Review Article

Nonsurgical Versus Surgical Management of Femoroacetabular Impingement: What Does the Current Best Evidence Tell Us

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ABSTRACT

Controversy exists as to the management of femoroacetabular impingement (FAI). When nonsurgical management of symptomatic FAI fails, surgical management is generally indicated. However, many groups with a stake in patient care (particularly payors) have insisted on higher levels of evidence. Recently, there have been several Level I studies published, comparing physical therapy (PT) with hip arthroscopy in the management of symptomatic FAI. All of these studies have used outcomes tools developed and validated for patients with nonarthritic hip pain (the International Hip Outcome Tool). Most highest level evidence confirms that although patients with FAI do benefit from PT, patients who undergo surgical management for FAI with hip arthroscopy benefit more than those who undergo PT (mean difference in the International Hip Outcome Tool 6.8 [minimal clinically important difference 6.1], $P = 0.0093$). Future large prospective studies are needed to evaluate the effect on the outcomes when there is a delay in surgical management in symptomatic individuals, assess whether FAI surgery prevents or delays osteoarthritis, and determine the role of other advanced surgical techniques.

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Symptomatic femoroacetabular impingement (FAI) is characterized as the abnormal contact between the proximal femur and acetabulum because of cam, pincer, or combined cam/pincer anatomic morphology. This pathologic repetitive contact with terminal ranges of hip motion can lead to labral tears, chondral damage, and subsequent osteoarthritis (OA).[1] FAI has become an increasingly recognized cause of hip/groin pain in young patients, and the prevalence of FAI morphology in the general cohort has been reported as 9% to 50%.[2-5] The prevalence of FAI morphology in the athletic cohort is even higher with reported rates of 95% in football,[6] 89% in basketball,[7] 50% to 72% in soccer,[8] and 85% in ice hockey.[9] However, many with FAI morphology do not develop symptoms.

Although it has been shown that cam FAI is associated with subsequent development of hip OA,[2,10,11] the relationship between pincer FAI and

subsequent hip OA is unclear.[2,11,12] With cam FAI, for patients aged 45 to 65 years, when compared with patients with normal alpha angle (<55°), the odds ratio (OR) for end-stage hip OA at 5 years was shown to be 3.67 for alpha angle >60°, 9.66 for alpha angle >83°, and 25.21 for alpha angle >83°, and hip internal rotation <20°.[10] It has also been reported that the risk of subsequent OA increased by 5% (from baseline of 11%), and the risk of total hip arthroplasty (THA) increased by 4% (from baseline of 3%) for every increase in alpha angle degree >65°.[11] Although the odds ratio for OA with cam FAI morphology is markedly increased, the absolute risk remains low because only 11% of patients with alpha angle >60° and 25% of patients with alpha angle >83° went on to develop end-stage OA at 5 years.[10] Hartofilakidis et al[13] also showed that 82% of patients with asymptomatic FAI remained OA-free at 18 years follow-up. In addition, and most importantly, there currently is no evidence that the treatment of FAI prevents or delays future OA. Therefore, the goal for treatment of FAI in symptomatic individuals is to reduce symptoms and not to prevent OA.

Nonsurgical Management

Traditionally, the management of symptomatic FAI starts with activity modification, a trial of nonsteroidal anti-inflammatory drugs, and physical therapy (PT). Activity modification includes a period of relative rest and avoiding hip positions that provoke symptoms (ie, avoiding range of motion extremes, such as with squatting or lunging). PT starts with muscle control and stability work that targets the pelvic, hip, and gluteal muscles. It then progresses to stretching and strengthening.[14] The addition of a core strengthening program to a FAI PT protocol is also beneficial. In a prospective, randomized controlled trial evaluating nonsurgical management of FAI with formal PT using a core strengthening and hip/pelvic girdle strengthening protocol versus PT using a hip/pelvic girdle strengthening only protocol, Aoyama et al[15] found that the core strengthening group compared with the hip/pelvic girdle strengthening only group had significantly higher Vail hip scores (81.6 ± 18.5 versus 61.1 ± 11.6; $P < 0.05$) and significantly higher International Hip Outcome Tool (iHOT) scores (78.7 ± 22.4 versus 53.0 ± 22.3; $P < 0.01$) after 8 weeks of intervention. Baseline scores between both groups before PT were similar: Vail hip score 58.9 ± 12.8 versus 62.2 ± 9.9; $P = 0.54$ and iHOT score 49.2 ± 18.4 versus 45.8 ± 24.1; $P = 0.73$.

