ORIGINAL ARTICLE

Acta Orthop Traumatol Turc 2013;47(5):311-317
doi:10.3944/AOTT.2013.3041

Arthroscopic treatment of femoroacetabular impingement: early outcomes

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Objective: The aim of the study was to assess the early outcomes of the arthroscopic treatment of femoroacetabular impingement.

Methods: Forty-two femoroacetabular impingement (FAI) patients (mean age: 35.1 years, range: 16 to 52 years) treated arthroscopically between 2006 and 2011 in our clinic were retrospectively analyzed. Twenty-five patients had Cam, 6 Pincer and 11 combined femoroacetabular impingement. Mean follow-up time was 28.2 (range: 10 to 72) months. Patients were assessed clinically and functionally using the Non-Arthritic Hip Score (NAHS), modified Harris Hip Score (mHHS), Oxford Hip Score, WOMAC score, and Visual Analogue Scale (VAS) pain scores preoperatively and at the final follow-up.

Results: In clinical and functional assessments, there were increases of 24.8 points in mean NAHS, 23.3 in mHHS, 20.6 in WOMAC score and 9.6 in Oxford Hip Score. VAS pain score decreased by 4.9 points in comparison to the preoperative scores. There were no major complications. However, transient pudendal nerve neuropraxia was present in two patients, transient lateral femoral cutaneous nerve neuropraxia in one and asymptomatic heterotopic ossification in one patient.

Conclusion: Short-term clinical results of the arthroscopic treatment of the FAI appear to be satisfactory.

Key words: Arthroscopic treatment; femoroacetabular impingement; postoperative early term.

Femoroacetabular impingement (FAI) is the abnormal contact between the acetabular rim and femoral head-neck junction secondary to the abnormal morphology of the hip joint. Diagnosis and treatment of FAI have become more popular following the description of its mechanical theory by Ganz et al. and its acceptance as a predisposing factor for osteoarthritis.[1,2]

The minor morphological abnormalities of the hip joint were first described by Murray[3] and later described by Solomon et al. and Harris as having a role in the development of coxarthrosis.[4-6] However, the relation between these morphological abnormalities and arthrosis could not be defined. Myers et al. published cases of FAI following periacetabular osteotomy and femoral neck fractures.[7,8] These studies investigating the vascular supply of the femoral head enabled the safe dislocation of the hip joint and the treatment of deformities.[9] In 2003, in a patient series, Beck et al. reported the

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Submitted: September 9, 2012 **Accepted:** May 6, 2013

Available online at
www.aott.org.tr
doi:10.3944/AOTT.2013.3041
QR (Quick Response) Code:

mechanism of femoroacetabular impingement and the mechanical theory of the labral and chondral injury.[10]

There are 3 types of FAI; Cam, Pincer and combined. In the literature, combined FAI is the most common.[2] Cam type FAI is caused by the abnormal morphology of the femoral head-neck junction and is mostly seen in young-adult active male patients. A shearing force is formed between the acetabular rim and femoral head-neck junction, especially during flexion of the hip, due to the decreased femoral head-neck offset which causes chondral and labral injury.[2]

Pincer type impingement is caused by focal (acetabular retroversion) or generalized overcoverage *(coxa profunda)* of the acetabulum. The labrum degenerates and ossifies due to impingement at the acetabular rim. These degenerative process and ossification increase the depth of the acetabulum and leads to further impingement. Additionally, with the flexion of the hip joint, a lever arm force is formed on the acetabular rim causing chondral damage in the posteroinferior side of the acetabulum (counter-coup lesion).[2] This degenerative process is slower than the Cam type and usually affects young-adult female patients.[2]

Femoroacetabular impingement typically affects active adults between the age of 25 and 50. Diagnosis may be delayed due to misinterpretation of clinical symptoms and unrecognized radiological signs. Burnett et al. reported a time between the onset of symptoms and diagnosis of 21 months and 3.3 doctor visits on average before the diagnosis of FAI in their patients.[11]

Common symptoms include groin pain (%88) and loss of motion. The first limitation is in internal rotation and adduction. Patients may also experience catching or clicking. The most important diagnostic test in FAI is the anterior impingement test and it is positive in 95% of patients.[11] Posterior impingement test, FABER and Drehmann sign may also be positive in these patients.

