


Modern Hip Arthroscopy for FAIS May Delay the Natural History of Osteoarthritis in 25% of Patients

A 12-Year Follow-up Analysis

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Background: Little is known about the effect of modern hip arthroscopy on the natural history of femoroacetabular impingement syndrome (FAIS) with respect to joint preservation.

Purpose: To (1) characterize the natural history of FAIS and (2) understand the effect of modern hip arthroscopy by radiographically comparing the hips of patients who underwent only unilateral primary hip arthroscopy with a minimum follow-up of 10 years.

Study Design: Cohort study; Level of evidence, 3.

Methods: Between 2010 and 2012, 619 consecutive patients were reviewed from the practice of a single fellowship-trained hip arthroscopic surgeon. Inclusion criteria were FAIS, bilateral radiographic findings of femoroacetabular impingement, primary unilateral hip arthroscopy (labral repair, femoroplasty, or capsular closure), and minimum 10-year follow-up. The preoperative and minimum 10-year postoperative radiographs of patients were evaluated at each time point. Both operative and nonoperative hips were graded using the Tönnis classification or the presence of hip arthroplasty by 2 independent reviewers. Subgroup analyses were performed.

Results: A total of 200 hips from 100 patients were evaluated at a mean follow-up of 12.0 years. Preoperatively, 98% and 99% of operative and nonoperative hips were evaluated as Tönnis grades 0 and 1, respectively; 5% of nonoperative hips had worse Tönnis grades than operative hips. The nonoperative hip advanced to a worse Tönnis grade in 48% (48/100) of cases compared with 28% (28/100) among operative hips. At follow-up, Tönnis grades between hips were equal in 70% (70/100) of the cases, the operative hip had a better grade 25% (25/100) of the time, and the nonoperative hip had a better grade 5% (5/100) of the time. Modern hip arthroscopy was associated with a relative risk reduction of 42% in osteoarthritis progression. Impingement with borderline dysplasia, age, preoperative Tönnis grade, and alpha angle $>65^\circ$ were key risk factors in the radiographic progression of osteoarthritis.

Conclusion: Although the majority of patients (70%) undergoing hip arthroscopy for FAIS did not experience differences between operative and nonoperative hips in terms of the radiographic progression of osteoarthritis, the natural history may be favorably altered for 25% of patients whose Tönnis grade was better after undergoing arthroscopic correction. Modern hip arthroscopy indications and techniques represent a valid joint-preservation procedure conferring a relative risk reduction of 42% in the progression of osteoarthritis. Arthroscopy for mixed patterns of impingement and instability were the fastest to degenerate.

Keywords: FAIS; natural history; joint preservation; osteoarthritis

Femoroacetabular impingement syndrome (FAIS) is an increasingly recognized cause of nonarthritic hip pain, primarily affecting young adults and defined by a constellation of symptoms, physical examination findings, and radiographic features indicating abnormal morphology of the femur (cam morphology) and/or the acetabulum (pincer

morphology).^{3,5,22} Abnormal morphology of the femur and/or acetabulum results in dynamic contact between the acetabular rim and the proximal femur that, over time, leads to hip pain, acetabular labral injury, and chondral damage that may predispose one to osteoarthritis.⁴ The treatment of FAIS includes both nonoperative and operative options to manage or improve symptoms.^{6,10,17,20,23} However, hip arthroscopy remains the most commonly performed, minimally invasive, high-volume treatment option that structurally alters the mechanical forces across the hip. Several prospective, multicenter randomized controlled trials have repeatedly demonstrated the efficacy

of the operation over guided physical therapy, although the long-term durability is less known.¹⁶