Most patients with symptomatic FAI can be treated nonsurgically. Pennock et al[16] prospectively followed 93 hips (76 patients) with symptomatic FAI with mean age 15.3 years and mean follow-up of 26.8 months and found that 82% of patients could be managed successfully with nonsurgical treatment (activity modification, PT, and 12% received intra-articular corticosteroid injection), although these patients reduced or changed sporting activities. Similarly, Emara et al[17] showed notable clinical improvements with nonsurgical management in 89% of patients (of 37 patients) with FAI and mild deformity (alpha angle <60°).

Surgical Management: Open Approach

When nonsurgical management of symptomatic FAI fails, surgical management is generally indicated. The goal of surgery is to reduce symptoms by restoring the normal femoral head/neck and acetabular anatomy, eliminating impingement, and treating associated labral and chondral pathology.[1]

Ganz et al[18] first described open surgical hip dislocation for the management of FAI, and this approach showed good clinical outcomes.[19,20] Steppacher et al[19] performed surgical hip dislocation with femoral neck osteoplasty and/or acetabular rim trimming with labral repair in 75 patients (97 hips) with FAI. At the 10-year follow-up, the Merle d'Aubigné-Postel score increased from preoperative 15.3 ± 1.4 to postoperative 16.9 ± 1.3 ($P < 0.001$), and the survivorship from any of the defined failures (conversion to THA, radiographic evidence of worsening OA, or a Merle d'Aubigné-Postel score <15) was 80%. They concluded that 80% of patients treated with open surgical hip dislocation for FAI have good clinical results without OA progression at 10 years. Their strongest predictors for failure were age older than 40 years, body mass index >30, lateral center edge angle <22° or >32°, and posterior acetabular coverage <34%. Novais et al[20] performed open surgical hip dislocation with femoral head/neck osteochondroplasty and/or acetabular rim trimming with labral repair in 24 adolescent athletes with FAI (mean age 15.5 ± 2.0 years, range 11 to 19 years) with a mean follow-up of 22 months (range 12 to 39 months). They found that 87.5% of athletes successfully returned to play after open FAI treatment with median time to return to play of 7 months. Of those who returned to play, 90% returned at a level that was equivalent to or greater than their level of play before surgery. There were also notable improvements in median modified Harris Hip

Score (mHHS) (52.8 preoperative vs 92.0 postoperative, $P < 0.0001$) and median Hip Disability and OA Outcome Scores (HOOS) (39.4 preoperative vs 91.3 postoperative, $P < 0.0001$).

Surgical Management: Hip Arthroscopy

Hip arthroscopy allows for a minimally invasive approach to treat FAI, and in recent years, the rate of hip arthroscopy has increased exponentially, with a 465% increase from 2005 to 2013.[21] Arthroscopic options include labral débridement or repair, femoral head/neck osteochondroplasty, acetabuloplasty, and chondral débridement or microfracture.

Hip arthroscopy has shown good clinical outcomes for the treatment of FAI with significant improvements in patient-reported outcomes and high rates of return to sport.[22] In a recent systematic review and meta-analysis, Minkara et al[22] reviewed 31 studies that evaluated the outcomes after arthroscopic management of FAI. With a total of 1981 hips (1,911 patients), with a mean age of 29.9 ± 1.9 years and a mean follow-up of 29.5 ± 14.0 months, they found that 87.7% of patients were able to return to sport after surgery, and mean patient-reported outcomes (including mHHS, Nonarthritic Hip Score [NAHS], Hip Outcome Score Activity of Daily Living [HOS-ADL], Hip Outcome Score sports scale [HOS-SS], Visual Analog Scale, Short-Form Health Survey [SF-12], and iHOT) improved postoperatively ($P < 0.05$), with the highest increase observed in the HOS-SS (41.7 points, $P < 0.001$). The pooled risk of revision surgery (including revision hip arthroscopy or subsequent THA) was 5.5% (95% CI, 3.6% to 7.5%), and the risk of complications was 1.7% (95% CI, 0.9% to 2.5%) (most commonly heterotopic ossification, followed by transient neurapraxia).