Conservative treatment including non-steroid anti-inflammatory drugs (NSAIDs) and activity modification have been reported in the literature. Open or arthroscopic surgery may be indicated for patients in whom conservative methods did not improve symptoms.[12-14] In the literature, successful treatment outcomes in the postoperative early and mid-term with safe dislocation of the hip have been reported.[10,15,16] Although, early on, hip arthroscopy was used for diagnostic purposes only in the treatment of FAI, arthroscopic femoroplasty, acetabuloplasty and labrum repair may now be done successfully with the advancement of the arthroscopic techniques.[17-20]

The purpose of this study was to evaluate the early term clinical and functional results of FAI patients treated arthroscopically.

Patients and methods

This retrospective study included 42 patients (25 male, 17 female; mean age: 35.1 years; range: 16 to 52 years) diagnosed with FAI and operated arthroscopically between 2006 and 2011. Mean follow-up time was 28.2 (range: 10 to 72) months. All patients underwent conservative treatments such as NSAID and activity modification before admitting to our clinic. MRI evaluation was performed on all patients for intra-articular and extra-articular pathologies. Computerized tomography with 3D reconstruction was performed in 20 patients for preoperative evaluation of the deformity. Preoperative planning was made using measurements of the alpha angle, anterior femoral offset, Tönnis angle and center-edge (CE) angle. Alpha angle measurements were performed using frog-leg X-rays.

All surgical treatments were performed by the senior author (MA), experienced in hip arthroscopy. Antibiotic and thromboembolism prophylaxis were applied in all patients. Patients were placed in the supine position on a traction table. Standard anterior, anterolateral and modified anterior, anterolateral and posterolateral portals were used for the hip arthroscopy. Chondral and Pincer lesions were treated at the central compartment labrum. Chondral pathologies were classified according to the Outerbridge classification.[21] After traction was released, femoral pathologies were treated at the peripheral compartment with dynamic hip movements (Fig. 1). The procedure was completed with visualization of the impingement free motion.

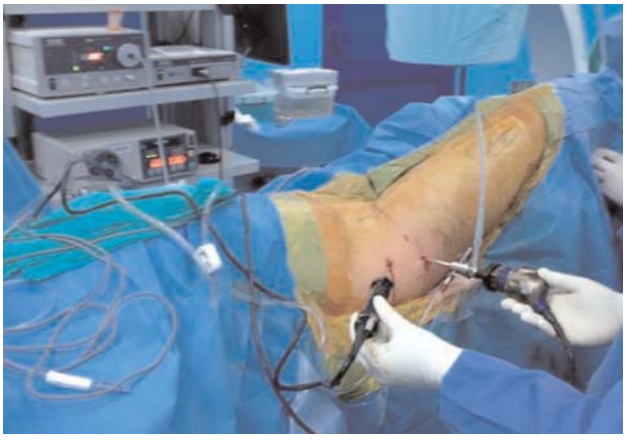

Fig. 1. Clinical view during peripheral compartment arthroscopy. [Color figure can be viewed in the online issue, which is available at www.aott.org.tr]

