Open Surgical Dislocation Versus Arthroscopic Treatment of Femoroacetabular Impingement

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Abstract

It is unclear if open surgical dislocation or arthroscopy of the hip is superior for the treatment of femoroacetabular impingement (FAI).

We prospectively compared the clinical results of these 2 surgical methods performed by a single surgeon. Five patients met the inclusion criteria for the open surgical dislocation group and 18 for the arthroscopic group. Patient-reported scores, including the modified Harris Hip Score (mHHS), Non-Arthritic Hip Score (NAHS), Hip Outcome Score–Sport-Specific Subscale (HOS–SSS) and Hip Outcome Score–Activities of Daily Living (HOS–ADL) were used preoperatively, and at 3 months, 6 months, and 1 year postoperatively to compare the 2 groups. Average follow-up was 14.7 months (range, 12 to 25 months); both groups showed significant improvement in their postoperative scores compared with preoperative scores ($P < .01$). The arthroscopic group had better, earlier improvement at 3- and 6-month follow-up, with NAHS significantly better at 3 months ($P < .0002$). However, improvements were comparable between the 2 groups at 1 year.

Open surgical dislocation and arthroscopy are viable options for the treatment of FAI. The arthroscopic group demonstrated a trend toward faster recovery and quicker return to sports, but larger and longer-term studies are needed.

Femoroacetabular impingement (FAI) describes the abnormal abutment between the anterior acetabular rim and femoral neck. Cam impingement describes an abnormally shaped femoral head-neck junction converging into the acetabular rim; pincer impingement depicts acetabular overcoverage of the femur. Femoroacetabular impingement has been identified as a common cause of hip pain in young, active patients with nondysplastic hips and a major factor in the development of osteoarthritis.[1]

Surgical treatment corrects deformities that cause bony contact during normal hip motion and associated labral tear and acetabular cartilage damage.[2,3] Ganz and colleagues[4] described an open surgical dislocation technique that allows complete visualization of the proximal femur and acetabulum without compromising the femoral head vasculature. Several investigators who have used this open technique have reported good early and midterm clinical success with minimal complications.[5-11] However, this method is a major surgery, which necessitates the use of a trochanteric osteotomy and hip-joint dislocation.

With improving technology and increasing experience, hip arthroscopy is a promising modality in treating FAI. This minimally invasive technique allows for outpatient surgery with faster rehabilitation and recovery. Early outcomes in the arthroscopic treatment of FAI have approached the results of the open technique.[12-16]

The superiority of the open surgical dislocation technique, originally considered the gold standard for FAI treatment, has been questioned in several meta-analyses.[17,18] However, there is a paucity of high-level evidence, such as comparative studies of open and arthroscopic procedures.

In this study, we prospectively compare the clinical results of open surgical dislocation with arthroscopic treatment of FAI performed by a single surgeon. According to our hypothesis, the arthroscopic approach will yield faster initial recovery, with equivalent outcomes at longer follow-up.

Materials and Methods

At our center, data were prospectively collected on all patients undergoing surgery of the hip. Dr. Domb performed 317 hip preservation surgeries between January 2008 and January 2010. Each patient was offered the choice of an open surgical dislocation of the hip or an arthroscopic procedure. The advan-

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tages and the disadvantages of each procedure were explained to patients, who chose the surgical technique.

Inclusion criteria were patients 30 years of age or younger, diagnosis of FAI that failed nonoperative treatment, and minimal 1-year follow-up. Exclusion criteria were workers' compensation, Legg-Calvé-Perthes disease, developmental dysplasia of the hip, previous surgery to the affected hip other than diagnostic arthroscopy, and missing 1-year postoperative follow-up questionnaires. Of the 23 patients who met the study criteria, 5 had open surgical dislocations and 18 had arthroscopic procedures. This study was approved by the institutional review board at our center.

Subjective data were collected from patients during their preoperative visits, and at 3-, 6- and 12-month postoperative visits. The 4 hip-specific questionnaires were the modified Harris Hip Score (mHHS)[19], the Non-Arthritic Hip Score (NAHS)[20], the Hip Outcome Score–Activities of Daily Living (HOS-ADL) and the Hip Outcome Score–Sport-Specific Subscale (HOS-SSS)[21].

