Hip Arthroscopy in the Pediatric and Adolescent Athlete

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Abstract

Hip disorders are increasingly common in pediatric and adolescent athletes, being both idiopathic problems aggravated by sports and overuse injuries caused by sports. These disorders are a major cause of morbidity and their long-term consequences carry into adulthood. In the past these problems have been primarily treated with open surgery using a surgical hip dislocation, but due to improved instruments and techniques, hip arthroscopy is becoming a mainstay in their treatment.

Arthroscopic management allows assessment and reconstructive treatment of most problems in practically all parts of the hip. Recent comparative studies have shown better clinical results, less complications and much faster recovery after arthroscopy when compared with open surgery for a number of indications, including impingement and labral tears. Typical pediatric hip disorders such as slipped capital femoral epiphysis (SCFE) and Legg-Calve-Perthes Disease (LCPD) may also benefit from hip arthroscopy.

Analyzing complications, hip arthroscopy has also performed very well. What stands out as a risk factor is the need for experience in pediatric hip arthroscopy techniques, which have been described to be distinctly different from the approach to the adult hip. Also, an understanding of the growing anatomy is crucial. Finally, a thorough and well-directed postoperative therapy is pivotal to realize the best possible outcome.

Keywords:
Pediatric sports, children, impingement, hockey, labrum, osteochondroplasty

Zusammenfassung

Hüftprobleme zeigen eine zunehmende Häufigkeit im Kinder- und Jugendsport – und zwar sowohl idiopathische Erkrankungen, die durch Sport angefacht werden, als auch Überlastungsprobleme oder Verletzungen, die durch den Sport entstehen. Diese Erkrankungen können sich zu bedeutsamen Problemen auswachsen und Konsequenzen bis ins Erwachsenenalter haben. In der Vergangenheit wurde vor allem die chirurgische Hüftluxation in der operativen Behandlung dieser Probleme angewandt, aber dank verbesserter Instrumente und Techniken kann heute zunehmend die Hüftarthroskopie eingesetzt werden.

Arthroskopische Chirurgie erlaubt eine genaue Untersuchung und rekonstruktive Behandlung der meisten Probleme in fast allen Bereichen der Hüfte. Rezente Vergleichsstudien haben sogar bessere klinische Ergebnisse mit weniger Komplikationen und schnellerer Erholung als bei offenen Eingriffen für Indikationen wie Impingement oder Labrumrupturen gezeigt. Patienten mit typischen pädiatrischen Hüftproblemen wie Epiphysiolyse oder Morbus Perthes können von einer arthroskopischen Behandlung ebenso profitieren.

In der wissenschaftlichen Aufarbeitung möglicher Komplikationen hat die Hüftarthroskopie auch positive Ergebnisse gezeigt. Als wichtiger Risikofaktor hat sich dabei die Erfahrung mit pädiatrischen Hüftarthroskopien gezeigt, da diese relevante Unterschiede zur Behandlung des Erwachsenen haben. Eine gute Kenntnis des wachsenden Skeletts ist ebenso wichtig. Zuletzt ist aber immer eine gründliche und gezielt geführte postoperative Nachbehandlung und Physiotherapie entscheidend, um das optimale Behandlungsergebnis zu verwirklichen.

Schlüsselwörter:
Kindersport, Jugendsport, Impingement, Hockey, Labrum, Osteochondroplastik

Introduction

Hip disorders are increasingly being recognized as an important problem in pediatric and adolescent athletes. They result in severe hip and groin pain, can reduce athletic performance, and become a significant cause of morbidity and long-term problems [1]. The best known hip disorders in the pediatric and adolescent age group, such as slipped capital femoral epiphysis (SCFE) and Legg-Calve-Perthes disease (LCPD) have also been identified as important risk factors for early onset osteoarthritis [2]. But other problems, such as femoroacetabular impingement, avulsions of the anterior inferior iliac spine, or cartilage defects, are increasingly seen in young athletes. This is particularly true in those sports that expose the hip to a high mechanical stress through a bend position, such as ice or field hockey, or have high strain, such as gymnastics or soccer.

