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Current Concept Review

The evolving role and technique of hip arthroscopy in children and adolescents

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ABSTRACT

Hip Arthroscopy in the pediatric and adolescent hip has evolved from its role as a diagnostic tool to a primary modality of management of variety of hip pathologies in children and adolescents. This article reviews current concepts and advances in hip arthroscopy in this population. We discuss the indications, techniques, outcomes, and complications of hip arthroscopy in children and adolescents. We explore the newer indications of hip arthroscopy in the treatment of SCFE (Slipped Capital Femoral Epiphysis) deformity correction, borderline hip dysplasia, septic arthritis, infantile developmental dysplasia, Perthes disease, and the existing and developing evidence. Finally, we address the challenges and future directions in research, education, and training, unique to the pediatric and adolescent population.

Key Concepts:

(1) Hip arthroscopy has significant surgical applications in the pediatric and adolescent population, and can be used to help address several intra-articular as well as extra-articular pathologies.
(2) The indications and potential for arthroscopic interventions and associated arthroscopic techniques is growing and developing rapidly, along with improving technology, techniques, and training.
(3) FAI (Femoro Acetabular Impingement) and labral pathology are the most common indications for surgery in the adolescent, and clinical outcome studies show excellent results. However, nonoperative optimization should be strongly emphasized before surgical consideration.
(4) Hip arthroscopy is minimally invasive and relatively low risk, though main risks and complications to be aware of is the potential need for revision or further surgery, transient neuropraxia of the pudendal nerve, surgical site infection, implant/tool-related breakage or failure, failed surgery, and venous thromboembolism.
(5) Continued research and innovation in the field of pediatric hip arthroscopy are essential for further improving outcomes and expanding treatment options for young patients with hip disorders, and more pediatric-specific clinical research is needed.

Introduction

Hip arthroscopy has come a long way from the initial description of the endoscopic visualization of the hip joint nearly a century ago [1]. The development of pediatric and adolescent hip arthroscopy has largely paralleled, and trailed shortly behind, the recent growth and technical development in adult hip arthroscopy over the last twenty years [2]. In the adult or general literature, large randomized controlled trials, observational cohorts, and national registries have made hip arthroscopy one of the most closely studied surgical techniques in orthopaedics, and have demonstrated that hip arthroscopy provides efficacy and clinically important benefit in specific indications [3–6]. Although similar evidence is not yet available for pediatric and adolescent patients, the growing experience and opportunity in the

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Table 1
List of common indications and interventions with hip arthroscopy in the pediatric population.

Indications	Intervention	Relevant study
Femoroacetabular impingement and labral tears	Labral repair, Chondral debridement, Osteoplasty/ Osteochondroplasty, Chondroplasty	Phillipon et al. [9], Byrd et al. [10], Menge et al. [10], Larson et al. [12], Barastegui et al. [13] Maldonado et al. [14], Yen et al. [15]
Slipped Capital femoral epiphysis	Post SCFE Chondral, Labral damage, Femoroacetabular impingement	Wylie et al. [16], Basheer et al. [17]
Septic arthritis	Irrigation, Debridement, Tissue for culture	Ellis et al. [18], Khazi et al. [19]
Legg-Calve-Perthes disease	Chondral debridement, Loose body removal, Osteochondral fragment excision, Osteo-chondroplasty	Lim et al. [20], Lee et al. [21], Kocher et al. [22]
Infantile Hip dysplasia	Removal of intraarticular blocks to reduction	Eberhardt et al. [23], Ozturk et al. [24]
DDH Sequalae	As an adjunct to PAO or isolated	Evans et al. [25], Murata et al. [26]
Traumatic hip dislocation	In Non acute settings, non-anatomical reduction, Hindrance to reduction	Philippon et al. [27], Kashiwagi et al. [28] Morris et al. [29]
Loose body	Loose body removal	Byrd et al. [30], Nepple et al. [31]
Tumor	Biopsy, Excision of exostoses	Bonnomet et al. [32], Alter et al. [33]
Inflammatory arthropathy	Synovectomy, Diagnosis, Therapeutic	Kouk et al. [34]
Extraarticular causes	Tendon lengthening, Release	Sampson [35], Illizaliturri [36]

PAO, peri-acetabular osteotomy; SCFE, slipped capital femoral epiphysis.

area have led to incredible development in the field and further embrace of hip arthroscopy as a surgical tool and technique with important pediatric impact and even more so future potential [7].