In a systematic review of mid- to long-term outcomes after hip arthroscopy, Kyin et al¹¹ evaluated 13 reports and found an overall paucity of long-term data, current indications, and consistent surgical techniques. In their review of the highest-quality long-term evidence, ≥ 2 studies included patients with cartilage damage and osteochondral defects, and the 2 studies with the longest-term follow-up periods, 10 and 20 years by Byrd and Jones¹ and Dwyer et al,² respectively, did not repair the labrum. Dwyer et al published the longest follow-up study to date surrounding hip arthroscopy, with a mean follow-up rate of 73% at 20 years in a cohort of 404 hips, and underscored the importance of considering articular cartilage status and age in the context of joint survivorship; however, there was no femoroplasty or capsular closure, and the labrum was either resected or debrided without a single repair.² No long-term study, however, has included a modern evaluation of FAIS using current surgical indications and techniques such as labral repair, femoroplasty, and capsular closure to comprehensively evaluate the long-term effects of this procedure.¹⁴ In 1 long-term study comparing 23 hips with femoroplasty with 17 hips without femoroplasty at a 19.7-year follow-up, the femoroplasty group had significantly greater 15-year total hip arthroplasty (THA)-free survivorship (78% vs 41%), suggesting that ≥ 1 modern technique does alter the natural history of femoroacetabular impingement at long-term follow-up.¹⁴

Despite the logical presupposition that an association exists between modern hip arthroscopy and joint preservation, no study to date has demonstrated the effect of this operation on the natural progression of osteoarthritis. Wyles et al²⁵ attempted to define the natural history of FAIS by characterizing and evaluating the contralateral hip of patients who at < 55 years of age had undergone previous THA. With a 74% follow-up at 20 years in a cohort of 172 patients with a mean age of 47 years, patients with radiographic signs of cam and dysplasia were the fastest to progress to THA. Khan et al⁹ similarly evaluated the contralateral hip for those who had already undergone hip arthroscopy for FAIS, with 84% follow-up at 7 years, and projected that 52% of contralateral hips would become symptomatic and 23% would undergo arthroscopy at 10 years of follow-up. The purpose of our study was to (1) characterize the natural history of FAIS with respect to radiographic joint degeneration and (2) understand the

effect of modern hip arthroscopy indications and techniques by radiographically comparing the hips of patients who had undergone unilateral primary hip arthroscopy with a minimum follow-up of 10 years.

METHODS

Patient Selection

After obtaining institutional review board approval for this study, we retrospectively identified patients undergoing hip arthroscopic surgery for the treatment of FAIS between January 1, 2010, and December 31, 2012. Patients were indicated for surgery after a period of failed nonoperative management including activity modification, physical therapy, and nonsteroidal anti-inflammatory medications and/or intra-articular hip injections. All surgeries were performed by a single fellowship-trained hip arthroscopic surgeon (B.T.K.) with 20 years of experience performing approximately 350 cases per year. All patients underwent labral preservation (refixation or selective debridement without resection), femoroplasty, and capsular closure. Acetabuloplasty, as defined by rim decortication, was performed in every patient undergoing a labral repair. However, decompression of subspine impingement as determined on a preoperative computed tomography scan and/or a clear rim lesion seen intraoperatively was performed on a case-by-case basis. In the immediate postoperative period, patients were restricted to toe-touch weightbearing and given a brace and a continuous passive motion machine with range of motion restrictions between 30° and 70° of flexion. This range of motion was advanced as tolerated over a weekly schedule. Indomethacin was also given to prevent heterotopic ossification.

Inclusion criteria were as follows: documented history, physical examination, and bilateral plain radiographic findings (cam, pincer, or mixed deformities) consistent with FAIS; primary unilateral hip arthroscopy including labral preservation, femoroplasty, and capsular closure; and a minimum 10-year follow-up. Exclusion criteria were as follows: acetabular dysplasia (defined by lateral center-edge angle $< 20^\circ$), underlying hip osteoarthritis (Tönnis grade > 2), previous contralateral hip procedure, revision hip procedure, any concomitant procedure, inflammatory arthropathy, unavailable preoperative or postoperative radiographs surpassing the minimum 10-year follow-

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Submitted August 1, 2023; accepted December 18, 2023.