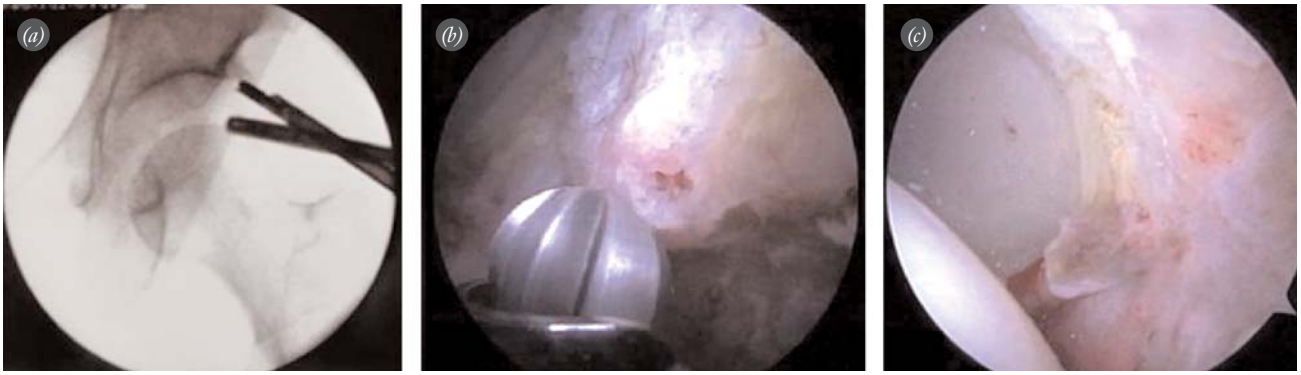

Fig. 2. Views from a Pincer type impingement patient. **(a)** Fluoroscopic view of the patient during central compartment arthroscopy. **(b)** Arthroscopic view of the Pincer lesion. **(c)** Arthroscopic view of the central compartment after excision of the lesion. [Color figure can be viewed in the online issue, which is available at www.aott.org.tr]

Patients were mobilized on the first postoperative day. The range of motion (ROM) and quadriceps strengthening exercises were begun in the second postoperative day. After femoroplasty, the patients were allowed to walk with partial weight-bearing for 3 weeks. Full weight-bearing was allowed after 3 weeks. Patients treated with acetabuloplasty were allowed to walk with weight as much as they could bear. Patients treated with microfracture were allowed to walk with partial weight-bearing for 6 weeks.

Patients were evaluated using ROM, Oxford, modified Harris Hip Score (mHHS), WOMAC, Non-Arthritic Hip Score (NAHS) and Visual Analog Scale (VAS) scores preoperatively and at the final follow-up. Additionally, patients were evaluated for avascular necrosis, arthrosis, CE angles, and alpha angles. In the assessment of arthrosis, the patients were graded with Tönnis classification.[22,23]

SPSS for Windows v12.0 (SPSS Inc., Chicago, IL, USA) software was used for the statistical analysis. In quantitative comparisons, data were assessed using the Student's t-test and paired samples t-tests. For qualitative comparisons, data were assessed using the chi-square and Fisher's exact chi-square tests. Statistical significance was accepted at a 95% confidence interval and for the p values less than 0.05.

Results

Six patients had Pincer type impingement, 25 Cam type and 11 combined. In the assessment of chondral pathologies, six patients had Grade 2, six patients Grade 3 and five patients Grade 4 focal chondropathy in the femoral head and four patients had Grade 3 and four Grade 4 focal chondropathy in the acetabulum.

Labrum tears were present in 41 of 42 patients. In 3 of the 6 patients with Pincer type impingement, the labrum had detached from the acetabular rim and was re-fixed using anchors after acetabuloplasty. Labrum repair was performed in 2 patients with Cam type impingement. In the other 36 patients, the degenerative labrum tears were treated with partial excision. In total, acetabuloplasty was performed in 11 patients and femoroplasty in 36 (Figs. 2 and 3). In 5 patients, focal full-thickness chondral pathology was treated with microfracture.

Preoperative mean hip flexion was 108.4 degrees, mean internal rotation in flexion was 22.5 degrees, and mean external rotation in flexion was 33.5 degrees. The mean preoperative alpha angles of 69.6 degrees decreased to 59.2 degrees postoperatively. At the final follow-up, mean hip flexion was 121 degrees, mean internal rotation in flexion was 28.7 degrees and external rotation in flexion was 39.5 degrees. Mean alpha angles, CE angles and ROM are detailed according to impingement type in Table 1.

Compared to preoperative values, NAHS scores increased by 24.8, mHHS by 23.3, WOMAC scores by 20.6 and Oxford scores by 9.6 points, while VAS scores decreased by 4.9 ($p<0.05$) (Table 2).

At the final follow-up, 14 patients (33.3%) had no symptoms and stated that they didn't feel any difference compared to the unaffected hip. Fifteen patients (36%) had pain with standing and walking for long distances, 12 (28.6%) had pain with squatting, ROM limitation and clicking. Anterior impingement test was positive at the final follow-up in 6 patients.

At the final follow-up, 8 patients (19%) had Grade 2 to 3 arthrosis and no patients had Grade 4 arthrosis. Revision surgery with safe dislocation during the first postoperative year was performed due to inadequate femoroplasty in one patient from the initial term of our arthroscopic FAI treatment period.

