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Research article

Arthroscopic hip preservation surgery practice patterns: an international survey

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ABSTRACT

To design and conduct a survey analyzing pre-, intra- and post- hip arthroscopy practice patterns among hip arthroscopists worldwide. A 21-question, IRB-exempt, HIPAA-compliant, cross-sectional survey was conducted via email using SurveyMonkey to examine pre-operative evaluation, intra-operative techniques and post-operative management. The survey was administered internationally to 151 hip arthroscopists identified from publicly available sources. Seventy-five respondents completed the survey (151 ± 116 hip arthroscopy procedures per year; 8.6 ± 7.1 years hip arthroscopy experience). Standing AP pelvis, false profile and Dunn 45 were the most common radiographs utilized. CT scans were utilized by 54% of surgeons at least some of the time. Only 56% of participants recommended an arthrogram with MRI. Nearly all surgeons either never (40%) or infrequently (58%) performed arthroscopy in Tönnis grade-2 or grade-3 osteoarthritis. Surgeons rarely performed hip arthroscopy on patients with dysplasia (51% never; 44% infrequently). Only 25% of participants perform a routine 'T' capsulotomy and 41% close the capsule if the patient is at risk for post-operative instability. Post-operatively, 52% never use a brace, 39% never use a continuous passive motion, 11% never recommended heterotopic ossification prophylaxis and 30% never recommended formal thromboembolic disease prophylaxis. Among a large number of high-volume experienced hip arthroscopists worldwide, pre-, intra- and post- hip arthroscopy practice patterns have been established and reported. Within this cohort of respondents, several areas of patient evaluation and management remain discordant and controversial without universal agreement. Future research should move beyond expert opinion level V evidence towards high-quality appropriately designed and conducted investigations.

INTRODUCTION

Hip arthroscopy is a rapidly growing, evolving area within arthroscopic Orthopaedic Surgery and has prompted an exponential growth of publications from authors worldwide [1–4]. Coupled with advancements in imaging modalities such as CT and MRI, as well as specialized instrumentation and techniques for hip arthroscopy, surgeons have become better equipped to safely and effectively treat pathology in and around the hip joint. One study demonstrated an 18-fold increase in the number of hip arthroscopies performed by surgeons who took Part II of the American Board of Orthopaedic Surgery exam in 2009 compared with 1999 [5]. However, there is no uniformity regarding preoperative workup, surgical technique, or postoperative protocols among surgeons who perform hip arthroscopy. As for most fields in surgical disciplines with evolving surgical indications, surgeons often emulate techniques from their training. As the quantity and quality of arthroscopic hip preservation literature advances, it is not only useful but beneficial to understand practice patterns of

Table I. Questions about experience of hip preservation surgeons

1. Approximately how many arthroscopic hip preservation surgeries did you perform for FAI and/or labral tears over the past 12 months?
2. Approximately how many open hip preservation surgeries did you perform for FAI and/or labral tears over the past 12 months?
3. How many years have you been performing hip preservation surgery?

experienced hip surgeons regarding evaluation and management of patients with hip pain. With this knowledge, hip surgeons can enhance their own techniques to provide patients the best possible outcome. The purpose of this investigation was to design and conduct a survey analyzing pre-, intra- and post- hip arthroscopy practice patterns among hip arthroscopists across the world. The authors hypothesized that a lack of universal agreement among high volume international hip arthroscopists exists on most aspects of management.

METHODS

A 21-question, IRB-exempt, HIPAA-compliant survey was conducted using SurveyMonkey (http://www.surveymonkey.com). The survey was emailed to hip preservation surgeons identified one of four ways: (i) members of ISHA (International Society for Hip Arthroscopy), (ii) ANCHOR (Academic Network for Conservative Hip Outcome Research), (iii) MAHORN (Multicenter Arthroscopy of the Hip Outcomes Research Network) and (iv) Pubmed search of 'hip arthroscopy'. Invitations were sent to authors found within the first 200 citations, who weren't previously identified. In all, 151 hip preservation surgeons were contacted. If no response within 2 weeks, another attempt was made by email. A total of four reminder emails were sent. The survey was not endorsed by any regional, national or international medical, surgical or hip preservation society.