One or more of the authors has declared the following potential conflicts of interest or source of funding. P.N.R. has received consulting fees from Pacira; hospitality payments from Stryker; consulting fees and royalties from Globus; research support from Arthrex; and support for education from Smith & Nephew and has ownership in Intelligent Health Analytics Inc and Overture. D.H.N. has received consulting fees from Linvatec Corporation; hospitality payments from Stryker and Arthrex; support for education from Gotham Surgical Solutions & Devices; and royalties from Smith & Nephew. B.T.K. has received consulting fees and royalties from Arthrex; hospitality payments from Stryker; and faculty or speaker fees from Synthes GmbH. AJSM checks author disclosures against the Open Payments Database (OPD). AOSM has not conducted an independent investigation on the OPD and disclaims any liability or responsibility relating thereto.

up threshold, and any patients who were lost to follow-up. Patients undergoing unilateral hip arthroscopy had symptoms originating only from the operated hip; those who underwent primary hip arthroscopy for contralateral symptoms were excluded.

Data Collection

Patient charts were retrospectively reviewed. Age, sex, laterality, and labral management (selective debridement vs repair) were noted. Preoperative and the most recent postoperative anteroposterior pelvis radiographs at a minimum 10-year follow-up were retrospectively evaluated at each time point. Both operative and nonoperative hips were assessed using Tönnis grading or by documenting the presence of hip arthroplasty at both time points, preoperatively and at the latest follow-up beyond 10 years. Arthroplasty was considered the highest Tönnis grade. The reviewers were blinded to which side underwent arthroscopy and which did not. The nonoperative hip was treated as an internal control, and evaluation of the change in Tönnis grading between time points served as a surrogate for the natural history of FAIS. Both operative and nonoperative hips had radiographic features of impingement.

The Tönnis grades were compared for 3 scenarios: nonoperative hip preoperatively versus at the latest follow-up (natural history of FAIS), operative hip preoperatively versus postoperatively at the latest follow-up (impact of modern hip arthroscopy on the natural history of FAIS), and a head-to-head comparison of the operative and nonoperative hips at the latest follow-up (impact of modern hip arthroscopy overall). In the presence of bilateral hip arthroplasties at the latest follow-up, the hips were considered the same Tönnis grade. In the presence of unilateral hip arthroplasty, the side with arthroplasty was considered the worse Tönnis grade. All arthroplasties were separately evaluated in a subgroup analysis. Two reviewers (P.N.R., D.H.N.) blinded to which side underwent arthroscopy independently and retrospectively graded the hips. To mitigate interrater reliability bias, any discrepancy was arbitrated by consensus agreement; thus, no interrater reliability was calculated. Additionally, FAIS was classified in terms of impingement only versus impingement with instability (ie, dysplastic features) and alpha angle $\geq 65^\circ$ versus alpha angle $< 65^\circ$. Instability was defined as lateral center-edge angle $< 25^\circ$, Tönnis angle $> 10^\circ$, and/or a positive prone apprehension relocation test on examination. The alpha angle was determined on a preoperative Dunn 45° lateral radiograph (long neck view). Subgroup analyses were performed for patient cohorts whose natural history was favorably or unfavorably altered, as well as for patients who underwent arthroplasty. These subgroup analyses were reported as descriptive statistics given the associated low power.

Statistical Analysis

The basic data analysis required no analytic expertise and was done internally. Descriptive statistics were performed using Microsoft Excel to count and establish percentages.