Relatively new, evolving concepts of assessing outcomes after hip arthroscopy, such as minimal clinically important difference (MCID) and Patient Acceptable Symptomatic State, will continue to inform us of the best outcome tools in assessing patients after arthroscopic FAI surgery; however, validation of these tools are still needed in multiple populations before becoming the standard of outcomes reporting. In a case-control study, Nho et al[23] evaluated 935 patients (mean age 33.3 ± 12.3 years) after hip arthroscopy for FAI. At 2 years postoperative, 73% of patients achieved the MCID for HOS-ADL. Another case-control study by Cvetanovich et al[24] showed that of 386 patients at 2 years postoperative after arthroscopic FAI surgery, 79% of patients achieved the MCID for HOS-ADL and 63% of patients achieved the Patient Acceptable Symptomatic State for HOS-ADL, demonstrating that hip arthroscopy benefits most patients with symptomatic FAI but also highlighting the need to determine the factors that negatively affect the outcomes in certain patient populations.

Risk factors that have been shown to be associated with negative outcomes or failure of arthroscopic FAI treatment include greater age (58 vs 39 years, mean difference = 18, 95% CI 8 to 28, $P = 0.001$), female sex (OR, 13.3; 95% CI, 1.3 to 92.6), preoperative cartilage degeneration or OA (joint space < 2 mm) (OR, 14.6; 95% CI 5.1 to 41.8), worse mHHS preoperatively (OR, 3.2; 95% CI, 1.1 to 9.4), intraoperative labral débridement rather than repair (mHHS 84.9 for débridement vs 94.3 for repair, $P = 0.001$), and greater duration of symptoms (>1.5 years) before surgical intervention (Effect, 11.0; 95% CI 2.3 to 19.8).[22,25] Factors that have been shown to be associated with positive outcomes after arthroscopic FAI treatment include the type of athlete (professional, collegiate, and overhead athletes), the type of activity (hiking, jogging, biking, and aerobics), male sex, preserved joint space (>2 mm), and intraoperative labral repair (rather than débridement).[22]

The evidence on capsular closure during hip arthroscopy is evolving. A cohort study by Frank et al[26] compared clinical outcomes of patients undergoing hip arthroscopy for FAI (by a single surgeon) with complete capsular closure of T-capsulotomy versus partial closure of T-capsulotomy (closure of vertical incision, but open interportal incision). There were 32 patients in each group, and at an average follow-up of 29.9 ± 2.6 months, HOS-SS was markedly better and revision surgery rate was lower in the complete capsular closure group, but no difference in HOS-ADL and mHHS between groups was noted. A recent randomized controlled trial by Economopoulos et al[27] randomly assigned 150 patients undergoing arthroscopic FAI surgery (by a single surgeon) to three groups: T-capsulotomy without closure, interportal capsulotomy without closure, and interportal capsulotomy with closure. At 2 years follow-up, the capsular closure group had markedly higher mHHS and HOS-ADL compared with both groups without capsular closure. These studies suggest that the results of arthroscopic FAI surgery are better with capsular closure versus partial or no closure. Currently, a multicenter randomized controlled trial with 200 patients is being performed, comparing capsular closure versus noncapsular closure in arthroscopic FAI surgery,[28] which will further help

determine the influence of capsular management on the outcomes after arthroscopic FAI surgery.

Hip Arthroscopy versus Open Surgical Management

Recent systematic reviews have shown that hip arthroscopy provides equivalent or superior outcomes compared with open surgical hip dislocation for the management of FAI.[29-31] Nwachukwu et al[29] assessed 16 studies (nine open surgical hip dislocation studies and seven hip arthroscopy studies). The open studies included 600 hips with a mean follow-up of 57.6 months (4.8 years), and the arthroscopic studies included 1,484 hips with a mean follow-up of 50.8 months (4.2 years). With THA as an outcome end point, both hip arthroscopy and open surgical hip dislocation showed excellent and equivalent hip survival rates (93% for open and 90.5% for arthroscopic, $P = 0.06$), but hip arthroscopy was associated with a significantly higher average pooled score on the SF-12 compared with open treatment (58.4 for 560 arthroscopic hips vs 48.2 for 394 open hips, $P < 0.001$), indicating improved health-related quality of life benefits with hip arthroscopy. Zhang et al[30] assessed five studies that compared hip arthroscopy versus open surgical hip dislocation for FAI treatment and found that hip arthroscopy resulted in markedly higher NAHS at the 12-month follow-up, and markedly lower revision surgery rate, compared with open surgical hip dislocation. No difference in mHHS, HOS, or complication rate was noted at the 12-month follow-up.