Hip arthroscopy is becoming a major tool in the treatment of hip disorders in pediatric and adolescent athletes. The obvious advantages of hip arthroscopy include being minimally invasive, having lower morbidity and reduced recovery time [3,4]. This paper will review the current evidence for the arthroscopic management of common hip problems in the pediatric and adolescent athlete and draws on the guidelines for advanced arthroscopic surgical techniques put forward by of the Arthroscopic Association of North America (AANA) [5].

Arthroscopic treatment of Slipped Capital Femoral Epiphysis (SCFE)

Slipped capital femoral epiphysis (SCFE) refers to a disorder where the femoral epiphysis remains reduced in the acetabular socket while the proximal femoral metaphysis displaces anteriorly [6]. This results in loss of the sphericity of the femoral head-neck junction and creates a cam lesion. The severity of the disease is generally described by the slip angle, i.e. mild (0–30 degrees), moderate [30–60] and severe (>60 degrees) [7]. Rab et al. demonstrate that even mild slips lead to a change of sphericity severe enough to cause clinically relevant impingement [8]. There is some evidence that the physis can remodel over time, but even in mild slips with less than three months of symptoms, labral and chondral damage can be found intra-operatively [9].

In situ pinning is considered the treatment of choice for mild and moderate SCFE, while severe slips can be treated with open surgery including a modified Dunn osteotomy or other intertrochanteric osteotomy [7]. Current studies show that even patients with less than 30° of slip have a 30% risk of hip pain and decreased Tegner and Lysholm scoring 6 to 14 years after surgery [10]. 15% of SCFE patients progress to show radiographic signs of osteoarthritis at 45 years of age, compared to less than 2% in the average population of that age [11]. These studies have shifted clinical trends toward (earlier) use of hip arthroscopy in treating and analyzing SCFE to allow timely treatment of cartilage defects and impingement in order to mitigate further joint damage.

Arthroscopic treatment of femoroacetabular impingement (FAI)

Femoroacetabular Impingment (FAI) refers to a mechanical conflict between the femoral neck and the acetabular rim. It stems from changes in the anatomy, i.e. an overly oval femoral head-neck junction – called "cam" – and/or too far a protruding acetabular edge – called "pincer". The etiology of FAI is multifactorial [12], but some pediatric hip conditions have been implied as causes. Even mild SCFE (see above) can lead to a loss of sphericity and result in a clinically relevant cam lesion [13], as can other diseases [5]. Thus, mild SCFE might be provoked by at-risk positions of the hip as described for young ice hockey players *(Figure 1)*. The

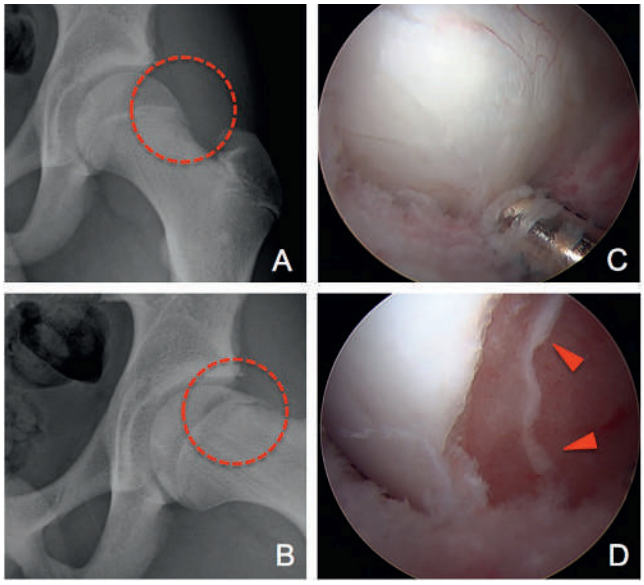

Figure 1: shows a.p. (A) and Dunn view (B) radiographs of a 14 year-old male. The red circles emphasize the anterolateral cam deformity around the level of the epiphyseal plate. (C) shows the arthroscopic view of the cam. Using an arthroscopic burr, a femoral osteoplasty is performed. This resection has to be performed from the neck to about 5–6mm above the level of the epiphysis, crossing the grwoth plate (red arrows, D).