All patients underwent a supine anteroposterior (AP) pelvis, Dunn view, cross-table lateral view, and a false profile view.[22, 23] All radiographs were measured by the same orthopedic surgeon. The alpha angle was measured on magnetic resonance imaging (MRI) as described by Nötzli and colleagues[24] and on the Dunn view as described by Meyer and colleagues.[22] Cam impingement was defined as an alpha angle greater than 50°. Pincer impingement was evaluated on the AP pelvis radiograph, examining the amount of femoral head coverage and the acetabular version. Acetabular depth was evaluated by noting the position of the acetabular fossa relative to the ilioischial line. Coxa profunda was diagnosed when the medial aspect of the acetabular fossa was in line or medial to the ilioischial line. Protrusio acetabuli was diagnosed when the medial aspect of the femoral head was medial to the ilioischial line. The acetabular retroversion was evaluated by a positive crossover sign, during which the anterior and posterior acetabular walls cross over each other. The findings of coxa profunda, protrusio acetabuli, and/or a positive crossover sign categorized a patient with pincer impingement. All hips were radiographically evaluated for arthritis according to the Tönnis grading system.[25]

All patients in this study had a magnetic resonance arthrogram (MRA) preoperatively to assess labral and chondral injuries. Simultaneously, they underwent intra-articular diagnostic injection of local anesthetic to clarify the intra-articular source of the pain. An isolated diagnostic injection under fluoroscopic or ultrasound guidance was performed if any ambiguity remained about the source of the pain.

The transtrochanteric approach was used for open surgical dislocation. In the surgical approach, a lateral incision and a greater trochanteric flip osteotomy were performed with the patient in the lateral position on a radiolucent table. A Z-shaped anterior capsulotomy was made in the interval between the short external rotators, and the head was dislocated anteriorly.

The dislocation of the femoral head allowed a 360° view of the femoral head and acetabulum. Sites of femoroacetabular impingement were assessed, such as the nonspherical portion of the femoral head-neck junction and anterior acetabular wall overcoverage. Soft-tissue injuries, such as articular cartilage damage and labral injuries, were documented. The size and location of labral tears were recorded in reference to hours on a clock face, adjusted to the right side.

Treatment of cam impingement involves removal of any nonspherical portions of the femoral head. The amount of bone to be resected was determined by using a transparent spherical template matching the head size and restoring the normal diameter of the neck. Pincer impingement was treated with resection of anterior acetabular rim, which also included resection of damaged articular cartilage. Remaining acetabular cartilage damage was debrided after bony resection. A microfracture procedure was not indicated in any case.

The arthroscopy of the hip was performed in the modified supine position.[26] The anterolateral and the midanterior portals are routinely used. The central compartment of the hip was examined first for articular cartilage damage and labral tears. For pincer impingement, the anterior acetabular rim was removed using a 5.5-mm round burr. The amount of bony resection determined the treatment modality for the labrum, as discussed by Fry and Domb.[27] For less than 3 mm of acetabular resection, the labrum was assessed for instability. Degenerative labral tears were debrided using a shaving technique. Although a stable labrum was not repaired, whereas an unstable labrum was refixated to the bony base with knotless 2.9-mm suture anchors (Arthrex, Naples, Florida). For acetabular resection greater than 3 mm, the labrum was detached from the acetabulum, debrided, and then refixated to the new labral rim with the knotless suture anchors. Depending on the labral width, 2 refixation techniques were used: a looped simple stitch for thinner labra and labral base refixation for thicker labra.[27] Articular cartilage injuries were treated with chondroplasty using a radiofrequency device. In the peripheral compartment, the cam impingement was visualized along the anterosuperior aspect of the femoral head-neck junction, and an osteoplasty was performed with a 5.5-mm round burr under fluoroscopy.

A standard postoperative protocol was used for patients with both procedures. Arthroscopic patients were allowed 20 lbs partial weight-bearing on the surgical side and were placed in a hip brace for 2 weeks. However, open surgical dislocation patients were treated with the same protocol for 6 weeks. Physical therapy began for both groups on postoperative day 1, with a stationary bike for 2 hours per day or a continuous passive motion machine for 4 hours per day.

