Arthroscopic treatment of femoroacetabular impingement secondary to paediatric hip disorders

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Open reduction of the prominence at the femoral head-neck junction in femoroacetabular impingement has become an established treatment for this condition. We report our experience of arthroscopically-assisted treatment of femoroacetabular impingement secondary to paediatric hip disease in 14 hips in 13 consecutive patients (seven women, six men) with a mean age of 30.6 years (24 to 39) at the time of surgery. The mean follow-up was 2.5 years (2 to 4).

Radiologically, 13 hips had successful restoration of the normal geometry and only one had a residual deformity. The mean increase in the Western Ontario McMasters Osteoarthritis Index for the series at the last follow-up was 9.6 points (4 to 14). No patient developed avascular necrosis or sustained a fracture of the femoral neck or any other complication.

These findings suggest that femoroacetabular impingement associated with paediatric hip disease can be treated safely by arthroscopic techniques.

Open resection of deformities of the femoral neck to improve the range of movement of the hip in skeletally mature patients after slipped capital femoral epiphysis (SCFE) with severe displacement was first described by Heyman, Herndon and Strong in 1957.¹ Nearly 30 years later Harris² demonstrated anatomical abnormalities in 90% of patients with the diagnosis of primary idiopathic osteoarthritis (OA). He divided the deformities into mild dysplasia and pistol-grip deformity. In 1993, Snow et al³ reported anterior impingement of the hip secondary to the residual deformities of Perthes' disease in four patients and undertook arthroscopic debridement of cartilage and bone. Goodman et al⁴ examined the relationship between OA of the hip and subclinical SCFE in 2665 complete human skeletons, and found that 215 (8%) had evidence of post-slip morphology. This was considered to be a major factor in the development of OA of the hip. The OA in this setting was characterised by anterior flattening of the acetabulum.

The concept of femoroacetabular impingement, which can be defined as abutment between the proximal femur and the anterior acetabular margin, was introduced by the Bernese group.^{5,6} Two types of femoroacetabular impingement have been described. Cam femoroacetabular impingement is caused by a non-spherical portion of the femoral head-

neck junction abutting against the acetabular rim in flexion. The resulting shear forces produce an outside-in abrasion of the acetabular articular cartilage, which is then avulsed from the labrum and the subchondral bone at the area of the anterosuperior rim.⁵

Pincer femoroacetabular impingement is the result of linear contact between the acetabular rim and the femoral head-neck junction. The proximal femur may be normal in morphology and the abutment is the result of a deep or retroverted acetabulum.⁷ The abnormal contact in flexion causes the acetabular labrum to fail.⁵

It has been suggested that femoroacetabular impingement can cause a progressive degenerative process and lead to early OA of the hip.^{5,6,8} Proximal femoral deformity secondary to disease of the paediatric hip is a cause of secondary impingement. In previous reports when no clear cause of the impingement has been apparent the condition has been referred to as a primary femoroacetabular impingement.³⁻⁵

Treatment of impingement aims to improve the clearance during movement of the hip and to eliminate the abutment of the acetabular rim and the junction of the femoral head-neck. The use of open surgery to reshape the bone in cam and pincer impingement deformities has been described and is considered to be the standard treatment for these conditions.^{5,9}

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Fig. 1

Arthroscopic view of an anterior hip capsulotomy for exposure of the cam lesion. A shaver is seen at the top with the edges of the hip capsule (HC) at either side. The deformity of the femoral head (FHD) or cam lesion is in the centre.

Fig. 2

Image-intensifier anteroposterior view of a left hip with a cam deformity secondary to Perthes' disease. The arthroscope is the lower instrument to the right of the image with the shaver tip immediately above it. The latter is used to reduce the lateral aspect of the cam deformity.

The application of hip arthroscopy to treat femoroacetabular impingement has received some attention with reports of early promising results.¹⁰⁻¹² We describe a prospectively studied consecutive series of young adults treated by arthroscopic decompression of an impingement deformity which was secondary to disease of the paediatric hip with a minimum follow-up of two years (2 to 4).

Our hypothesis was that an effective, reproducible and safe decompression of femoroacetabular impingement could be performed using an arthroscopic technique to reshape the proximal femur in the case of cam impingement and rim trimming in the case of pincer impingement, secondary to disease of the paediatric hip.

