

Preoperative Magnetic Resonance Imaging Offers Questionable Clinical Utility, Delays Time to Hip Arthroscopy, and Lacks Cost-Effectiveness in Patients Aged ≤ 40 Years With Femoroacetabular Impingement Syndrome: A Retrospective 5-Year Analysis



Prem N. Ramkumar, M.D., M.B.A., J. Matthew Helm, M.D., Ava S. Berrier, M.S., Jose F. Vega, M.S., M.D., Sercan Yalcin, M.D., Kyle N. Kunze, M.D., Joshua D. Harris, M.D., and Benedict U. Nwachukwu, M.D., M.B.A.

Purpose: To assess the clinical utility of preoperative magnetic resonance imaging (MRI) and quantify the delay in surgical care for patients aged ≤ 40 years undergoing primary hip arthroscopy with history, physical examination, and radiographs concordant with femoroacetabular impingement syndrome (FAIS). **Methods:** From August 2015 to December 2020, 1,786 consecutive patients were reviewed from the practice of 1 fellowship-trained hip arthroscopist. Inclusion criteria were FAIS, primary surgery, and age ≤ 40 years. Exclusion criteria were MRI contraindication, reattempt of conservative management, or concomitant periacetabular osteotomy. After nonoperative treatment options were exhausted and a surgical plan was established, patients were stratified by those who presented with versus without MRI. Those without existing MRI received one, and any deviations from the surgical plan were noted. All preoperative MRIs were compared with office evaluation and intraoperative findings to assess agreement. Demographic data, Hip Disability and Osteoarthritis Outcome Score (HOOS)-Pain, and time from office to MRI or arthroscopy were recorded. **Results:** Of the patients indicated by history, physical examination, and radiographs alone (70% female, body mass index 24.8 kg/m^2 , age 25.9 years), 198 patients presented without MRI and 934 with MRI. None of the 198 had surgical plans altered after MRI. Patients in both groups had MRI findings demonstrating anterosuperior labral tears that were visualized and repaired intraoperatively. Mean time from office to arthroscopy for patients without MRI versus those with was 107.0 ± 67 and 85.0 ± 53 days, respectively ($P < .001$). Time to MRI was 22.8 days. No difference between groups was observed among the 85% of patients who surpassed the HOOS-Pain minimal clinically important difference (MCID). **Conclusion:** Once indicated for surgery based on history, physical examination, and radiographs, preoperative MRI did not alter the surgical plan for patients aged ≤ 40 years with FAIS undergoing primary hip arthroscopy. Moreover, preoperative MRI delayed time to arthroscopy. The necessity of routine preoperative MRI in the young primary FAIS population should be challenged.

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Femoroacetabular impingement syndrome (FAIS) is an increasingly common cause of nonarthritic hip pain primarily affecting young adults, defined by a constellation of symptoms, physical examination

findings, and radiographic features indicating abnormal morphology of the femur (cam morphology) or the acetabulum (pincer morphology).¹⁻³ The abnormal morphology of the femur or acetabulum is believed to

From the Department of Orthopaedic Surgery, Brigham & Women's Hospital, Boston, Massachusetts, U.S.A. (P.N.R.); the Department of Orthopaedic Surgery, McGovern Medical School University of Texas Health Science Center, Houston, Texas, U.S.A. (J.M.H.); the Department of Orthopaedic Surgery, Baylor College of Medicine, Houston, Texas, U.S.A. (A.S.B.); the Sports Health Center, Cleveland Clinic, Cleveland, Ohio, U.S.A. (J.F.V.); the Department of Sports Medicine, Yale School of Medicine, New Haven, Connecticut, U.S.A. (S.Y.); Houston Methodist Orthopedics & Sports Medicine, Houston, Texas, U.S.A. (J.D.H.); and the Center for Hip Preservation, Hospital for Special Surgery, New York, New York, U.S.A. (P.N.R., K.N.K., B.U.N.).