Complications of Hip Arthroscopy

The complication rate and revision surgery rate for hip arthroscopy are relatively low. In a systematic review that included 92 studies and more than 6,000 patients who underwent hip arthroscopy, Harris et al[32] found that after hip arthroscopy, major complications (eg, deep infection, pulmonary embolism, osteonecrosis, femoral neck fracture, and dislocation) occurred at a rate of 0.58%, minor complications (eg, iatrogenic chondrolabral damage, temporary nerve palsy, superficial infection, deep vein thrombosis, and heterotopic ossification) occurred at a rate of 7.5%, and revision surgeries (eg, conversion to THA, periacetabular osteotomy, arthroscopic loose body removal, and arthroscopic lysis of adhesions) occurred at a rate of 6.3% at a mean of 16 months postoperative. THA was the most common revision surgery (rate of 2.9%). A separate PearlDiver database study by Truntzer et al[33] included over 2,500 patients who underwent hip arthroscopy, and they found that the major and minor complication rates within a 1-year postoperative period after hip arthroscopy were 1.74% and 4.22%, respectively. Major complications included deep infections, proximal femur fractures, osteonecrosis of the femoral head, hip dislocations, and pulmonary embolism. Minor complications included superficial wound complications, DVT, nerve injuries, bursitis, and heterotopic ossification. Conversion rate to THA within 1 year was 2.85%, and revision hip arthroscopy within 1 year was 6.87%. At 5 years postoperative, the conversion rate to THA was 4.74%, and the rate of revision hip arthroscopy was 8.92% (matched to laterality). This study also evaluated several major complications at 1 and 5 years postoperative and found a 0.89% and 1.08% rate of proximal femur fracture, and 0.58% and 0.77% rate of hip dislocation at 1 and 5 years postoperative, respectively (without matching for laterality) and 0.58% rate of osteonecrosis at 5 years (the one year rate was too small to report per Pearl Diver policy).

However, hip arthroscopy remains technically challenging, and it has been shown that revision surgery rate is directly related to surgeon experience. Mehta et al[34] showed that low volume hip arthroscopy surgeons (0 to 97 career cases) had 15.4% revision surgery rate, medium volume surgeons (98 to 388 cases) had 13.8% revision surgery rate, high volume surgeons (389 to 518 cases) had 10.1% revision surgery rate, and highest volume surgeons (≥519 cases) had only 2.6% revision surgery rate. Therefore, cases performed by surgeons with career volumes ≥519 cases had significantly lower risk of revision surgery ($P < 0.0001$) than those performed by lower volume surgeons, and cases performed by surgeons with lower career volumes had higher revision surgery rates than the overall revision surgery rates described previously by Harris et al[32] and Truntzer et al.[33]

Randomized Controlled Trials

The previous literature on hip arthroscopy for the treatment of FAI was limited by lower level evidence that consisted mostly of case series.[22] However, recently, there have been higher level evidence studies with several randomized controlled trials comparing the outcomes of hip arthroscopy versus PT for the treatment of FAI (summarized in Table 1).[35-37]

Hip Arthroscopy versus Physical Therapy

The first randomized controlled trial comparing hip arthroscopy versus PT for the treatment of FAI was

Table 1. **Summary of Randomized Controlled Trials Comparing Hip Arthroscopy Versus Physical Therapy for the Treatment of Femoroacetabular Impingement**

Study	No. of Patients	Mean Age (yrs)	Outcomes	Complications and Revision surgery
Mansell et al[35]	40 PT	30.1	At 2 yr, both groups had notable improvements in HOS-ADL, HOS-SS, and iHOT, but no statistically significant difference between the groups	Hip scope group: 1 hip fracture, 1 HO, 5 revision surgery, 1 THA
	40 hip scope			PT group: None
Griffin et al[36]	177 PT	35.3	At 12 mo, both groups had notable improvements in iHOT, but iHOT was 6.8 points higher in favor of hip arthroscopy over PT[a]	Hip scope group: 1 overnight admission, 1 scrotal hematoma, 2 superficial wound infection, 1 hip joint infection that went on to THA, 1 fall
	171 hip scope			PT group: 1 biliary sepsis
Palmer et al[37]	110 PT	36.2	At 8 mo, the mean HOS-ADL was 10.0 points higher in the hip arthroscopy group compared with the PT group[a]	Hip scope group: 1 superficial wound infection, 2 lateral femoral cutaneous nerve injury
	112 hip scope			PT group: None