Patients and Methods

Between January 2003 and January 2004 we identified 13 patients (14 hips) with femoroacetabular impingement secondary to disease of the paediatric hip. Patients with impingement which could not be attributed to disease of the paediatric hip, or who had OA of grade 3 or worse according to the classification of the American College of Rheumatology,¹³ were excluded. There were seven women and six men with a mean age of 30.6 years (24 to 39) in the study. In seven patients (53.8%) the right hip was affected, in five (38.5%) the left and in one (7.7%) the condition was bilateral. The primary diagnosis was SCFE in eight hips (57.1%) (one bilateral), Perthes' disease in four (28.6%) and developmental dysplasia of the hip in two (14.3%). In six of the seven patients (8 hips) with SCFE, previous surgery to stabilise the femoral head (one bilateral) had been performed. In three of the SCFE patients the fixation had been removed previously, and in the others it was still *in situ*. All patients gave their informed consent for inclusion in the study.

All complained of intermittent locking and catching at the hip and pain after sitting for long periods of time. At the

pre-operative examination they all demonstrated a positive 'C' sign¹⁴ and log-roll tests,¹⁴ and pain was reproduced by applying internal rotation in different degrees of flexion of the hip.¹⁴

The pre-operative and final range of movement at the most recent assessment was recorded by the research fellows (JMN-B, EA-R). Our follow-up routine for arthroscopy of the hip required attendance two weeks post-operatively, then at one, three and six months, and annually thereafter.

The imaging studies included anteroposterior (AP) and Lauenstein (frog lateral) pelvic radiographs in every patient, CT in 11 (84.6%), MR arthrograms in two (15.4%),¹⁵ depending on the individual circumstances of each patient. No MR arthrograms were performed in patients who had metalwork from previous operations *in situ* or in those in whom the bony deformity was more suitable for identification by CT. Inverted polarity Western Ontario and McMasters Universities Osteoarthritis Index questionnaires¹⁶ (where the least symptomatic patient will score 96 points) in Spanish were used for the clinical assessment of every patient before surgery, at the six-month review and at the last follow-up. These were completed independently by the patients without supervision from medical staff.

Operative technique. Arthroscopy of the hip was performed in the lateral position on a fracture table with special accessories for traction (Maquet, Rastatt, Germany). An image intensifier was positioned to provide an AP view of the hip. Central compartment arthroscopy was performed using an anterolateral, posterolateral and direct anterior portal technique described elsewhere with traction applied.^{16,17} Peripheral compartment arthroscopy was performed without traction¹⁷ with the hip flexed to 40°, abducted and externally rotated; the arthroscope was introduced through the anterolateral portal to the anterior fem-

oral neck inside the joint capsule.¹⁸ The working portal was established using triangulation with a spinal needle and guide-wire technique and further developed with a slotted cannula. In some cases an anterolateral inferior accessory portal was used. The cam deformity was identified at the periphery of the hip and further exposed by an arthroscopic anterior capsulectomy¹⁰ (Fig. 1) which was restricted to between the 12 and 6 o'clock positions to protect the vascularity of the hip.^{11,12} Once the cam lesion had been fully identified a 5.0 mm spherical burr at 6000 rpm (Smith and Nephew, Andover, Massachusetts) was used to reshape the head-neck junction. Throughout the procedure the lateral retinacular vessels were avoided. The hip was moved through a range of movement to visualise the anterior and lateral aspects of the femoral neck while being inspected with the image intensifier to ensure that there was adequate decompression of the cam lesion and to avoid excessive bone resection from the femoral neck (Fig. 2). Resection in excess of 30% of the volume of the femoral neck was avoided as this has been shown to increase the risk of fracture of the femoral neck.¹⁹ At the end of the arthroscopy those patients with retained hardware from previous surgery had it removed. The patients were allowed to move their hip freely post-operatively, but were limited to partial weight-bearing for six weeks.

The extent of the remodelling of the cam lesion was determined from the pre- and post-operative AP and Lauenstein radiographs and quantified by measurement of the alpha angle²⁰ on the pre- and post-operative lateral radiographs by JMN-B and EA-R. The mean follow-up was 2.3 years (2 to 4).