Three of the questions posed concerned the surgeon's arthroscopic and open hip preservation surgery volume and years of experience (Table I). Eight questions concerned preoperative evaluation (Table II). Five of the questions concerned intra-operative decision-making and technique (Table III) and five concerned post-operative management and rehabilitation (Table IV).

Results of each were collected and kept confidential. All data were organized via the SurveyMonkey web tool. Survey participation and completion required each participant to answer every question. Descriptive statistics were calculated for each question. Likert-style questions were utilized when appropriate. Continuous variable data were reported as mean ± SD. Categorical data were reported as frequencies with percentages. We have chosen to not attempt to define consensus among the respondents. Instead, we have included the data available for the reader to review and let the reader assign consensus agreement, in part because of the vast array of definitions for consensus in the absence of evidence or clinical practice guidelines on hip arthroscopy.

RESULTS

A total of 75 responses (50% response rate) were received from surgeons across eight countries worldwide (United States, Japan, Switzerland, United Kingdom, Scotland, Canada, Brazil, Australia). Surgeons performed 151 ± 116 hip arthroscopy procedures annually (median 120 procedures per year; interquartile range 60–250) and had 8.6 ± 7.1 years of hip arthroscopy experience. Twenty-six (35%) respondents also performed open hip preservation surgeries in the past 12 months, with a mean of 33 ± 34.9 open cases for the surgeons who performed at least one open procedure in the past 12 months.

Preoperative evaluation

In patients with a clear diagnosis of symptomatic femoroacetabular impingement (FAI), 68% of surgeons utilized at least one preoperative local anesthetic/corticosteroid some of the time (Table II). More surgeons utilized a standing weight-bearing AP pelvis (69%) rather than a supine (35%). The standing false profile view was performed in over half of patients (52%). The supine Dunn 45° was the most frequently performed lateral radiograph (51%), followed by the cross-table lateral (28%), frog-leg lateral (24%), supine Dunn 90° (14%), Lauenstein lateral (4%) and Dunn 70° (1%). Over half of the surgeons (54%) ordered a preoperative CT at least some of the time. Only 4% of surgeons never obtained a preoperative CT. Regarding preoperative MRI, 72% obtained an axial oblique series, 41% obtained a radial series, 56% utilized arthrogram series and 7% obtained 3D reconstructions. Interestingly, several surgeons commented that if a 3-Tesla magnet strength was utilized, no arthrogram was obtained.

Table II. Questions and answer choices about preoperative evaluation

4. Do you utilize pre-operative intra-articular local anesthetic/steroid injection in a patient with a clear diagnosis of symptomatic FAI and labral injury?	• Always (100% of the time) 8.5% • Frequently (67–99% of the time) 37% • Some of the time (33–66% of the time) 23% • Infrequently (1–32% of the time) 24% • Never (0% of the time) 8.5% • Other (please specify)
5. Which radiographs do you routinely obtain in patients with hip pain?	• Standing AP pelvis 69% • Supine AP pelvis 35% • Standing AP hip 4.2% • Supine AP hip 7.0% • Standing false profile 52% • Supine cross-table lateral 28% • Supine frog-leg lateral 24% • Supine Lauenstein lateral 4.2% • Supine Dunn 45 lateral 51% • Supine Dunn 90 lateral 14% • Other (please specify)
6. How often do you perform CT scan on patients with symptomatic FAI and labral injury that are scheduled to undergo surgery?	• Always (100% of the time) 17% • Frequently (67–99% of the time) 17% • Some of the time (33–66% of the time) 20% • Infrequently (1–32% of the time) 42% • Never (0% of the time) 4% • Other (please specify)
7. On preoperative MRI, which series do you routinely order?	• Coronal 93% • Sagittal 93% • Axial 83% • Axial oblique (parallel to long axis of femoral 72% neck) • Radial 41% • Arthrogram (MRA) 56% • 3D reconstructions 7.0% • Other (please specify)