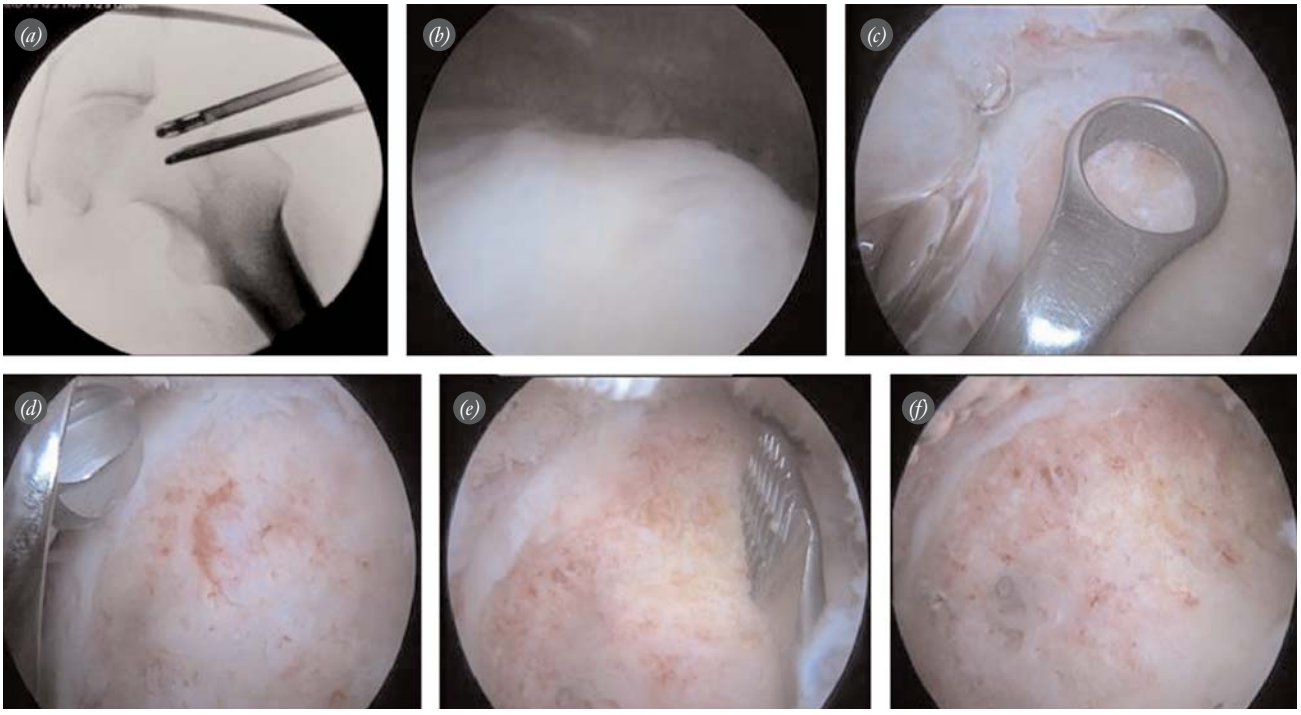

Fig. 3. Views from a Cam type impingement patient. **(a)** Fluoroscopic view of the patient during peripheral compartment arthroscopy. **(b)** Arthroscopic view of the Cam lesion before femoroplasty. **(c)** Excision of the lesion with open curette. **(d)** Excision of the lesion with burr. **(e)** Excision of the lesion with rasp for achieving a smooth surface. **(f)** Arthroscopic view of the peripheral compartment after femoroplasty. [Color figure can be viewed in the online issue, which is available at www.aott.org.tr]

Avascular necrosis, deep vein thrombosis, femoral neck fracture or surgical site infection did not occur. There were complications in 4 patients; transient pudendal nerve neuropraxia that resolved totally at the 3rd postoperative month in 2 patients, asymptomatic heterotopic ossification in one patient and a broken scalpel during detachment of the labrum from the acetabular rim in one patient with Pincer type impingement. In this patient, in which transient lateral femoral cutaneous nerve neuropraxia was also observed, the broken part was excised arthroscopically and surgery was completed as planned.

Discussion

Murray first suggested that proximal femoral deformity could lead to the development of osteoarthritis in 1965.[3] The demonstration of radiological signs of femoroacetabular impingement in cases that were previously thought to be primary osteoarthritis supported the

Table 1. Preoperative and postoperative mean alpha angle and ROM values.

