Technical Note

Hip Arthroscopy in Adolescents Through an Extra-Capsular Approach

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Abstract: Hip arthroscopic treatment for femoroacetabular impingement syndrome and labral tears is the gold standard in the adult and adolescent population, as we all know the most common surgical approach to the hip is entering the central compartment with fluoroscopy and with continuous distraction. A periportal capsulotomy in traction must be done to have visibility and instrument maneuverability. These maneuvers avoid scuffing the femoral head cartilage. In adolescents, extreme care must be taken in hip distraction, as the force used can cause iatrogenic neurovascular lesions, avascular necrosis, and lacerations of the genitals and foot/ankle. Experienced surgeons around the world have developed an extracapsular approach to the hip with smaller capsulotomies with a low complication rate. This approach to the hip has brought attention in the adolescent population because it is more secure and simple. Less force of distraction is needed because the capsulotomy is done first. This surgical technique allows observation of the cam morphology while entering to the hip without distraction. We describe an extracapsular approach as an option to treat femoral acetabular impingement syndrome and labral tears in the pediatric and adolescent population.

Introduction

The use of hip arthroscopy (HA) in the pediatric population was introduced in 1977. Children and adolescents present with a variety of orthopedic conditions, including developmental dysplasia of the hip (DDH), Legg-Calve-Perthes disease (LCPD), and slipped capital femoral epiphysis (SCFE). Hip arthroscopy is known to be a minimally invasive procedure, with a short period and recovery time; better outcomes and results have been published in the literature in the past 15 to 20 years. Today, one of the most common causes of hip disorders in adolescents and children are associated with femoroacetabular impingement syndrome (FAIS), occurring as a result of excessive and abnormal osseous femoral morphology[1] (Fig 1). Recent studies describe that nontreated FAIS leads to labral tears, acetabular cartilage disruption, and an evolution of early-onset degenerative hip arthritis. Adolescent FAIS has been successfully treated by HA trough, a standard central compartment (CC) access with continuous distraction. This distraction can create iatrogenic lesions of the hip, distension of the femoral nerve, vein, and artery and avascular necrosis in this adolescent population. HA has been demonstrated to be safe, effective, and reproducible through extracapsular and outside-in approaches in the published literature, presenting almost any iatrogenic complications like avascular necrosis, growth arrest, infections, nor hip instability.[2,3] Distraction of the hip joint is mandatory in HA when entering the central compartment (CC). Although hip distraction is necessary to treat intra-articular disorders, traction-related injuries, such as foot palsies and lacerations, vaginal or scrotal lacerations, and pudendal nerve dysfunction are very common, and several surgeons have recommended limiting traction time to under 2 hours. Entering the CC is the most important step when initiating HA, and this is performed blindly with the use of cannulated needles and obturators (Seldinger technique); an image intensifier is used for portal position. Sufficient force is needed to distract the head of the femur ~10 mm away from the acetabulum. This takes no direct account of the thickness of the

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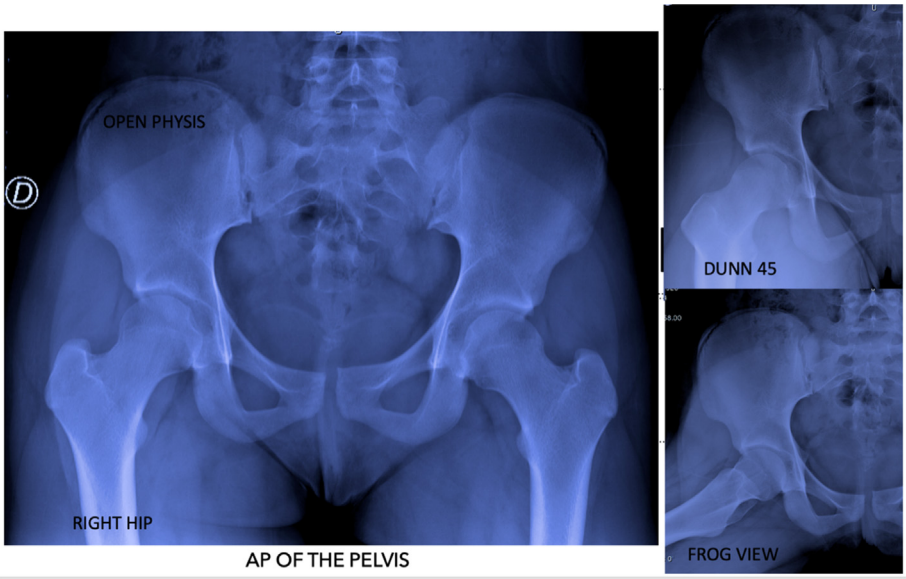

