Review Article Clinics in Orthopedic Surgery 2021;13:437-442 • https://doi.org/10.4055/cios21109

Controversial Issues in Arthroscopic Surgery for Femoroacetabular Impingement

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Femoroacetabular impingement (FAI) is a common cause of painful hip in the young and middle-aged population. This condition frequently leads to a labral tear, damage of acetabular cartilage, and secondary arthritis of the hip. When nonsurgical managements are not effective, surgical procedures (open surgery and hip arthroscopy) are indicated. Due to its less invasiveness, hip arthroscopy has replaced open surgery during the last two decades. The effectiveness of arthroscopic surgery in pain relief for FAI syndrome has been well established. The procedure is also expected to slow or prevent further progression to hip arthritis. In this review, we provide the updated knowledge of arthroscopic procedures for the management of FAI syndrome.

Keywords: *Hip, Femoroacetabular impingement, Arthroscopy*

Femoroacetabular impingement (FAI) is a disorder of the hip due to a contact between the femoral head-neck junction and the acetabulum during motion. It develops in individuals who have flattened or protruded femoral necks or overcoverage of the acetabulum or both. Clinically, FAI presents with hip pain and restricted range of motion (ROM).[1,2] With time, it leads to a tear of the acetabular labrum and damage of the articular cartilage. FAI has been revealed as an important cause of hip arthritis in considerable cases, which was previously known as idiopathic osteoarthritis.[1]

There are two distinct morphologies of FAI. Cam-type impingement is caused by a protrusion or bump of the femoral neck, while pincer-type impingement arises from increased acetabular coverage. Cam FAI commonly involves young men while pincer FAI is common in middle-aged women.[2] However, a high percentage of patients with FAI have combined morphology,[3] and an isolated diagnosis of either cam or pincer FAI is inadequate in FAI patients.[4] FAI morphologies are fairly common in the general population including people without hip symptoms. In a cross-sectional study in the United States, cam morphology was seen in more than 25% of men and 10% of women, while pincer morphology was identified in 7% of men and 10% of women.[5] In East Asia, a cross-sectional observational study using simple radiographs reported the prevalence of FAI morphologic features in asymptomatic Korean volunteers. In the study, cam-type morphologies were seen in 38% (men, 57%; women, 26%) and pincer-type morphologies in 23% (men, 27%; women, 21%) of the study population.[6]

When an FAI symptom is not controllable by nonsurgical measures such as pharmaceuticals, activity modification, and physiotherapy, surgical treatments are indicated. Hip arthroscopy is less invasive and has replaced open surgery as the preferred surgical treatment for FAI.[1] In the United Kingdom, 1,908 arthroscopic operations were done, while only 491 open operations were done for FAI syndrome in 2013.[7] In the United States, the number of hip arthroscopies increased by 3.65 times during the period from 2004 to 2009.[8] The aims of arthroscopic surgery are to reshape the hip joint and to concurrently repair or reconstruct coexisting damages of articular cartilage and

Received July 4, 2021; Revised August 6, 2021;
Accepted August 6, 2021
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labrum.[9] In this article, we provide updated opinions on the controversial issues in arthroscopic surgery of FAI.

CONTROVERSIAL ISSUES

Pincer-Type FAI

In pincer-type impingement, the aim of a surgical procedure is to reduce the coverage of the acetabular rim by removing an overhanging portion. Both global and focal acetabular overcoverage can be managed by acetabuloplasty.[10] However, in turn, the procedure also reduces the weight-bearing area of the acetabulum. Therefore, it should not be performed in hypoplastic acetabulum.[11]

The reduction in the center-edge angle (CEA) is an important determinant for postoperative hip function. Nevertheless, the target value of CEA remains unknown. In a computed tomography (CT)-based analysis of 474 asymptomatic hips, Larson et al.[12] reported a normal CEA value of 31°, which may represent a reliable postoperative target.

