Efficacy of Osseous Abnormalities Correction with Arthroscopic Surgery in Femoroacetabular Impingement

Cartilage
1(3) 233–237
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DOI: 10.1177/1947603510362252
http://cart.sagepub.com
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Abstract

Femoroacetabular impingement (FAI) is a clinical syndrome characterized by subtle abnormal morphology of the proximal femur and/or the acetabulum that leads to abnormal contact between the femoral neck and the acetabular rim during the hip range of motion. Traditionally, FAI has been managed safely and effectively with surgical hip dislocation; less invasive arthroscopic techniques are now being used to an increasing extent, trying to emulate the results of the open technique. The purpose of this study was to evaluate the radiographic results of arthroscopic acetabular rim trimming and femoral osteochondroplasty in FAI. This was a retrospective analysis of preoperative and postoperative plain radiographs of 80 patients treated for FAI with arthroscopic surgery between April 2007 and December 2008. We evaluated 2 parameters: the Wiberg angle (center-edge angle) (normal, 25°–35°), and the anterior/posterior relation of femoral head-neck offset (normal, 0.8–1). Of 80 hips, 10 (12.5%) were pincer-type impingement, 17 (21.25%) were cam type, and 53 (66.25%) were mixed type. The preoperative Wiberg average was 39° (range, 25°–51°), and the postoperative Wiberg average was 32° (range, 25°–42°). The preoperative anterior/posterior femoral offset relation average was 0.42 (range, –0.38 to 1), and the postoperative anterior/posterior femoral offset relation average was 0.94 (range, 0.61–1.2). Our results show that it is possible to obtain an anatomical correction of the osseous abnormalities with arthroscopic surgery in FAI. Level of evidence: level III.

Keywords

femoroacetabular impingement, correction, arthroscopy, cam, pincer, Wiberg, offset, arthroscopy, hip, clinical trial

Introduction

Femoroacetabular impingement (FAI) is a clinical syndrome recognized as a source of hip mechanic pain in young patients and one of the most relevant factors in the onset of early osteoarthritis (OA).¹ Subtle abnormal morphology of the proximal femur and/or the acetabulum results in abnormal contact between the femoral neck and the acetabular rim during the hip range of motion, leading to the development of lesions in the labrum and the acetabular cartilage.¹

Initially, FAI was described by Smith-Petersen in 1936 as an old, slipped capital femoral epiphysis with protrusion of the acetabulum; Murray and Duncan described its potential risk of degenerative hip disease, and Demarais and Lequesne described the associated hip pain.² Myers and Ganz et al.³ described it as a consequence of Bernese periacetabular osteotomy with resultant acetabular retroversion and a secondary femoral bump. Later, the same clinical presentation and radiographic images were found in patients who never had a hip surgery before.

Ganz et al.^{1,4} divided FAI into 2 types: cam-type (abnormal femoral head-neck junction with an increased head radius)

impingement and pincer-type impingement (overcoverage, coxa profunda, acetabular retroversion, etc.). A combined cam-pincer type is the most frequent presentation (80%).²

Traditionally, FAI has been managed safely and effectively with hip dislocation with or without trochanteric osteotomy,⁵ allowing full access to the acetabulum and proximal femur and preserving the femoral head blood supply. This technique had promising early and midterm success in patients with minimal degenerative changes but requires a large dissection, a trochanteric slide osteotomy, and a prolonged rehabilitation period; the complications include vascular femoral necrosis, trochanteric fracture, trochanteric osteotomy nonunion, and others.

Less invasive arthroscopic techniques are now being used to an increasing extent. Initially, the arthroscopies were

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Figure 1. Wiberg (center-edge) angle. **(Left)** The technique in a well-centered pelvis anteroposterior projection. **(Right)** A close-up of the Wiberg measurement.

combined with an anterior mini-open⁶; now, mainly, it is performed alone. The goal of the arthroscopic surgery is to emulate the results of the open technique.

The authors do not have knowledge of published studies that evaluate the capacity of arthroscopic surgery to restore the normal anatomical characteristics of the hip with acetabular rim trimming and femoral osteochondroplasty. The purpose of this study was to evaluate the radiographic results of arthroscopic acetabular rim trimming and femoral osteochondroplasty in FAI.

Methods

A retrospective analysis of preoperative and postoperative plain radiographs of 80 patients treated for FAI with arthroscopic acetabular rim trimming and/or femoral osteochondroplasty was performed between April 2007 and December 2008. The decision to perform one or both procedures (acetabular rim trimming and/or femoral osteochondroplasty) was based on each patient's anatomical characteristic of the acetabulum and femoral offset, as we describe below (Wiberg angle and relation of femoral head-neck offset).