The early use of hip arthroscopy in pediatric patients was mostly as a diagnostic modality or treatment adjunct. Since then, the indications have grown with our understanding and technical capabilities, and there are a number of accepted and well described pediatric surgical indications [8]. Table 1 Enlists many of the common indications and interventions with hip arthroscopy in the pediatric population. Femoroacetabular impingement (FAI) and associated labral pathology remains the most common indication for hip arthroscopy, and this remains true in the adolescent population. Septic arthritis of the native hip is another indication where there is a significant benefit with hip arthroscopy over traditional open debridement due to better intra-articular access and visualization and lesser surgical morbidity. Some of the other indications are post-SCFE (Slipped Capital Femoral Epiphysis) FAI, Perthes sequelae, loose body, tumor, trauma, and as an adjunct to PAO (Peri-Acetabular Osteotomy) and other osteotomies. Some studies have reported experience with arthroscopic shelf procedure for adolescent hip dysplasia and post-Perthes hip dysplasia. Other indications have limited evidence in literature either as case reports or series.

Femoroacetabular impingement and labral tears

Femoroacetabular impingement (FAI) refers to the impingement or dynamic abutment of the femoral and acetabular sides of the hip joint, particularly with hip flexion and internal rotation. The morphology of the femoral head-neck junction and/or the acetabular rim may put an individual at higher risk for chronic, pathologic irritation at the chondrolabral junction, causing labral tears and inflammatory response. This pathologic condition is more specifically labeled FAI Syndrome (FAIS) and distinguishes symptomatic pathology from asymptomatic radiographic findings of the femur or acetabulum. Adolescence is the key timepoint for the development of FAI morphology, and several studies [37,38] now have shown that sports which can have increased or abnormal loading of the hip joint, such as hockey, football, and soccer, can be associated with the development of FAI. Hip arthroscopy enables combined access to central and peripheral compartment pathologies such as labral tears, cartilage injury, both femoral and acetabular impingement, and synovitis. Published literature has shown a high rate of successful return to activity and sports after arthroscopic hip procedures for idiopathic FAI [39].

Hip impingement may be caused by other patho-etiologies besides idiopathic FAI, such as SCFE, Legg-Calve-Perthes disease, dysplasia of the hip, and juvenile arthritis, as well as certain forms of tumor [40]. Arthroscopy can help in these cases by aiding removal of inflamed synovium besides addressing the underlying morphology/ pathology. Inflammatory conditions have also been suggested to have a possible impact on the development of FAI, and may correlate with higher alpha angles and negative femoral neck-head offset on radiographs. The presence of more extreme femoral morphology in young patients should raise the suspicion of a possible underlying or co-morbid inflammatory condition [41].

Septic arthritis

Septic arthritis of the native pediatric hip is a relatively common pediatric orthopaedic concern, and the potential benefits of hip arthroscopy over open arthrotomy are significant. An arthroscopic approach to the septic hip allows far more complete and circumferential access to the joint, more targeted and comprehensive debridement and irrigation, all while preserving the native anatomy thereby reducing chances of postoperative instability [42].

Hip arthroscopy in septic arthritis can be done without the need to fully distract the joint, thereby reducing the technical complexity of an added traction setup in a small child and the potential for iatrogenic labral or cartilage damage. An excellent overview of the technique can be found here [18]. Comparative study between open arthrotomy versus arthroscopic debridement have shown similar outcomes with reduced hospital admission requirement [19]. A systematic review on the arthroscopic management of septic arthritis of the hip found five studies focused on pediatric patients; all had positive outcomes and no reported complications [43]. Prospective and multi-center studies, as well as further growth in skills and technique adoption, will help us to better and further understand the potential differences between arthroscopy and open arthrotomy for the septic hip.

Infantile hip dysplasia

The use of arthroscopy as an adjunct for failed closed reduction in the infantile dislocated dysplastic hip has been documented, but has not yet gained wide adoption. It can also be an aid in removing intra-articular blocks to reduction such as the ligamentum teres, pulvinar and synovium. The research and use for this purpose is still in nascent stages, but Zhao et al. [44] reflected on 8 patients who failed closed reduction of the hip and underwent arthroscopically-assisted reduction with successful reduction in all cases with no evidence of osteonecrosis at final follow up. In a study by Xu et al.[45], 32 of 40 (80%) patients had a successful reduction without re-dislocation, though nineteen patients needed open surgery at an average 13 months follow up. Although still considered to be niche and not widely adopted, arthroscopic shelf acetabuloplasty using allograft has been recently shown to be a minimally invasive surgical option in hip dysplasia and Perthes [40].