HOS-ADL = Hip Outcome Score-Activity of Daily Living; HOS-SS = Hip Outcome Score-Sports Scale; HO = Heterotopic Ossification; iHOT = International Hip Outcome Tool; PT = Physical Therapy; THA = Total Hip Arthroplasty
[a]Statistically and clinically significant.

performed by Mansell et al.[35] They randomized 80 patients (58.8% men, mean age 30.1 years) with symptomatic FAI in a military cohort to either formal PT treatment (40 patients) or hip arthroscopy treatment (40 patients). Both groups had similar baseline characteristics, and at the 2-year follow-up (with 77.5% follow-up), both groups had notable improvements in HOS and iHOT scores, but no notable difference between the two groups was observed, suggesting equal outcomes between PT versus hip arthroscopy for the treatment of FAI. However, there are major concerns that limit the conclusions of this study.[38] First, a very high crossover rate was observed because 70% of patients assigned to the PT group crossed over to the hip arthroscopy group. Second, there was an underpowered "as treated" analysis: after accounting for crossover and loss to follow-up, only 11 patients were left in the PT group. Third, gains in patient-reported outcomes after surgery were diminished and not consistent with the previous published results in the literature: the study reported mean improvements of 7.4 in HOS-ADL, 4.7 in HOS-SS, and 20.9 in iHOT after surgery, but the previous literature has shown much higher mean improvements of 23.6 in the HOS-ADL, 41.3 in the HOS-SS, and similar trends in the iHOT after surgery.[22] Fourth, patients with less than 2 years of follow-up were included in the primary analysis of the study. Finally, the generalizability of the study is questionable because there was only one surgeon in the study at one center, and all patients were military service members. The military cohort brings unique issues, in that recovery after surgery could lead to a loss of disability benefits, and this could negatively affect the outcomes.[38]

Subsequent randomized controlled trials have shown different results. The UK FASHIoN study (**F**ull **R**andomized Controlled Trial of **A**rthroscopic **S**urgery for **H**ip **I**mpingement Versus Best Co**N**ventional) by Griffin et al[36] was a multicenter (23 hospitals in the UK with 27 surgeons and 43 physical therapists), assessor-blinded randomized controlled trial that randomized 348 patients to either receive hip arthroscopy (171 patients) or formal PT (177 patients) for the treatment of FAI. The mean age of patients was 35.3 ± 9.6 years, and the baseline characteristics between the two groups were similar. At the 12-month follow-up (with 92% follow-up), both groups had notable improvement in iHOT scores (39.2 ± 21 preoperative to 58.8 ± 27 postoperative for hip arthroscopy group, 35.6 ± 18 pretreatment to 49.7 ± 25 posttreatment in PT group), but the mean difference in iHOT scores (adjusted for impingement type, sex, baseline iHOT score, and center in the primary intention-to-treat analysis) between the two

groups was 6.8 (P = 0.0093) in favor of hip arthroscopy compared with PT, which exceeded the MCID of 6.1. Fourteen patients (8%) who were randomized to PT treatment crossed over to hip arthroscopy treatment, and no patients allocated to surgery crossed over to PT treatment. In the hip arthroscopy group, 6 (4.3%) serious adverse events were noted: one patient had a hip joint infection that required further surgery and ultimately THA, one patient had scrotal hematoma requiring re-admission, one patient required an overnight admission, two patients had superficial wound infections that required oral antibiotics, and one patient had a fall that was unrelated to surgery. In the PT group, there was 1 (0.7%) serious adverse event: one patient developed biliary sepsis that was unrelated to treatment. To date, this is the largest randomized controlled trial comparing hip arthroscopy versus PT for FAI treatment, and the results showed that both hip arthroscopy and PT improved patient outcomes, but hip arthroscopy led to a greater improvement in outcomes. The large number of patients, centers, surgeons, and physical therapists in this study gives its findings improved generalizability over the previous randomized controlled trial discussed.