The inclusion criteria were the following: 1) patient with FAI diagnosis treated in our hospital with hip arthroscopy; and 2) have a complete set of preoperative and postoperative images that include a pelvis well-centered anteroposterior (AP) projection (with coccyx and pubic symphysis aligned, and a distance between them of approximately 11 mm in men and 22 mm in women) and affected hip AP and cross-table projections. We excluded those patients who do not have a complete preoperative or postoperative radiographic study.

In the images, we evaluated 2 parameters:

1. The Wiberg angle (center-edge angle),⁷ as it was described by Wiberg in 1939. This was measured in a pelvis AP projection. We consider a normal Wiberg to be $30^\circ \pm 5^\circ$ (Wiberg $<25^\circ$ was considered to be a dysplastic acetabulum, and Wiberg $>35^\circ$ was considered overcoverage) (**Fig. 1**).

2. The relation of femoral head-neck offset. This was evaluated in a hip cross-table projection, measuring the anterior and posterior head-neck offset and obtaining a relation between anterior/posterior offset. We consider a normal anterior/posterior relation to be between 0.8 to 1 (**Fig. 2**).

These measurements were done in preoperative and postoperative radiographs, and we compared them in order to evaluate if there is a significant change obtained with hip arthroscopy (**Figs. 3 and 4**). All the arthroscopies were performed by the same surgeon in the supine position, through 2 portals (anterior and anterolateral), and with intraoperative radioscopy to evaluate deformity correction; data were registered in our specific hip arthroscopy form, registering preoperative and intraoperative findings and postoperative results and outcome.⁸

Results

A total of 80 plain radiographs were evaluated in 76 patients (4 bilateral). Fifty-eight patients (76.3%) were women, and 18 (23.7%) were men. The mean age was 29.7 years with a range between 18 and 57 years. Of 80 FAI, 10 hips (12.5%) were pincer type, 17 (21.25%) were cam type, and 53 (66.25%) were mixed type.

The preoperative Wiberg average was 39° (range, 25° – 51°) (**Fig. 5**), and the postoperative Wiberg average was 32° (range, 25° – 42°) (**Fig. 6**). All patients with a postoperative Wiberg angle greater than 35° had a preoperative angle over 50° .

The preoperative anterior/posterior femoral offset relation average was 0.42 (range, -0.38 to 1) (**Fig. 7**), and the postoperative femoral offset relation average was 0.94 (range, 0.61–1.2) (**Fig. 8**). Fourteen patients had a postoperative anterior/posterior offset relation less than 0.8. Seven of these patients had a preoperative offset relation less than 0, and the other 7 patients had insufficient bump resection.

Discussion

Surgical treatment of FAI focuses on the relief of symptoms, improving the hip range of motion and alleviating abnormal femoral contact against the acetabular rim. Classically, resection osteoplasty of the prominent anterior neck or no spherical head and resection of acetabular overcoverage have been performed by an open surgical dislocation, preserving the femoral head irrigation. Hip arthroscopy arises as an attractive and less invasive method to treat FAI, and literature reports offer promising results for this procedure.^{2,9}

One disadvantage of the arthroscopic technique compared with the open procedure is that, when performing the former, the surgeon has difficulties in orienting himself to

Figure 2. (A) Preoperative cross-table X-ray. (B) Measurement of anterior femoral head-neck offset. (C) Measurement of the posterior femoral head-neck offset to obtain the relation anterior-posterior femoral head-neck offset. Line 1 follows the femoral neck direction, line 2 is parallel to line 1 and is tangential to the point in which the femoral head loses the anterior sphericity, and line 3 is parallel to 1 and 2 and is tangential to the most anterior point of the femoral head. The distance between line 2 and 3 is what we considered to be the anterior femoral head-neck offset. Line 4 is parallel to the described lines and is tangential to the point in which the femoral head loses the posterior sphericity, and line 5 is tangential to the most posterior point of the femoral head. The distance between line 4 and 5 is what we considered to be the posterior femoral head-neck offset.

Figure 3. Preoperative (left) and postoperative (right) Wiberg angle measurement (as described by Wiberg in 1939).

Figure 4. Preoperative (left) and postoperative (right) anterior femoral head-neck offset measurement (as described in Fig. 2).

the location and extent of the required bone resection. This may lead to insufficient correction and residual impingement or even excessive resection, which is associated with the risk of femoral neck fracture. Our results show that it is possible to achieve adequate orientation and satisfactory results in anatomical abnormalities correction with this technique.