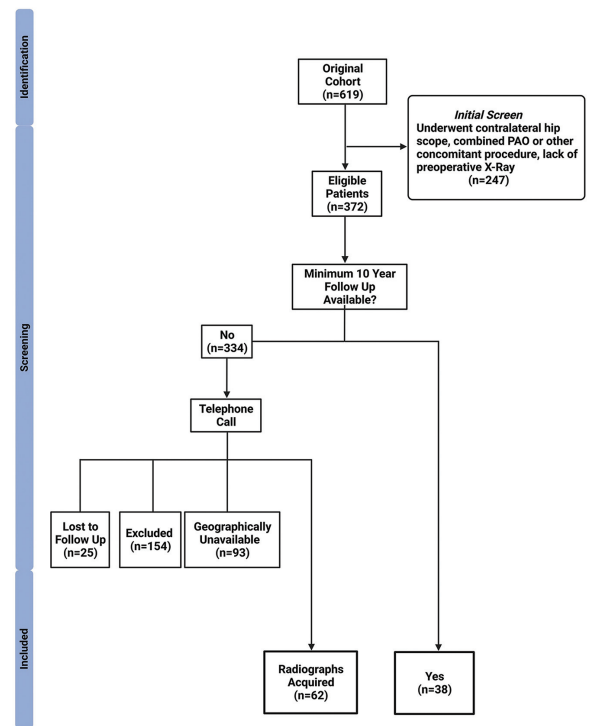


Figure 1. Flowchart of inclusion and exclusion criteria of 100 patients (200 hips) in the current study. The patients excluded after the telephone call (n = 154) were removed because they had undergone a contralateral procedure (n = 110), had undergone a concomitant periacetabular osteotomy (PAO) or other procedure, or did not have a preoperative radiograph in our system.

RESULTS

During the study period, 100 patients (200 hips) underwent primary unilateral hip arthroscopy with no contralateral procedure at a minimum follow-up of 10 years. The final cohort had a mean age of 33.8 years (range, 17-53 years) at the time of surgery, was 46% female, had a mean body mass index of 22.5, and had a mean follow-up of 12.0 years. After excluding patients who did not meet inclusion criteria or were geographically unavailable to follow-up, the follow-up rate was 74% (Figure 1). The labrum was repaired in 93% (93/100) of patients. Acetabular rim decortication was performed in 93% (93/100) of patients, and subspine decompression was performed in 35% (35/100) of patients.

Of the 200 hips, 91% (182/200) of Tönnis grade advances were by no or 1 grade only, with the following exceptions: 4 advanced by 2 grades, 1 advanced by 3 grades, and 13 progressed to hip arthroplasty. Table 1 demonstrates the Tönnis grading for all 200 hips for both operative and nonoperative hips at both preoperative and postoperative time points. Overall, 98% and 99% of patients had preoperative Tönnis grades of 0 or 1 for the operative and nonoperative hips, respectively, before hip arthroscopy. Table 2 summarizes the overall change in Tönnis grading between (1) the operative hip at a minimum 10-year follow-up, (2) the

TABLE 1
Tönnis Grading for 100 Patients (200 Hips) Who Underwent Unilateral Primary Hip Arthroscopy^a

Tönnis Grade	Preoperative Radiographs		≥10-Year Postoperative Radiographs	
	Operative Hip	Nonoperative Hip	Operative Hip	Nonoperative Hip
0	78	73	57	38
1	20	26	34	45
2	2	1	2	9
3	0	0	0	2
Arthroplasty			7	6

^aDashes indicate not applicable.

TABLE 2
Overview Summarizing the Progression of Osteoarthritis in the Setting of Femoroacetabular Impingement Syndrome

Tönnis Grade Comparison	Operative Hip ≥10 Years Later	Nonoperative Hip ≥10 Years Later	Operative Hip vs Nonoperative Hip ≥10 Years Later
Worse: higher Tönnis grade	28	48	5
No difference: same Tönnis grade	72	52	70
Better: lower Tönnis grade	0	0	25

nonoperative hip at a minimum 10-year follow-up, and (3) the operative versus nonoperative hip at a minimum 10-year follow-up. The Tönnis grade of the nonoperative hip was unchanged 52% (52/100) of the time and advanced to a worse Tönnis grade 48% (48/100) of the time; comparatively, the Tönnis grade of the operative hip was unchanged 72% (72/100) of the time and advanced to a worse Tönnis grade 28% (28/100) of the time. Hip arthroscopy was associated with an absolute risk reduction of 20% (0.48 – 0.28 = 0.20) and a relative risk reduction of 42% (0.20/0.48) for FAIS as a joint-preserving intervention that delays the radiographic progression of osteoarthritis. Figure 2 illustrates representative cases.

When comparing the operative and nonoperative hips at the latest follow-up, there was no difference in Tönnis grades 70% (70/100) of the time. The operative hip had a better Tönnis grade 25% (25/100) of the time, whereas the nonoperative hip had a better Tönnis grade 5% (5/100) of the time.

