



Arthroscopic Treatment of Femoroacetabular Impingement Syndrome: An Updated Review

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Treatment strategies for femoroacetabular impingement (FAI) syndrome have evolved in tandem with increased comprehension of FAI's impact on hip joint health. Early intervention, including arthroscopic surgery, has gained popularity due to its potential to delay the progression of osteoarthritis. Arthroscopic surgery has demonstrated significant efficacy in treating FAI syndrome, with robust evidence from randomized controlled trials and systematic reviews supporting its use. Despite arthroscopic surgery's success, complications and reoperations are not uncommon. The incidence ranges from 1% to 31% and 4% to 13%, respectively. Adjunctive biologic treatments, such as bone marrow aspirate concentrates and platelet-rich plasma, have shown promise in chondral lesion management. However, robust evidence supporting their routine use in FAI syndrome is currently lacking. Among conservative treatment methods, intra-articular injections offer diagnostic and therapeutic benefits for FAI patients. While they may provide pain relief and aid in prognosis, their long-term efficacy remains a subject of debate. Comparative studies between conservative and arthroscopic treatments highlight the importance of personalized approaches in managing FAI syndrome. In conclusion, recent advancements in FAI syndrome management have illuminated various treatment modalities. Arthroscopic surgery stands as a pivotal intervention, offering substantial benefits in pain relief, function, and quality of life. However, careful patient selection and postoperative monitoring are crucial for optimizing outcomes. Adjunctive biologics and intra-articular injections show promise but require further investigation. Tailoring treatment to individual patient characteristics remains paramount in optimizing FAI syndrome management.

Keywords: Femoroacetabular impingement, Arthroscopic surgery, Conservative treatment, Treatment outcome, Review

Femoroacetabular impingement (FAI) syndrome was first described as a disease entity by Ganz et al.¹⁾ in acetabular and femoral anatomy in 2001. Since then, the number of articles on FAI has increased approximately 3.4 times during the past 10 years. According to a study published in 2022, FAI syndrome—although it might not have been

recognized as a disease—was present in ancient Nubia as early as 3,000 years ago.²⁾ The contemporary definition of FAI syndrome is largely based on the 2016 Warwick Agreement consensus, which emphasizes the triad of symptoms, clinical signs, and image findings to diagnose the condition.³⁾

The primary symptom of FAI syndrome is the motion- or position-related pain that is located on the hip, back, buttock, or anterior thigh.⁴⁾ Other than pain, mechanical symptoms such as catching, locking, giving way, or clicking could occur with a restricted range of motion.⁵⁾ The clinical sign of FAI syndrome is most commonly tested with flexion, adduction, and internal rotation (FADIR) test due to its high sensitivity, but it does not show high

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specificity.⁶⁾ Diagnostic imaging of FAI syndrome mainly focuses on finding the pincer or cam lesions with lateral or anterior center-edge angle on pelvic anteroposterior, Dunn view, cross-table lateral, or frog-leg lateral radiographs.⁷⁾

Treatments of FAI syndrome have evolved along with the further understanding of the disease. The rationale for treating FAI syndrome stems from the reports that FAI syndrome causes osteoarthritis of the hip joint. This notion was proposed by Stulberg et al.⁸⁾ with the term, “unrecognized childhood hip disease,” which could cause idiopathic osteoarthritis of the hip. In 2003, Ganz et al.⁴⁾ reviewed over 600 cases and suggested the early intervention of FAI to delay osteoarthritis of the hip in young patients. Currently, the standard treatment of FAI syndrome consists of activity modification, rehabilitation, or surgery with the increasing popularity of arthroscopic surgery.^{3,9)} It should be noted, however, that cam-type FAI syndrome and pincer-type FAI syndrome have different clinical features and prognoses.¹⁰⁻¹³⁾ Cam lesions are more commonly found in post-adolescent men, while pincer lesions are more prevalent in middle-aged women.¹⁴⁾ It has been established that cam lesions are associated with the development of subsequent osteoarthritis, but the relationship between pincer lesions and osteoarthritis is less evident.¹⁵⁾

As the primary endpoint of the treatment of FAI syndrome is more focused on preventing subsequent osteoarthritis rather than curing FAI syndrome itself, it differs from the definitive treatment such as arthroplasty, which is the gold standard for end-stage hip osteoarthritis. For conservative treatment, activity modification, physiotherapy, pain control with oral analgesics, and intra-articular hip joint injection are commonly prescribed.^{3,16)} For surgery, both traditional open surgery and arthroscopic approach have been reported effective but the latter may be recently gaining more popularity due to fast recovery.^{1,17)} However, the clinical evidence to clarify the treatment strategy of FAI syndrome is rapidly aggregating with controversial effectiveness of the treatment modality.^{16,18)} Therefore, the purpose of this study was to review recent literature to assess the effectiveness of arthroscopic treatment of FAI syndrome and compare with that of conservative treatment.