(continued)

8. What percentage (%) of your hip arthroscopy patients have Tönnis grade-2 or grade-3 osteoarthritis?	• 0% 39% • 1–32% 58% • 33–66% 2.8% • 67–99% 0% • 100% 0% • Other (please specify)
9. What percentage (%) of your hip arthroscopy patients have borderline dysplasia? Borderline dysplasia (lateral center edge angle 20 - 25 degrees; Tonnis angle 10 - 15 degrees; anterior center edge angle 20 - 25 degrees).	• 0% 7.0% • 1–32% 80% • 33–66% 11% • 67–99% 1.4% • 100% 0% • Other (please specify)
10. What percentage (%) of your hip arthroscopy patients have dysplasia? Dysplasia (lateral center edge angle <20 degrees; Tönnis angle >15 degrees; anterior center edge angle <20 degrees).	• 0% 51% • 1–32% 44% • 33–66% 4.2% • 67–99% 1.4% • 100% 0% • Other (please specify)
11. Would you perform arthroscopic hip preservation surgery in a 20 year old athlete with clear radiographic FAI and a labral tear, but is completely asymptomatic (no pain, no loss of function, no limitations).	• Yes; To prevent pain, loss of function, improve function 5.6% • Yes; To prevent osteoarthritis 2.8% • Yes; To improve sports activity level 1.4% • No; There is no evidence to support it. 94% • Other (please specify)

Further, although several surgeons recommended utilization of T2-mapping, there were no recommendations for dGEMRIC, T2* mapping, Na^{+} imaging, or any other advanced 'physiologic' MRI. Nearly all surgeons either never (40%) or infrequently (58%) performed arthroscopy for patients with Tönnis grade-2 or grade-3 osteoarthritis. Surgeons rarely performed hip arthroscopy on patients with dysplasia (51% never; 44% infrequently) or borderline dysplasia (7% never; 80% infrequently). Regarding surgery on asymptomatic patients (no pain, no loss of function, no limitations) with clear radiographic FAI and labral tear, four surgeons (5.3%) indicated they would perform arthroscopy to prevent pain or loss of function, two (2.7%) would perform arthroscopy to prevent osteoarthritis and one (1.3%) would perform arthroscopy to improve sports activity level (Table VI).

Intraoperative evaluation

Intra-operatively, surgeon decision-making and technique was highly variable. Regarding capsular management, 25% of surgeons performed a 'T' capsulotomy, 6% did not perform one at all, and 12% performed different locations and sizes of capsulotomies based on patient and surgical factors. Forty-one percent indicated they only close the capsule if the patient is at risk for post-operative instability, and 22% indicated that they do not routinely close the

Table III. Questions and answer choices about intraoperative techniques and decision making