Five patients had worse Tönnis grades after hip arthroscopy compared with the nonoperative side, 2 of which progressed to hip-resurfacing arthroplasties. All were male, the mean age was 31.0 years, and all had radiographic patterns of both impingement and instability. In

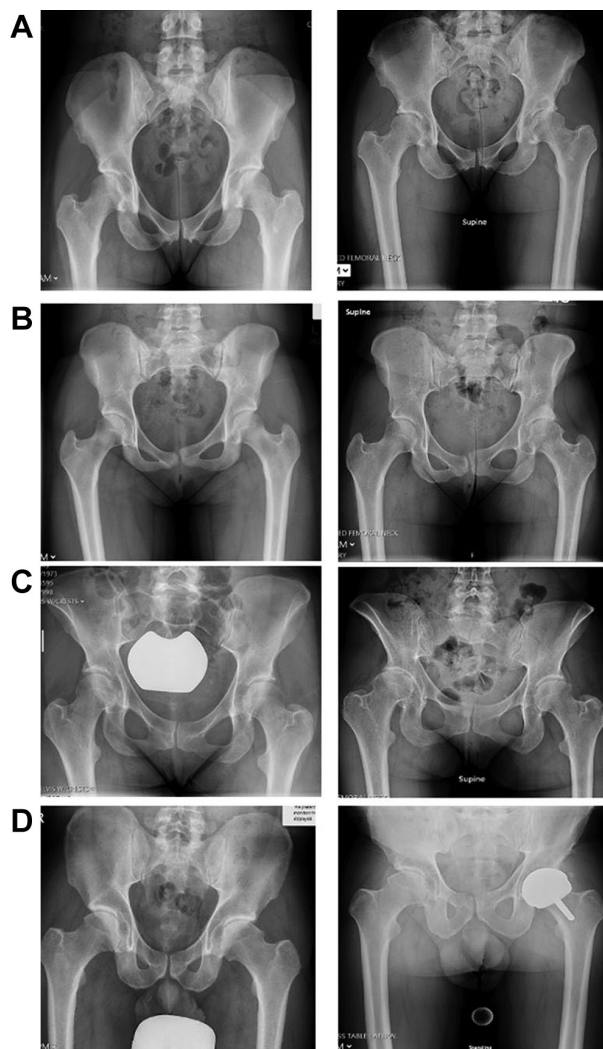


Figure 2. Example anteroposterior radiographs obtained in patients with FAIS both (left) preoperatively and (right) >10 years postoperatively. (A) Radiograph obtained in a 29-year-old woman who underwent right hip arthroscopy and developed comparatively worse progressive osteoarthritis in the nonoperative left hip at age 41 years. (B) Radiograph obtained in a 19-year-old woman who underwent right hip arthroscopy and developed comparatively worse progressive osteoarthritis in the nonoperative left hip at age 31 years. (C) Radiograph obtained in a 38-year-old woman who underwent left hip arthroscopy and developed comparatively worse progressive osteoarthritis in the nonoperative right hip at age 49 years. (D) Radiograph obtained in a 45-year-old man who underwent right hip arthroscopy and maintained arthroplasty-free survivorship compared with the left hip that underwent hip resurfacing arthroplasty when the patient was 57 years of age.

terms of preoperative Tönnis grades, 2 hips were Tönnis grade 0, 2 were Tönnis grade 1, and 1 was Tönnis grade 2.

A total of 25 patients had better Tönnis grades after hip arthroscopy compared with the nonoperative side, one of

which was a hip-resurfacing arthroplasty. Overall, 48% (12/25) of these patients were female, their mean age was 33.9 years, and 80% had radiographic patterns of impingement alone (20% had radiographic patterns of both impingement and instability). Overall, 68% (17/25) had alpha angles $>65^\circ$. In terms of preoperative Tönnis grades on the operative hip, 20 of 25 of hips were Tönnis grade 0, 5 of 25 were Tönnis grade 1, and 0 were Tönnis grade 2. In terms of preoperative Tönnis grades on the nonoperative hip, 16 of 25 hips were Tönnis grade 0, 9 of 25 were Tönnis grade 1, and 0 were Tönnis grade 2.