Arthroscopic labral treatment and capsular plication has shown to have favorable outcome in adolescents with borderline hip dysplasia [25]. We would be remiss not to mention of the failure of arthroscopy alone in treating borderline dysplasia as shown by failure in 43% of adolescents if Lateral Centre Edge Angle < 22 [46]. The role of arthroscopy and arthroscopically assisted/associated repairs and reconstruction in the setting of dysplasia and borderline dysplasia is an area of both controversy and current exploration, and comparison to existing standards of care within and institution and region should always be considered during surgical discussions and planning.

Other diagnoses and pathologies

One of the important and unique elements to consider with hip arthroscopy is that it is not in and of itself a specific pathology-oriented technique, but rather can be considered to be a surgical approach. Arthroscopy provides a minimally invasive approach to the intra-articular central compartment space, as well as to the peripheral compartment within the hip capsule, and even to the areas surrounding the joint extra-articularly and outside the capsule. This means that many more unique indications, such as loose body removal/excision, resolution or assistance with post-traumatic hip dislocation with incongruent reduction, synovial chondromatosis, excision or removal of certain tumors such as osteoid osteoma, excision of exostoses of the proximal femur, the treatment of certain osteochondral lesions such as osteochondritis dissecans, chronic joint-adjacent osteomyelitis, secondary changes to the joint, coxa saltans interna or externa, etc. Many such indications are evidenced with only case reports or case series, but many have encouraging findings such as experience of Bonnomet et al. [32] in dealing with hereditary multiple exostoses with hip joint affection, Ilizaliturri's [36] experience in treating snapping hip syndrome or Lindner et al.'s [47] study which used hip endoscopy to deal with chronic partial hamstring avulsion.

The key to understanding the potential in pediatric hip arthroscopy is to view arthroscopy as simply a surgical approach to the hip. An approach that can provide excellent access and visualization to most of the central and peripheral compartments as well as endoscopic access to other areas around the hip. As the tools and techniques continue to improve and mature, we will see the indications and evidence develop further. However, it is important for the hip arthroscopist to approach the treatment of new pathology with some caution as the use of hip arthroscopy in these advanced conditions can be very technically challenging, and the surgeon may need to be prepared for alternative strategies (such as conversion to an open approach) if needed.

Risks and complications

The risk of complications in pediatric hip arthroscopy are relatively low, as a minimally invasive procedure performed most commonly in an otherwise generally healthy population, but can also be thought of as being potentially biased in these early days by sub-specialized practices and relatively lower volumes. The risks have been reported in the range of 1.8–7.0% [22,48], transient pudendal nerve neuropraxia being the predominant complication (associated with the use of a traction post), followed by instrument breakage and suture abscess [48]. Major complications like osteonecrosis, deep infection, and fracture have not been described in recent systematic reviews of pediatric hip arthroscopies. Use of neuromuscular relaxation in anesthesia and advancement in post-free traction has led to a reduction in neuropraxia related complications. Should a neuropraxia develop, the majority appear to resolve spontaneously within 3 months [22]. Beckmann demonstrated in a randomized trial a significant reduction in postoperative heterotopic ossification (HO) when treated prophylactically with Naproxen twice daily for 3 weeks (4%) compared to placebo (44%) [49]. However, the clinical significance of HO which developed was not studied there. HO has not been a specific limiting complication in the pediatric population thus far, and administration of prophylactic Non steroidal anti-inflammatory is debated [50]. Still, the use of prophylactic Non steroidal anti-inflammatorys is common after most hip arthroscopy, given the potential difficult to solve long-term issues associated with HO and the low relative risk of prophylaxis in most patients.