12. What type of capsulotomy do you perform during hip arthroscopy?	• Limited interportal (anterolateral to mid-anterior, or smaller) 41% • Large interportal (extends beyond anterolateral to mid-anterior) 20% • Interportal plus 'T' extension down anterolateral femoral neck to intertrochanteric line 25% • No capsulotomy; Only capsule incision large enough for portal/cannula/instrument 5.8% • Other (please specify)—Depends on patient/surgical variables 12%
13. Are you using straight or curved drill guides for suture anchor placement during labral repair?	• Straight 68% • Curved 7.2% • Both 25%
14. What is your typical treatment of a large full-thickness articular cartilage 'wave sign' delamination injury (after appropriate acetabular osseous management)?	• Remove all unstable, loose articular cartilage to stable rims, and leave exposed bone, no microfracture or drilling 2.9% • Remove unstable, loose articular cartilage to stable rims and perform microfracture or drilling 39% • Do not remove articular cartilage, leave alone, do not integrate into labral repair suture 7.2% • Do not remove any articular cartilage, integrate articular cartilage with labral repair suture 42% • Do not remove any articular cartilage, inject fibrin glue under articular cartilage, with or without integration with labral repair suture 8.7% • Other (please specify)
15. How do you manage snapping iliopsoas, IPI, and a 3 o'clock position labral tear that has failed rest, activity modification, oral and injection anti-inflammatory medications and physical therapy?	• Labral repair 16% • Labral repair, iliopsoas tenotomy 39% • Labral repair, AIIS subspine decompression 22% • Labral repair, iliopsoas tenotomy, AIIS subspine decompression 23% • Other (please specify)
16. How do you close the capsule at the conclusion of hip arthroscopy?	• I do not routinely close the capsule 22% • I only close the capsule if patient at risk for post-operative instability (excessive soft tissue laxity, microinstability, dysplasia) 41% • Close the capsule using non-absorbable suture 26% • Close the capsule using absorbable suture 20% • Other (please specify)

Table IV. Questions and answer choices about post-operative management

17. Do you use a hip orthosis/brace following hip arthroscopy?	• Always 12% • Most of the time 14% • Some of the time 6.1% • Rarely 17% • Never 52% • Other (please specify)
18. Do you use a CPM machine following hip arthroscopy?	• Always 32% • Most of the time 15% • Some of the time 4.5% • Rarely 9.1% • Never 39% • Other (please specify)
19. Do you use derotational boots following hip arthroscopy?	• Always 14% • Most of the time 7.6% • Some of the time 3.0% • Rarely 6.1% • Never 70% • Other (please specify)
20. Do you use HO prophylaxis following hip arthroscopy?	• Always 62% • Most of the time 17% • Some of the time 6.1% • Rarely 4.5% • Never 11% • Other (please specify)
21. After hip arthroscopy, which of the following thromboembolic disease (DVT) prophylaxis do you use?	• I do not use any mechanical or chemical Prophylaxis 30% • Mechanical only (sequential compression devices, Ted hose, compression stockings, foot pumps) 12% • Pharmacologic only (aspirin, enoxaparin, rivaroxaban, warfarin) 29% • Both mechanical and pharmacologic Other (please specify) 29%

Table V. Comments from surgeons regarding preoperative intraarticular anesthetic/steroid in a patient with clear diagnosis of symptomatic FAI

Provides powerful prognostic and diagnostic information to the patient and the clinician.
It is very educational to the patient as most FAI and labral tears are insidious in onset and many people accommodate more than they realize and probably underreport symptoms. The injection helps to demonstrate to them why they are pursuing treatment.
Patients prefer to avoid steroids
If need to delay surgery
Use it as part of MR arthrogram
75% of the injections I perform are to meet preoperative insurance requirements
Some patients refuse this recommendation
Potentially damaging, uncomfortable, pointless

Table VI. Comments from surgeons regarding circumstances where they would perform arthroscopic hip preservation surgery on a 20-year-old patient with clear radiographic FAI and a labral tear, but is completely asymptomatic (no pain, no loss of function, no limitations)

For severe deformity
Unethical way to practice
I follow these patients carefully and at least 90% will become symptomatic in short period of time. This scenario usually arises when findings are on opposite asymptomatic side at the time of presentation for symptomatic index side
I would like to be able to do this, but as of right now we don't have the evidence. I treat these like the contralateral hip in a SCFE patient. I tell them as soon as they have pain, then come back in to have it treated. I wish we could treat more hips earlier in the disease process. I might also consider treating an asymptomatic contralateral hip in patients with symptomatic FAI who play at risk sports like hockey, soccer, or football.

