Retrospective Study

FEMOROACETABULAR IMPINGEMENT SYNDROME: CLINICAL OUTCOMES AND COMPLICATIONS OF THE ARTHROSCOPIC-ASSISTED MINI-OPEN SURGERY AT MID-TERM FOLLOW-UP

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ABSTRACT

Femoroacetabular impingement syndrome (FAI) is a painful condition derived from a complex of anatomical patterns involving the femoral neck-head junction and acetabulum. It is a well-established cause of early degenerative disease of the hip, and a prompt diagnosis is crucial to implement modifications of activities, physical therapy, and eventually to correct the deformity through surgery. The aim of this study was to report clinical-functional and radiographic outcomes of patients who underwent femoroacetabular impingement correction with a mini-open arthroscopic assisted direct anterior approach. A retrospective analysis of a prospectively collected database of patients operated for femoroacetabular impingement in a single center from 2012 to 2019 was performed. Harris Hip Score, the degree of hip internal rotation, and radiographic alpha angle were measured pre-operatively and compared to values registered at the latest follow-up. Operative times and intra-operative times of exposure to X-rays were also recorded. A total of 69 procedures on 64 patients were included. Of these, 46 were males (71.9%). The mean age was 34.4±6.6 years. The mean follow-up was 75.7±24.4 months. Mean values of Harris Hip Score, internal rotation of the hip, and alpha angle at the latest follow-up significantly improved from those registered preoperatively ($p<0.01$). Operative time significantly decreased after the first 34 procedures ($p<0.01$). One patient (1.4%) required conversion to total hip arthroplasty after 5 years of the index procedure. The arthroscopic-assisted mini-open technique showed good clinical outcomes with a low rate of complications and can be a reliable choice to treat FAI. This strategy may represent a suitable alternative to arthroscopy due to its low operating times, costs, short learning curve, and reduced total time of traction and X-ray exposure.

KEYWORDS: *femoroacetabular impingement syndrome, FAI, femoral head-neck junction, acetabular rim*

INTRODUCTION

Femoroacetabular impingement (FAI) is a syndrome characterized by abnormal biomechanics of the hip due to abnormal morphology of either the femoral head-neck junction or the acetabular rim, which cause pain, functional

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limitations, chondral and labral lesions and predispose to early hip osteoarthritis (OA) (1, 2). There are three different types of morphology related to FAI: cam, with decreased head-to-neck ratio, loss of sphericity of the femoral head, and femoral neck retroversion; pincer, which has abnormal acetabular morphology, such as anterosuperior acetabular rim overhang, acetabular retroversion, coxa profunda or protrusion acetabuli; mixed, which involves characteristics of the previous two types (3-6). Several hypotheses concerning FAI etiologies have been postulated, such as genetic factors, type of physical activity, history of pediatric hip disease, and previous hip fracture (7-8). The treatment should be tailored to the patient's symptoms, clinical presentation, and anatomical abnormalities. Behavioral and postural interventions, activity modification, physical therapy, and oral anti-inflammatory drugs are the first-line approach. In case of failure of conservative treatments, surgery is indicated, aiming at improving symptoms and quality of life, decreasing pain, and delaying the onset of OA.

Depending on the cases, surgery may involve femoral and acetabular osteochondroplasty and acetabular labral repair (3, 9). Several different surgical techniques have been described, and the first one was the surgical dislocation described by Ganz (10), which played an important role in the treatment of this condition and remains an excellent technique for the treatment of complex conditions. More recently, hip arthroscopy has been considered as the *gold standard* due to reduced surgical invasiveness and shorter return to physical activity (11-13). However, the arthroscopic approach has some limitations, such as inadequate bony correction, persistence of pain and subsequent revision, and neurovascular trauma due to long traction and operative time (14-16). In 2005, a combined arthroscopic and mini-open procedure was described by Ribas and colleagues, which is less invasive compared to open surgery and has a shorter operative time and learning curve compared to arthroscopy (15, 17, 18). The purpose of this study was to analyze arthroplasty-free survivorship, clinical outcomes, and complications of patients who had an arthroscopic assisted mini-open surgery to treat FAI syndrome.