Complications were recorded on first- and third-month postoperative visits. Hip arthroplasty and revision surgery were considered failure of the procedure. The unpaired, 2-tailed *t* test was used to evaluate statistical significance between clinical outcome scores between the arthroscopic and open, surgical dislocation group, and for changes in preoperative values and postoperative values.

Results

The mean age of the patient population was 19 years (range, 14 to 26 years), with a significant difference between the groups

at 18 and 20 years for the open and arthroscopic groups, respectively (P = .001). All 23 study patients were women. There was no statistical significance in any preoperative hip subjective scores between the open and the arthroscopic groups (**Table I**).

All patients in both groups were diagnosed with a labral tear, with an average size of 2.7 hours on the clock-face (range, 0.5 to 4 hours). The mean tear size for the arthroscopic group was 2.5 hours (range, 0.5 to 4 hours) and 2.9 hours (range, 2 to 4 hours; P = .36) for the open group. Three patients in the arthroscopic group underwent labral debridement; the remaining 15 had labral repair with 12 simple loop-stitch repairs and 3 labral base refixations. In the open group, all patients underwent labral refixation, 3 with simple loop stitch and 2 with labral-base. Acetabuloplasty to resect the acetabular rim was performed for all but 2 arthroscopic cases. Femoral neck osteoplasty was performed in all open cases and in 8 arthroscopic cases.

Table I. **Patient Population Parameters**[a]

	Arthroscopic Group	Open Group	*P* Value
Number of Patients	18	5	
Age (y)	20.1	18.1	.001
Preoperative mHHS	67.8	66.2	.57
Preoperative NAHS	66.5	66.9	.75
Preoperative HOS-ADL	72.6	66.4	.19
Preoperative HOS-SSS	45.7	52.3	.63

Abbreviations: ADL, activities of daily living; HOS, Hip Outcome Score; mHHS, modified Harris Hip Score; NAHS, Non-Arthritic Hip Score; SSS, Sport-Specific Subscale.

[a]The preoperative mHHS, NAHS, HOS-ADL, HOS-SSS scores between the open and arthroscopic groups are similar.

All patients in the study were graded Tönnis 0. The mean preoperative alpha angle measured on the Dunn view was 61° (range, 43° to 83°) versus 62° (range, 48° to 83°) for the open and arthroscopic groups, respectively (P = .12). The postoperative alpha angle for all patients who underwent femoral neck osteoplasty was 43.5°. However, there was a significant difference between the groups, with a mean of 40° (range, 38° to 44°) in the open group and 45.6° (range, 33° to 56°) in the arthroscopic group (P = .05; **Figure 1**).

The average follow-up for patients was 14.7 months (range, 12 to 25 months). There was insignificant difference in follow-up time, with the arthroscopic group having an average follow-up of 14.3 months (range, 12 to 24 months) and the open group 16.2 months (range, 12 to 25 months; P = .53).

The 4 hip scores showed improvement after surgery (P < .01; **Figures 2A-2D**). The arthroscopic group showed a significant improvement over the dislocation group for 3-month NAHS (P = .0002). Differences between the groups for mHHS, HOS-ADL, and HOS-SSS were not statistically significant. By 6-month follow-up, the open group started to close the gap in recovery for all scores, excluding the HOS-SSS, which measures higher-demand sport activity. At 1 year, score results were comparable. The HOS-ADL and HOS-SSS tended to be higher for the open group than the arthroscopic group, displaying the first higher values for the open group.

One patient in the arthroscopic group experienced reinjury 2 months after surgery, requiring revision surgery. One patient in the open group required screw removal because of persistent trochanteric pain. No patients developed avascular necrosis, neuropraxia, heterotopic ossification, deep vein thrombosis, or deep infection. One patient in the arthroscopic group developed a superficial infection that was resolved with oral antibiotics.

Discussion

To our knowledge, this is the first prospective study comparing open surgical dislocation with arthroscopic treatment of FAI. Our findings are consistent with previous treatment results, with all patients demonstrating an improved hip subjective score after surgery. As predicted, the arthroscopic group had higher subjective scores at 3 months postoperatively, not an unlikely finding given the difference in exposure in arthroscopic versus open treatment. However, the subjective score differences between the groups were smaller at 6 months, and all subjective hip scores were comparable at 12 months.