Role of anesthesia

The standard in anesthesia for hip arthroscopy has been the use of general anesthetic, with the adjunctive use of neuromuscular blockade to assist with ease of traction and decreasing necessary force. As traction is one of the major causes of complications associated with this procedure, deep neuromuscular paralysis during anesthesia can help with the safe establishment of central compartment access, and has shown to reduce perineal pressure and has thereby been postulated to decrease pudendal nerve compression as well [51]. Neuraxial anesthesia has more recently grown in use in adults for hip arthroscopy, and has shown some early success in comparative outcomes, but has not yet been widely adopted or studied in the pediatric and adolescent patient [52]. The use of regional anesthesia to assist with pain control intra- and postoperatively has grown tremendously across orthopaedic procedures. However, the use of regional in hip arthroscopy The use of a femoral nerve block has been shown to have a limited role in postoperative analgesia, and did not significantly reduce postoperative opioid consumption at 24 hours while also increasing the incidence of postoperative falls due to the motor inhibition of the quadriceps which makes it difficult to recommend for outpatient hip arthroscopy [53,54]. Fascia iliaca block has been shown to not be significantly better in reducing postoperative pain [55]. The economics of time required for nerve blocks versus its potential benefits by reducing the intraoperative opioid consumption and reduced postoperative admission requirement are careful considerations to be made for individual centers as has been commented on in this systematic review [56]. There is even less evidence in the pediatric population, and the use of regional anesthesia is still very much in the early and developmental/experimental phase for both the procedure and the patient population.

Surgical setup and steps

In general, a patient can be positioned either supine or lateral for hip arthroscopy, with the use of traction with a post. Post-free traction, using a supine position and surface area friction rather than a perineal post, has grown in popularity and technical availability. Pediatric hip arthroscopy in younger children, with specific technical and anatomic needs, such as for irrigation and debridement in the septic hip, can be performed supine on a standard operating room table. The figure shows a routine traction table with or without a perineal post (Fig. 1). Traction-less hip arthroscopy is utilized for children with septic arthritis, where the joint already has an effusion present and the bulk of

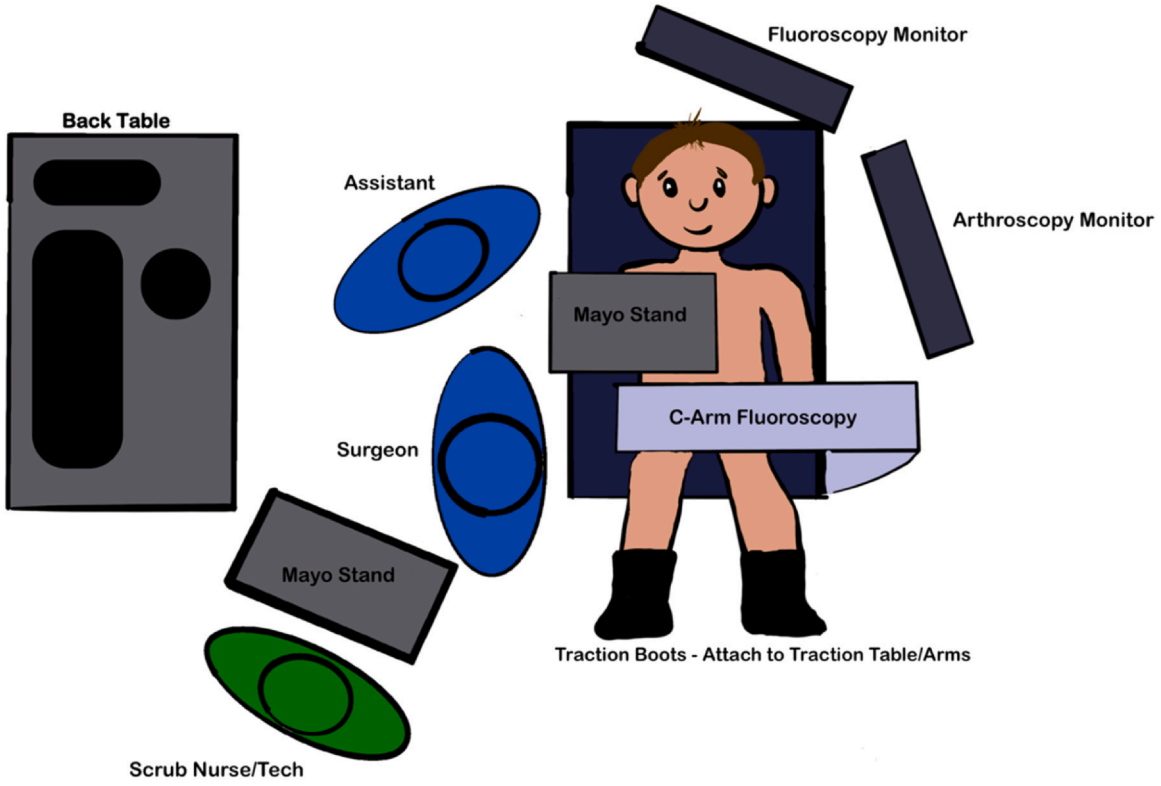

Figure 1. Shows the typical room setup for a case of hip arthroscopy.