MATERIAL AND METHODS

This is a retrospective analysis of a prospectively collected database of patients who underwent arthroscopic assisted mini-open direct anterior approach to treat FAI. All procedures were performed by a single surgeon (A.N.) between October 2012 and December 2019. The minimum follow-up was set at 36 months. Patients who underwent prior hip surgeries were excluded.

Outcome measures

Preoperative clinical evaluation included physical examination with measurement of the internal rotation and Harris Hip Score (HHS), which were recorded and tabulated in a dataset. All patients underwent preoperative X-rays (anteroposterior pelvis view and bilateral hip axial Dunn view) to assess osteoarthritis, Wiberg and alpha angles, and arthro-MRI to assess cartilage and labrum preoperatively. Radiographic parameters were evaluated independently by two different authors. The same clinical tests and imaging studies were conducted at the last follow-up. All possible complications and operative variables were recorded.

Surgical technique

All procedures were performed under general anesthesia. Patients were positioned supine on a regular table with a traction system extension (Advanced Supine Hip Positioning System - Smith & Nephew®) (Fig. 1A). All vulnerable body areas were protected to avoid pressure marks. Mini direct anterior approach was performed in all cases, 3 to 6 centimeters, depending on patient morphotype (Fig. 1B).

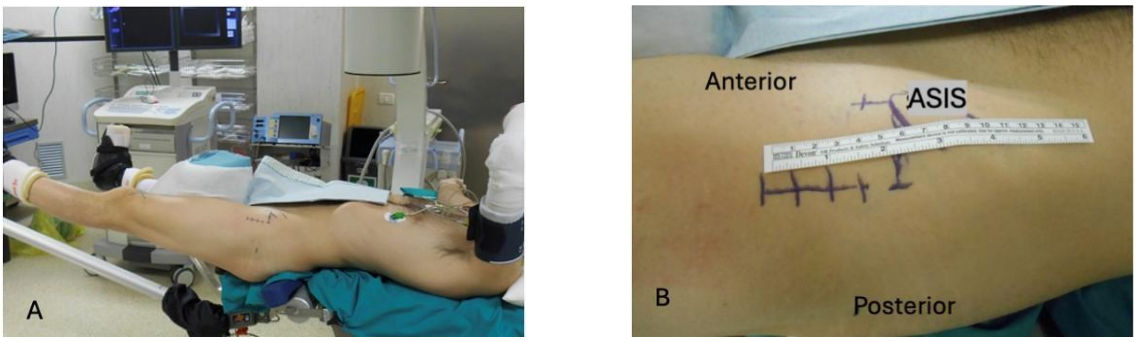

Fig. 1. *Setting in the operative theatre. **A**): patient positioning on the traction table; **B**): anatomical landmarks for skin incision.*

Three Homann retractors (medial and lateral to the neck and over the anterior acetabular wall) were placed to visualize the capsule. An H or inverted T-shape capsulotomy was performed, proximal to the circumflex artery avoiding coagulating it. Thereafter traction was applied to inspect the acetabulum and rim by a 70° arthroscope. Sutures were carried on with 1 to 3 bioabsorbable anchors (Osteoraptor 2.3 - Smith & Nephew®). Traction was applied to the operated limb only during central compartment inspection and labral suture. The femoral osteochondroplasty was carried out with a high-speed burr (Fig. 2).

Fig. 2. *Radiographic images of 31 years old male patient.* ***A****): pre-operative CAM deformity.* ***B****): intraoperative fluoroscopy for assessment of CAM correction.* ***C****): X-ray of the hip at latest follow-up.*

Whether the labrum was not detached and the acetabular rim osteochondroplasty was not necessary, the labrum was not treated although were present degeneration signs, considering the spontaneous healing after the resolution of bony impingement demonstrated by Harris (19), even avoiding further joint instability. The accuracy of the correction was assessed under direct visualization, with an impingement test in flexion, adduction and internal rotation and a final fluoroscopy check in coronal and Dunn view. Fluoroscopy was used only to check the accuracy of CAM resection. At the end of the procedure, the capsule was repaired, and the skin was closed using staples or an intradermal absorbable running suture.