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Address correspondence to Prem N. Ramkumar, M.D., M.B.A., 75 Francis St, Boston, MA 02115, U.S.A. E-mail: premrakumar@gmail.com

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result in dynamic contact between the acetabular rim and the proximal femur which, over time, leads to hip pain, acetabular labral injury, and possibly hip osteoarthritis.⁴

Treatment of FAIS remains controversial. Although arthroscopy improves symptoms better than nonsurgical options, both operative and nonoperative modalities improve symptoms.⁵⁻⁹ Nonetheless, hip arthroscopy for FAIS has grown tremendously over the past 15 years.¹⁰⁻¹³ From 2011 to 2018, the incidence of hip arthroscopy for FAIS increased 85%.^{14,15} Recent data suggests that early surgical intervention (within 6 months of symptom onset) in the form of hip arthroscopy may yield better outcomes compared with delayed surgical intervention, suggesting that time to hip arthroscopy from presentation may be a critical factor.⁶

Hip magnetic resonance imaging (MRI) is an expensive advanced imaging modality routinely ordered to aid in the evaluation of FAIS, averaging \$2,114 per patient.¹⁶ While limited, there already exist data to suggest that the routine use of MRI is not cost-effective in the diagnosis and treatment of FAIS.¹⁷ However, the clinical utility of MRI in the setting of a concordant history, physical, and plain radiographs has not yet been challenged. The use of advanced imaging remains a primary driver of rising health care costs in the United States.¹⁸ In an increasingly value-conscious environment, it is important to critically evaluate the clinical utility of MRI as hip arthroscopy volume continues to rise. Clinical utility is defined by any change in the decision to operate or the surgical plan, consisting of femoroplasty, acetabuloplasty, and labral repair, based on information from the preoperative MRI.

The purpose of this study was to assess the clinical utility of preoperative MRI and quantify the delay in surgical care for patients aged ≤ 40 years undergoing primary hip arthroscopy with history, physical examination, and radiographs concordant with FAIS. We hypothesized that preoperative hip MRI adds little to no diagnostic or therapeutic value in patients ≤ 40 indicated for arthroscopy to correct FAIS, and that routinely pursuing preoperative hip MRI delays time to surgery.

Methods

Patient Selection

This study was approved by the institutional review board (IRB no. 21-470) as exempt status (retrospective chart review). We retrospectively identified patients undergoing hip arthroscopic surgery for treatment of FAIS at a quaternary referral center from August 27, 2015, to December 31, 2020. Patients were indicated for surgery only after a period of failed nonoperative management, including activity modification, physical therapy, and nonsteroidal anti-inflammatory medications, intraarticular hip injections, or both. All surgeries

were performed by 1 fellowship-trained hip arthroscopist with 12 years of arthroscopy postfellowship experience, handling ~ 300 cases per year. Inclusion criteria were documented history, physical examination, and plain radiographic findings (cam, pincer, or mixed deformities) consistent with FAIS in patients age ≤ 40 years with no previous hip surgery undergoing primary hip arthroscopy. The age threshold was arbitrarily defined. Exclusion criteria included overt acetabular dysplasia (defined by lateral center edge angle $< 20^\circ$), underlying hip osteoarthritis (Tonnis grade ≥ 2), patients with a contraindication to undergo MRI, patients who elected to reattempt an additional round of conservative management, and patients who underwent a concomitant periacetabular osteotomy or were otherwise delayed by extraneous factors (i.e., pursuit of intraarticular injection or social circumstances). As an example, patients who presented with atypical hip pain, suspicion of stress reaction, synovitis, or pain out of proportion did not meet inclusion criteria for consideration, as they failed to have FAIS concordance across the history, physical examination, and radiographs.