Statistical analysis. This was performed using the SPSS version 10.0 for Windows software (SPSS Inc., Chicago, Illinois). The WOMAC scores were tested for a normal distribution using the Kolmogorov-Smirnov test.²¹ Student's *t*-test was performed to establish differences between the means of pre- and post-operative WOMAC scores. The results were considered to be significant at $p \leq 0.05$.

Results

No patient was lost to follow-up. Cam deformities were seen in all the patients and were confirmed arthroscopically. Only one patient (7.7%) had a combined cam and pincer impingement deformity. This patient had a SCFE with a complete anterior labral tear, anterior rim osteophyte and delamination of the anterior acetabular cartilage. The anterior osteophyte produced pincer femoroacetabular impingement. The osteophyte was exposed by removing the torn labrum and then resected using a burr while traction was applied to the hip. The large cam lesion in this patient was also remodelled according to the technique described previously (Fig. 3). The two MR arthrograms showed the labral pathology in both patients.

At arthroscopy, delamination of the anterior acetabular articular cartilage and anterior marginal labral tears were

found in every hip. All the labral tears were treated by partial resection of the damaged labral tissue. The hips with isolated cam impingement had fibrillated tears of the free margin of the labrum and were not suitable for repair. The patient with the combined cam and pincer impingement had an irreparable complex tear of the anterolateral labrum which was treated by resection. Cartilage delamination was treated by resection of unstable cartilage and microfractures of exposed subchondral bone.

Hypertrophic synovial tissue was found in the acetabular fossa in six patients (46%). Two of these had osteophytes at the margins of the acetabular fossa. The synovium was resected with a shaver and a radiofrequency probe and the osteophytes were removed with a spherical burr.

The patients with a past history of Perthes' disease had chondral defects which affected the femoral head. These were filled with fibrous tissue and surrounded by normal articular cartilage which extended over the rest of the femoral head.

The radiological measurements showed that the mean pre-operative alpha angle²⁰ in the lateral exposure was 74.21° (72° to 77°). Post-operatively the mean alpha angle on the lateral exposures was reduced to 44.92° (41° to 65°). In 13 hips (92.9%) the post-operative films in two projections showed complete remodelling of the cam lesion (Fig. 4). In one patient with a SCFE incomplete remodelling was achieved with a residual alpha angle of 65°. There was no change in the joint space seen between the pre-operative hip radiographs and the latest post-operative films.

In nine patients (69.2%) limited movement was the main pre-operative complaint. In eight with SCFE the hip was in external rotation which increased as the hip was flexed. None of these patients could achieve any internal rotation and seven could only flex the hip to 80°. Two of the patients (15.4%) with Perthes' disease lacked any internal rotation and had flexion of less than 90°. The remaining two patients (15.4%) with Perthes' disease had internal rotation of less than 10° but were able to flex their hips to more than 90°. The patients with developmental dysplasia of the hip had no reduction in their range of movement.

At the final follow-up all the patients with SCFE could flex to more than 90° and six of these had internal rotation of up to 5° in flexion and extension. The other other patients with SCFE were able to position the hip in neutral rotation in flexion and extension. The patients with incomplete remodelling of the cam femoroacetabular impingement secondary to SCFE also obtained an improvement in their range of flexion of more than 90° and neutral internal rotation.

The patients with Perthes' disease were able to flex their hip to more than 90° and had internal rotation of up to 10° in flexion and extension. There were no changes in range of movement in the patients with developmental dysplasia of the hip.

Fig. 3a

Fig. 3b

Fig. 3c

Fig. 3d

A patient with slipped capital femoral epiphysis and a resulting combined pincer and cam femoroacetabular impingement deformity. a) Pre-operative anteroposterior and lateral radiographs of the right hip showing a cross-over sign (arrows) associated with a pincer femoroacetabular impingement lesion (left) and a large cam femoroacetabular impingement lesion (right). b) CT of the same hip with an arrow marking the anterior wall osteophyte which caused the pincer lesion. c) An arthroscopic image of the anterior wall osteophyte (O) after resection of the anterior labrum. The femoral head (FH) is at the bottom. d) Post-operative radiographs showing resection of both the pincer and cam lesions.

The mean pre-operative WOMAC score was 77.7 points (74 to 82) and the mean score at the last follow-up was 87.4 (80 to 94). The mean WOMAC increment at the last follow-up was 9.6 points (4 to 14) (95% CI 7.2 to 12.1; Student's *t*-test, $p = 0.0001$).