capsule. When capsular closure was performed, 26% used non-absorbable and 20% used absorbable sutures. Most (68%) used a straight drill guide for suture anchor placement during labral repair (32% either curved or both straight and curved). When encountering a large full-thickness articular cartilage 'wave sign' delamination injury, after appropriate acetabular osseous management, most surgeons either removed all unstable, loose articular cartilage to stable rims and performed microfracture or drilling (39%), or they left the cartilage and integrated the delaminated articular cartilage into the labral repair suture (42%). Nine percent utilized fibrin glue to adhere the delaminated articular cartilage to the underlying subchondral bone. One surgeon utilized a collagen patch over a microfractured defect. In patients with a snapping iliopsoas, iliopsoas impingement (IPI) and a 3 o'clock position labral tear that failed non-operative management, 39% performed a labral repair and an iliopsoas tenotomy. An additional 23% added an anterior inferior iliac spine (AIIS) subspine decompression. However, 22% performed a labral repair in conjunction with AIIS subspine decompression without an iliopsoas tenotomy.

Post-operative evaluation

Following surgery, there was a wide variation in treatment and rehabilitation. Over half of surgeons (52%) indicated never using a brace. Although nearly half (48%) either never (39%) or rarely (9%) used a continuous passive motion (CPM), 32% always used one. Seventy percent of surgeons never utilized derotational boots. Although heterotopic ossification (HO) prophylaxis was recommended always (62%) or most of the time (17%) by over two-thirds of surgeons, 11% never recommended it. Thromboembolic disease prophylaxis recommendations were widely distributed: 30% indicated not using any, 29%

using both mechanical and pharmacologic, 29% only pharmacologic and 12% only mechanical.

DISCUSSION

The purpose of this investigation was to design and conduct a survey analyzing pre-, intra- and post-hip arthroscopy practice patterns among hip arthroscopists worldwide. The authors' hypotheses were confirmed as there was a lack of universal agreement of practice patterns of international hip arthroscopists. As the specialty continues to grow and evolve, improved evidence will improve surgeons' arthroscopic hip preservation evaluation and management so that agreement and consensus can exist.

Determining the etiology of patients presenting with atypical hip pain can be challenging, especially in young patients without signs of osteoarthritis, and the response to diagnostic intra-articular hip injections is often used to help guide treatment. However, the role of and response to diagnostic intra-articular hip injections prior to hip arthroscopy is still undefined. Kivlan *et al.* [6] reported that patients with chondral damage had greater relief from injections than patients without, but the presence of and severity of FAI and labral pathology did not influence percentage of relief from a diagnostic injection. Mathews *et al.* [7] found that intra-articular findings in patients who did not respond to intra-articular injections did not differ from patients who were responders to them, noting that some patients may have false negative results and the injection is not 100% reliable. They also noted that relief of pain from injection cannot always be attributed to intra-articular pathology seen on MRI scans. Martin *et al.* [8] reported that patients with a definite or possible labral tear, 39 and 45%, respectively, did not achieve >50% reduction of pain. Further, they noted physical exam findings such as groin pain, clicking, flexion abduction external rotation test, flexion-internal rotation-adduction test, among others, were not useful in identifying patients with greater than 50% relief from those with 50% or less. The administration of anesthetic has also been recently investigated. Byrd *et al.* [9] found ultrasound guided injections of the hip were convenient, well-tolerated, and highly accurate (98% of injections were successfully placed) [9]. Although inconsistencies were seen between pathology and response to injections, further studies will need to identify how closely a patient's response to injections correlates with their postoperative course.

The radiographic evaluation of the 3D cam deformity is suboptimally assessed on AP and lateral images of the hip, since the location of the typical pathology is not often in a plane that allows adequate assessment with these standard views. As evidenced by the numerous views obtained preoperatively, there is a lack of universal agreement on which views allow the best representation of the pathology. Ross *et al.* [10] reported their experience comparing radial reformatted CT scans with intraoperative fluoroscopic views. This information is especially relevant because, although 3D imaging is the gold standard for evaluation of FAI preoperatively, surgeons rely on intraoperative fluoroscopy to assess the amount of boney correction. They found that the highest alpha angle was located at the 1:15 o'clock face position on CT scan, while the AP 30° external rotation view yielded the highest fluoroscopic alpha angle. As suggested by Rakhra *et al.* [11], radial series may be a more appropriate sequence than axial oblique. A mean difference in alpha angle of 17° was found in their study, including 54% of patients who would have been misdiagnosed as not having a cam lesion if based solely on the axial oblique images. The use of a preoperative MRI in the evaluation of FAI is not without its limitations. The 3D reconstruction of MRI data is not readily clinically available. MRIs are expensive, have a long acquisition time, and are unable to reliably visualize articular cartilage injury and distinguish between delamination, full thickness or partial thickness injuries.