Fig 1. Right hip of an adolescent patient with femoroacetabular impingement syndrome and a labral tear. (Right) AP of the pelvis. (Top right) A Dunn view at 45°. (Bottom right) A frog view. Observe the open physis (Risser type 2-3), in this young patient who underwent an uneventful right hip arthroscopy with labral repair.

articular cartilage, which most often is not directly visible.[4,5] Some significant iatrogenic lesions, such as scuffing of the femoral head, labral penetrations, and labral punctures, while accessing the CC can be created when surgeons start their learning curve. This access is more difficult than other joints because of the constrained, deep, and strong musculature and anatomy. Surgeons typically use a hip fracture table or a commercial specialized hip distractor to obtain proper distraction and perform a reproducible and reliable surgery.[6,7,8,9] Counterdistraction is needed in HA and is achieved with the placement of a bulky cushioned perineal post measuring ~25 to 30 cm; this width is necessary and very important to avoid lesions of the pudendal and perineal nerve, erectile dysfunction, and vaginal or scrotal lacerations.[10,11,12]

Surgical Technique

HA is performed with the patient in the modified supine position, supported on a standard operating room (OR) table. The hip is distracted with a postless hip distractor (ArthroMX, San Pedro Garza Garcia, Mexico) under general anesthesia, and no muscle relaxants are used, although they may be added. The upper body of the patient is prepared in the Tutankhamun fashion with the yoga mat technique. Both arms are placed over the chest in a figure of 8 or X position. Bony prominences are protected with an egg crate foam at the level of the elbows and wrists. Hands are left free for intravenous line and medication passage, which are double checked by the anesthesiologist. Anatomic landmarks are marked on the patient's operative hip, and portals are established to access the peripheral compartment and central compartment. An anterolateral portal (AL) is used for vision, immediately anterior to the trochanteric tip; a paratrochanteric space portal (PSP) is used as a working portal, 3 cm distal from the anterolateral portal and over the anterior trochanteric border; and a new modified midanterior portal (MA) is located 1.5 cm above and between the anterolateral and paratrochanteric space portals, which we call the trochanteric triangle portal (Fig 2 and Table 1). We approach the hip through the peritrochanteric compartment penetrating the iliotibial band (ITB), aiming toward the PC. The surgeon slides the arthroscopic sheath and obturator from the trochanteric border to the anterior femoral neck to

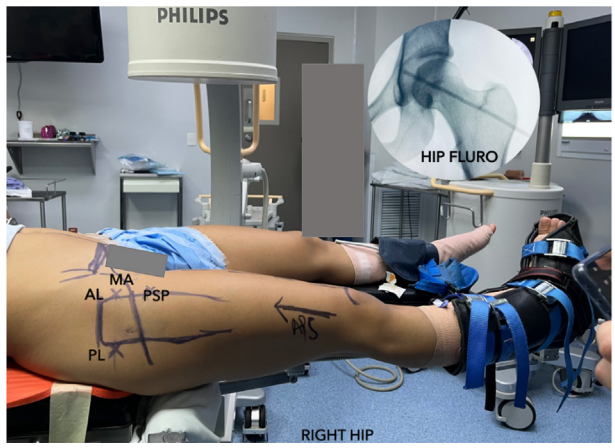

Fig 2. Hip arthroscopy in the modified supine position. Observe the anatomic landmarks to access the hip when performing the extracapsular approach. Hip arthroscopy portals are marked on this right hip. AL, anterolateral portal; MA, mid-anterior portal; PSP, peritrochanteric space portal; PL, posterolateral portal. In this case, we perform a labrum reconstruction.