No patient developed a fracture of the femoral neck or avascular necrosis and there were no infections or neurovascular complications.

Discussion

Deformity of the hip has been shown to cause OA.^{2,4} Femoroacetabular impingement has been implicated as contributing to the process of arthritis.²² Open remodeling of this by careful dislocation of the hip while protecting the lateral retinacular vessels has been described.⁵ The mid-term results of this treatment have been reported mainly for primary impingement. In a series of 19 patients with a mean follow-up of 4.5 years (4 to 5.2) and a mean age of 36 years (21 to 52) treated by open reshaping of the head-neck junction, five subsequently required a total hip replacement (THR), but no patient sustained a fracture of the femoral neck or developed avascular necrosis of the hip.²³ Murphy et al²⁴ reported a series of 23 patients treated by open surgery with a mean age of 35 years (17 to

54) and a minimum follow-up of two years. Only one had isolated pincer femoroacetabular impingement and the rest all had cam or combined impingement. In 12 patients the diagnosis was primary impingement and the remainder had secondary impingement. In four patients this was because of previous trauma (two cases of traumatic subluxation, one malunion of a Pipkin fracture and one malunion of a fracture of the femoral neck), in four because of developmental dysplasia of the hip,¹ in one from SCFE, one from Perthes' disease and one from osteochondromatosis. In their series, seven patients required a THR at six years and no patient had a fracture of the femoral neck or avascular necrosis. Weiland and Philippon¹¹ published a technical description of the use of a burr under arthroscopic control to reduce the cam lesion in femoroacetabular impingement in the peripheral compartment without traction and a limited capsulectomy to expose the cam lesion while preserving the vascularity of the hip. They also described an arthroscopic technique to treat pincer femoroacetabular impingement by resection of the excessive anterior cover of the acetabular rim with an osteotome and labral reattachment by suture-anchors. The results were not presented in this technical description. Other similar reports have also been described,^{10,12}

Fig. 4a

Fig. 4b

Fig. 4c

Fig. 4d

a) Anteroposterior and lateral radiographs of a right hip after Perthes' disease. A cam femoroacetabular impingement deformity is clearly visible at the lateral and anterior femoral neck. b) MR arthrogram showing the anterior cam deformity, a hypertrophic anterior labrum and a marginal tear. c) Post-operative pelvic radiograph showing reduction of the cam lesion. d) Lateral radiograph after resection of the cam lesion.

and the place of arthroscopic surgery of the hip has recently been reviewed by Khanduja and Villar.²⁵

We believe that our study is the first to report arthroscopic treatment of femoroacetabular impingement secondary to disease of the paediatric hip. We were successful in restoring the geometry of the hip in 13 of the 14 hips (92.9%) without any complications. All our patients obtained an improvement in clinical outcome using the WOMAC score and within the short period of follow-up we found no evidence of radiological progression of OA. This may be because the main complaint in our series was limited movement with occasional mechanical symptoms in patients without advanced OA. The patients in our series were younger than those treated in previously mentioned studies.

We recognise that the WOMAC index has not been designed to evaluate arthroscopy of the hip and that other specially designed scores have been previously validated and published for this purpose.^{26,27} However, the latter have not been validated in Spanish.

A longer follow-up of a larger series of patients is needed to evaluate the results of open and arthroscopic treatment of femoroacetabular impingement in order to determine the

impact of decompression procedures in the progression of OA of the hip.

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References

1. Heyman CH, Herndon CH, Strong JM. Slipped femoral epiphysis with severe displacement: a conservative operative treatment. *J Bone Joint Surg [Am]* 1957;39-A:293-303.
2. Harris WH. Etiology of osteoarthritis of the hip. *Clin Orthop* 1986;213:20-33.
3. Snow SW, Keret D, Scaragnella S, Bowen JR. Anterior impingement of the femoral head: a late phenomenon of Legg-Calve-Perthes' disease. *J Pediatr Orthop* 1993;13:286-9.
4. Goodman DA, Feighan JE, Smith AD, et al. Subclinical slipped capital femoral epiphysis: relationship to osteoarthritis of the hip. *J Bone Joint Surg [Am]* 1997;79-A:1489-97.
5. Leunig M, Beck M, Dora C, Ganz R. Femoroacetabular impingement: etiology and surgical concept. *Oper Tech Orthop* 2005;15:247-55.
6. Ito K, Minka MA 2nd, Leunig M, Werlen S, Ganz R. Femoroacetabular impingement and the cam-effect: a MRI based quantitative anatomical study of the femoral head-neck off-set. *J Bone Joint Surg [Br]* 2001;83-B:171-6.
7. Kim WY, Hutchinson CE, Andrew JG, Allen PD. The relationship between acetabular retroversion and osteoarthritis of the hip. *J Bone Joint Surg [Br]* 2006;88-B:727-9.
8. Tanzet M, Noisieux N. Osseous abnormalities and early osteoarthritis: the role of hip impingement. *Clin Orthop* 2004;429:170-7.