Another randomized controlled trial, the FAIT study (FAI **T**rial) by Palmer et al,[37] was a multicenter (7 centers in the UK), assessor-blinded trial that randomized 222 patients with symptomatic FAI to receive either hip arthroscopy (112 patients) or PT (110 patients). The mean age of patients was 36.2 ± 9.7 years, and the mean baseline HOS-ADL score was 65.9 ± 18.7. At the 8-month follow-up (with 85% follow-up), mean HOS-ADL score was 78.4 for the hip arthroscopy group and 69.2 for the PT group. After adjusting for baseline characteristics, the mean HOS-ADL was 10.0 points higher in the hip arthroscopy group compared with the PT group ($P < 0.001$), which exceeded the MCID of 9. Other patient-reported outcomes measures including HOS-SS, NAHS, Oxford Hip Score (OHS), iHOT, Copenhagen Hip and Groin Outcome Score (HAGOS), UCLA, PainDetect, EQ-5D, and HADS depression score were markedly higher in patients who received hip arthroscopy compared with those who received PT ($P < 0.05$). Four patients (3.6%) who were randomized to PT treatment crossed over to hip arthroscopy treatment. In the surgery group, there were 3 (3%) complications: one patient had superficial wound infection that resolved with oral antibiotics, and two patients had injury to the lateral femoral cutaneous nerve. No patients had serious adverse events. This trial also showed that hip arthroscopy achieved superior outcomes compared with PT for the treatment of symptomatic FAI.

Arthroscopic Osteochondroplasty with or without Labral Repair versus Lavage with or without Labral Repair

A recent randomized controlled trial by Ayeni et al[39] called the FIRST study (FAI **R**andomized Controlled **T**rial) demonstrated the efficacy of surgical correction of FAI with cam and/or pincer resection, comparing arthroscopic osteochondroplasty with or without labral repair versus arthroscopic lavage of the hip joint with or without labral repair. The study had 214 male and female patients aged 18 to 50 years (mean age 36.0 years) with nonarthritic FAI suitable for surgical management across 10 centers in Canada, Finland, and Denmark. Patients were randomized to receive either arthroscopic osteochondroplasty with resection of their cam and/or pincer lesion or to receive arthroscopic lavage with washing out of the hip joint with 3 L of normal saline. In both groups, surgeons repaired the labrum if it was mechanically unstable once probed (88.3% of patients had a labral tear, of which 60.3% were repaired). Baseline characteristics were similar in both groups, and there was relatively equal proportion of labral tears and impingement type in both groups. At 1-year postoperative, the primary outcome of patient-reported pain on Visual Analog Scale improved in both groups, but no significant difference was observed between the groups (mean difference, 0.11; 95% CI, −7.22 to 7.45; P = 0.98). Secondary outcomes of SF-12 score, EQ-5D index, and iHOT score also did not show significant differences between the groups at 1 year postoperative. However, at 2 years postoperative, the authors found that there were significantly fewer reoperations in the osteochondroplasty group (8/105) than in the lavage group (19/104) (OR, 0.37; 95% CI, 0.15 to 0.89; P = 0.026), and the primary reasons for revision surgery were hip pain (55.6%) and reinjury of the labrum (40.7%), suggesting that the correction of FAI morphology with osteochondroplasty (with or without labral repair) was a more effective surgical treatment for FAI than lavage (with or without labral repair) was in minimizing recurrence of FAI-related symptoms.

Summary

FAI morphology is common and can lead to hip labral tears, chondral damage, and subsequent OA. Many patients with symptomatic FAI can be treated successfully with nonsurgical management as first-line treatment. However, when nonsurgical management fails, surgery should be considered. There is rapidly increasing

evidence for the efficacy of hip arthroscopy for the treatment of symptomatic FAI, and hip arthroscopy has shown superior outcomes compared with nonsurgical management and PT in most recent randomized controlled trials. Future large prospective studies are needed to evaluate the effect on the outcomes when there is a delay in surgical management in symptomatic individuals, assess whether FAI surgery prevents or delays OA, and determine the role of other advanced surgical techniques.

References

References printed in **bold type** are those published within the past 5 years.

1. Ganz R, Parvizi J, Beck M, Leunig M, Nötzli H, Siebenrock KA: Femoroacetabular impingement: A cause for osteoarthritis of the hip. *Clin Orthop Relat Res* 2003;417:112-120.

2. Gosvig KK, Jacobsen S, Sonne-Holm S, Palm H, Troelsen A: Prevalence of malformations of the hip joint and their relationship to sex, groin pain, and risk of osteoarthritis: A population-based survey. *J Bone Joint Surg Am* 2010;92:1162-1169.

3. Kang AC, Gooding AJ, Coates MH, Goh TD, Armour P, Rietveld J: Computed tomography assessment of hip joints in asymptomatic individuals in relation to femoroacetabular impingement. *Am J Sports Med* 2010;38:1160-1165.