Once primary patients age ≤ 40 were diagnosed with FAIS (concordant history, physical examination, and radiographs) and had maximally exhausted nonoperative treatment modalities, the plan was established to perform hip arthroscopy consisting of femoroplasty, acetabuloplasty, and labral repair. Where appropriate, the lead surgeon performed selective debridement and labral reconstruction. In the event a labral reconstruction was necessary for this primary population under age 40, graft was readily available if necessary. Patients were then stratified into 2 groups for comparison: those who presented without existing MRI versus those with MRI. MRIs in those who presented without MRI were ordered according to protocol and prior authorization concerns, although this was not specifically measured in the present study; these 3T MRIs were ordered without contrast and were performed within the health system region at 1 of 6 different locations. MRIs among those who presented with MRI were of mixed quality (1.5T, 3T, and other) and were both with and without contrast. The radiologist and lead surgeon reviewed the MRIs if ordered within the health system for all patients, without MRI and with MRI. Only the lead surgeon reviewed the MRI for patients who presented with MRI outside the health system. Postoperatively, patients were flatfoot weightbearing, referred to early physical therapy, and placed in a brace for the first 2 weeks with flexion restricted beyond 90° .

Data Collection

Patient charts were retrospectively reviewed to record plain radiographic and MRI findings, documented history and physical examination findings, and baseline

Table 1. Demographic data for cohort of included patients

Characteristic	Overall	Without MRI	With MRI
Number of cases	1,132	198	934
Age (y)	24.8 ± 7.4	25.1 ± 7.0	24.7 ± 7.7
Body mass index (kg/m ²)	25.6 ± 5.3	24.8 ± 5.4	25.8 ± 6.1
Female sex	792 (70)	129 (70)	663 (71)

Data are mean ± standard deviation or n (%).
Abbreviation: MRI, magnetic resonance imaging.

demographic data. Clinical diagnostic criteria for FAIS were noted as groin or hip pain, pain in the anterior impingement or FABER positions, and limited hip flexion and internal rotation. Radiographic diagnostic criteria for FAIS were noted as evidence of a cam morphology on the femur, pincer lesion on the acetabulum (crossover sign), a mixed cam-pincer deformity, Tönnis grade <2, α angle >55°, lateral center edge angle >40°. MRI findings of presence of labral tear and location were recorded, and the preoperative MRI interpretations were compared to the in-office evaluation consisting of history, physical examination, and plain radiographs and the intraoperative findings at the time of hip arthroscopy to assess for agreement.

In addition to baseline demographic data, time from the last office visit whereby the next step was established to be hip arthroscopy was recorded in both groups; time from this office visit to MRI was also recorded in the group who presented without MRI. Patients were either called or seen again in the office after acquiring the MRI to review the findings and schedule surgery. Hip Disability and Osteoarthritis Outcome Score (HOOS)-Pain scores were prospectively collected preoperatively and at 1 year follow-up.

Statistical Analysis

The basic data analysis required no analytic expertise and was done internally. Statistics were performed in Excel (Microsoft, Redmond, WA).

Results

During the study period, a total of 1,786 patients underwent hip arthroscopy. Of the patients who met criteria and were indicated for hip arthroscopy, 70% were female, mean body mass index was 24.8 kg/m², and mean age was 25.9 years (Table 1). Of the patients indicated for hip arthroscopy based on history, physical examination, and radiographs and whose plan was FAIS correction (acetabuloplasty, femoroplasty, labral repair), 198 patients presented without MRI (17.5%) versus 934 with MRI (82.5%) (Fig 1).