	Cam type		Pincer type		Combined type		All patients	
	Preop	**Postop**	**Preop**	**Postop**	**Preop**	**Postop**	**Preop**	**Postop**
Alpha angle (range)	73.82 (61-98)	62.45 (48-80)	38.20 (35-40)	38.20 (35-40)	67.44 (58-75)	57.56 (45-64)	69.6 (35-98)	59.2 (35-80)
Flexion (range)	112.05 (60-130)	123.64 (90-130)	95.00 (80-100)	120.00 (110-130)	105.56 (80-130)	115.56 (90-130)	108.4 (60-130)	121 (90-130)
Internal rotation in flexion (range)	21.82 (0-35)	28.41 (10-40)	21.25 (20-25)	30.00 (20-40)	25.00 (10-30)	28.89 (10-45)	22.5 (0-35)	28.7 (10-45)
External rotation in flexion (range)	33.41 (10-50)	40.23 (10-60)	31.25 (30-35)	38.75 (30-45)	35.00 (20-45)	38.33 (20-50)	33.5 (10-50)	39.5 (10-60)
Abduction (range)	38.18 (20-45)	41.59 (20-50)	30.00 (25-35)	38.75 (30-45)	36.67 (20-45)	40.00 (30-50)	36.86 (20-45)	40.86 (20-50)
CE angle (range)	33.68 (29-35)	33.68 (29-35)	45.75 (42-54)	38.75 (35-42)	42.32 (40-49)	39.10 (35-44)	35.34 (29-54)	33.83 (29-44)

suggestion that the disease is an etiological factor for osteoarthritis. The relation between osteoarthritis and FAI has also been supported with prevalence studies. Gosvig et al.[24] analyzed 4151 patients for hip deformities and found that 10.8% of the patients had pistol grip deformity or acetabular overcoverage and 13.5% of these patients had groin pain. The authors reported that osteoarthritis prevalence was statistically higher in these patients. For this purpose, prospective studies with larger patient series were undertaken, although no long-term results have been published.[25]

The demonstration of safe controlled hip dislocation in 2001 by Ganz et al. provided an opportunity for correction of the deformities that causes chondral damage without the risk of avascular necrosis.[9] In 2004, Beck et al. first reported functional improvement in 19 patients (mean follow up: 4.7 years) treated with safe dislocation.[10] Murphy et al. reported a 34% failure rate and 7 revision surgeries with total hip replacement in their 23-patient series.[16] In another study reviewing 37 hips of 34 patients and with a mean follow-up of 3.1 years, the authors reported 16% failure and 18% dissatisfaction rates.[15] In a 2010 series of 94 patients (mean follow-up: 26 months), Peters et al.[26] reported trochanteric osteosynthesis problems in 2 patients and revision surgeries with total hip arthroplasty in 6 patients out of 96 hips of 94 patients. Mean functional scores were improved and there were no avascular necrosis, infection and thromboembolism.

In patients treated with open surgery, major complications like avascular necrosis, femoral neck fracture and trochanteric fixation failure have been reported at rates of 0 to 18%.[27] Interest in arthroscopic treatment of FAI increased due to these potential complications and long recovery and rehabilitation time.

In a series of 22 patients with a mean follow-up of 6 months, Stähelin et al.[28] reported good-excellent results in 17 (77%) patients. The authors related bad functional outcomes with chondral pathologies. In addition, they reported that there was statistically no significant relation in their postoperative functional results and postoperative alpha values.

In 2008, Larson and Giveans[29] reported 75% good to excellent results with a mean follow-up of 9.9 months in 100 hips of 96 patients. Of these, heterotopic ossification was present in six patients, transient sciatic nerve neuropraxia in one and revision to total hip arthroplasty in three.[29]

Byrd and Jones reported a 20-point increase in HHS scores in 207 hips of 200 arthroscopically treated patients, with a mean follow-up of 16 months in 2009.[18] In the same year, Philippon et al. reported good functional results and 10 (9%) total hip replacements in 112 patients with a mean follow-up of 2.3 years.[30]

In 2010, Horisberger et al.[31] reported the short-term results in 105 hips of 88 patients. Despite clinical success in these patients, total hip replacement was needed in 9 patients (8.6%) after a mean follow-up of 2.3 years. Twelve patients (11%) had pudendal nerve, lateral femoral cutaneous nerve and sciatic nerve neuropraxias.

