Original Research

Beyond the patella: Treatment of cam femoroacetabular impingement syndrome improves anterior knee pain

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ABSTRACT

Objectives: This study aimed to investigate if there is a relationship between cam femoroacetabular impingement syndrome (cam-FAIS) and chronic anterior knee pain (AKP).

Methods: This is a pilot retrospective review of 12 AKP patients with no structural anomalies in the patellofemoral joint and no skeletal malalignment in the lower limbs. All the patients were resistant to proper conservative treatment for AKP (AKP-R). Subsequently, these patients developed pain in the ipsilateral hip several months later, and upon evaluation, were diagnosed with cam-FAIS. Arthroscopic femoral osteoplasty and labral repair were performed and clinical follow-up of hip and knee pain and function (Kujala Score and Non-arthritic Hip Score -NAHS-) was carried out.

Results: All the patients showed improvement in the knee and hip pain scores with a statistically significant clinical difference in all of them at 69 months follow up (range: 18 to 115) except one patient without improvement in the groin VAS score post-operatively. Visual analogical scale (VAS) of knee pain improved from 6.3 (range: 5 to 8) to a postoperative 0.5 (range: 0 to 3.5), (p < 0.001). The VAS of groin pain improved from 4.4 (range: 2 to 8) to a postoperative 0.9 (range: 0 to 3), (p < 0.001). NAHS improved from a preoperative 67.9 (range: 28.7 to 100) to a postoperative 88 (range: 70 to 100), (p < 0.015) and knee Kujala’s score improved from a preoperative 48.7 (range: 22 to 71) to a postoperative 96 (range: 91 to 100), (p < 0.001).

Conclusion: This study’s principal finding suggests an association between cam-FAIS and AKP-R in young patients who exhibit normal knee imaging and lower limbs skeletal alignment. Addressing cam-FAIS in these cases leads to resolution of both groin and knee pain, resulting in improved functional outcomes for both joints.

Study design: Retrospective cohort series with a single contemporaneous long-term follow-up.
Level of Evidence: IV.

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What are the new findings?
- Proximal etiology of anterior knee pain needs to be considered.
- Anterior knee pain could be related to cam femoracetabular impingement.
- Treatment of cam femoracetabular impingement improves anterior knee pain.

INTRODUCTION

Anterior knee pain (AKP) has long been attributed primarily to patellar-related issues and problems with the alignment of the lower limb, less common causes may include hip osteoarthritis, so call referred pain [1]. Consequently, standard treatment protocols have focused on addressing patellofemoral joint (PFJ) abnormalities and skeletal malalignment of the lower limbs. However, recent clinical observations revealed a puzzling phenomenon wherein a subset of AKP patients, devoid of any detectable structural anomalies in the knee through imaging studies and without skeletal malalignment in the lower limbs, exhibited resistance to proper conventional conservative treatments (AKP-R). Interestingly, these individuals returned after some time presenting incapacitating groin pain [2,3]. Subsequent evaluation led to a diagnosis of cam femoracetabular impingement syndrome (cam-FAIS) [2,3]. Femoral cam morphology is an anatomic condition characterized by an asphericity of the anterior or anterolateral femoral head. It is defined by an abnormal alfa angle greater than or equal to 55° in a 45° Dunn axial view [4,5]. Cam-shaped femoral heads can cause groin-pain, which define cam-FAIS [6]. When there is no hip pain, it is assumed that the patient has femoral cam morphology without FAIS.

The aim of this pilot study is to investigate if there is a relationship between cam-FAIS and AKP-R. We hypothesized that there is an association between cam-FAIS and AKP-R.

METHODS

This pilot retrospective cohort series with a single contemporaneous long-term follow-up study was approved by our local Institutional Review Board. Between May 2011 and May 2015, 12 patients that underwent arthroscopic femoral osteoplasty (including labral repair, if necessary) with ipsilateral AKP, were identified. These patients displayed no structural anomalies in the PFJ and no skeletal malalignment in the lower limbs, according to image studies (X-rays and torsional computed tomography (CT) as described in the inclusion criteria section), and they were resistant to proper conservative treatment including analgiesics (AKP-R). All of them developed pain in the ipsilateral hip several months after the onset of AKP and, upon evaluation, were diagnosed with cam-FAIS. All the hip procedures were performed by the same surgeon, following the same surgical technique. During arthroscopy, the impingement was confirmed with the hip at 90° of flexion and maximum internal rotation. In the same way, the external femoral rotation revealed the disappearance of the impingement in all the cases. The labrum was reinserted with bone anchors when necessary. Three patients required additional bone marrow stimulation (microfractures augmented with chitosan) of cartilage injuries in accordance with our routine surgical indication on cam-FAIS [7]. After hip arthroscopy, no specific physiotherapy for the knee was carried out.