After acquiring and reviewing the preoperative MRI for the 198 patients who presented without MRI, none had surgical plans altered with respect to the decision to operate, the technical plan, or the requested equipment. All patients in both groups had preoperative MRI findings demonstrating anterosuperior labral tears that

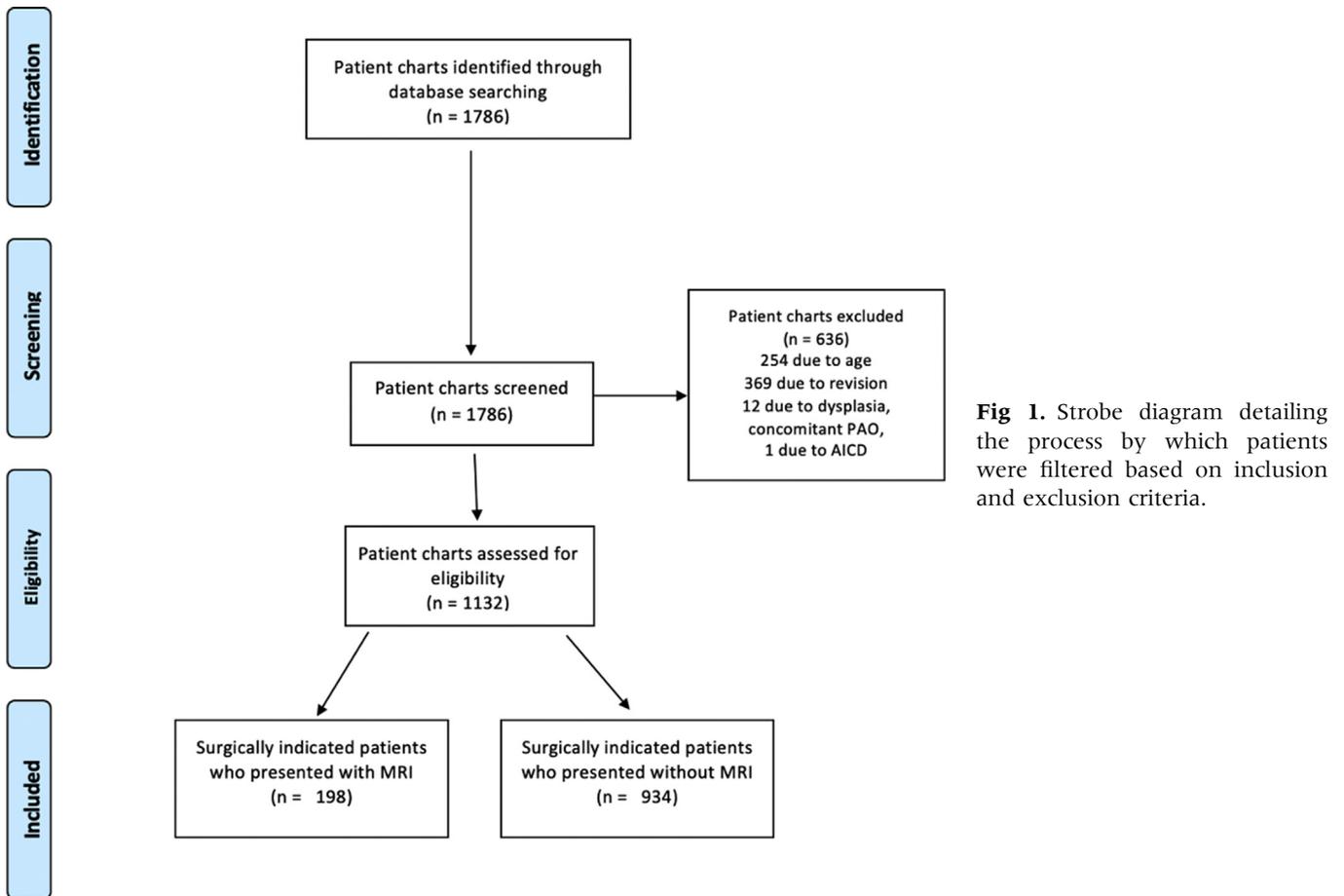
were re-demonstrated upon surgeon review and repaired intraoperatively during arthroscopy (Table 2). Radiologists reported labral pathology in 641 of the 647 MRIs within the system; upon surgeon review, all 647 had labral pathology. No patients were amenable to selective debridement or necessitated primarily labral reconstruction, although graft was readily available. Not a single patient in either group was found to have the unexpected diagnosis of advanced arthritic changes, osteonecrosis, tumor (i.e., synovial chondromatosis, pigmented villonodular synovitis), or a stress fracture. MRI demonstrated questionable articular cartilage pathology in 7 patients; however, none required additional surgical treatment.