There was group universal agreement regarding the use of arthroscopy in patients with Tönnis grade-2 or grade-3. Philippon *et al.* [12] showed that patients undergoing hip arthroscopy with greater than or equal to 2 mm of cartilage were more likely to have a good outcome and report increased satisfaction. Patients with <2 mm of cartilage were 39× more likely to progress to total hip arthroplasty. Similarly, hip arthroscopy surgeons tend not to perform surgery on patients with dysplasia or borderline dysplasia, as studies show cause for concern [13,14]. There was universal agreement regarding lack of evidence for performing hip preservation surgery in a young athlete without symptoms but with radiographic findings of FAI with a labral tear. To this point, while most agree that FAI can lead to osteoarthritis of the hip, there is lack of evidence to support prophylactic treatment in asymptomatic patients [15]. There are several clinical scenarios where asymptomatic patients with radiographic findings of FAI could be encountered, including preparticipation sports physicals, imaging of contralateral hip after treatment of symptomatic FAI, or research settings. It is likely that these patients would be counseled and followed closely clinically.

Intra-operative techniques varied significantly among surgeons. Although agreement exists regarding capsulotomy for visualization and treatment, the extent of the capsulotomy differed considerably between surgeons, as only 25% utilize a 'T' capsulotomy. Performing a capsulotomy that affords appropriate visualization to completely resect a cam

deformity is of paramount significance, as the leading cause of revision hip arthroscopy is residual deformity, present in as much as 90% of patients as recently reported by Ross *et al.* [16]. The choice of whether or not to close the capsulotomy similarly varies. Although not all surgeons close the capsulotomy, many surgeons will do so only if they feel the patient is at risk for postoperative macro-instability (dislocation) or micro-instability (excessive translation of femoral head in addition to rotation) [17–21]. Instability following hip arthroscopy, based on clinical and basic science data, has led the lead author, among others, to advocate for routine closure [22–25]. Further, the outcomes of hip arthroscopy are significantly better following complete capsular closure (of a 'T' capsulotomy) versus partial closure [26]. A preference for straight drill guides seemed to be commonplace among the respondents, although not an insignificant percentage of surgeons would use both straight and curved drill guides depending on circumstance. This agrees with findings from Nho *et al.* [27], who demonstrated in a cadaveric model that the use of a curved guide, flexible drill and flexible suture anchor may provide more precise placement of suture anchors, and Haughom *et al.* [28] advocating the use of flexible drills when performing microfracture of the hip. Identification of a large full thickness articular cartilage 'wave sign' delamination injury is not uncommon during hip arthroscopy and frequently observed in patients with cam morphology. This is likely a prearthritic lesion, as loss of articular cartilage is the sine qua non of osteoarthritis, and cartilage degeneration predicts outcome 12 months after hip arthroscopy [29]. Thus, in addition to management of bony FAI deformity and labral injury, intra-operative articular cartilage management is a crucial factor in the long-term outcome of arthroscopic hip preservation. The two dominant answers involved removing unstable cartilage and performing microfracture, while another common practice involves incorporating the cartilage defect into the repair. Another small subset utilized fibrin glue, shown to have encouraging mid-term results in the repair of delaminated acetabular cartilage treated concomitantly with microfracture [30]. Viability of the chondral flaps has been investigated by Meulenkamp *et al.* [31], who reported 90% chondrocyte viability in 11 of 12 FAI patients and suggested that primary repair is preferable to resection. Microfracture for acetabular chondral defects has shown good results in the short term. At an average follow-up of 17 months, Karthikeyan *et al.* [32] showed 19 of 20 patients had a mean fill of 96%, with macroscopically good quality repair tissue histologically found to be primarily fibrocartilage. A study by Fontana *et al.* [33] examining chondral lesions associated with FAI compared acetabular microfracture with an enhanced microfracture technique with autologous matrix-induced chondrogenesis (AMIC). They found that the enhanced technique with AMIC sustained improved modified Harris Hip scores between post-operative years 1 through 5, while the microfracture group slowly deteriorated. Additional high level investigations with longer follow-up should be performed to help identify the most appropriate treatment for these lesions. For patients with a snapping iliopsoas, IPI and a 3 o'clock position labral tear, surgeons consistently recommended labral repair. However, 39% recommended an iliopsoas tenotomy, which may leave the patient with significant residual hip flexion weakness. As an alternative, 45% recommended a subspine decompression, reducing the angle around which iliopsoas excursion occurs during hip motion [34, 35]. Domb *et al.* [36] described techniques and outcomes for patients with IPI after noting a distinct pattern of labral pathology that was directly anterior and could not be attributed to other pathologies. In their series, in which they debrided or repaired the labrum along with an iliopsoas tenotomy, outcomes scores where significantly improved.