ARTHROSCOPIC SURGERY FOR FAI SYNDROME

Recently, there has been a swift rise in accounts of successful results from arthroscopic surgery performed to treat FAI syndrome. High-level evidence based on robust randomized controlled trials (RCTs) and systematic reviews/

meta-analyses, which were globally conducted, adds rationale to arthroscopic treatment in FAI syndrome.¹⁹⁻²⁵⁾ Due to the less invasiveness and comparable surgical outcomes, hip arthroscopy is gradually replacing open surgery in FAI syndrome. In the United States, the number of hip arthroscopy increased over 3 times between 2004 and 2009.²⁶⁾ In 2013, arthroscopic surgeries for FAI accounted for 1,908 cases, while open surgery accounted for only 491 cases in the United Kingdom.²⁷⁾

The distinctive morphologic features of FAI syndrome are directly visualized through arthroscopic examination.²⁸⁾ During arthroscopic surgery, cam lesions or pincer lesions, as well as the subtle chondral lesions or labral tears, are observed.²⁹⁾ Some of these lesions are not readily visualized in computed tomography scans or magnetic resonance imaging but only found in arthroscopic examination.^{28,29)} Arthroscopic confirmation of suspected lesions, as well as consequent treatment performed directly through arthroscopic management, is one of the factors that contribute to the increasing popularity of arthroscopic surgery.

Biomechanics of FAI Syndrome

Cam-type and pincer-type FAI syndrome exhibit impingement at different sites of femoral neck. Typically, cam-lesions develop at the anterosuperior aspect of the femoral neck, which was originally described as the extension of the abnormal epiphysis of the femoral head.^{12,13)} In contrast, pincer lesions are related to the acetabular overcoverage, often with the maturation of preexisting os acetabuli.¹¹⁾ However, it should be noted that mixed type FAI syndrome with both cam and pincer lesions are very commonly found.¹⁰⁾

From a biomechanical point of view, a systematic review was conducted on 12 studies on cam-type FAI syndrome (173 cam-lesions vs. 177 controls) and reported that cam lesions reduce the sagittal range of motion of the hip joint, maximum extension angle, and abduction angle of the hip joint and decrease iliopsoas muscle power and walking speed.¹³⁾ Van Houcke et al.³⁰⁾ reported that in cam-type FAI syndrome, the peak contact stress during 20° of internal rotation nearly decreased by half (26.6–11.4 MPa) after arthroscopic cam resection. Another study using finite element modeling on pincer lesions showed that the maximum stress-strain increased 2 to 3.4 times in the anterosuperior acetabular rim compared to that in the control group.³¹⁾

A recent systematic review concluded when arthroscopic surgery is performed for FAI, flexion and internal rotation of the hip joint often improve after surgery, but external rotation angle may not increase significant-

ly.²⁰⁾ These studies provide a biomechanical background on how arthroscopic surgery could aid in pain and functional improvement in FAI syndrome.

Patient Selection in Arthroscopic Surgery for FAI Syndrome

Patient selection in treating FAI syndrome is especially important in that the complication rate could vary among different patient demographics. It is commonly accepted that obese patients who developed arthritis are not the ideal candidates for surgical procedures to treat FAI syndrome. Some studies have constructed evidence on ideal features of patients to be treated with arthroscopic surgery.^{21,22)}

Kay et al.²¹⁾ reported factors affecting pain, function, and quality of life in patients who are included in the FIRST (Femoroacetabular Impingement Randomised Controlled Trial) study in 2021. The results of the study showed that 1 year after surgery, the improvement in quality of life was greater in younger patients, and the improvement in pain was greater in patients with lower body mass index (BMI). No factors showed an association with reoperation, which occurred in 13%.²¹⁾

More recently, Migliorini et al.²²⁾ focused on return to sports after arthroscopic surgery for FAI syndrome in 41 studies (4,063 cases) and found that 89% were able to resume within 3 years. In particular, patients with younger age, lower body weight, lower arthritis stage (Tönnis grade I) before surgery, and better hip function had better post-operative function.