Table 1. Pearls and Pitfalls

Pearls	Pitfalls
Can be applied in the modified supine and lateral position for HA	If you resect important hip stabilizers like the iliocapsularis, gluteus minimus, and other muscles around the anterior hip, you will destabilize the stability arc of the anterior capsule.
Can be applied with a perineal post and in postless HA	Perform a capsulectomy instead of capsulotomy when the hip capsule arms (iliofemoral and pubofemoral ligaments) are resected and not properly identified.
Use the anterolateral portal (tip of the greater trochanter) as the anatomic landmark to introduce the arthroscopic sheath for visualization.	Fluid extravasation into the thigh if the fluid pump is above 60 mmHg for more than 2 hours while working in the extracapsular space.
Slide the arthroscope to the femoral head neck junction to the anterior capsule bursae (this will appear in a bright yellowish color); here, you will find the stability arc of the anterior capsule.	Avascular necrosis can occur while doing the cam resection if you don't know the safe zone on the femur vascularity.
The operative foot is placed in external rotation to expose the femoral head and neck; this will assure that your arthroscopic sheath and obturator will stop at the head neck junction over the anterior capsule.	Neuropraxia can occur of bony prominences and perineum if the post is used and the traction is prolonged for more than 2 hours.
The assistant can perform hip flexions and rotations; this will move arthroscopically the anterior capsule for identification.	Neuropraxia of the elbow if HA is done postless while positioning and if the surgery takes more than 2 hours.
MA or PSP are done routinely and via triangulation. The capsule is tackled with the shaver and RF wand.	Lacerations of the foot and ankle by the foot if they're not well padded
The iliocapsularis muscle will appear medially, and then the reflected head of the rectus femoris, the gluteus medius-minimus superiorly and laterally and the vastus lateralis inferiorly trough the trochanteric crest. They form a triangle in the anterior capsule and the stability arc.	Not closing the capsule can create instability (pediatric patients and adolescents are more lax than adult patients).

AL, anterolateral; HA, hip arthroscopy; PSP, peritrochanteric space; MA, midanterior portals; OR, operating room; RF, radio frequency.

visualize the anterior capsule bursa and anterior capsule fibers, and posteriorly, following our previous radiographic and anatomic landmarks, we perform a longitudinal anterior capsulotomy with a radio frequency wand. After opening the capsule, we tackle the osseous morphologies. If we encounter a large and posterior cam morphology, a small "T" capsulotomy is performed. Hip distraction is done under direct visualization every 30 minutes, to avoid iatrogenic lesions while distracting the hip. If a labrum or a ligamentum teres is torn, we do a labral repair and a LT debridement in a standard fashion. In some cases, where we have found irreparable labral tears, a labral reconstruction is performed, capsule closure with 2 Parcus braid suture (Parcus Medical, Sarasota, FL) and plication are done in every patient.[13,14,15,16] (Figs 3 and 4, Table 2, and Video 1).