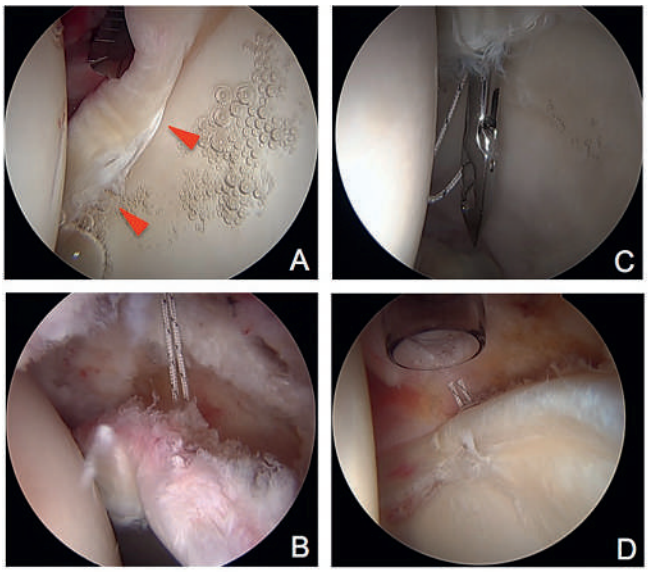

Figure 2: shows a tear of the labrum off the acetabulum due to FAI (A). For repair, the bony base is burred and a suture anchor is paced (B). Using a suture passing device, the labrum is caught (C) and repaired to the acetabular rim (D). This is repeated with as many anchors as needed to obtain a stable labrum. Labral repair is typically followed by osteoplasty as shown in Figure 1.

acetabular labrum and cartilage is what is being impinged, and over time increasingly is torn. *(Figure 2)* Surgical hip dislocation has been developed to approach this problem, however, complications including iatrogenic SCFE, avascular necrosis of the femoral head, and premature closure of the physis have been reported [14].

Hip arthroscopy, consisting of the removal of excess bone from the acetabulum and femur, refixation of the labrum and cartilage treatment as needed, has been assessed for its use in pediatric and adolescent FAI. Philippon et al. published data on the 5 year follow up of 60 patients between 11 and 16 years of age at the time of surgery. Their data shows a modified Harris Hip Score (HHS) of 91 pts (95% CI, 88 to 94) and median patient satisfaction of 10/10 (range, 5 to 10) [12]. Kocher et al published data on 30 patients with labral repair for FAI and showed an HHS of 89.2 (8.1) pts [15]. The largest study so far was published by Byrd et al. and showed a mean postoperative HHS of 95 pts for 114 adolescent patients undergoing hip arthroscopy for FAI [16]. Of note, arthroscopic treatment of SCFE-induced FAI is technically more complicated than the the typical, non-SFCE induced FAI. SCFE-induced FAI patients typically are obese, and only limited traction can be used due to the pre-existing growth plate damage. At the same time, the amount of bone that needs to be resected is larger and spread over a wider area. Finally, there is quite frequently hardware in situ, that needs to be removed or circumnavigated.

Arthroscopic treatment of extra-articular & subspine impingement

A forceful, eccentric contraction of the overstretched, rectus femoris muscle can lead to an avulsion of its proximal insertion including an osseous avulsion fracture of the anterior inferior iliac spine – a problem, that is seen especially in martial arts, soccer and hockey goalkeepers. These injuries can be severely debilitating in the initial phase, but typically heal well. In some cases however, excessive callus formation is found [17] and can lead to soft tissue complications and so-called subspine impingement (SSI), which might be combined with FAI as well [18]. As with classic FAI, hip arthroscopy has been proven to be a reliable treatment option for these young players [19].

Using arthroscopic technique, this callus can be removed *(Figure 3)*. DeSa et al. have collected the data on arthroscopic management of SSI and present an improvement in flexion by 20°, a postoperative HHS of 91.3 pts and a postoperative pain score of 1.2 [19]. Other studies corroborate these findings [18].