Clinical Outcomes of Arthroscopic Surgery in FAI Syndrome

Recently, there is a growing body of evidence to support the efficacy of arthroscopic surgery in FAI syndrome.^{19,22-24,32,33)} To compare the specific arthroscopic procedures in terms of efficacy, FIRST study was conducted as a multicenter, blinded RCT in 10 institutions in Canada, Finland, and Denmark.²⁵⁾ Arthroscopic osteochondroplasty was compared with arthroscopic lavage regarding outcomes of pain, remaining functions, and quality of life. The background of this study reflects the current perception of FAI syndrome, which has become a huge economic burden without the consensus on the effectiveness of the surgery.²⁵⁾

Almasri et al.³²⁾ sought to report the clinical course, especially in the osteochondroplasty group, in the FIRST trial. They evaluated pain and functional score at baseline, 2 weeks, 6 weeks, 3 months, 6 months, and 12 months after the surgery. Pain visual analog scale improved rapidly after the surgery and functional scores gradually recov-

ered, but there was no significant improvement after 6 months.³²⁾ In 2022, Almasri et al.³³⁾ compared randomized to lavage group, randomized to osteochondroplasty group, those who declined to participate in the RCT but received osteochondroplasty, and those who did not fit the inclusion criteria but received osteochondroplasty in terms of complication and functional scores. Pain and function improved in all patient groups after 1 year. Many of the groups not included in the RCT were patients who did not respond to diagnostic hip injection, but in this group of patients, osteochondroplasty showed a lower reoperation rate and greater functional improvement. As for the cause, the authors suggested that because patients included in RCTs were randomized, they tended to report more minor symptoms because they believed they had received the randomly assigned treatment instead of the best possible treatment.³³⁾

In 2021, Migliorini et al.²³⁾ reviewed 10 prospective studies and analyzed 470 surgeries in a systematic review. The study was conducted on young patients with an average age of less than 16 years, and 94% were able to return to sports after more than 2 years of follow-up. Another systematic review was conducted on 5 studies of arthroscopic acetabular labral repair. In 210 cases, patients returned to exercise within 2 years of surgery, and all clinical scores improved at 34 months.²⁴⁾ In 2021, Annin et al.¹⁹⁾ reported a systematic review including 18 studies and 1,123 patients on return to exercise and function upon return after arthroscopic surgery in athletes with FAI. Regarding surgical techniques, labral repair was performed more than 3 times more often than resection, and reconstruction was rarely performed. Femoroplasty was performed in over 90% of cases. Return to exercise was reported in 73% to 100%.¹⁹⁾ They concluded that in the athletes, arthroscopic treatment of FAI syndrome resulted in significant functional improvement compared to the preinjury level.¹⁹⁾

High-quality studies including RCTs and systematic reviews agree that arthroscopic surgery is effective in FAI syndrome.^{19,22-24,32,33)} However, there are still some limitations that the specific type of surgery (labral debridement, labral repair, acetabuloplasty, and femoroplasty) or the type of FAI syndrome (pincer, cam, or mixed) was not separately investigated.

Complications and Reoperations after Arthroscopic Surgery in FAI Syndrome

Despite the prominent value of the arthroscopic surgery in FAI syndrome, the adverse events are not rare. The incidence of complications and reoperations after arthroscopic surgery range from 1% to 31% and 4% to 13%, respectively.^{22,24,33,34)} The common adverse events included persis-

tent hip pain, labral re-injury, temporary paresthesia of the lateral femoral cutaneous nerve, transient perineal nerve paresthesia, recurrence of cam lesion, capsulolabral adhesions, hip osteoarthritis, and superficial infection.^{22,24,33,34} However, Ohlin et al.³⁴ reported that 86.5% of the adverse events resolved within 24 month after arthroscopic surgery and there were no life-threatening complications. The authors further treated persistent complications with revision arthroscopic surgery with osteochondroplasty, labral repair, or drainage for infection without any substantial impairment.³⁴ Similarly, Annin et al.¹⁹ reported 5.5% of revision surgery and 0.6% of subsequent total hip arthroplasty in a systematic review including 18 studies and 904 patients.

In the FIRST study, the complications were divided into operatively treated ones and nonoperatively treated ones. Those who were allocated in the lavage group in the FIRST trial showed the highest complication rate (18% and 13%), followed by the osteochondroplasty group in the FIRST trial (8% and 14%), those who declined to randomization but received osteochondroplasty (10% and 4%), and those who did not fit the inclusion criteria (4% and 4%).³³

Ohlin et al.³⁴ reported in 2020 on adverse events during arthroscopic surgery in FAI syndrome based on the FIRST study cohort. The percentage of adverse events that occurred during the 2-year follow-up was 24% and reoperation was 13%. Revision surgery was most commonly performed at a median of 15 months (range, 1–25 months) after the index surgery and over 86% of the adverse events resolved within the 24-month follow-up.³⁴