None of the 100 patients underwent subsequent hip arthroscopy. Of the 13 hips that went on to arthroplasty, 7 were the operative hip and 6 were the nonoperative hip from 8 total patients (5 bilateral). The mean age of this cohort was 40.0 years. All 7 patients had radiographic patterns of both impingement and instability. In terms of preoperative Tönnis grades, 2 hips were Tönnis grade 0, 8 were Tönnis grade 1, and 3 were Tönnis grade 2.

DISCUSSION

This study retrospectively evaluated 100 patients with bilateral radiographic signs of FAIS who had undergone primary unilateral hip arthroscopy alone, to evaluate the effect on the radiographic progression of osteoarthritis. Several important findings are reported. First, this study established the natural history of impingement in the context of osteoarthritis development by demonstrating that patients with radiographic signs of impingement who do not undergo arthroscopy advance to a worse grade of osteoarthritis nearly half (48%) the time at a minimum 10-year follow-up when the contralateral hip with radiographic features of impingement is treated as an internal control. Second, this study suggests a favorable alteration in the natural history of impingement in the context of osteoarthritis development by demonstrating that patients who do undergo modern hip arthroscopy (labral repair, femoroplasty, or capsular closure) comparatively advance to a worse grade of osteoarthritis only 28% of the time. Although hip arthroscopy for FAIS did not result in Tönnis grade differences that altered the natural history between operative and nonoperative hips in 70% of the cases, the operative hip was better preserved than the nonoperative side among 25% of patients. This suggests that modern hip arthroscopy may confer major advantages in the delay of osteoarthritis development by offering greater joint preservation with an absolute risk reduction of 20% and a relative risk reduction of 42% in the radiographic progression of osteoarthritis development over 12 years. Third, with a 74% follow-up of geographically available patients at 12.0 years, this is the first long-term study to comprehensively assess the effect of modern hip arthroscopy techniques (labral repair, femoroplasty, and capsular closure). Fourth, in the subgroup analyses (of the 5% of patients whose nonoperative hip had a better Tönnis grade than the operative hip, the 25% of patients whose operative hip had a better Tönnis grade than the nonoperative hip,

and the 8 patients who went on to arthroplasty) the most thematic risk factors for joint degeneration were radiographic signs of both impingement and instability, a higher preoperative Tönnis grade, older age, and large cams with an alpha angle $>65^\circ$. Finally, this is the first study to validate modern hip arthroscopy indications and techniques as a joint-preserving procedure.

The literature surrounding FAIS and hip arthroscopy has undergone incremental advances that were first validated by short-term and midterm outcomes. Published long-term outcomes after hip arthroscopy, however, are less common. Attention to the importance of femoroplasty, labral preservation (ie, labral repair), and capsular closure has been the greatest advance over the past decade, and major dividends have been reaped. Femoroplasty, in particular, is one of the key technical considerations directly associated with higher patient-reported outcome measures (PROMs) and 15-year THA-free survivorship, suggesting that hip arthroscopy alters the natural history of osteoarthritis in the context of FAIS. Nepple et al¹⁴ demonstrated that in a group of 23 hips that underwent femoroplasty versus 17 that did not, at the 16-year follow-up 78% of those that received bony correction went on to THA-free survivorship compared with the 41% that did not. Husen et al⁸ unequally compared 132 symptomatic hips that underwent arthroscopy with 982 asymptomatic hips at a mean follow-up of 12.5 years and found that 12% of the operative hips progressed to Tönnis grade 2 compared with 22% of the nonoperative hips. Not only did this study fail to use the asymptomatic contralateral hip as an individual control for nonoperative hips, but also femoroplasty was only performed 93% of the time, labral repair was performed 91% of the time, and capsular repair was performed 45% of the time. In our study, which included long-term evaluation of labral preservation (93% repair), femoroplasty, and capsular closure, the Tönnis grades for operative and nonoperative hips with bilateral radiographic impingement stigmata were individually assessed preoperatively and postoperatively 12 years later; again, the state of the 2 hips was directly compared at long-term follow-up. The vast majority (91%) of changes were 0 or 1 Tönnis grade. Assuming the nonoperative hip to be a valid internal control and surrogate for the natural history of FAIS, as established in 2 key studies by Wyles et al²⁵ and Khan et al,⁹ the natural history of FAIS resulted in radiographic progression of osteoarthritis 48% (48/100) of the time and no change only 52% (52/100) of the time. This statement alone, that nearly half of patients progress to a worse grade of arthritis 12 years later, is meaningful to share when counseling patients who seek to better understand the radiographic course of their pathophysiology.