No patient in either group required primary labral reconstruction or labral debridement. The mean time from the office visit (when the surgical plan was finalized) to the operating room was 107.0 ± 67 and 85.0 ± 53 days for patients who presented without versus with MRI, respectively ($P < .001$). Time to noncontrast MRI acquisition was 22.8 days for the patients without MRI. Follow-up for HOOS-Pain was available at 1 year among 82% of patients. A total of 85.1% of patients surpassed the minimal clinically important difference (MCID) of 9 for HOOS-Pain, with no statistical difference in rates between the 2 groups (85.3% vs. 84.9%, $P = .18$). A total of 11% of patients improved but did not reach the MCID for HOOS-Pain, and 4% worsened.

Discussion

Despite routine use in the preoperative assessment of patients ≤40 presenting with FAIS and already indicated for surgery, the acquisition of preoperative hip MRI was found to offer no clinical utility, as the imaging did not affect the decision to operate or the preoperative plan. Moreover, the routine use of preoperative hip MRI was found to delay surgery by >3 weeks, delaying time to arthroscopy and wasting resources in the process.

After exhausting nonoperative modalities and indicating 1,132 patients under age 40 for primary hip arthroscopy with FAIS correction (femoroplasty, acetabuloplasty, labral repair), and establishing the plan to operate based on history, physical examination, and radiographs alone, patients were stratified by those who presented without MRI ($n = 198$, 17.5%) vs. with MRI ($n = 934$, 82.5%). For the 198 patients who later acquired preoperative MRI, neither the decision to operate nor the preoperative plan was altered for a single patient upon imaging review. Patients in both groups had preoperative MRI findings demonstrating anterosuperior labral tears that were re-demonstrated and repaired intraoperatively during arthroscopy. Moreover, acquiring the preoperative MRI delayed surgery by an average of 22.8 days, which was a statistically significant difference.



For primary patients age ≤ 40 indicated for femoroplasty, acetabuloplasty, and labral repair, the history, physical examination, and plain radiographs provided sufficient information, regardless of whether they had an MRI. All patients with preoperative MRIs revealed the same soft tissue pathology: anterosuperior labral tear. Additionally, radiology reports should not be the basis for authorizing surgery, as the surgeon review found 6 undocumented labral tears. While cartilage pathology was present in 7 patients, this was not actionable information. More importantly, no “surprise” clinical diagnoses were encountered (osteonecrosis, stress fracture, synovial chondromatosis, pigmented villonodular synovitis, infection) once the patient had already exhausted nonoperative management for FAIS and was indicated for surgery based on a nuanced history, physical examination, and plain radiographs from a hip arthroscopist.

Moreover, the routine use of preoperative hip MRI was found to delay surgery by >3 weeks, delaying time to arthroscopy and potentially impacting outcomes, although in this small cohort, no difference was found when comparing prevalence of reaching the MCID.⁶ Although MRI costs were not directly measured for

this cohort, lost health care resources total an approximate value of \$2,393,048 for this cohort of 1,132 patients.¹⁴ The indirect costs associated with the preconceived notion that MRI is necessary before referral to a hip arthroscopist would only further drive

Table 2. Patients with history, clinical exam, radiographic findings, and MRI consistent with FAIS