In a systematic review on the arthroscopic surgery for FAI syndrome in adolescents, complications were reported in approximately 1%, and arthroscopic reoperation was required in 5% at a mean of 28 months of follow-up. The most common complications were temporary paresthesia of the lateral femoral cutaneous nerve (0.4%) and transient perineal nerve paresthesia (0.4%). The authors concluded that arthroscopic surgery was beneficial for hip pain, function, and quality of life in adolescent FAI syndrome.²³ In a systematic review specifically on the arthroscopic labral repair for FAI syndrome, the reoperation rate was 4.3% and arthroplasty was required in 2% at 38 months after surgery on average.²⁴ A systematic review on athletes who had FAI syndrome showed that 5.5% of the patients required reoperation at a minimum of 2 years of follow-up.

The Role of Adjunctive Biologics in Arthroscopic Surgery for FAI Syndrome

Many adjunctive procedures have been developed to be used during arthroscopic surgery for FAI syndrome and

enhance the clinical outcomes. It should be noted that these procedures are mostly performed during and in addition to arthroscopic surgery rather than as an independent procedure such as intra-articular injection. These biologic treatments include bone marrow aspirate concentrates, platelet-rich plasma (PRP), growth factors, culture-expanded mesenchymal stem cells, and autologous chondrocyte derivatives.³⁵⁻⁴⁴ In most studies, the main target of biologics was the chondral lesions rather than the labral lesions. Although autologous chondrocyte implantation was related to difficulty in harvesting and variety in the concentration of the delivered chondrocytes, studies reported variable improvements in clinical scores.^{35,38,40} Studies using PRPs as an adjunctive therapy resulted in no statistical difference compared to the control group in terms of clinical scores, additional surgery, and subsequent arthroplasty.^{37,42,43} The use of biologic adjuncts in FAI syndrome is not supported with robust evidence and should not be considered primarily in the current status.

COMPARISON WITH CONSERVATIVE TREATMENT

The mainstream treatment modality for FAI syndrome has been surgical, especially arthroscopic in the contemporary literature. However, it is reported that a wide range of patients benefitted from various conservative treatments.⁴⁵⁻⁴⁸ The efficacy of arthroscopic surgery should be compared with conservative treatment due to its invasiveness.

Intra-articular Injection for FAI Syndrome

Among conservative treatment, intra-articular injection for FAI syndrome is known for its effectiveness in both diagnosis⁴⁹ and pain relief.⁵⁰ However, the duration of pain relief and its clinical impact has long been and is still controversial.⁵¹⁻⁵⁴ In fact, there were not many studies with high-level evidence, reporting the results of injection for FAI syndrome. Abate et al.⁴⁵ reported in 2014 that when hyaluronic acid injection was performed under ultrasound guidance in 20 FAI patients, all clinical symptoms improved without any patient requiring surgery for 1 year.

Some studies advocate activity restriction or physical therapy over the injections in conservative treatment.^{55,56} Zogby et al.⁵⁶ conducted a prospective study in which patients who did not respond to the previous treatment were treated in the following order: activity restriction, drug treatment, injection, and arthroscopic surgery. There was no significant difference in clinical scores in any patient group at 5 years. However, the rate of return to exercise was highest in the group of patients who received only

activity restrictions and drug treatment, which may be due to selection bias in that the more severe the condition, the more likely the patients were to receive more intensive treatment.⁵⁶⁾ A meta-analysis published in 2019 compared the physical therapy group and the injection group among conservative treatments, and both pain and function showed better results in the physical therapy group than the injection group.⁵⁵⁾

Lee et al.⁵⁷⁾ published an RCT in 2016 that compared triamcinolone and hyaluronic acid injection in patients with FAI syndrome. Patients who had no improvement after taking each drug one by one were alternately administered for 2 weeks. As a result, both drugs were effective for pain, but only patients who took the cross-medication showed a significant improvement in terms of function. By medication, triamcinolone showed rapid pain relief, while hyaluronic acid had a slower effect but resulted in greater functional improvement. Side effects mainly occurred when using triamcinolone, the most common being facial flushing and menstrual abnormalities.⁵⁷⁾

In a 2-year follow-up study, 208 patients underwent arthroscopic surgery for FAI syndrome after injection of betamethasone and lidocaine.⁵⁸⁾ Those who responded to the injection had better 2-year clinical outcomes than those who did not respond to injections after arthroscopic surgery. This study highlighted the predictive value of the injection on subsequent arthroscopic surgery in FAI syndrome regardless of the efficacy in diagnosis or pain relief.⁵⁸⁾