arthroscopic work is performed in the peripheral compartment [18]. As pudendal nerve compression and perineal compression are the cause of some of the more common complications of these procedures, recent advances in positioning have included post-free traction using body weight skin surface friction as counter traction, and mild Trendelenburg position when needed, which has reduced the incidence of pudendal nerve neuropraxia dramatically [57,58]. However, it is important to note in smaller pediatric or adolescent patients friction-based post-less hip arthroscopy techniques may have a more difficult time gaining adequate traction. In some cases, venting the hip capsule may improve this distraction, but the addition of a post should be considered if inadequate traction is present.

The following surgical description and accompanying video outline a typical case performed in the supine position, with post-free positioning. The patient is supine on a traction table, on a single-use foam pad designed to create surface-area friction to allow for gentle countertraction to the foot/limb placed in traction. The ipsilateral limb is placed in a traction boot and positioned in minimal adduction and very gentle traction. The contralateral limb is held in a position of slight abduction and given a small amount of traction if needed or left at rest. The surgeon stands on the side of the operative hip with the arm of the fluoroscopic imaging device coming from the opposite side, perpendicular to the patient and aligned over the hip. The arthroscopy tower is on the opposite side of the patient, with the screen lined up in front of the surgeon line of sight. The draping should be such that a sterile limb positioning can be possible intraoperatively to perform rotation and flexion-extension at the hip. Preoperatively it can be of great benefit to check positioning and femoral morphology using fluoroscopy before sterile preparation and draping. We use a standard 6 clock-face views of the femur from the 11:45 to the 2:45 positions, taken preoperatively to ensure positional understanding of the morphology and the site(s) of impingement, and as a control for intra- and postoperative assessment [59].

The standard routine portals used for hip arthroscopy include some combination of anterolateral and mid-anterior portals, and some surgeons may use an adjunct postero-lateral portal. We will focus our example and discussion here on the use of the anterolateral and mid-anterior portals, but the use of other portals has been well described. The anterolateral portal is made under fluoroscopy guidance. First, a spinal needle is introduced to break the fluid seal of the hip joint and to create an air arthrogram. One the seal is broken, less traction is required to distract the joint safely and the space between the labrum and the femoral head is increased. The bevel of the spinal needle (typically 14–18 gauge) is rotated so as to not scuff the articular surface of the femoral head. Targeting the needle to the distal edge and anterior in the joint helps to avoid iatrogenic injury to the acetabular labrum which is generally closer than it appears on fluoroscopy. A Nitinol wire or guide wire is then introduced into the joint, and a cannula can then be introduced using the modified Seldinger technique, and cannulated instruments used for further development of the portal as needed. The next portal, in this case mid-anterior, is then made under direct arthroscopic visualization into the anterior capsular triangle. Capsulotomy can then be performed based on surgeon-specific technique and anatomic and technical considerations. A “peri-portal” technique, inter-portal capsulotomy, or “T capsulotomy” can all be used successfully, and each has relative risks and benefits and technical elements inherent. Once access has been established, a diagnostic arthroscopy can be performed, and repairs and reconstruction performed as needed.

Arthroscopically, the hip joint is generally divided into 2 compartments, based on access: (1) The “Central compartment” or iliofemoral joint and (2) the “Peripheral compartment,” which includes intra-articular structures lateral and peripheral to the labrum and the intra-articular seal. Access to the Central compartment requires traction.

Order of access to the Central and Peripheral compartments can vary depending on surgeon preference as well as the anatomic and/or pathological need (eg, some surgeons prefer to enter the peripheral compartment first, but also some anatomic situations may demand it, including situations such as severe pincer FAI, coxa protrusion, extreme femoral deformity, or chondrolysis).

Figure 2. Portals routinely used in hip arthroscopy. A, anterior; AL, anterolateral; DALA, distal anterolateral; MA, mid-anterior.

Dienst described the anterior portal under arthroscopic visualization which would reduce the iatrogenic injuries to the hip joint [60]. Distal anterolateral (DALA) portal can be used as the workhorse for labral repair and/or osteoplasty, due to straight line of insertion for anchors and access to the femoral neck region. Cadaveric studies have shown equivalent accessibility compared to the mid-anterior portal [61]. These portal locations have been demonstrated in Fig. 2.