Postoperative care

The patients were discharged one or two days after surgery, depending on residual pain and general conditions. Postoperative rehabilitation protocol consisted of ambulation with crutches and partial weight bearing for 2-5 weeks depending on the amount of CAM resection and other procedures performed during surgery (labral suture or microfractures). Motion over maximum degrees of flexion and internal rotation were restricted for 3 weeks. Postoperatively all patients received 3 weeks treatment with nonsteroidal anti-inflammatory drugs (Celecoxib 200mg 2/die) for heterotopic ossification prophylaxis.

Data analysis

Continuous variables were presented as mean ± standard deviation. Categorical variables were reported as the total number of cases or percentage. Data distribution was assessed using the Shapiro-Wilk test. Continuous variables registered preoperatively were compared to those obtained at latest follow-up using paired t-test. Statistical significance was set at $P < 0.05$ for all the variables analyzed. Statistical analysis was conducted using IBM SPSS Statistics 26.0 (IBM Corp., Armonk, NY, USA).

RESULTS

A total of 69 procedures performed on 64 patients were included. Of these, 46 (71.9 %) were men. The mean age at the time of surgery was 34.4±6.6 years (range 18-45 years). No patient was lost at follow-up, and the mean follow-up time was 75.7±24.4 months (range 36-114 months) (Table I).

Table I. *Demographic data of patients.*

Variable		Number of cases (%)	Mean ± SD
Number of patients included		69 (100)	-
Sex	Male	46 (71.9)	-
	Female	18 (28.1)	-
Mean Age		69 (100)	34.4 ± 6.6
BMI, kg/m^2		69 (100)	23.4 ± 3.7
Operative Time		69 (100)	83.1 ± 22.3
Follow-up, mo		69 (100)	75.7 ± 24.4

BMI: Body Mass Index; mo: months.

The mean operative time (OT) was 83.1 minutes±22.3 (range 50-140). The mean OT of the first 34 procedures was 103.4 min±17.3 (range 75-140) while the OT of 35 last cases was 66.5 min±15.6 (range 50-110) ($p < 0.01$). Mean limb-traction time was 26.5±7.7 minutes (range 16-41). Thirty-nine patients (56.5%) presented labrum tears that required sutures, and in 23 cases (33.3%) an acetabular rim resection was performed. In 9 cases (13.0%) a resection of unstable chondral flap was conducted, and in 2 cases (2.9%) microfractures were performed to treat full-thickness cartilage tear. Mean total time of intraoperative X-ray exposure was 2.7±1.1 seconds (range, 1-5). Radiographic evaluation demonstrated Tönnis grade 0 in 31 hips (44.9%), grade 1 in 30 hips (43.5%), and grade 2 in 8 cases (11.6%).

Arthroplasty-free survivorship

One patient (1.4%) required conversion to total hip arthroplasty. This patient had Tönnis grade 1 osteoarthritis at the time of mini-open surgery and underwent replacement of the hip due to persistent hip pain five year after the index procedure. This patient was later found positive to HLA B-27 test.

Clinical outcomes

Internal rotation of the hip improved from mean preoperative value of 8.7°±9.0 to 21.7°± 6.6 ($p<0.01$) at last follow-up. The mean Harris Hip Score (HHS) increased significantly from preoperative value of 67.4±8.9 points to 87.7±7.9 points at final follow-up, with mean improvement of 20.3 points ($p <0.01$) (Table II).

Table II. *Clinical and Radiographic outcomes.*

Variable	Preoperative	Postoperative	p-value
Internal Rotation	8.7° ± 9.0	21.7°± 6.6	<**0.01**
Alpha Angle	66.0° ± 10.6	51.8° ± 6.5	<**0.01**
HHS	67.4° ± 8.9	87.7° ± 7.9	<**0.01**

HHS: Harris Hip Score; p-value is for paired t-test.

When stratifying patients based on age (< or ≥ 35 years) and Tönnis grade (< or ≥ grade 1): the mean post-operative HHS was 91.2 for group A (< 35y and Tönnis 0) and 87.2 for group B (≥ 35y and Tönnis 1 or 2). A total of 16 patients (25%) were semi-pro athletes (martial arts, basketball, and football) and the rate of return to the same level of competition was 81.3%.

