cartilage pathology. Therefore, arthroscopic treatment is unlikely to improve their hip function

Table 3 Predictors of poor post-operative functional hip scores following hip arthroscopy

	mHHS	ADL score	ADL rating	Sport score	Sport rating	IHOT
Age	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
Gender	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
Pre-Op CEA	n.s.	n.s.	0.06	n.s.	n.s.	n.s.
Post-Op CEA	n.s.	n.s.	n.s.	n.s.	0.03	n.s.
Post-Op alpha angle	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
Pre-Op Tönnis OA grade	0.02	0.06	0.07	0.04	n.s.	n.s.
Post-Op Tönnis OA grade	0.001	0.006	0.007	0.003	n.s.	n.s.

to normal levels. Similarly, neither preoperative nor post-operative CEA was consistently associated with lower hip function. This result is similar to a previous study which reported excellent hip function after arthroscopic treatment of patients with global over-coverage, even when post-operative CEA was greater than 40° [10, 16]. This may indicate that the reduction in CEA is a more important determinant of hip function than the magnitude of the pre-operative or post-operative CEA. Additionally, for patients with global over-coverage, the magnitude of CEA reduction and target post-operative CEA remain unknown. However, a recent CT-based analysis of asymptomatic patients reported a normal CEA value of 31°, which may provide surgeons with an acceptable post-operative target [9].

Despite the selective patient inclusion, this study is limited by the relatively small surgical cohort and retrospective analysis. Primarily, the small cohort size makes complete assessment of risk factors of lower post-operative hip function more difficult and this study was likely underpowered to detect the rate of cartilage intra-operative grade on post-operative function which has been shown to affect hip function [7]. Likewise, this study evaluated only post-operative functional scores and does not describe changes in hip function from preoperative values. Additionally, patients with coxa profunda were not randomized to arthroscopic treatment (vs. open surgical treatment) which may introduce selection bias. Despite these, the strengths of this study include the selected patient cohort, evaluation of multiple hip function parameters, and intermediate-term follow-up.

Conclusion

Patients with coxa profunda can achieve similar functional scores to more traditional FAI cohorts after arthroscopic treatment. Baseline osteoarthritis is predictive of lower hip function after hip arthroscopy. This study demonstrates that patients with global over-coverage can benefit from hip arthroscopy and may influence surgeons to treat these patients with less invasive arthroscopic techniques which avoid the morbidity of open surgical procedures.

References

1. Byrd J, Jones K (2009) Hip arthroscopy for labral pathology: prospective analysis with 10-year follow-up. Arthroscopy 25:365–368
2. Byrd J, Jones K (2014) Primary repair of the acetabular labrum: outcomes with 2 years follow-up. Arthroscopy 30:588–592
3. Domb B, Gui C, Lodhia P (2015) How much arthritis is too much for hip arthroscopy: a systematic review. Arthroscopy 31:520–529
4. Gupta A, Redmond J, Stake C, Dunne K, Domb B (2016) Does primary hip arthroscopy result in improved clinical outcomes? 2-year clinical follow-up on a mixed group of 738 consecutive primary hip arthroscopies performed at a high-volume referral center. Am J Sports Med 44:74–82
5. Jamali A, Palestro A, Meehan J, Sampson M (2014) Management of incarcerating pincer-type femoroacetabular impingement with hip arthroscopy. Arthrosc Tech 3:155–160
6. Kemp J, MacDonal D, Collins N, Hatton A, Crossley K (2015) Hip arthroscopy in the setting of hip osteoarthritis: a systematic review of outcomes and progression to hip arthroplasty. Clin Orthop Relat Res 473:1055–1073
7. Krych A, King A, Berardelli R, Sousa P, Levy B (2016) Is subchondral acetabular edema or cystic change on MRI a contraindication for hip arthroscopy in patients with femoroacetabular impingement? Am J Sports Med 44:454–459
8. Larson C (2010) Arthroscopic management of pincer-type impingement. Sports Med Arthrosc 18:100–107
9. Larson C, Moreau-Gaudry A, Kelly B, Byrd J, Tonetti J, Lavallee S, Chabanas L, Barrier G, Bedi A (2015) Are normal hips being labeled as pathologic? A CT-based method for defining normal acetabular coverage. Clin Orthop Relat Res 473:1247–1254
10. Matsuda D (2012) Protrusio acetabuli: contraindication or indication for hip arthroscopy? And the case for arthroscopic treatment of global pincer impingement. Arthroscopy 28:882–888
11. Matsuda D, Gupta N, Hanami D (2014) Hip arthrscopy for challenging deformities: global pincer femoacetabular impingement. Arthrosc Tech 3:197–204
12. Palmer D, Ganesh V, Comfort T, Tatman P (2012) Midterm outcomes in patients with cam femoroacetabular impingement treated arthroscopically. Arthroscopy 28:1671–1681
13. Philippon M, Briggs K, Yen Y, Kuppersmith D (2009) Outcomes following hip arthroscopy for femoroacetabular impingement with associated chondrolabral dysfunction: minimum two-year follow-up. J Bone Joint Surg Br 91:16–23
14. Robertson W, Kelly B (2008) The safe zone for hip arthroscopy: a cadaveric assessment of central, peripheral, and lateral compartment portal placement. Arthroscopy 24:1304–1311
15. Sabetta E, Scaravella E (2015) Treatment of pincer-type femoroacetabular impingement. Joints 3:78–81
16. Safran M, Epstein N (2013) Arthroscopic management of protrusion acetabuli. Arthroscopy 29:1777–1782
17. Sansone M, Ahlden M, Jonasson P, Thomee C, Sward L, Baranto A, Karlsson J, Thomee R (2015) Good results after hip arthroscopy for femoroacetabular impingement in top-level athletes. Orthop J Sports Med 3:2325967115569691
18. Sansone M, Ahlden M, Jonasson P, Thomee C, Sward L, Ohlin A, Barranto A, Karlsson J, Thomee R (2016) Outcome after hip arthroscopy for femoroacetabular impingement in 289 patients with minimum 2-year follow-up. Scand J Med Sci Sports. doi:10.1111/sms.12641
19. Schairer W, Nwachukwu B, McCormick F, Lyman S, Mayman D (2016) Use of hip arthroscopy and risk of conversion to total hip arthroplasty: a population-based analysis. Arthroscopy 32:587–593
20. Spencer-Gardner L, Eischen J, Levy B, Sierra R, Engasser W, Krych A (2014) A comprehensive five-phase rehabilitation programme after hip arthroscopy for femoroacetabular impingement. Knee Surg Sports Traumatol Arthrosc 22:848–859