Intraoperative fluoroscopy is important for precise acetabular and femoral osteoplasty. Over-resection can lead to hip instability [62,63] while under-resection may leave residual impingement, which is the most common reason cited for revision hip arthroscopy in the general population [64].

Some studies have suggested that capsular closure may improve patient-reported outcomes, reduce pain, and prevent postoperative instability or laxity [65]. Though there is no consensus, an increasing number of surgeons are routinely performing capsular closure, in particular in the setting of a "T" capsulotomy. Capsular closure may also have some drawbacks, such as increased operative time, capsulolabral adhesions, or stiffness. The decision to perform capsular closure, either with absorbable or non-absorbable suture, may depend on several factors, such as the type and extent of capsulotomy performed, the patient's specific hip morphology and stability, age, activity level, type and extent of surgery, quality and thickness of the capsule, and surgeon's preference. Capsular closure may be more indicated for young, active patients who have signs of instability or laxity, or who have undergone extensive surgery that may compromise the integrity of the capsule or after an extensive T capsulotomy [66].

Postoperative course

The postoperative weight-bearing status can vary depending on the procedure performed, surgeon's findings and preference. Typically, a few weeks of protected weight bearing is allowed with crutches and avoidance of hip flexion beyond 90 degrees. Though pain is usually limited, poor firing and muscle inhibition of gluteus medius can cause early issues with gait and discomfort. Isometric contraction, ankle pump and active assisted range of motion is important in the early recovery period, and further discussion of rehabilitation can be found in the accompanying *JPOSNA*® article focusing on rehabilitation after hip arthroscopy. The use of postoperative Non steroidal anti-inflammatorys, either Naproxen or Indomethacin, has dramatically decreased the risk and incidence of heterotopic ossification postoperatively, but use is not standardized in pediatric patients [49].

Although hip arthroscopy is relatively low risk, some of the known possible complications include transient neuropraxia of pudendal nerve, surgical site infection, broken hardware, failed surgery and venous thromboembolism. Hip arthroscopy still has its limitations in indications and may not achieve the desired outcome for some patients, especially if the underlying hip condition is severe or complex. For example, patients with chondral damage, large labral tears, or significant dysplasia may not benefit from hip arthroscopy and may require further surgery [67].

Venous thromboembolism (VTE) is a rare but serious complication of hip arthroscopy. Catastrophic complications like pulmonary embolism, which can be life-threatening is known. There is limited evidence only in form of retrospective studies for VTE prophylaxis. The best practice guidelines published for VTE prophylaxis in adolescents are broad and is an area which needs further research [68]. Considering the prolonged period of altered immobility after surgery, the risk benefit ratio for chemical VTE prophylaxis should be carefully considered. Medications such as aspirin (81 mg) have a very favorable safety profile, and while the risk of VTE is low, it can be life-threatening if it occurs should be noted. Most surgical patients in hip arthroscopy are adolescents (> 12 years) where an individual assessment on risks/benefit can be made and prophylaxis can be considered based on ICM (International Consensus Meeting)-VTE recommendations [69].

The hip is a deep-seated joint with large muscle covering the joint. During hip arthroscopy, instruments such as arthroscopes, shavers, burrs, and probes are inserted into the hip joint and leveraged through small incisions. These may break, requiring removal and replacement. This complication should be kept in mind, in particular by the novice and developing surgeon [48].

Hip arthroscopy for FAI and labral tears in the pediatric population has resulted in significant improvements in pain, function, and patient-reported outcomes at short-term (up to 2 years) and intermediate-term (2–5 years) follow-up [9,70]. Literature shows a high rate of return to sport (up to 94%) and a low rate of complications (1.8–10%) [49,71]. The younger population has a higher relative rate of revision hip arthroscopy, but much lower risk of conversion to total hip arthroplasty as compared to older adults undergoing hip arthroscopy [72]. The

success rate of hip arthroscopy in adolescents may be upwards of 80–90%, but some patient characteristics such as milder deformity and being a non-athlete may predispose to less predictable or optimal outcomes [15]. Hip arthroscopy for FAI and labral tears in the pediatric population has shown better outcomes when performed earlier, before the onset of degenerative or osteoarthritic changes, or severe chondral damage. The outcomes worsened when associated with global laxity and secondary hip pathologies. Unlike the adult population, symptom duration did not affect the outcome significantly which promotes an initial trial of nonoperative treatment for pediatric FAI [73,74]. In fact, some studies have shown much higher levels of success with nonoperative treatment in the young, and it is worth considering nonoperative optimization before committing to surgical intervention [75,76].