In the current study, increases of 24.86 points in NAHS, 23.32 in mHHS, 9.57 in Oxford Score and 20.66 in WOMAC scores and a 4.86 point decrease in VAS scores were recorded (Table 2). In the satisfaction survey of our patient, 95.3% of patients reported being satisfied with the surgical procedure. However, 15 patients experienced residual hip pain that did not affect their normal daily activities. At the final follow-up, 6 of patients had positive anterior impingement signs. Two of these patients had Tönnis Grade 3 arthrosis related to the ongoing degenerative process and one patient underwent revision surgery with safe dislocation at the first postoperative year due to inadequate femoroplasty. In the remaining 3 patients, their pain did not affect their daily activities and further intervention was not necessary. In two of the patients with Tönnis Grade 3 arthrosis, we recommended total hip replacement for ongoing symptoms. Patients, however, chose to wait for total hip replacement.

In our patients, chondral pathologies were classified according to the Outerbridge classification.[21,32] In recent years, some authors have suggested that the Outerbridge classification is insufficient in chondral pathologies, especially in chondrolabral delamination (carpet sign) and new classifications such as those from Konan and Beck described.[12,33] However, no consensus regarding these classifications, their usability and reliability has been formed.[34,35] Meermans et al. reported occurrences of 26.9% softening and 51.9% chondral lesions of different grades in the chondrolabral junction in their Cam type impingement patients.[33] In our

Table 2. Preoperative and postoperative mean functional scores of the patients.

Mean	Preop	Postop
NAHS (range)	55.5 (30-72)	80.3 (45-94)
mHHS (range)	68.7 (40-84)	92 (74-100)
Oxford (range)	34.8 (25-43)	44.4 (36-48)
WOMAC (range)	72.8 (49-86)	93.4 (75-100)
VAS (range)	6.8 (4-10)	1.9 (0-9)

series, 5 (20%) of the 25 Cam type patients had chondral lesions in the acetabular side and 11 patients had chondrolabral degeneration of different grades. However, we did not observe any typical chondrolabral delamination defined as carpet sign.

Cross-over sign is a radiological sign described for Pincer type impingement related to cranial acetabular retroversion.[36,37] However, some studies have reported that this sign can also be seen without impingement or retroversion and can be seen due to position failure during radiologic imaging.[38,39] Furthermore, the CE angle has been reported to be more valuable in diagnosis and follow-up after treatment.[40] As there was no incidence of cross-over sign in our Pincer or combined type impingement patients, we used the Tönnis and CE angle for diagnosis and follow-up.

In most of the FAI cases, labral lesions accompany impingement. Partial labrum excision dissolves mechanical symptoms immediately and successful results have been reported in the literature.[41,42] Philippon et al.[30] reported no functional differences between patients undergoing labrum repair (58 patients) and debridement (54 patients) in 2009. However, there was no evaluation considering biologic healing. In another comparative study (36 labrum debridement and 39 labrum repair patients),[19] the authors reported 66.7% good and excellent results in the debridement group and 89.7% good and excellent results in the repair group. The difference between the two groups was statistically significant. In a 2011 report, Larson and Giveans reported 66.7% good and excellent results in the debridement group and 90% good and excellent results in the repair group after a mean follow-up time of 34 months.[43]

In a general evaluation of the literature, understanding the functions of the labrum motivated the surgeons for labrum preservation. Whole thickness labrum defects result in the loss of sealing function of the labrum. Some short-term studies have reported this as a possible factor in cartilage degeneration leading to osteoarthritis.[44] In our series, the majority of labral tears were degenerative. We believe this may be correlated with the time between symptom onset and surgical treatment (mean was 2.1 years in our series).

Although safe dislocation is accepted in the literature as the gold standard treatment for FAI, good results can be obtained with the advancements in hip arthroscopy and arthroscopic techniques. When comparing treatment outcomes, good clinical outcomes have been reported with both open and arthroscopic methods in short-term follow-up. However, these studies used different scoring systems and parameters that make comparison difficult. There is no objective data in the literature for the treatment method selection regarding open or arthroscopic but due to previously mentioned advantages, arthroscopic surgery can be considered a step forward in the treatment of FAI.[45,46]

In conclusion, short-term pain and functional treatment results were successful following the arthroscopic treatment of FAI. However, the success rate lowers in patients with progressed degenerative hips, making patient selection important for the success of joint preserving surgical procedures. Patients must be informed about the natural prognosis of the disease and the expected results of the surgical treatment.

Conflicts of Interest: No conflicts declared.

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