Several studies have evaluated the short and midterm outcomes of FAI treatment with open surgical dislocation.[5-11] Bedi and colleagues[17] reviewed the results of these studies, noting that a total of 197 patients were followed for an average of 40 months. Good to excellent results were reported in 65% to 85% of patients. Failure rates, defined as patient dissatisfaction

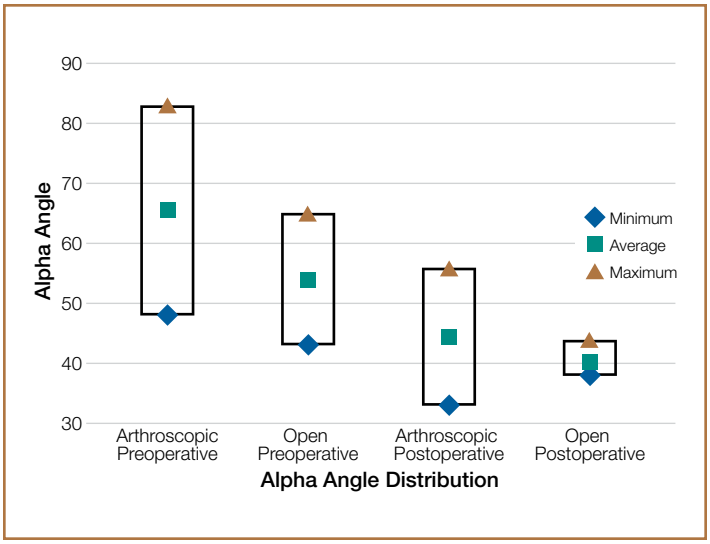

Figure 1. Alpha angle distribution before and after surgery. Although the alpha angle was improved in both groups, the open surgical dislocation group had a statistically significant lower alpha angle compared with the arthroscopic group.