Postoperative Period

All patients start physical therapy 8 to 12 hours postoperatively, and a continuous passive motion machine (CPM) is placed in the operative hip from 0 to 60°. This is applied to every patient to obtain gentle and controlled mobilization of the hip. This avoids fibrosis and scar tissue on the anterior capsule; a hip brace may be added from 0 to 60° of flexion. All patients use crutches with 50% of weight bearing allowed for the first 14-21 days. From week 4 to 6, all patients complete

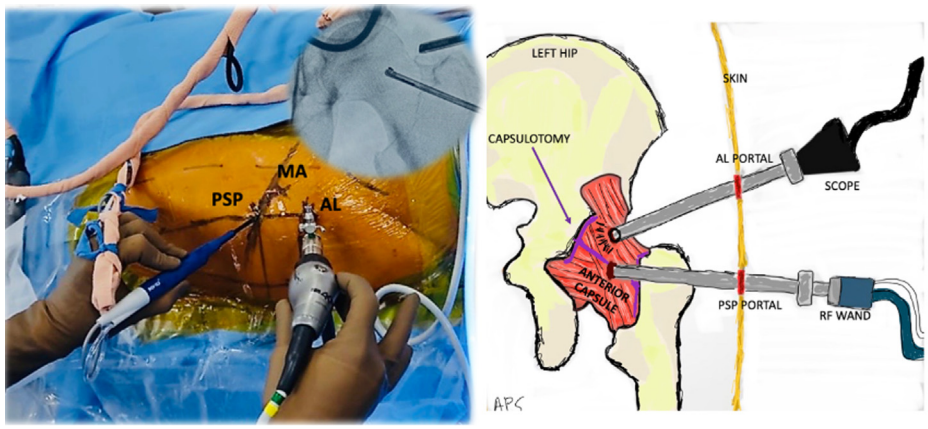

Fig 3. The extracapsular approach in hip arthroscopy. The hip is in the modified supine position. This is a left hip. (Left) Portals to access the hip (AL, MA, and PSP portal). (Right) A schematic drawing where the scope is placed in the anterolateral portal (AL) and the radio frequency wand in placed in the peritrochanteric portal (PSP). A small "T" capsulotomy is planned to access the hip joint. MA, mid-anterior portal.

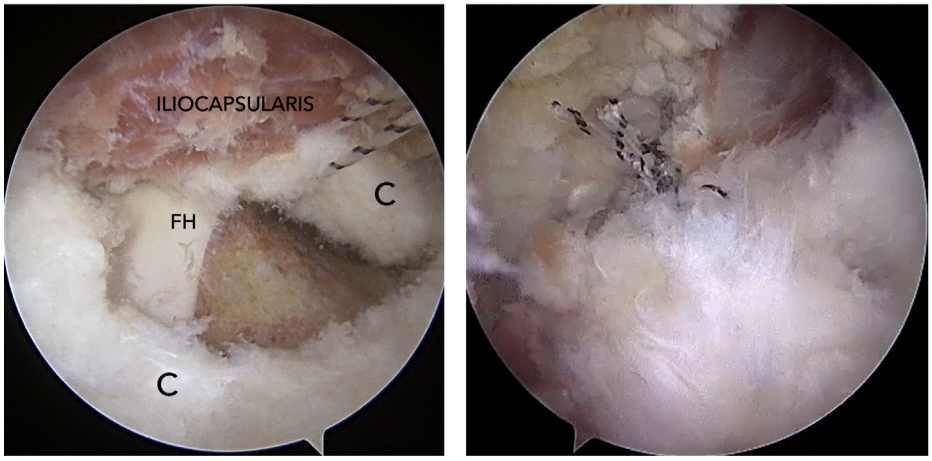

Fig 4. A Hip capsulotomy performed in this adolescent patient. A small T capsulotomy (left) is performed to work on the femoral and acetabular morphology. Observe the iliocapsularis muscle on the medial side of the hip. A capsule closure is made with 2 stitches at the end of the procedure (right).

their full range of motion and total weight bearing; at weeks 7-12, patients progressively increase strength, start jogging, and begin with surveilled sport activities. From 12 to 16 weeks, all patients begin with personalized training.