In cam-type treatment evaluation, Mardones et al.¹⁰ evaluated the effect of the size of the resection in femoral head-neck junction in 15 fresh-frozen cadaveric specimens with the open technique. They concluded that a depth of resection equivalent to 30% of the diameter of the femoral head-neck junction should be the very highest limit of

Figure 5. Preoperative Wiberg angle. The angle degrees are in the vertical axis, and the number of patients is in the horizontal axis. The darkest area represents the normality values interval. We can see that the majority of the patients had a Wiberg angle greater than 35°.

Figure 6. Postoperative Wiberg angle. The angle degrees are in the vertical axis, and the number of patients is in the horizontal axis. The darkest area represents the normality values interval. We can see that the majority of the patients had a postoperative Wiberg angle between 25° and 35°. All patients with a postoperative Wiberg angle greater than 35° had a preoperative angle over 50°.

Figure 7. Preoperative head-neck anterior-posterior offset relation. The relation value is in the vertical axis, and the number of patients is in the horizontal axis. The darkest area represents the normality values interval. We can see that the majority of the patients had an offset relation less than 0.8.

Figure 8. Postoperative head-neck anterior-posterior offset relation. The relation value is in the vertical axis, and the number of patients is in the horizontal axis. The darkest area represents the normality values interval. The majority of the patients had an offset relation greater than 0.8; none exceeded a 1.3 relation.

resection, without compromising the proximal femoral strength. All 80 patients in our series obtained after surgery an anterior-posterior femoral head-neck offset relation less than 1.3. Less than 30% of the diameter of the femoral head-neck junction was achieved in all cases.

Beck et al.¹¹ reported the results of open treatment of cam FAI in 19 patients with an average age of 38 years at 4.5 years' follow-up. They had no postoperative osteotomy complications, neck fractures, or vascular necrosis of the hip, and 5 patients required total hip arthroplasty.

Murphy et al.¹² reported the results of open treatment of FAI with a minimum 2 years' follow-up in 23 patients, of which only one had isolated pincer FAI. One patient required subsequent hip arthroscopy for a labral tear, and 7 required total hip arthroplasty for no improvement of the symptoms or progressive deterioration at 6 years'

follow-up. No cases of femoral neck fractures or a vascular necrosis were reported.

Sampson¹³ reported his experience in 120 arthroscopic procedures with 1-year follow-up. He combined a central compartment arthroscopy with an anterior capsulotomy to expose the cam deformity. Three patients went on to a total hip arthroplasty, and one patient presented a femoral neck fracture after the procedure.

The results of arthroscopic treatment of cam FAI compare well with the published results of the open procedure.^{2,14} In both techniques, long-term follow-up is needed to fully understand the results of surgical intervention for the treatment of FAI. Our study shows adequate anatomical correction with an arthroscopic procedure.

Zumstein et al.¹⁴ evaluated how accurately the acetabular rim can be trimmed in arthroscopic surgery. They found that the pincer type can be adequately corrected by an arthroscopic procedure. Our results show that it is possible to obtain an anatomical correction of the osseous abnormalities with arthroscopic surgery in FAI, managing to obtain a normal Wiberg angle (25°-35°) in 82.5% of our patients and a relation between anterior/posterior femoral head-neck offset between 0.8 to 1 in 81.25% of the patients.

In a recent published study, Mardones et al.¹⁵ performed a cadaveric comparison of open versus arthroscopic debridement of the femoral bump in cam-type FAI. They evaluated 5 fresh-frozen cadaveric specimens; one hip was treated with the open procedure, and the other hip of the same specimen was treated with hip arthroscopy. The study concluded that the depth and width of the osteoplasty were reliably obtained by the arthroscopic technique; however, there was a tendency to underestimate the osteoplasty length and to place the osteoplasty more posterior and distally than intended with the arthroscopic procedure. There were no statistically significant differences between the open and arthroscopic procedures in any of the measurements.

The authors of the present study have no knowledge of previously published studies that evaluated the ability to obtain an adequate correction of anatomical abnormalities with arthroscopic surgery in FAI.

Acknowledgments

Investigation was performed at the Orthopaedic Department of Clinica Las Condes, Santiago, Chile.

Declaration of Conflicting Interests

The authors declared no potential conflicts of interests with respect to the authorship and/or publication of this article.

Funding

The authors received no financial support for the research and/or authorship of this article.

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