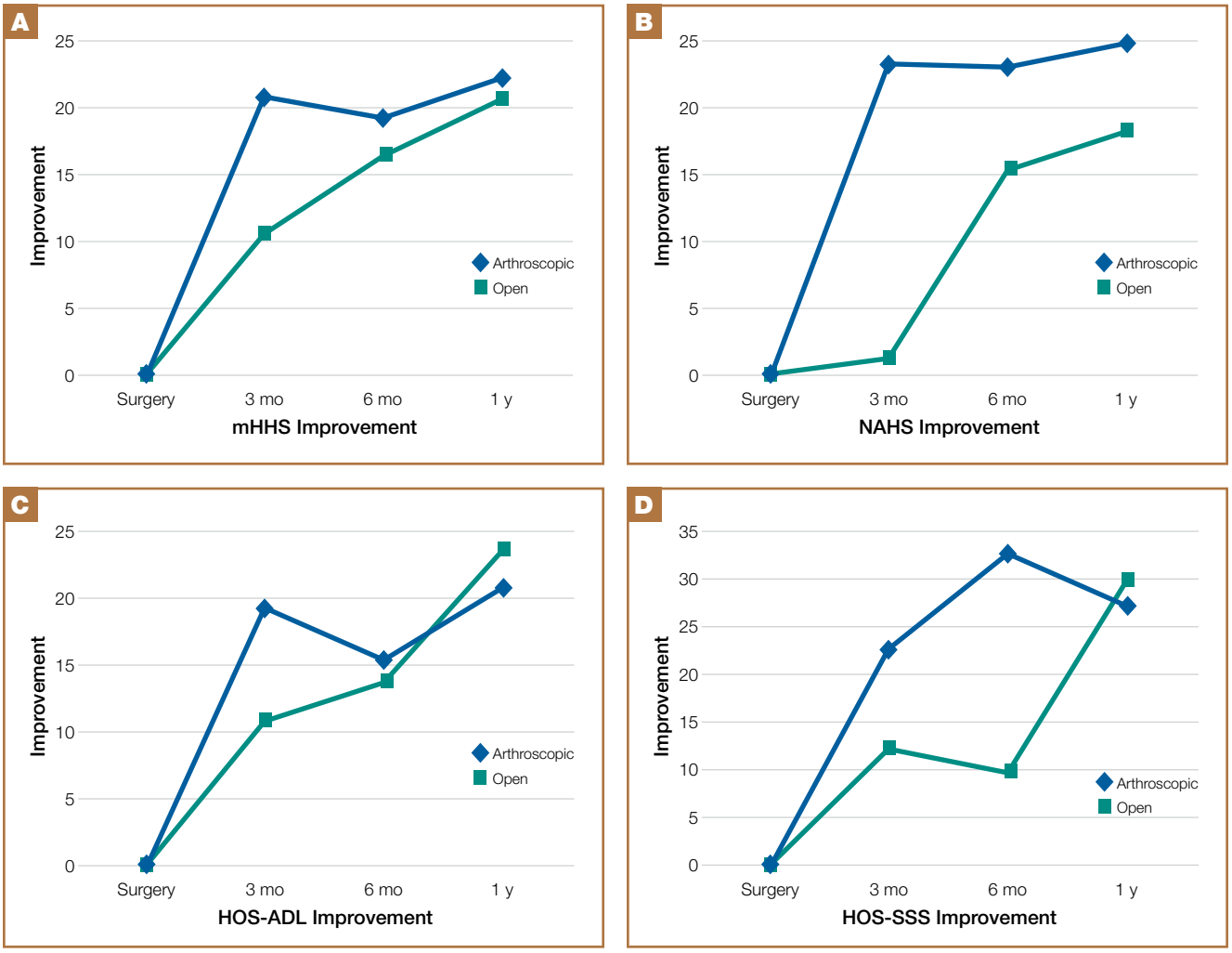

Figure 2. Improvement from the preoperative score for the open surgical dislocation group (green line) and the arthroscopic group (blue line). The arthroscopic group showed a significant improvement for 3-month Non-Arthritic Hip Score (NAHS) (P = .0002). One year postoperatively, all scores were comparable between the 2 groups. (A) Modified Harris Hip Score (mHHS) improvement; (B) NAHS improvement; (C) Hip Outcome Score–Activities of Daily Living (HOS-ADL) improvement; (D) Hip Outcome Score–Sport-Specific Subscale (HOS-SSS) improvement.

Abbreviations: mo, months; y, year.

Table II. Advantages and Disadvantages of Open Dislocation and Arthroscopic Treatment of FAI

	Advantages	Disadvantages
Open Surgical Dislocation	Good visualization of joint	Major operation
	360° joint access	Soft-tissue damage
	Enables treatment of all pathologies	Trochanteric osteotomy – risk for nonunion and hardware pain
	Templates can be used for femoral osteoplasty to ensure precise sphericity	Need to sacrifice ligamentum teres
		Increased blood loss
		Longer rehabilitation
Arthroscopic Surgery	Minimally invasive	Difficult access to ligamentum teres and inferior portion of joint
	Outpatient surgery	Potential traction complications – genital and perineal injury; pudendal neuropraxia
	Minor soft-tissue damage	Potential lateral femoral cutaneous nerve neuropraxia (portal injury)
	Easy approach to peripheral compartment and soft tissues	Potential abdominal compartment syndrome
	Faster rehabilitation	

or conversion to total hip arthroplasty, occurred in 4% to 30% of patients and were attributed to advanced arthritis, older age, and more severe preoperative pain. Avascular necrosis was not reported in any study. Complications were uncommon, reported in 0% to 18% of procedures, and included early loss of trochanteric fixation, heterotopic ossification, and symptomatic hardware.[3]

Among the major advantages of the open surgical dislocation technique are visualization of, and 360° access to, the hip joint, which allows identification and more precise treatment of all pathologies (**Table II**). For example,

templates can be used for femoral osteoplasty to ensure the right amount of bone resection to obtain a spherical shape to the head. This accuracy is reflected in our study by the narrow distribution of the postoperative alpha angle in the open group versus the arthroscopic group (**Figure 1**). However, the open approach requires a larger incision with increased soft-tissue damage, blood loss, sacrifice of the ligamentum teres, and trochanteric osteotomy with the inherent risk for nonunion and hardware pain. The more invasive nature requires longer rehabilitation and recovery.