The future of pediatric and adolescent hip arthroscopy, and necessary continued innovation

As hip arthroscopy continues to grow and become further refined, we can expect that techniques and tools will continue to develop, allowing for easier and more generally accessible opportunities for orthopaedic surgeons, greater safety and improved outcomes for patients, and further opportunities to use arthroscopic surgical exposure to perform repairs and reconstructive surgeries in the pediatric patient.

To date there is very little prospective surgery in pediatric hip arthroscopy, and a better understanding of existing surgical use and clinical outcomes is absolutely necessary in order to improve things in the future. There are currently mixed signals with respect to the role and timing of surgery in FAIS in the adolescent, as we have evidence that supports excellent postoperative clinical outcomes [9,11,25,70,71], we have good evidence supporting a more judicious use of surgery and the importance of adequate trials of nonoperative treatment [77,78], and also evidence supporting getting to surgery sooner than later in order to maximize outcomes [79]. How does the individual surgeon decide both on whether surgery is indicated, and the timing? Further multi-center prospective comparative cohorts and randomized trials in the young are necessary to better understand and apply. There is still much more evidence needed in understanding the development of FAI in the young, and the potential role for prevention, prophylaxis, and mitigation. We know that there is a correlation between the development of FAI morphology in adolescents and level and type of physical activity [80,81], but there is also a strong genetic/hereditary component [82], and causation is still not entirely clear, to say nothing of whether or not the natural history is in any way modifiable with nonoperative means.

One of the greatest areas of recent growth has been the use of arthroscopy in the treatment of adolescent and young adult borderline hip dysplasia [25,83], and as an adjunct to periacetabular osteotomy in hip dysplasia. There are currently prospective studies underway in these condition groups, and the evidence that develops will be of particular importance in the young.

Peer-reviewed evidence is key to improving outcomes and moving the technique and the field forwards. To date, challenges to obtaining higher level evidence for pediatric hip arthroscopy may be attributable to patient volume, population heterogeneity, and confounding technical variables. As with other less common surgical techniques and diagnoses, multi-center and longer-term prospective collaborations will be necessary.

Continued technological development will also serve pediatric patients and pediatric orthopaedic surgeons. The vast majority of orthopaedic instrumentation is designed for the “average” adult-sized patient. This works well for most older adolescents but can be challenging to say the least for the younger and smaller patient. Further options in sizing of tools, in particular for joint access and patient positioning, would be much appreciated. Similarly, given the constrained and relatively spherical nature of the hip, angle and flexible camera equipment and tools can have an interesting role. A 70-degree arthroscope is used as standard in the central compartment by most hip arthroscopists as a necessary tool in order to visualize more of a constrained space, improving technology will likely eventually lead to further flexibility, and a smaller diameter may allow for more interesting and even less invasive access and decreased need for capsulotomy(ies). Surgical planning and intraoperative assessment is already an area that has been under development and with various commercially available tools available, but the capabilities and options for the pediatric and adolescent hip are still in the early phases. The development and validation of post-free traction and associated traction beds and systems has been a very positive technological, scientific, and clinical step forwards, and we can and should expect that further developments such as this will allow for more improvements in safety, quality, and clinical outcomes for our pediatric patients.

Summary & conclusion

Hip arthroscopy is a minimally invasive technique for visualizing and treating many pediatric and adolescent hip disorders. With the access it provides to intraarticular and extraarticular structures through small portals, it has opened new avenues for treatment of pathologies previously more difficult to manage. The advances in instrumentation and equipment have helped make the procedures safer by reducing the incidence of complications. The skills for pediatric hip arthroscopy have a challenging learning curve, mandating a combination of practice, surgical volume, and the necessary training, equipment and support. Further research and continued development in the subspecialty will help to further push our progress and guide us as the technique evolves and becomes more commonplace and standard practice over the longer term.

Author contributions

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Declarations of competing interests

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Sasha Carsen reports a relationship with Stryker Sports Medicine that includes: speaking and lecture fees. Sasha Carsen reports a relationship with Smith and Nephew Inc that includes: speaking and lecture fees.

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Appendix A. Supporting material

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.jposna.2024.100064.

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