Cam-Type FAI

The presence of cam morphology is associated with an increased risk of future progression to hip osteoarthritis.[1] Thus, the purpose of arthroscopic surgery is to remove a protruded portion at the femoral neck and reshape the spherical femoral head. A multicentre randomised controlled trial (UK FASHIoN) has shown that arthroscopy in purely cam-type FAIs results in greater clinical benefit compared to that in mixed or pincer-type FAIs.[9] However, it should be noted that the arthroscopic outcome is poor when the total volume of cam deformity is great.[13]

Likewise with the pincer-type FAI, the target amount for arthroscopic correction of the cam morphology is debated. In a meta-analysis of 29 studies reporting outcomes of hip arthroscopy, the mean preoperative alpha angle of 72.2° decreased to 48.6° after arthroscopic surgery with a mean reduction of 23.6°.[14] In a retrospective review of 38 patients, who underwent hip arthroscopy for cam-type FAI, the mean alpha angle decreased from 69.7° preoperatively to 50.7° postoperatively with a mean reduction of 19.0°.[15] In the literature, the threshold alpha angle inducing a cam impingement varied widely from 50° to 83°.[16-19] Although there is no validated target to correct cam deformity, an alpha angle of 60° might be a reasonable target.[20,21]

A concern raised after the correction procedure is the risk of postoperative femoral neck fracture. Resection of the anterolateral portion of the femoral head-neck junction might reduce the load-bearing strength of the proximal femur. Two biomechanical studies evaluated the relationship between the amount of bone removal and the risk of fracture.[22,23] Up to 30% of the anterolateral head-neck junction can be removed without increasing the risk of femoral neck fracture. However, post-arthroscopic fractures have been reported after resections within these limits. Thus, patients undergoing osteoplasty of the anterolateral portion of the femoral head-neck junction should be advised to modify postoperative rehabilitation until the time of cortical remodelling at the removal site.[22,23]

Underresection may result in residual FAI. Conversely, overresection (> 5% of the diameter of the femoral head) may disrupt the mechanism of labral seal and disturb the chondroprotective fluid dynamics of the hip.[24] Thus, arthroscopic removal of cam deformity should be adherent to the above advocated targets. Otherwise, it can compromise the load-bearing capacity and the integrity of the labral seal.

Concomitant Labral Damage

FAI Patients frequently have labral tears. In the past, labral resection was done as a first-line treatment. However, current studies showed that the resection impairs sealing of the joint, which leads to secondary osteoarthritis of the hip[25] and worse postoperative outcomes compared to labral repair.[26] Therefore, there is now consensus supporting labral repair/reattachment of the labrum over the resection. In a systematic review of 68 studies including 7,241 hip arthroscopies for FAI, the performance of labral repair increased from 19% to 81% between 2009 and 2017.[27] In pincer FAI where the chondrolabral junction remains intact, acetabuloplasty and labral refixation is recommended, whenever possible.[11]

Concomitant Articular Cartilage Damage

Damage of the articular cartilage is common in FAI patients.[28] In the Danish Hip Arthroscopy Registry, cartilage damage was associated in 88% of symptomatic FAI patients, mainly on the acetabular side.[29] The damage occurs due to the impaction between the acetabular edge and the femoral head. It proceeds in the following sequence: (1) cartilage bulging at the chondrolabral junction, (2) flap formation, and (3) defects in the affected areas.[30]

Early damages can be managed by shaving or radiofrequency ablation of bulging cartilage flaps. This is the most common arthroscopic procedure, which accounts for more than 81% of all arthroscopic procedures in FAI patients.[29] More advanced damages require reparative procedures: microfracture and autologous chondrocyte transplantation (ACT).[31-34]

There are only a handful of papers describing the outcome of microfracture in the hip.[34] However, in a recent systematic review, it appeared as a safe and effective treatment, especially for full-thickness, focal chondral defects.[33] Currently, the proportion of acetabular microfracture procedures among the whole hip arthroscopies was around 5% in North America and Denmark.[29,35] Given its efficacy, the number of this procedure may rise in the near future. Although recent studies reported promising results of ACT in FAI lesions,[31,36] the effectiveness of ACT is not supported by high-level evidence and needs further investigation.

Capsular Closure

For arthroscopic approach of the hip, two capsulotomies, interportal capsulotomy and T-shaped capsulotomy, are in wide use. The interportal capsulotomy is a transverse incision of the capsule between the two established portals in the capsule. The T-capsulotomy, an additional perpendicular incision to the interportal capsulotomy, has been introduced to improve visualization and access to the femoral head-neck junction.[37] Iatrogenic instability caused by an unrepaired capsulotomy appeared as a concern of hip arthroscopic procedures.

Recently, capsular closure has been advocated because recent studies showed that it prevents iatrogenic hip instability after hip arthroscopy and reduces the incidence of conversion to hip arthroplasty.[38] Some cadaveric studies demonstrated that a long capsulotomy compromises hip joint stability, while it can be restored to the near-intact state by capsular repair.[39,40] In a systematic review, Riff et al.[27] showed that the performance of capsular closure increased from 7% to 58% between 2009 and 2017 in patients undergoing hip arthroscopic surgery for FAI syndrome.