All the patients were studied preoperatively and at the follow-up with the visual analog scale (VAS) for AKP, VAS for groin pain, the Kujala knee score and the non-arthritic hip score (NAHS). VAS has been used in several studies to measure the level of pain and has demonstrated good reliability and concurrent validity when compared with other methods of pain measurement [8]. It is a sensitive outcome measure for AKP, with a difference of 2 cm being considered clinically relevant [8]. The Kujala knee score has been widely used to evaluate disability in patellofemoral conditions [9]. The NAHS is a short reproducible self-administered hip score with internal consistency that was designed for use in young patients [10].

Inclusion and exclusion criteria

The inclusion criteria were as follows: (1) pain reported by the patient on the anterior aspect of the knee that fails to respond to a proper physical therapy regimen of at least 3 months, (2) a knee VAS of 5 or higher, (3) normal knee imaging studies of the knee (magnetic resonance imaging -MRI- and CT), and (4) a cam-FAIS diagnosis defined by groin pain, a positive impingement test, a positive compression test, an alpha angle greater than or equal to 55° (based on the 45° Dunn axial view), and normal Wiberg (25-40°) and Tonnis (<13°) angles in an anteroposterior (AP) pelvis view. Normal imaging studies of the knee included: a torsional CT study (femoral antversion 15° ± 10 and external tibial torsion 30° ±15), tibial tuberosity—trochlear groove (TT-G) distance <20 mm, patellar tilt <20°, a Caton—Deschamps index of 0.8–1.2, no trochlear dysplasia grade C or D, a normal mechanical axis of the lower limb, limb length discrepancy of less than 1.5 cm, and body mass index (BMI) less than 30.

Exclusion criteria were any surgery of the lower extremities, rheumatic disease, or signs of osteoarthritids in the knee or hip joints.

Statistical analysis

Descriptive statistics for each of the measures evaluated was calculated. Quantitative variables were described with mean and standard deviations. The normality of the data was checked with the Kolmogorov-Smirnov test. The mean preoperative and postoperative knee VAS, hip VAS, Kujala score, and NAHS values were compared using the Student’s t-Test. The significance level was set at p < 0.05. All statistical analyses were done using the Statistical Package for Social Sciences (SPSS), version 16.0 (SPSS Inc., Chicago, Illinois, USA).

RESULTS

The current series consisted of 11 men (92%) and 1 woman (8%) with an average age 33.3 ± 8.1 years (Table 1). AKP was always the initial reason for consultation. The time interval between the consultation for AKP and groin pain attributed to cam-FAIS was variable. The mean duration of the knee pain from its onset to the moment of hip surgery was 27.3 ± 15.6 months. A typical case of femoral cam morphology with hip and AKP, with normal knee imaging, that resolved after femoral osteoplasty is shown in Fig. 1. The mean duration of follow-up for this cohort was 69 months (range: 18 to 115).

All the patients showed improvement in the knee pain scores, while hip scores improved in the patients without cartilage lesion, with a statistically significant clinical difference in all of them (Table 2). Visual analogical scale (VAS) of knee pain improved from 6.3 (range: 5 to 8) to a postoperative 0.5 (range: 0 to 3.5), (p < 0.001). The VAS of groin pain improved from 4.4 (range: 2 to 8) to a postoperative 0.9 (range: 0 to 3), (p < 0.001), except one patient without improvement in the groin VAS score post-operatively (Table 1, case # 1). It is interesting to note that even in this case in which the hip pain did not improve due to the presence of a chondral lesion, the knee pain did improve after the cam-FAIS surgery (Table 1, case # 1). Patient reported outcome measures (PROMs) showed improvement after cam-FAIS surgery (Table 2). NAHS improved from a preoperative 67.9 (range: 28.7 to 100) to a postoperative 88 (range: 70 to 100), (p < 0.015) and knee Kujala’s score improved from a preoperative 48.7 (range: 22 to 71) to a postoperative 96 (range: 91 to 100), (p < 0.001).

The clinical outcomes obtained in the first 7 patients of the current series [2] were maintained in the last follow-up. There were no statistically significant differences between the VAS knee pain score at the first and last follow-up (p = 0.157). It was the same for the VAS hip pain score
Knee visual analogic scale (VAS) 1 preoperative knee VAS. Knee VAS 2 preoperative knee VAS in our first study [2]. Knee VAS 3 postoperative knee VAS in the last follow-up.

Hip VAS 1 preoperative hip VAS. Hip VAS 2 preoperative hip VAS in our first study [2]. Hip VAS 3 postoperative hip VAS in the last follow-up.

Kujala preoperative Kujala score in our first study [2]. Kujala post 2 postoperative Kujala score in the last follow-up.

Non-arthritic hip score (NAHS) preoperative NAHS in our first study [2]. NAHS post 2 postoperative NAHS in the last follow-up.