4. Laborie LB, Lehmann TG, Engesæter I, Eastwood DM, Engesæter LB, Rosendahl K: Prevalence of radiographic findings thought to be associated with femoroacetabular impingement in a population-based cohort of 2081 healthy young adults. *Radiology* 2011;260:494-502.

5. Reichenbach S, Jüni P, Werlen S, et al: Prevalence of cam-type deformity on hip magnetic resonance imaging in young males: A cross-sectional study. *Arthritis Care Res (Hoboken)* 2010;62:1319-1327.

6. Kapron AL, Anderson AE, Aoki SK, et al: Radiographic prevalence of femoroacetabular impingement in collegiate football players: AAOS exhibit selection. *J Bone Joint Surg Am* 2011;93:e111(111-110).

7. Siebenrock KA, Behning A, Mamisch TC, Schwab JM: Growth plate alteration precedes cam-type deformity in elite basketball players. *Clin Orthop Relat Res* 2013;471:1084-1091.

8. Gerhardt MB, Romero AA, Silvers HJ, Harris DJ, Watanabe D, Mandelbaum BR: The prevalence of radiographic hip abnormalities in elite soccer players. *Am J Sports Med* 2012;40:584-588.

9. Larson CM, Ross JR, Kuhn AW, et al: Radiographic hip anatomy correlates with range of motion and symptoms in national hockey league players. *Am J Sports Med* 2017;45:1633-1639.

10. Agricola R, Heijboer MP, Bierma-Zeinstra SM, Verhaar JA, Weinans H, Waarsing JH: Cam impingement causes osteoarthritis of the hip: A nationwide prospective cohort study (CHECK). *Ann Rheum Dis* 2013;72:918-923.

11. Thomas GE, Palmer AJ, Batra RN, et al: Subclinical deformities of the hip are significant predictors of radiographic osteoarthritis and joint replacement in women. A 20 year longitudinal cohort study. *Osteoarthritis Cartilage* 2014;22:1504-1510.

12. Agricola R, Heijboer MP, Roze RH, et al: Pincer deformity does not lead to osteoarthritis of the hip whereas acetabular dysplasia does: Acetabular coverage and development of osteoarthritis in a nationwide prospective cohort study (CHECK). *Osteoarthritis Cartilage* 2013;21:1514-1521.

13. Hartofilakidis G, Bardakos NV, Babis GC, Georgiades G: An examination of the association between different morphotypes of femoroacetabular impingement in asymptomatic subjects and the development of osteoarthritis of the hip. *J Bone Joint Surg Br* 2011;93:580-586.

14. Griffin D, Wall P, Realpe A, et al: UK FASHIoN: Feasibility study of a randomised controlled trial of arthroscopic surgery for hip impingement compared with best conservative care. *Health Technol Assess* 2016;20:1-172.

15. Aoyama M, Ohnishi Y, Utsunomiya H, et al: A prospective, randomized, controlled trial comparing conservative treatment with trunk stabilization exercise to standard hip muscle exercise for treating femoroacetabular impingement: A pilot study. *Clin J Sport Med* 2019;29:267-275.

16. Pennock AT, Bomar JD, Johnson KP, Randich K, Upasani VV: Nonoperative management of femoroacetabular impingement: A prospective study. *Am J Sports Med* 2018;46:3415-3422.

17. Emara K, Samir W, Motasem eH, Ghafar KA: Conservative treatment for mild femoroacetabular impingement. *J Orthop Surg (Hong Kong)* 2011;19:41-45.

18. Ganz R, Gill TJ, Gautier E, Ganz K, Krügel 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;83:1119-1124.

19. Steppacher SD, Anwander H, Zurmühle CA, Tannast M, Siebenrock KA: Eighty percent of patients with surgical hip dislocation for femoroacetabular impingement have a good clinical result without osteoarthritis progression at 10 years. *Clin Orthop Relat Res* 2015;473:1333-1341.

20. Novais EN, Mayo M, Kestel LA, Carry PM, Mayer SW: Return to play following open treatment of femoroacetabular impingement in adolescent athletes. *J Am Acad Orthop Surg* 2016;24:872-879.

21. Maradit Kremers H, Schilz SR, Van Houten HK, et al: Trends in utilization and outcomes of hip arthroscopy in the United States between 2005 and 2013. *J Arthroplasty* 2017;32:750-755.