Originally, hip arthroscopy was used to treat labral tears or osteoarthritis without treating the underlying impingement.[28-34] Although success rates ranged from 67% to 91%,[35-39] failure to address impingement resulted in persistent pain and patient dissatisfaction. According to Philippon and colleagues,[40] persistent impingement is the most common reason for revision hip arthroscopy. Bardakos and colleagues[13] found higher postoperative scores and more good to excellent results with treatment of impingement when comparing treatment of cam-type impingement with labral debridement versus isolated labral debridement. In Larson and Giveans,[15] the investigators followed 100 hips for 3 years; these patients had been treated arthroscopically with labral debridement or repair/refixation and proximal femoral osteoplasty and/or acetabular rim trimming. Good to excellent results were seen in 75% of patients with significant improvements in subjective hip scores. Byrd and Jones[12] prospectively followed 200 patients treated for FAI arthroscopically for an average of 16 months, with an average increase of 20 points in the mHHS. The complication rate was 1.5%, with 0.5% of patients converting to total hip arthroplasty.

The overall rate of complication with hip arthroscopy has been reported to be 1.5%.[41] No reports of avascular necrosis have been identified. The most common complication of hip arthroscopy is transient nerve injury due to portal or traction damage. Only 1 patient in our study had a complication, a superficial infection of an arthroscopic portal. Although 1 open surgical dislocation patient underwent removal of the hardware 1 year postoperatively, this procedure is not considered a complication and is done routinely by some surgeons. One arthroscopic patient underwent revision arthroscopy because of a traumatic reinjury. Since both groups are small, and the complication rate is very low, we are unable to consider the complication rates as measures of success.

Several systematic review articles have attempted to compare the open surgical dislocation technique with the arthroscopic technique for treatment of FAI.[2,3,17,18] Most studies agree that both treatments improve short-term and mid-term pain and function in patients without advanced osteoarthritis. However, comparisons between procedures have proved difficult because of many factors, including the heterogeneous nature of the literature. Studies investigate different pathologies (eg, cam impingement alone or together with pincer impingement), and outcome measures vary, because 6 different hip outcome measures, some validated and some not, are used.[3,18] Thus, no conclusion can be made from the literature regarding optimal treatment for FAI.

There are several strengths to this study. First, a single surgeon performed all the surgeries using a similar technique. Although the approach to the hip can be different, open versus arthroscopic, labral repair was performed similarly between groups. This allowed the surgical approach to be the chief variable and mitigated other confounding factors. The study also allowed the prospective collection of data between 2 well-matched groups. All patients had treatment for both cam and pincer impingement lesions.

The homogeneity of the patient population, however, was also the study's greatest weakness. The study was underpowered because of the limited number of patients that met study criteria, especially for the open surgical dislocation group. Although differences were seen in a number of subjective hip outcome measurements at 3 months, only NAHS was statistically significant. The difference in outcomes between the arthroscopic and the open surgical groups can be larger than our findings demonstrate. In addition, the selectivity of the study also limited the external validity of these results. Open surgical dislocation can be the preferred method for patients with increased arthritis or increased deformity; arthroscopy can be a better choice because of limited incisions and shorter recovery time.

Arthroscopic treatment of femoroacetabular impingement (FAI) showed better hip subjective outcome scores at 3 months compared with open surgical dislocation. Because the results of each surgical technique normalized by 1 year, both are viable options for treatment of FAI.

Another limitation was patient choice of treatment. Likely, the public has preconceived ideas regarding minimally invasive arthroscopy compared to "maximally invasive" surgery. The results were neither blinded to the patient nor to the primary investigator, Dr. Botser, who charted the results postoperatively. Although blinding this type of study to patients is unrealistic, it may be possible to blind outcome measures to eliminate some bias. In addition, the study's short follow-up provided too little time to evaluate thoroughly long-term differences between these 2 techniques. The study's average follow-up was 14.7 months, which, according to the patients' reported outcomes, was sufficient time to show the short-term benefit of arthroscopic treatment compared with open treatment. Over time, the subjective scores between the 2 groups became similar.

Conclusion

Arthroscopic treatment of FAI showed better hip subjective outcome scores at 3 months compared with open surgical

dislocation. Because the results of each surgical technique normalized by 1 year, both are viable options for treatment of FAI; however, larger studies with longer follow-up are needed.