There are other forms of so-called extra-articular hip impingement beyond SSI. The better-known ones are psoas impingement and trochanter/pelvic impingement. Both are relatively rare, and, even though the can be treated arthroscopically in select patients, typically warrant conservative treatment and specialized physical therapy [19]. Psoas releases during growth should be resevered for patients with spastic palsy.

External hip snapping, which is snapping of the iliotibial tract over the greater trochanter, is another soft tissue indication of hip arthroscopy. The problem is most frequent in athletes and dancers in their teens and twenties and does sometimes, with insufficient response to conservative treatment, require surgical intervention. An arthroscopic release and bursectomy is a reliable treatment with quick recovery and early return to sports, and abductor repair can be done at the same time [20,21]. However, most pediatric and adolescent cases respond well to conservative management.

Arthroscopic treatment of hip chondromatosis

Synovial chondromatosis is a rare disorder where numerous cartilaginous masses form within the synovial membrane. The exact reasons are unknown, but has been shown to be triggered spontaneously and by trauma as well. The resulting intra-articular loose bodies may cause pain and mechanical symptoms and reduce range-of-motion of the affected joint. In those cases where the cartilaginous masses have not calcified, plain x-rays can be misleading, and the overall prevalence of the disease might be underdiagnosed for this reason. Surgical treatment consists of removal of the loose bodies, and total synovectomy to stop further progression of the disease. *(Figure 4)* Through an open approach this can be done only by using substantial dissection and causing relatively slow recovery. Given the benign nature of the disorder, a minimally-invasive approach seems better justified.

A number of studies have assessed the effectiveness of arthroscopic management of synovial chondromatosis of the hip. Lee et al. found that pain scores reduced to 1.3 pts and HHS improved to 92 pts 41 months after hip arthroscopy [22]. Zini et al found similar results, and showed that the complication rate was 0/11 patients [23]. The largest

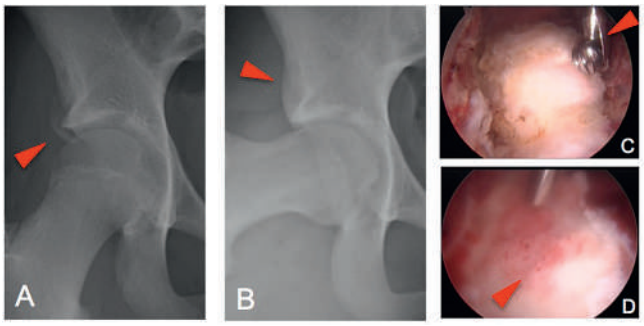

Figure 3: A 12 year-old hockey player sustained an avulsion of the anterior inferior iliac spine (red arrow, A). This resulted in excessive callus formation (red arrow, B), causing so-called extra-articular, sub-spine impingement. This callus can be approched during arthroscopy (C) and resected (D).

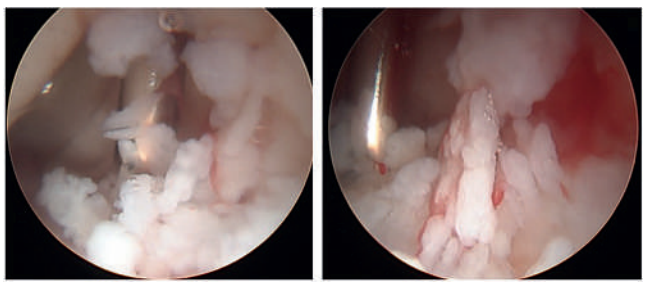

Figure 4: shows the tyically cartilaginous loose bodies seen in synovial chondromatosis. The loose bodies are removed using a shaver, and a total synovectomy is done using a radiofrequency device.

study so far, including 197 patients, corroborates the above-mentioned findings, but showed a recurrence rate of the disease of 7.1% [24].