22. Minkara AA, Westermann RW, Rosneck J, Lynch TS: Systematic review and meta-analysis of outcomes after hip arthroscopy in femoroacetabular impingement. *Am J Sports Med* 2019;47:488-500.

23. Nho SJ, Beck EC, Nwachukwu BU, et al: Survivorship and outcome of hip arthroscopy for femoroacetabular impingement syndrome performed with modern surgical techniques. *Am J Sports Med* 2019;47:1662-1669.

24. Cvetanovich GL, Weber AE, Kuhns BD, et al: Hip arthroscopic surgery for femoroacetabular impingement with capsular management: Factors associated with achieving clinically significant outcomes. *Am J Sports Med* 2018;46:288-296.

25. Saadat E, Martin SD, Thornhill TS, Brownlee SA, Losina E, Katz JN: Factors associated with the failure of surgical treatment for femoroacetabular impingement: Review of the literature. *Am J Sports Med* 2014;42:1487-1495.

26. Frank RM, Lee S, Bush-Joseph CA, Kelly BT, Salata MJ, Nho SJ: Improved outcomes after hip arthroscopic surgery in patients undergoing T-capsulotomy with complete repair versus partial repair for femoroacetabular impingement: A comparative matched-pair analysis. *Am J Sports Med* 2014;42:2634-2642.

27. Economopoulos KJ, Chhabra A, Kweon C: Prospective randomized comparison of capsular management techniques during hip arthroscopy. *Am J Sports Med* 2020;48:395-402.

28. Dippmann C, Kraemer O, Lund B, et al: Multicentre study on capsular closure versus non-capsular closure during hip arthroscopy in Danish patients with femoroacetabular impingement (FAI): Protocol for a randomised controlled trial. *BMJ Open* 2018;8:e019176.

29. Nwachukwu BU, Rebolledo BJ, McCormick F, Rosas S, Harris JD, Kelly BT: Arthroscopic versus open treatment of femoroacetabular impingement: A systematic review of medium- to long-term outcomes. *Am J Sports Med* 2016;44:1062-1068.

30. Zhang D, Chen L, Wang G: Hip arthroscopy versus open surgical dislocation for femoroacetabular impingement: A systematic review and meta-analysis. *Medicine (Baltimore)* 2016;95:e5122.

31. Botser IB, Smith TW, Nasser R, Domb BG: Open surgical dislocation versus arthroscopy for femoroacetabular impingement: A comparison of clinical outcomes. *Arthroscopy* 2011;27:270-278.

32. Harris JD, McCormick FM, Abrams GD, et al: Complications and reoperations during and after hip arthroscopy: A systematic review of 92 studies and more than 6,000 patients. *Arthroscopy* 2013;29:589-595.

33. Truntzer JN, Hoppe DJ, Shapiro LM, Abrams GD, Safran M: Complication rates for hip arthroscopy are underestimated: A population-based study. *Arthroscopy* 2017;33:1194-1201.

34. Mehta N, Chamberlin P, Marx RG, et al: Defining the learning curve for hip arthroscopy: A threshold analysis of the volume-outcomes relationship. *Am J Sports Med* 2018;46:1284-1293.

35. Mansell NS, Rhon DI, Meyer J, Slevin JM, Marchant BG: Arthroscopic surgery or physical therapy for patients with femoroacetabular impingement syndrome: A randomized controlled trial with 2-year follow-up. *Am J Sports Med* 2018;46:1306-1314.

36. Griffin DR, Dickenson EJ, Wall PDH, et al: Hip arthroscopy versus best conservative care for the treatment of femoroacetabular impingement syndrome (UK FASHIoN): A multicentre randomised controlled trial. *Lancet* 2018;391:2225-2235.

37. Palmer AJR, Ayyar Gupta V, Fernquest S, et al: Arthroscopic hip surgery compared with physiotherapy and activity modification for the treatment of symptomatic femoroacetabular impingement: Multicentre randomised controlled trial. *BMJ* 2019;364:l185.

38. Faucett SC, Nepple JJ, Andrade T, et al: Randomized controlled trial of hip arthroscopy surgery vs physical therapy: Letter to the editor. *Am J Sports Med* 2018;46:NP35-NP38.

39. Ayeni OR, Karlsson J, Heels-Ansdell D, et al: Osteochondroplasty and labral repair for the treatment of young adults with femoroacetabular impingement: A randomized controlled trial. *Am J Sports Med* [published online ahead of print September 24, 2020] doi: 10.1177/0363546520952804