Postoperative Rehabilitation

The healing time of the diverse arthroscopic procedures (labral repair, acetabuloplasty, osteochondroplasty, and microfracture) should be considered in postoperative rehabilitation.[11] Even though the body of literature on hip arthroscopy has grown, there is a lack of studies on postoperative rehabilitation programs.

Grzybowski et al.[41] conducted a systematic review on 18 studies reporting rehabilitation protocols. After labral repair, pincer acetabuloplasty, and/or femoral osteochondroplasty, a tolerable weight-bearing was allowed immediately after the procedure in 9 studies. Microfracture necessitated protected weight bearing for 1 to 2 months in 4 studies. Four studies recommended specific rehabilitation protocols based on four phases: phase I (0–6 weeks) is a period of protection with limited weight-bearing, restoration of early ROM, and isometric strengthening of hip flexor; phase II (4–12 weeks) advances to free weight-bearing and ROM; phase III (8–20 weeks) focuses on sport activity; and phase IV (12 weeks~) is a full recovery to unrestricted ROM and activity.

Revision Hip Arthroscopy

The British National Health Service data revealed that 4.5% of patients (286/6,395) undergoing hip arthroscopy between 2005 and 2013 necessitated revision hip arthroscopy at a mean of 1.7 years.[42] The main reason for the revision arthroscopy was persistent symptoms due to residual cam or pincer-type deformity after the primary procedure.[43] It should be acknowledged that the outcomes of revision arthroscopy were inferior to primary hip arthroscopy for FAI.[43]

Dysplasia with FAI Syndrome

Developmental dysplasia of the hip (DDH) leads to labral tears and chondral damage.[44,45] Borderline DDH (BDDH) is defined as a CEA angle of 18° to 25°.[46] It is not certain whether hip arthroscopic surgery is beneficial to patients with a BDDH. In 2019, Ding et al.[47] systematically reviewed 9 studies involving 425 BDDH patients undergoing hip arthroscopy. In their review, the modified Harris hip score and patient-reported outcomes improved significantly. However, the mean failure rate was 14.1%, the mean reoperation rate was 8.5%, and the mean conversion rate to total hip arthroplasty ranged from 4.4% to 26.0%. Combined defects including cartilage damage, ligamentum teres tears, FAI, and hip osteoarthritis were risk factors for the poor outcome. Furthermore, Hatakeyama et al.[46] reported that age ≥ 42 years, broken Shenton line, osteoarthritic change, Tönnis angle ≥ 15°, and VCA angle ≤ 17° were predictors of poor outcomes after arthroscopic surgery of BDDH patients. In the selection of candidates for the arthroscopy, combined defects, patient's age, and radiological indices should be considered.

Management of FAI in Adolescents

An open physis is the critical concern in the treatment of FAI in adolescent patients. Closure of the proximal femoral physis starts at 16–18 years of age, and complete fusion occurs at 20 years of age.[48] The location of the cam morphology is adjacent to the proximal femoral physis (a mean distance of 0.07 cm).[49] Osteochondroplasty has a potential risk of growth arrest of the proximal femur and iatrogenic slipped capital femoral epiphysis. There

is a paucity of literature on the treatment of adolescent patients with FAI. In the report of Larson et al.,[50] 93% of adolescent FAI patients, who had been treated with hip arthroscopy using a non-physeal-sparing approach, returned to their pre-injury level of sports activity without limitations. One systematic review has shown that hip arthroscopy and open surgical dislocation were safe and effective in adolescent FAI patients without physeal arrest, growth disturbance, or iatrogenic epiphyseal slippage.[48] Nevertheless, the follow-up period was short in previous studies, and future studies are warranted to evaluate the safety and effectiveness in the long-term.

CONCLUSION

FAI syndrome presents with hip pain and restricted ROM, and it is an etiological factor for further development of osteoarthritis of the hip. Hip arthroscopy is substantially beneficial compared to open surgery with hip dislocation. Even though several studies suggested the target CEA for pincer-type FAI and the target amount of resection for cam deformity, those target values remain unvalidated. The therapeutic efficacy of labral repair compared to resection has been well documented, especially in normal and hypoplastic acetabulum. Arthroscopic hip surgery seems to be safe and effective in adolescent patients with FAI.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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