Arthroscopic treatment of femoroacetabular cartilage defects/OCD

Osteochondrititis dissecans (OCD) is another well known, yet poorly understood articular pathology. It describes a progressive disorder of subchondral bone damage, believed to be an avascular necrosis, that can lead to complete destruction of the subchondral bone and formation of a free-floating cartilage fragment. It is unknown if and to what extent sports participation is a risk factor of OCD, but sport does precipitate the typical symptoms of pain and swelling.

In the hip, OCD has been suggested to rather be part of a larger disease, such as AVN or Perthes, than a limited disease on its own [25]. Since the hip is fairly well constrained and occlusive, conservative treatment is often an excellent choice in the first line of treatment. Since the hip is also exposed to high compressive and shear forces during ambulation and sports, conservative management fails in some proportion of OCD patients. In these situations, surgical fixation or replacement of the loose cartilage piece is indicated. This can be reliably achieved using arthroscopic techniques [26,27].

Hip cartilage defects may as well be of traumatic origin and should be suspected in any patient suffering from a hip dislocation. In FAI, cartilage defects result from increasing abrasion and/or impaction of the cam against the cartilage of the actebulum. This progresses in a somewhat predictable fashion, ranging from surfactant loss to cartilage softening, delamination and finally tearing. *(Figure 5)* Treatment options include debridement, microfracture and cartilage repair techniques and might be combined with other procedures such as cam resection as relevant to the individual pathology.

Arthroscopic treatment of Legg-Calve-Perthes disease

Legg-Calve-Perthes disease is a primary avascular necrosis of the proximal femoral epiphysis with variable presentation and course [28]. The disease progresses through multiple stages: the initial avascular necrosis, fragmentation of the epiphysis, resorption and collapse, followed by re-ossification or healing. While some healed cases will show only little changes in femoral head shape, most are of moderate severity and will result in lasting alterations in hip morphology. Arthroscopy may help these patients by reduction of the femoral head deformity and its resultant acetabular incongruity. Patients with mechanical symptoms such as clicking, catching or locking due to a torn labrum, chondral flaps, loose bodies, or any combination of these are suitable for arthroscopic treatment.

Kocher et al, in 2005, published a case series of 54 consecutive cases in patients of 18 years and younger [29]. In 8 patients with Perthes, a significant improvement of the modified Harris Hip Score from 49.5 pts to 80.1 pts was seen over the 17 months follow-up. More recently, a paper by Freeman et al followed 22 patients (23 hips) with a median age of 27 years over 2 years after hip arthroscopy for Perthes disease and found an improvement in the modified Harris Hip score from 56.5 pts to 85 pts [30].