Factor	Overall
Clinical exam consistent with FAIS (%)	100
History consistent with FAIS (%)	100
Radiographic findings consistent with FAIS (%)	100
Surgeon review: MRI presence of anterosuperior labral tear (%)	100
Intraoperative presence of anterosuperior labral tear (%)	100
Time from surgical indication visit to MRI (patient without MRI; mean days)	22.8
Time from surgical indication visit to operating room (mean days)	
Without MRI (n = 198)	107.0 \pm 67
With MRI (n = 934)	85.0 \pm 53

Data are mean \pm standard deviation.
Abbreviations: FAIS, femoroacetabular impingement syndrome; MRI, magnetic resonance imaging.

this cost estimate when taking into account patients who were never indicated for surgery and not captured in this study. Taken together, these data suggest that the use of preoperative MRI may be ineffective from both clinical and cost perspectives in young primary patients who present with a clinical picture consistent with FAIS based on history, physical exam, and radiographs alone. Rather, routine use of MRI may lead to excess cost, treatment delay, and theoretically worse clinical outcomes.⁶

As the United States continues to transition to a value-based health care system, it is becoming increasingly important to critically evaluate all facets of patient care to maximize quality and minimize cost, thereby optimizing value.^{19,20} One of the primary drivers of exorbitant health care spending in the United States is advanced imaging, which represents the fastest rising cost segment in United States health care spending.^{17,18} For reasons that remain unclear, preoperative hip MRI is routinely performed as part of the work-up for suspected FAIS. Anthony et al.¹⁶ recently performed a prospective study in which they found the median cost of a noncontrast hip MRI to be \$2,114. While their study was limited to the state of Iowa, their results provide a reasonable estimate for the average cost of a hip MRI, as Iowa ranks 27th of the 50 states and District of Columbia in terms of personal health care spending per capita. Cunningham et al.¹⁷ performed a cost-utility analysis to determine whether hip MRI adds value in diagnosing FAIS. In support of our findings, they found that history and physical exam alone, with plain radiographs of the hip, was the most cost-effective strategy to diagnose FAIS. The addition of MRI (or magnetic resonance angiogram [MRA]) did not provide any additional value and increased costs. They concluded that advanced imaging in the form of hip MRI has little if any role in the diagnosis of FAIS. This further supports our conclusion that routine preoperative hip MRI adds limited utility in primary patients age ≤ 40 with FAIS if the history, examination, and radiographs are concordant. Thus, routine preoperative use of MRI is questionable from the perspective of the patient, surgeon, and insurer.

Our data quantify the statistically significant time delay to hip arthroscopy among patients who present without MRI. The magnitude of a 3-week delay may or may not be clinically relevant. However, given that postoperative outcomes in FAIS patients undergoing hip arthroscopy improve with earlier intervention, time to arthroscopy represents a modifiable risk factor that may translate to improved quality.⁶ While 3 weeks may not seem significant, consider that most hip arthroscopy surgeons require a trial of nonoperative treatment (activity modification, regimented physical therapy, possibly intra-articular injection, etc.) for at least 6 to 8 weeks as part of the algorithm for treating FAIS. Taken

together, the time required to conclude that nonoperative treatment has failed, surgical intervention is indicated, and scheduling the arthroscopy is roughly only 12 weeks.^{7,21} This does not take into account the amount of time that it takes for patients to seek and receive care from the time of symptom onset with the correct specialist, which only further shortens the window for intervening surgically.