When addressing patient concerns and projecting the radiographic survivorship of the joint, there has previously been little to no foundational, long-term understanding of what modern hip arthroscopic interventions offer. Compared with the nonoperative side that advanced to a worse arthritic state 48% of the time, the operative hip worsened only 28% (28/100) of the time at long-term follow-up. Importantly, nearly three-fourths of the hips that underwent arthroscopy (72%; 72/100) did not radiographically progress to a worse

Tönnis grade. Thus, the absolute and relative risk reduction in undergoing hip arthroscopy among symptomatic patients with FAIS may confer 20% and 42% protection, relatively, in the radiographic progression of osteoarthritis. In shared decision-making, this knowledge may better arm both the surgeon and the patient in the discussion to arrive at a more informed conclusion about the effect of the operation. Furthermore, knowledge that hip arthroscopy may delay osteoarthritis could cue patients to recognize their symptoms in the context of long-term joint survivorship. In an editorial by Westermann and Schaver,²⁴ there is a resounding hope and belief that the recent refinement of indications and techniques in modern hip arthroscopy may lead to joint preservation. Kyin et al¹¹ presented a poorly generalizable body of work on the mid- to long-term outcomes of hip arthroscopy in which the highest-quality studies underwent surgery in the presence of severe osteochondral defects, did not repair labrums, did not correct cam lesions, and/or did not repair the capsule. The most important information gleaned from these long-term studies was that articular cartilage status and patient age were risk factors in osteoarthritis progression. However, the 20-year follow-up study on 404 patients (mean age, 38 years) who underwent hip arthroscopy between 1989 and 2000, 41% of whom were eventually converted to THA, is outdated in the context of modern indications and techniques.² This cohort underwent microfracture in the setting of preoperatively known osteochondral defects, segmental labral debridements or resections, no femoroplasty, and no capsular closure.² In 1 prospective study of 150 patients who underwent unilateral hip arthroscopy, at the 7.1-year follow-up 75 of 150 patients (50%) had developed symptomatic FAIS and 26 of 150 (17%) went on to surgery.⁹ Although no analysis of radiographic progression of arthritis was performed—likely because of the abbreviated time span—this study by Khan et al. helped to better contextualize the symptom-based natural history of patients who initially have FAIS.

The subgroup analyses revealed several important findings. Bolstering the work of Wyles et al,²⁵ patients in the current study with signs of instability and impingement were the fastest to radiographically progress in terms of Tönnis grade. These dysplastic radiographic findings were encountered in all 4 patients whose operative Tönnis grades were worse compared with the nonoperative side and, again, in all 7 patients who progressed to hip arthroplasty. Of note, mixed findings of impingement and instability were encountered in only 5 of the 25 patients (20%) whose operative hip Tönnis grades were better than those of the nonoperative hip. Patients who had impingement findings alone in the absence of instability were encountered in the group that experienced the greatest delay in radiographic progression of osteoarthritis. For at-risk, symptomatic patients who are older with features of both impingement and instability, the 2 senior surgeons (B.T.K., D.H.N.) advocate for a minimalistic approach centered on labral debridement, small periportal capsulotomy, and early mobilization. A head-to-head comparison for this at-risk cohort is the subject of future study. Increased preoperative age and Tönnis grade were also thematic risk factors in the progression of osteoarthritis after hip

arthroscopy, as previously studied.^{7,13,15} In terms of the 8 patients (13 hips, 5 bilateral) who progressed to arthroplasty, 7 of the procedures occurred on the side that underwent hip arthroscopy and 6 occurred on the nonoperative side, representing a near-even distribution. More importantly, this population was evaluated after the age of 40 years and were likely unable to experience meaningfully favorable alterations in the natural history of the joint. It is important to note that the decision to proceed with arthroplasty may be a patient-related factor rather than purely related to radiographic progression or the patient's hip arthroscopy.