Complications

Eleven cases (15.9%) of femoral cutaneous nerve and one case (1.5%) of pudendal nerve transient injuries were recorded; all of them were totally recovered at the final follow-up evaluation. No heterotypic ossifications, superficial or deep infection, or avascular necrosis of the femoral head were registered. There was no need for a blood transfusion during the hospital stay (Table III).

Table III. *Prevalence of potential complications associated with the procedure.*

Complications	Number of cases (%)
Neuroapraxia*	12 (17.3)
Heterotopic Ossification	0 (0)
Avascular Necrosis	0 (0)
Infection	0 (0)
THA conversion	1 (1.5)

*THA: Total hip arthroplasty; *11: transient lateral cutaneous nerve; 1: transient pudendal nerve.*

DISCUSSION

Clinical outcomes of the mini-open arthroscopic assisted approach are evaluated in a few articles, with a small number of subjects analyzed. In the present study, 69 consecutive procedures were analyzed, and a good HHS mean value of 87.7 points was found at the last follow-up. A recent literature review reported similar values (84.5 for arthroscopy and 88.1 in open surgery)(20). All the patients included reached a good restoration of the internal rotation, considering a mean value of 21.9 degrees at the last follow-up, values consistent with those encountered in the literature on patients treated with other techniques.(20, 21). No major complication was recorded, and the more common complication in the present case series was lateral femoral cutaneous nerve neuropraxia in 11 (15.9%) cases, which is similar to the mean values reported in the literature (22-25). The cases of neuroapraxia were all solved at the last follow-up without permanent consequences.

The overall reoperation rate was 1.4%, which is non-inferior compared to arthroscopy (26). The one patient who was reoperated was found positive for HLA-B27 associated spondyloarthropathy and underwent total hip arthroplasty 5 years after the indexed procedure due to progression of arthrosis and persistence of groin pain. The direct visualization of the surgical approach helps the surgeon to easily address the extent of the correction required, test the dynamic impingement intraoperatively, and then prevent inadequate osteochondroplasty that may lead to the persistence of pain and further surgical revision (11, 27) .

A recent review analyzed the cost-effectiveness of arthroscopic treatment of FAI, comparing it with non-operative treatment, concluding that the surgical approach is more expensive but led to a significant improvement in quality of life (28). Currently, the literature is missing a cost-effectiveness analysis that compares the arthroscopic technique with the mini-open arthroscopic-assisted technique. In the present study, the mean operative time was 88.1 minutes, reaching a mean of 66.5 minutes in the last 30 procedures. The mean operative time decreased by more than 20 minutes, suggesting a short learning curve of the mini-open approach. The reduced mean operative time, together with good to excellent clinical outcomes and the absence of major complications, make this procedure attractive and competitive with arthroscopy. Moreover, although several studies showed excellent outcomes together with a low complication rate of FAI correction through hip arthroscopy, these case series are performed by experienced surgeons with a high volume of procedures per year (22, 25). Furthermore, one of the most important drawbacks of arthroscopy is the long learning curve and the high cost of the procedure and instrumentation.

The arthroscopic-assisted mini-open approach is a reproducible technique with a shorter learning curve, especially for surgeons skilled in direct anterior approach for hip arthroplasty. This technique was analyzed by a few authors (11, 15, 17, 18) with a consequent small number of procedures and only a few studies comparing it to other techniques (20, 21, 25). The surgical procedure proposed in the present case series is a safe and effective treatment of FAI syndrome, providing good functional outcomes.

This study presents several limitations that should be considered when interpreting the results. First, the retrospective nature of the analysis with all the inherent issues typical of this level of evidence. For instance, the total number of complications reported could be lower than the real prevalence since minor complications could not have been registered. However, this study presents some strengths since all patients were treated by a single surgeon following a standardized protocol in a hip surgery unit, reducing the impact of potential variabilities.

CONCLUSIONS

The arthroscopic-assisted mini-open technique showed good clinical outcomes with a low rate of complications and can be a reliable choice to treat FAI. This strategy may represent a suitable alternative to arthroscopy due to its low operating times, costs, short learning curve, and reduced total time of traction and X-ray exposure.

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