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References

1. Ganz R, Parvizi J, Beck M, Leunig M, Nötzli H, Siebenrock KA. Femoroacetabular impingement: a cause for osteoarthritis of the hip. *Clin Orthop.* 2003;(417):112-120.
2. Ng VY, Arora N, Best TM, Pan X, Ellis TJ. Efficacy of surgery for femoroacetabular impingement: a systematic review. *Am J Sports Med*. 2010;38(11):2337-2345.
3. Clohisy JC, St John LC, Schutz AL. Surgical treatment of femoroacetabular impingement: a systematic review of the literature. *Clin Orthop*. 2010;468(2):555-564.
4. Ganz R, Gill TJ, Gautier E, Ganz K, Krugel N, Berlemann U. Surgical dislocation of the adult hip a technique with full access to the femoral head and acetabulum without the risk of avascular necrosis. *J Bone Joint Surg Br.* 2001;83(8):1119-1124.
5. Peters CL, Erickson JA. Treatment of femoro-acetabular impingement with surgical dislocation and debridement in young adults. *J Bone Joint Surg Am*. 2006;88(8):1735-1741.
6. Murphy S, Tannast M, Kim YJ, Buly R, Millis MB. Debridement of the adult hip for femoroacetabular impingement: indications and preliminary clinical results. *Clin Orthop*. 2004;(429):178-181.
7. Jager M, Wild A, Westhoff B, Krauspe R. Femoroacetabular impingement caused by a femoral osseous head-neck bump deformity: clinical, radiological, and experimental results. *J Orthop Sci.* 2004;9(3):256-263.
8. Graves ML, Mast JW. Femoroacetabular impingement: do outcomes reliably improve with surgical dislocations? *Clin Orthop*. 2009;467(3):717-723.
9. Beaulé PE, Le Duff MJ, Zaragoza E. Quality of life following femoral head-neck osteochondroplasty for femoroacetabular impingement. *J Bone Joint Surg Am*. 2007;89(4):773-779.
10. Beck M, Leunig M, Parvizi J, Boutier V, Wyss D, Ganz R. Anterior femoroacetabular impingement: part II. Midterm results of surgical treatment. *Clin Orthop*. 2004;(418):67-73.
11. Peters CL, Schabel K, Anderson L, Erickson J. Open treatment of femoroacetabular impingement is associated with clinical improvement and low complication rate at short-term followup. *Clin Orthop*. 2010;468(2):504-510.
12. Byrd JW, Jones KS. Arthroscopic femoroplasty in the management of cam-type femoroacetabular impingement. *Clin Orthop.* 2009;467(3):739-746.
13. Bardakos NV, Vasconcelos JC, Villar RN. Early outcome of hip arthroscopy for femoroacetabular impingement: the role of femoral osteoplasty in symptomatic improvement. *J Bone Joint Surg Br.* 2008;90(12):1570-1575.
14. Ilizaliturri VM Jr, Orozco-Rodriguez L, Acosta-Rodriguez E, Camacho-Galindo J. Arthroscopic treatment of cam-type femoroacetabular impingement: preliminary report at 2 years minimum follow-up. *J Arthroplasty*. 2008;23(2):226-234.
15. Larson CM, Giveans MR. Arthroscopic management of femoroacetabular impingement: early outcomes measures. *Arthroscopy.* 2008;24(5):540-546.
16. Philippon MJ, Briggs KK, Yen YM, Kuppersmith DA. Outcomes following hip arthroscopy for femoroacetabular impingement with associated chondrolabral dysfunction: minimum two-year follow-up. *J Bone Joint Surg Br.* 2009;91(1):16-23.
17. Bedi A, Chen N, Robertson W, Kelly BT. The management of labral tears and femoroacetabular impingement of the hip in the young, active patient. *Arthroscopy.* 2008;24(10):1135-1145.
18. Botser IB, Smith TW Jr, Nasser RM, Domb BG. Open surgical dislocation versus arthroscopy for femoroacetabular impingement: a comparision of clinical outcomes. *Arthroscopy.* 2011;27(2):270-278.