The last group of questions was designed to ascertain the post-operative protocols of the respondents, an area where limited evidence-based literature is available. Several fundamental principles exist following hip arthroscopy, including soft tissue healing considerations, control of edema and pain, early ROM, weight-bearing limitations and early initiation of muscle activity followed subsequently by progressive strengthening and training [37]. There are various approaches, as survey results revealed, employed by surgeons to manage these principles. A majority of surgeons rarely or never use a hip orthosis/brace, similar to the utilization of derotational boots. Although a more even split was seen between CPM utilization. When examining post-operative protocols several patient-specific factors may be involved, from hip pathology to confidence in repair as well as external factors such as patient insurance coverage. These will impact treatment decisions. The last two questions of the survey were aimed at possible complications after hip arthroscopy—HO and development of deep vein thrombosis (DVT), which have reported incidences of 0.1 and 0.7%, in a systematic review of 92 studies and over 6000 patients [21]. A significant majority of surgeons were concerned enough to prescribe prophylaxis for HO most of the time or always. An investigation by Bedi *et al.* [38]examined the addition of indomethacin in addition to an existing protocol of naproxen and found an HO incidence of 1.8% with indomethacin and naproxen compared with 8.3% with just naproxen. The majority of their patients had Brooker grade 1 HO, and 7 of the 29 patients with HO subsequently had surgical intervention for treatment, an overall reoperation rate of 1.1%. Although Bedi *et al.* [38] were unable to identify

statistically significant clinical risk factors for the development of HO, all of their cases occurred in the setting of osteoplasty for symptomatic FAI. In a separate retrospective study, Beckmann *et al*. [39] reported a statistically significant 25% incidence of HO when a patient did not receive prophylaxis, versus 5.6% when receiving NSAIDs. From this data, it appears the use of HO prophylaxis is well supported in the literature. Although a review of several large studies investigating the incidence of DVT in hip arthroscopy showed a 0% rate of DVT or pulmonary embolism for over 5500 patients, subsequent publications have shown earlier investigations likely under reported the complication. Mohtadi *et al*. performed a prospective study on the incidence of DVT following elective hip arthroscopy, reporting ultrasound confirmation of five DVTs in a cohort of 115 patients without known risks factors, which was managed without pharmacologic or mechanical prophylaxis, with one asymptomatic and four symptomatic DVTs [40, 41]. Concrete guidelines for managing the risk of developing DVT are still lacking, although recommendations exist for and against prophylaxis [42].