9. Crawford JR, Villar RN. Current concepts in the management of femoroacetabular impingement. *J Bone Joint Surg [Br]* 2005;87-B:1459-62.
10. Sampson TG. Arthroscopic treatment of femoroacetabular impingement. *Tech Orthop* 2005;20:56-62.
11. Weiland DE, Philippon MJ. Arthroscopic technique of femoroacetabular impingement. *Oper Tech Orthop* 2005;15:256-60.
12. Guanche CA, Bare AA. Arthroscopic treatment of femoroacetabular impingement. *Arthroscopy* 2006;22:95-106.
13. Altman R, Alarcon G, Appelrouth D. The American College of Rheumatology criteria for classification and reporting of osteoarthritis of the hip. *Arthritis and Rheumatism* 1991;34:505-14.
14. Byrd JWT. Physical examination. In: Byrd JWT, ed. *Operative hip arthroscopy*. Second ed. New York: Springer-Science 2005:36-50.
15. Werlen S, Leunig M, Ganz R. Magnetic resonance arthrography of the hip in femoroacetabular impingement: technique and findings. *Oper Tech Orthop* 2005;15:191-203.
16. Escobar A, Quintana JM, Bilbao A, Azkarate J, Guenaga JL. Validation of the Spanish version of the WOMAC questionnaire for patients with hip or knee osteoarthritis. *Clin Rheumatol* 2002;21:466-71.
17. Ilizaliturri VM Jr, Mangino G, Valero FS, Camacho-Galindo J. Hip arthroscopy of the central and peripheral compartment by the lateral approach. *Tech Orthop* 2005;20:32-6.
18. Ilizaliturri VM Jr, Mangino G, Valero FS, Camacho-Galindo J. Special instruments and technique for hip arthroscopy. *Tech Orthop* 2005;20:9-16.
19. Mardones RM, Gonzalez C, Chen Q, et al. Surgical treatment of femoroacetabular impingement: evaluation of the effect of size of the resection. *J Bone Joint Surg [Am]* 2005;87-A:273-9.
20. Notzli HP, Wyss TF, Stoecklin CH, et al. The contour of the femoral head-neck junction as a predictor for the risk of anterior impingement. *J Bone Joint Surg [Br]* 2002;84-B:556-60.
21. Daniel WW. Estadísticas no paramétricas y a libre distribución. In: Daniel WW, ed. *Bioestadística. Base para el análisis de las ciencias de la salud*. First ed. Mexico City: Limusa, 1982:374-7.
22. Beck M, Kalhor M, Leunig M, Ganz R. Hip morphology influences the pattern of damage to the acetabular cartilage. *J Bone Joint Surg [Br]* 2005;87-B:1012-18.
23. Beck M, Leunig M, Parvizi J, et al. Anterior femoroacetabular impingement. Part II: midterm results of surgical treatment. *Clin Orthop* 2004;418:67-73.
24. Murphy S, Tannast M, Kim YJ, Buly R, Millis MB. Debridement of the adult hip for femoroacetabular impingement. *Clin Orthop* 2004;429:178-81.
25. Khanduja V, Villar RN. Arthroscopic surgery of the hip. *J Bone Joint Surg [Br]* 2006;88-B:1557-66.
26. Martin RL, Kelly BT, Philippon MJ. Evidence of validity for the hip outcome score. *Arthroscopy* 2006;22:1304-11.
27. Christensen CP, Althausen PL, Mittleman MA, Lee JA, McCarthy JC. The non-arthritic hip score: reliable and validated. *Clin Orthop* 2003;406:75-83.