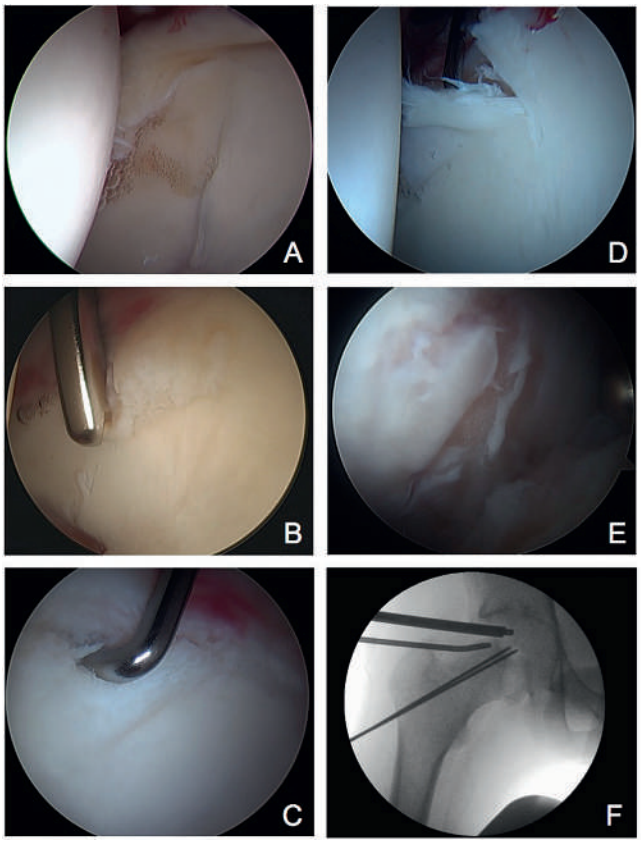

Figure 5: shows various stages of cartilage damage in the hip. Early damage shows air bubbles adhering the cartilage because of the destruction of the superficial phospholipid layer (A). Increasing damage will soften the structure of the cartilage (B), resulting in the so-called "wave sign". This then leads to cartilage delamination (C) and rupture (D). On the femoral side, cartialge defects compose superficial cartilage tears (E). In an adolescent population, OCD of the femoral head can be seen as well, and anterograde drilling using k-wires is an effective treatment (F).

Complications in pediatric and adolescent hip arthroscopy.

Arthroscopy in children and adolescents is still considered by many to be a high-risk procedure compared to adults, due to the smaller size of the joint cavity and the growth plates. This is not true, and, in fact, it has been shown for various joints, that arthroscopic management actually has a lower risk profile than in adults [31,32]. In direct comparison, both, open and arthroscopic treatment for hip disorders haven been shown to be effective, but hip arthroscopy has consistently produced better results for health-related quality-of-live (HrQOL), clinical scores, and duration of postoperative recovery [3,4,33,34]. These studies, however, do stress the flat learning curve in hip arthroscopy.

Hip arthroscopy has it own set of risks. Most prominent are traction-related complications such as pudenal, femoral or sciatic neuropraxia or soft tissue defects from pressure [35]. These are directly related to the time under traction and the amount of traction, both of which are correlated to the level of surgical skill and experience in hip arthroscopy. Fur-

thermore, there is a risk for iatrogenic labral and cartilage damage from instrument insertion and manipulation. This can be avoided by accurate portal placement, which, again, is correlated with experience in the technique [35]. Finally, with osteochondroplasty of the femoral neck there is a risk of fracture or AVN. However, while it has been shown that resection of up to 30% of the neck will not cause a substantial reduction of biomechanical strength [36], underresection of cam is the leading cause for revision hip arthroscopy [37]! Fluid extravasation from the portals is common, but usually not a problem.

Discussion

There is a growing awareness of hip problems in pediatric and adolescent athletes. In many cases it is not fully understood if these problems arise due to overuse in sports, or if their cause is idiopathic and their course aggravated by sports participation. What is known is that hip disorders can be considerably painful, will limit sports participation and can cause further problems well into adulthood.

Traditional surgical treatment used to be an open hip dislocation, i.e. an osteomtomy of the trochanter and complete twist of the whole leg out of the socket, followed by screw fixation of the greater trochanter and the hip abductors. Over recent years, hip arthroscopy has become a minimally-invasive alternative of proven equal effectiveness and resulting in quicker recovery and even better overall health-related quality-of-live [3,4,33,34]. However, it has also been pointed out that achieving these improved outcomes is dependent on surgical skills and familiarity with the required surgical techniques, and that pediatric and adult hip arthroscopy require rather distinctly different sets of solutions and strategies [34, 5].

Once the learning curve is mastered, arthroscopy is also an invaluable tool in the management of many other hip disorders of the growing patient not described in this text. It should not go unmentioned, that the cartilage damage frequently seen in multiple epiphyseal dysplasia (MED) and spondyloepiphyseal dysplasia (SED) can be very effectively addressed by hip arthroscopy. The same is true for septic and inflammatory osteoarthritis. Finally, hip arthroscopy is starting to be used in trauma cases as well, but currently only in a limited group of indications.

Yet it cannot be stressed enough, that the outcome of any arthroscopic procedure around the hip – especially in children – is very much dependent on a well-directed and specialized postoperative physical therapy. A close contact and frequent communication between the surgeon and physical therapist is crucial. Likewise, expectation management is pivotal, and patients must be made to understand and embrace the fact the building a sound muscle base after a hip intervention is the key to lasting success of the treatment.

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