This study has several limitations. We treated the contralateral hip as an internal control when comparing patients. Even though not all hips are symmetrically designed, the contralateral hip has been established by Wyles et al²⁵ to be an appropriate comparison in the literature. Khan et al⁹ demonstrated at 7-year follow-up that half the contralateral hips become symptomatic and nearly one-fourth progress to hip arthroscopy, suggesting that there may be more symmetry than expected. It is well established that symptomatology does not always match imaging, but we attempted to mitigate this by confirming that both hips had radiographic features of FAIS in each of the 100 patients. The contralateral hips are an imperfect comparator in that there is no way to know their prognosis at inception compared with that of the operated hips. In this vein, not all hips started at the same Tönnis grade, which resulted in differential head-to-head comparisons for 5 patients at long-term follow-up. Our report purely addressed radiographic progression without any PROMs. Although there were no baseline PROMs available for the study, radiographs suggestive of joint degeneration remain an important clinical metric, as they indicate a decade-long window of opportunity to perform arthroscopy or, alternatively, a prerequisite sign of joint degeneration that would indicate a hip replacement if an arthroplasty surgeon were consulted. Another limitation is the use of Tönnis grading to evaluate radiographic progression of osteoarthritis. Even though this is the most commonly used metric and is consistently evaluated from a medicolegal and billing documentation standpoint, it carries a variable interrater reliability ranging from 0.55 to 0.99¹² and has recently demonstrated moderate reliability in grading osteoarthritis.¹⁸ Anteroposterior pelvis radiographs may also not provide the ideal radiographic view to assess joint degeneration. Magnetic resonance imaging to evaluate cartilage status may have been ideal, but this was logistically and fiscally impractical to accomplish; moreover, a recent study by Pullen et al¹⁹ showed that magnetic resonance imaging scans demonstrated strong reliability in evaluating subchondral cysts but did not improve the interobserver variability of grading hip arthritis. Ideally, this study would have included more surgeons for generalizability. Even though labral repair, femoroplasty, and capsular closure are becoming the gold standard in hip arthroscopy, each surgeon has variable technical skillsets that may not be generalizable to all.²¹ Another limitation is the rate of loss to follow-up (26%) of geographically available patients. Although this rate is

similar to or better than those of other long-term studies,^{1,2,11,14} the study remains at risk for selection bias. In addition, a large number of patients were classified as geographically unavailable, further reducing the actual follow-up rate and increasing the risk of selection bias. At our institution, data loss most commonly occurred as paper charts were transitioned to the electronic health record; moreover, many patients who traveled for surgery were out of a reasonable geographic region for follow-up. Importantly, more patients included in the study would have been ideal. However, the best long-term data evaluating any modern hip arthroscopy technique (femoroplasty) to date compared 17 hips with 23 hips.¹⁴ Our report assessed 200 hips in 100 patients, representing the largest cohort with long-term follow-up in whom modern hip arthroscopy techniques were evaluated, and was the first to contextualize the operation in terms of joint preservation.

CONCLUSION

Although the majority of patients (70%) undergoing hip arthroscopy for FAIS did not experience differences between operative and nonoperative hips in terms of the radiographic progression of osteoarthritis, the natural history may be favorably altered for 25% of patients whose Tönnis grade was better after undergoing arthroscopic correction. Modern hip arthroscopy indications and techniques represent a valid joint preservation procedure conferring a relative risk reduction of 42% in the progression of osteoarthritis. Arthroscopy for mixed patterns of impingement and instability for which arthroscopy was performed were the fastest to degenerate.

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