According to the recent literature, intra-articular injection in FAI syndrome seems to be effective in some patients in terms of pain alleviation and prognosis prediction for further treatment. However, it should be considered rather than mandated in those with FAI syndrome with warnings that the effects could be slightly better or comparable to the physical therapy.^{49-54,57,58)}

Comparison of Clinical Results between Conservative versus Arthroscopic Treatments

In 2020, Bastos et al.⁵⁹⁾ reported that there was no significant functional difference between the surgery group and the conservative treatment group in a meta-analysis of 650 patients included in 3 RCTs. However, as the follow-up period of the included studies ranged from 6 months to 2 years, the long-term effects were unknown. In contrast, another meta-analysis on 6 RCTs including 1,187 patients reported that arthroscopic surgery significantly improved clinical scores within 1 year compared to conservative treatment.⁶⁰⁾

One of the causes of discrepancy among comparisons seems to be the diversity of conservative treatment

for FAI syndrome. Arthroscopic surgery for FAI syndrome mainly consists of labral debridement, labral repair, acetabuloplasty, and femoroplasty.^{9,18,24,33)} However, the modality of conservative treatment varies greatly and this might lead to inconsistent effects. To objectively compare the effects of conservative treatment and arthroscopic surgery in FAI syndrome, UK FASHIoN (Full Randomised Controlled trial of Arthroscopic Surgery for Hip Impingement versus best CoNventional) trial was conducted as a multicenter RCT in 24 hospitals in England, Scotland, and Wales.⁶¹⁾ This study compared the effectiveness of individualized conservative treatment and arthroscopic surgery in FAI syndrome. The conservative treatment group received personalized hip therapy, which was led by the consensus of physiotherapists, physicians, and surgeons for 12–24 weeks. The core components of the personalized hip therapy were (1) an exercise program, (2) patient education, and (3) pain relief with or without intra-articular steroid injection.⁶¹⁾ A total of 171 patients in the arthroscopic surgery group were compared with 177 patients in the conservative treatment group. At 1-year follow-up, the international Hip Outcome Tool score increased in both groups, but the improvement was significantly greater in the hip arthroscopy group. However, patient-reported adverse events were also higher in the surgery group.⁶¹⁾

One of the factors that might favor conservative treatment over arthroscopy could be the steep learning curve of hip arthroscopic surgery.^{62,63)} Despite the recent popularity, hip arthroscopic surgery procedures are technically challenging, even starting from the traction application and portal placement.⁶⁴⁾ To achieve the favorable outcomes expected from arthroscopic surgery for FAI syndrome, surgeons should overcome the learning curve. A systematic review on this subject was conducted in 2014 and suggested that at least 30 cases were used as the cutoff value for the learning curve for hip arthroscopy.⁶⁵⁾ In 2020, You et al.⁶³⁾ reported that surgical effectiveness was maximized after 110 cases in a prospective study of 190 cases of hip arthroscopic surgery in FAI syndrome. Comparing the low- and high-volume surgeons, Mehta et al.⁶²⁾ reported that 519 cases of career volumes were the optimal cutoff value for decreasing the risk of subsequent hip surgery. These findings indicate that hip arthroscopists should reach a certain level of surgical volume to provide the expected outcomes of arthroscopic surgery that could surpass those of conservative treatments.

The efficacy of conservative treatment and arthroscopic surgery in FAI syndrome seems to be comparable.^{59,60)} There might be some confounding factors such as the subtypes of FAI syndrome or accompanying intra-

articular pathologies. In the clinical settings, however, surgical intervention is usually considered after a certain duration of conservative treatment.⁵⁶⁾ Therefore, in patients who have intractable pain even after sufficient personalized conservative therapy, arthroscopic surgery could be beneficial if performed carefully following right indications.

CONCLUSION

Recent studies provided the following answers to the questions frequently asked by patients with FAI syndrome in outpatient clinics. Arthroscopic surgery for FAI syndrome was effective with regard to hip pain, function, return to exercise, range of motion, and quality of life. However, while hip pain improved quickly, functional recovery seemed to plateau after 6 months. Arthroscopic surgery showed relatively better results in younger patients, patients with low BMI or good preoperative function, and those who responded well to injection, and most complications were resolved within 2 years. Reoperation after arthroscopic surgery was required in approximately 4% to 13% of patients. There is currently no robust evidence showing that biologic adjuncts are effective in arthroscopic

surgery for FAI syndrome. Intra-articular injection for FAI syndrome may be effective depending on the patient and could be considered in cases of the lack of response to medication before surgery. The initial functional results of arthroscopic surgery may not differ significantly from those of conservative treatment.

CONFLICT OF INTEREST

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

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