Kahlenberg et al.²² reported that patients with FAIS saw an average of 4.0 health care providers, underwent 3.4 diagnostic imaging tests, and tried an average of 3.1 treatment modalities, resulting in a cost of \$2,456.97, before even receiving the diagnosis of FAIS. Beyond the potential improvement in patient-reported outcomes,⁶ delay to hip arthroscopy in low-resource environments waiting on an MRI may increase the risk that a patient is prescribed narcotics, thereby increasing the risk of opioid use disorder, as seen in the Covid pandemic that worsened the underlying opioid crisis.²³ Thus, even a 3-week delay may be meaningful in avoiding exacerbation symptom states. The difference of 85.0 days for those with MRI and 22.8 days after acquiring MRI helps elucidate 2 points: (1) surgeon and operating room availability is an important driver, and (2) the dramatically shorter 3-week waiting period from MRI underscores that surgical dates were likely saved as placeholders, since the MRI pretest probability of changing management was low. It is important to note that the delay in the group without MRI should not be interpreted to mean that all patients referred to a hip arthroscopist should present with an MRI. On the contrary, patients should be referred to a hip arthroscopist to perform a nuanced history, physical examination, and radiographic assessment while retaining the option to order an MRI of the hip if indicated. To optimize the patient experience and appropriately use resources, referral to the hip arthroscopist without routine acquisition of MRI represents a more judicious workflow.

Overall, our study demonstrates that FAIS can be accurately diagnosed with a concordant history, physical examination, and plain radiographs of the hip alone. The use of preoperative hip MRI adds questionable clinical value, but instead increases costs and delays time to arthroscopy. The use of routine preoperative hip MRI in patients presenting with FAIS should be challenged by all relevant stakeholders—patients, physicians, payors—from both clinical and value-based perspectives. Future studies are warranted to determine the generalizability and impact of relying solely on history, physical examination, and radiographs to treat primary hip arthroscopy patients with FAIS.

Limitations

This study has several limitations. The data collected come from the practice of a single fellowship-trained hip arthroscopist at a quaternary referral center. This

may limit the generalizability of the study results, particularly the time to acquire an MRI and the time from MRI to arthroscopy. Many variables exist in this process, namely patient, insurer, and surgeon availability. In this report, delay to the operating room of 85 (with MRI) and 107 (without MRI) days was a product of preauthorization approval, surgeon and operating room availability, and patient scheduling. Thus, generalizing time as a surrogate for delay would be better served by evaluating additional institutions, health systems, surgeon practices, or patient populations. In the same vein, while the lead surgeon does selectively perform labral debridement (i.e., os acetabuli) and labral reconstruction (i.e., revision arthroscopy), there was lack of variation in the treatment of the labrum.²⁴ Additionally, the readily available graft in the event of labral reconstruction is not generalizable. Although primary labral reconstruction was not necessary for this select primary population, more data are required before abandoning preparation for the irreparable labrum.

Additionally, the study is retrospective in nature, and only patients who elected for surgery were assessed longitudinally. Ideally, a prospective, multicenter study that longitudinally follows the 2 patient groups would better assess the reproducibility of our findings. Further, we were unable to assess the impact of attempting to book surgery without a preoperative MRI to determine the frequency of prior authorization denials, which may drive the practice pattern of routine acquisition; this represents an area of future study.

It is important to emphasize that we do not recommend preoperative MRI be wholly abandoned should there be any discordance in the history, physical examination, or radiographs among primary patients with FAIS under age 40, particularly in cases where trauma, infection, and oncologic etiologies remain on the differential. Preoperative MRI remains clinically useful to better evaluate subtle radiographic findings such as early osteoarthritis or a hypertrophic labrum in dysplasia that represents more than mild disease. Patients who presented with atypical hip pain, suspicion of stress reaction, synovitis, or pain out of proportion were not evaluated in this study, as they failed to be diagnostically concordant with FAIS across the history, physical examination, and radiographs. In this case, MRI is certainly important in diagnosis and management, but these patients were never captured in the study with strict inclusion criteria. Future studies will further examine the impact of referral patterns to high-volume hip arthroscopists and prospectively evaluate the impact of pursuing arthroscopy without MRI.

Conclusion

Once indicated for surgery based on history, physical examination, and radiographs, preoperative MRI did

not alter the surgical plan for patients aged ≤ 40 years with FAIS undergoing primary hip arthroscopy. Moreover, preoperative MRI delayed time to arthroscopy. The necessity of routine preoperative MRI in the young primary FAIS population should be challenged.

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