Discussion

HA and preservation surgery have become the gold standard treatment for FAIS in the adult and pediatric population. As we all know, two distinct types of morphologies, pincer, and CAM, have been identified, with a mixed type occurring in a high grade of percentage. Castaneda et al. highlighted that the occurrence of FAIS or the pistol grip deformity in even a low-grade slip is not uncommon. Almost 80% of their patients presented clinical and radiographic signs of FAIS. What is more, they also found that the degree of deformity was directly related to the presence of hip arthritis in early adulthood.[17] In the Kocher and Lee study in 2005, they collected data of 54 hip arthroscopies from children and adolescents, with an average age of 15.2 years old. Modified Harris hip scores (MHHS) improved in all cases around 30 points. The authors determined that hip arthroscopy is a safe and reproducible procedure in pediatrics with excellent outcomes. Complications, such as pudendal nerve palsy, resolved spontaneously by 3 months postoperatively. Equipment breakage of an obturator and recurrent labral tears occurred in two patients with prior hip surgery from dysplasia, and both cases were treated with a revision surgery with improvement of symptoms postoperatively.[18,19] Philippon et al. reported on 16 adolescent patients with a mean age of 15 years who were treated for idiopathic FAI. All patients had labral tears and underwent arthroscopic rim trimming and limited femoral head-neck osteoplasty. The MHHS increased from 55 to 94, whereas the hip outcome score (HOS) for activities of daily living and sports increased from 58 to 94 and 33 to 89, respectively. Mean patient satisfaction was 9 out of 10 at 1 year. Forty-eight hips in 43 patients were studied in 2018 with acetabular retroversion and were treated arthroscopically.[2,3] Litrenta et al. concludes that femoroacetabular impingement caused by acetabular retroversion in the adolescent treated with hip arthroscopy demonstrates good outcomes at 2 years with a low complication rate and that symptomatic patients may be safely and successfully treated arthroscopically, potentially avoiding an anteverting PAO. In their other study in adolescent patients with FAIS and labral tears, they mention that

Table 2. Advantages and Disadvantages

Advantages
1. Less traction to the adolescent patient, because the capsulotomy is done first
2. Easy to apply in severe cam and pincer morphologies
3. Easy to apply in deformities like SCFE and Perthes disease
4. Hip arthroscopic triangulation and better maneuverability while working in the anterior capsule and peripheral compartment of the hip
5. Femoral osteochondroplasty is done first.
6. Rim recession or acetabuloplasty can be performed with or without traction.
7. Hip distraction is only applied for intra-articular work.
8. The longitudinal capsulotomy can be extended to a small "T" when large cam morphologies are present.
Disadvantages
1. Not knowing gross an arthroscopic hip anatomy to identify muscles, ligaments, and bursae of the anterior capsule triangle (stability arc).
2. Hip iatrogenic instability in hypermobile and dysplastic patients when the capsule is not closed.
3. Labral and femoral head cartilage damage with the RF wand or beaver blade if the capsule is not done smoothly and in layers (from its superficial to its deep fibers)
4. Under resection of the large posterolateral CAM morphology if the capsule is not properly performed.

mmHg, millimeters of mercury; RF, radio frequency; SCFE, slipped capital femoral epiphysis.

arthroscopic surgery is highly challenging, and this patient should be approached with caution. They demonstrate that hip arthroscopy is a safe procedure with stable improvements in their reported outcomes at 5 years.[7,8] Chandrasekaran et al., in 2017, reported that HA is associated with an improvement in outcomes and pain, as well as high satisfaction scores at minimum 2-year follow-up in the adolescent population. The pattern of labral injury is different in males and females and dictates the arthroscopic approach. Females are likely to require a capsular plication and iliopsoas release to address soft-tissue laxity and impingement.[9]

Conclusion

Hip arthroscopy for FAIS and labral tears via the extracapsular approach in the pediatric and adolescent population is a safe, effective, and reproducible procedure and produces excellent improvements without postoperative complications like infections, instability, avascular necrosis, growth arrest, and the dreaded neurovascular injuries.

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