Duration of the knee pain (months) from its onset to the moment of hip surgery.

DISCUSSION

The main finding of the current investigation is that chronic AKP-R is resolved by treating cam-FAIS. These patients with chronic AKP had no abnormalities in the knee based on imaging studies and no skeletal malalignment in the lower limbs. All the patients were previously treated for AKP that was non-responsive to proper conservative treatment.

The first question that arises in this study is whether the AKP in the patients of our series is a pain referred from the hip or it is the consequence of a biomechanical gait disturbance. We theorized that there is an adaptive functional external femoral rotation that prevents hip impingement and therefore hip pain in these patients [3]. Therefore, it is not a referred pain. According to Arendt-Nielsen and Svensson [11] referred pain is “pain perceived at a location other than the site of the painful stimulus/origin. It is the result of a network of interconnecting sensory nerves that supplies many different tissues. When there is an injury at one site in the network it is possible that when the signal is interpreted in the brain signals are experienced in the surrounding nervous tissue.” In 2008, Lesher et al. [12] published a descriptive study in which they analyzed the patterns of referred pain from the hip. The authors performed fluoroscopically guided intra-articular hip joint injection of bupivacaine and corticoids in order to analyze referral hip pain patterns. They show that the most common referred pain is buttock pain (71%) and not the knee pain. One of the patients in our series had a preoperative kinetic and kinematic analysis of the gait pattern and the way of going up stairs [3]. During gait, an increase in the hip external rotation angle compared with the contralateral healthy control was seen in the pathologic limb [3]. In theory, this excessive hip external rotation was functional given that it was associated with hip internal rotation weakness as we were able to deduce from kinetic analysis [3]. During stair climbing, an increase in both the hip external rotation angle and hip external rotation moment was found [3]. Both, kinetic and kinematic parameters were normalized after cam-FAIS resolution [3]. This is in accordance with the paper by Savage et al. [13] that found that patients with cam-FAIS walked with hip external rotation. This further confirms that AKP is not a referred pain, but it is secondary to a biomechanical gait disturbance.

Although the etiology of AKP is multifactorial, it is generally accepted that the main starting point is related to abnormal PFJ biomechanics. The current literature supports the link between torsional abnormalities and AKP [14–23]. The association between femoral anteverision and AKP or patellar instability has been extensively documented [15,21,22,24,25], but few studies have considered femoral retroversion (FR) [26]. The association between AKP and cam-FAIS was recently suggested for the first time [2,3,27]. Cam morphology as well as cam-FAIS produces abnormal biomechanics in the lower limbs like FR [28]. They act like a functional retrotorsion, although there is no abnormal structural torsion. Femoral head cam morphology presents a mechanical limitation to internal rotation by mechanical block when the femoral head strikes the anterior acetabular rim. Hip external rotation conditioned by the cam morphology of the femoral head to avoid hip impingement and pain behaves as a functional FR [3]. In these cases, external hip rotation is a defense mechanism to avoid hip impingement and the associated pain. Functional FR may eventually provoke a PFJ imbalance that in turn might be responsible for AKP [5]. Over time, the defense mechanisms end up collapsing and the impingement mechanism of the cam morphology of the femoral head against the anterior acetabular rim causes hip pain and, in more advanced cases, a labral injury. This is why cam-FAIS always appears later than AKP. As expected, given that FR was not structural but functional, the patients evaluated in our first study [2]
and who were subsequently reevaluated in the present study did not develop AKP again over time.

The major limitation of our study was the small number of patients included (n = 12). Moreover, the retrospective nature of the work has inherent restrictions. Therefore, a prospective cross sectional study would be required to draw definitive conclusions. Another limitation of the current investigation is that the presence of an externally rotated gait was evaluated only from a clinical point of view. Gait analyses would be helpful to assess the link between AKP and cam-FAIS. In only one case was gait in external rotation evaluated by kinetic and kinematic analysis. Further biomechanical studies with a larger sample size would be necessary to double check the external rotation gait in these patients and its correction after femoral osteoplasty.

Nevertheless, according to the obtained results it can be hypothesized that AKP may be a symptom of cam-FAIS in some cases. Therefore, cam-FAIS should be ruled out in cases of AKP patients with normal knee imaging studies and no skeletal malalignment in the lower limbs, particularly in cases with knee pain recalcitrant to conservative treatment (AKP-R). These insights may significantly impact the understanding and management of AKP potentially guiding more effective treatment approaches and enhanced patient care.

**CONCLUSIONS**

The main finding of the present study suggests an association between cam-FAIS and AKP in young patients who exhibit normal knee imaging and lower limbs skeletal alignment. Addressing cam-FAIS in these cases leads to resolution of both groin and knee pain, resulting in improved functional outcomes for both joints. If one has AKP-R even without groin pain, look for cam-FAIS.

**Declaration of competing interest**

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this article.
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References