19. Byrd JW, Jones KS. Prospective analysis of hip arthroscopy with 2-year follow-up. *Arthroscopy.* 2000;16(6):578-587.
20. Christensen CP, Althausen PL, Mittleman MA, Lee JA, McCarthy JC. The nonarthritic hip score: reliable and validated. *Clin Orthop*. 2003;(406):75-83.
21. Martin RL, Philippon MJ. Evidence of validity for the hip outcome score in hip arthroscopy. *Arthroscopy.* 2007;23(8):822-826.
22. Meyer DC, Beck M, Ellis T, Ganz R, Leunig M. Comparison of six radiographic projections to assess femoral head/neck asphericity. *Clin Orthop*. 2006;(445):181-185.
23. Dunn DM. Anteversion of the neck of the femur; a method of measurement. *J Bone Joint Surg Br.* 1952;34-B(2):181-186.
24. Nötzli HP, Wyss TF, Stoecklin CH, Schmid MR, Treiber K, Hodler J. The contour of the femoral head-neck junction as a predictor for the risk of anterior impingement. *J Bone Joint Surg Br.* 2002;84(4):556-560.
25. Tönnis D, Heinecke A. Acetabular and femoral anteversion: relationship with osteoarthritis of the hip. *J Bone Joint Surg Am.* 1999;81(12):1747-1770.
26. Kelly BT, Weiland DE, Schenker ML, Philippon MJ. Arthroscopic labral repair in the hip: surgical technique and review of the literature. *Arthroscopy.* 2005;21(12):1496-1504.
27. Fry R, Domb B. Labral base refixation in the hip: rationale and technique for an anatomic approach to labral repair. *Arthroscopy.* 2010;26(9 suppl):S81-S89.
28. Byrd JW, Jones KS. Hip arthroscopy for labral pathology: prospective analysis with 10-year follow-up. *Arthroscopy.* 2009;25(4):365-368.
29. Larson CM, Giveans MR. Arthroscopic debridement versus refixation of the acetabular labrum associated with femoroacetabular impingement. *Arthroscopy.* 2009;25(4):369-376.
30. Philippon MJ, Briggs KK, Hay CJ, Kuppersmith DA, Dewing CB, Huang MJ. Arthroscopic labral reconstruction in the hip using iliotibial band autograft: technique and early outcomes. *Arthroscopy*. 2010;26(6):750-756.
31. Sierra RJ, Trousdale RT. Labral reconstruction using the ligamentum teres capitis: report of a new technique. *Clin Orthop*. 2009;467(3):753-759.
32. Byrd JW. Labral lesions: an elusive source of hip pain case reports and literature review. *Arthroscopy.* 1996;12(5):603-612.
33. Norman-Taylor FH, Villar RN. Arthroscopic surgery of the hip: current status. *Knee Surg Sports Traumatol Arthrosc*. 1994;2(4):255-258.
34. Anderson K, Strickland SM, Warren R. Hip and groin injuries in athletes. *Am J Sports Med*. 2001;29(4):521-533.
35. Robertson WJ, Kadrmas WR, Kelly BT. Arthroscopic management of labral tears in the hip: a systematic review of the literature. *Clin Orthop*. 2007;(455):88-92.
36. Santori N, Villar RN. Acetabular labral tears: result of arthroscopic partial limbectomy. *Arthroscopy*. 2000;16(1):11-15.
37. Farjo LA, Glick JM, Sampson TG. Hip arthroscopy for acetabular labral tears. *Arthroscopy.* 1999;15(2):132-137.
38. Potter BK, Freedman BA, Andersen RC, Bojescul JA, Kuklo TR, Murphy KP. Correlation of Short Form-36 and disability status with outcomes of arthroscopic acetabular labral debridement. *Am J Sports Med*. 2005;33(6):864-870.
39. O'Leary JA, Berend K, Vail TP. The relationship between diagnosis and outcome in arthroscopy of the hip. *Arthroscopy*. 2001;17(2):181-188.
40. Philippon MJ, Schenker ML, Briggs KK, Kuppersmith DA, Maxwell RB, Stubbs AJ. Revision hip arthroscopy. *Am J Sports Med*. 2007;35(11):1918-1921.
41. Clarke MT, Arora A, Villar RN. Hip arthroscopy: complications in 1054 cases. *Clin Orthop*. 2003;(406):84-88.