Limitations

There are several limitations to the information that can be gathered from this survey. The aggregated data represent Level V expert opinion of hip arthroscopy surgeons worldwide. However, when there is a lack of high level evidence, expert opinion can guide best practices. The aggregate data represented in this study only provide information from respondents who answered the questions and may not be representative of all surgeons performing hip arthroscopy. The location of the response was not known from the survey. The survey setup did not query country of origin of response, thus the authors were unable to query geography. Therefore, there could be geographical differences in responses that were left unanswered with this investigation and could be an interesting addition to future research. Further, some requested participants may have been unable to participate as the survey was available only in the English language. Future international surveys should be given in primary languages spoken by the participants. There also was a response rate of 50%, which indicates data from half of the intended recipients are not available for analysis. The reason for the 50% response rate may be the choice of email as the contact method, as some email addresses could have been incorrect. It is also possible that some answers could have been answered erroneously if the survey participant clicked on an unintended answer choice while using small mobile devices. There could also be bias in the surgeons' answers if they were answering theoretically rather than based on actual clinical cases.

CONCLUSIONS

Among a large number of high-volume, experienced hip arthroscopists worldwide, pre-, intra- and post- hip arthroscopy practice patterns have been established and reported. Within this cohort, several areas of patient evaluation and management remain discordant and controversial without universal agreement. Future research should move beyond expert opinion level V evidence towards high-quality appropriately designed and conducted investigations.

See all survey questions in Appendix 1.

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CONFLICT OF INTEREST STATEMENT

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APPENDIX 1

QUESTIONS LISTED (NON-TABLE FORMAT)

1. Approximately how many arthroscopic hip preservation surgeries did you perform for FAI and/or labral tears over the past 12 months?

2. Approximately how many open hip preservation surgeries did you perform for FAI and/or labral tears over the past 12 months?

3. How many years have you been performing hip preservation surgery?

4. Do you utilize preoperative intra-articular local anesthetic/steroid injection in a patient with a clear diagnosis of symptomatic femoroacetabular impingement (FAI) and labral injury.

5. Which radiographs do you routinely obtain in patients with hip pain?

6. How often do you perform CT scan on patients with symptomatic FAI and labral injury that are scheduled to undergo surgery?

7. On preoperative MRI, which series do you routinely order?

8. What percentage (%) of your hip arthroscopy patients have Tonnis grade 2 or 3 osteoarthritis?

9. What percentage (%) of your hip arthroscopy patients have borderline dysplasia? Borderline dysplasia (lateral center edge angle 20–25 degrees; Tonnis angle 10–15 degrees; anterior center edge angle 20–25 degrees).

10. What percentage (%) of your hip arthroscopy patients have dysplasia? Dysplasia (lateral center edge angle $<$20 degrees; Tonnis angle $>$15 degrees; anterior center edge angle $<$20 degrees).

11. Would you perform arthroscopic hip preservation surgery in a 20-year old athlete with clear radiographic FAI and a labral tear, but is completely asymptomatic (no pain, no loss of function, no limitations).

12. What type of capsulotomy do you perform during hip arthroscopy?

13. Are you using straight or curved drill guides for suture anchor placement during labral repair?

14. What is your typical treatment of a large full-thickness articular cartilage 'wave sign' delamination injury (after appropriate acetabular osseous management)?

15. How do you manage snapping iliopsoas, iliopsoas impingement and a 3 o'clock position labral tear that has failed rest, activity modification, oral and injection anti-inflammatory medications and physical therapy?

16. How do you close the capsule at the conclusion of hip arthroscopy?

17. Do you use a hip orthosis/brace following hip arthroscopy?

18. Do you use a continuous passive motion machine following hip arthroscopy?

19. Do you use derotational boots following hip arthroscopy?

20. Do you use heterotopic ossification prophylaxis following hip arthroscopy?

21. After hip arthroscopy, which of the following thromboembolic disease (deep vein thrombosis) prophylaxis do you use?

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