

Anterior femoro-acetabular impingement. Radiological signs in young patients diagnosed with hip osteoarthritis

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Purpose. To determine the incidence of the characteristic radiological signs of anterior femoro-acetabular impingement (AFAI) in young patients diagnosed with idiopathic hip osteoarthritis.

Materials and methods. Retrospective review of the clinical records of patients under 50 years of age diagnosed with idiopathic hip osteoarthritis between 1995 and 2000. The functional assessment of the hip was made by means of the Merle D'Aubigne scale. The radiological study that revealed the presence of the figure-of-8 sign and the head/neck bump sign. The hip joint was evaluated by means of Tönnis' scale.

Results. Fifty-one (43%) of the 121 patients under 50 were diagnosed with idiopathic hip osteoarthritis. We reviewed 45 hips. The mean age in this group was 44.5 years (range: 30-50). The mean value obtained on the Merle d'Aubigne scale was 16 (range: 12-17). In 10 hips (22 %) the figure-of-8 sign was observed, in 26 (58%) the head/neck bump sign was observed. Both signs were observed in 6 cases (13%). Thirty hips (66%) presented with at least one of these radiological signs. In 18 hips (60%) lytic images were seen in the proximal femur. Seventy percent of patients that had at least one of the characteristic signs of FAI were grade I on the Tönnis classification; the remaining 30% were grade II.

Conclusions. In our series, 66 % of patients diagnosed with idiopathic hip osteoarthritis presented, at the time when the diagnosis was made, radiological signs characteristic of AFAI. Also, AFAI could be construed as the cause for the primary hip osteoarthritis in some of the patients.

Key words: hip, hip osteoarthritis, femoro-acetabular impingement, young adults, radiological signs.

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Atrapamiento fémoro-acetabular anterior. Signos radiológicos en pacientes jóvenes diagnosticados de coxartrosis

Objetivo. Determinar la incidencia de los signos radiológicos característicos del atrapamiento fémoro-acetabular anterior (AFA) en pacientes jóvenes diagnosticados de coxartrosis idiopática.

Material y método. Revisión retrospectiva de historias clínicas de los pacientes menores de 50 años diagnosticados de coxartrosis idiopática entre los años 1995 y 2000. Evaluación funcional de la cadera con la escala de Merle D'Aubigne. Estudio radiológico, donde se observa la presencia del signo del lazo y el signo de la giba, así como la valoración de la articulación coxofemoral con la escala de Tönnis.

Resultados. Cincuenta y uno (43%) de los 121 pacientes menores de 50 años fueron diagnosticados de coxartrosis idiopática. Revisamos 45 caderas, con una edad media del grupo de 44,5 años (30-50). El promedio de los valores obtenidos en la escala de Merle d'Aubigne fue de 16 (12-17). En 10 caderas (22%) se observó el signo del lazo, en 26 (58%) se evidenció el signo de la giba, y en seis casos ambos signos (13%). En 30 caderas (66%) se observaron algunos de estos signos radiológicos. En 18 (60%) caderas se apreciaron imágenes líticas en el fémur proximal. El 70% de los pacientes en los que se observó alguno de los signos característicos del AFA presentaba un grado I en la clasificación de Tönnis, el 30% restante presentó un grado II.

Conclusiones. En nuestra serie un 66% de los pacientes diagnosticados de coxartrosis idiopática presentaban, en el momento del diagnóstico, signos radiológicos característicos de AFA. Algunos de los pacientes diagnosticados de coxartrosis primaria podrían corresponder a un AFA como causa inicial de su coxartrosis.

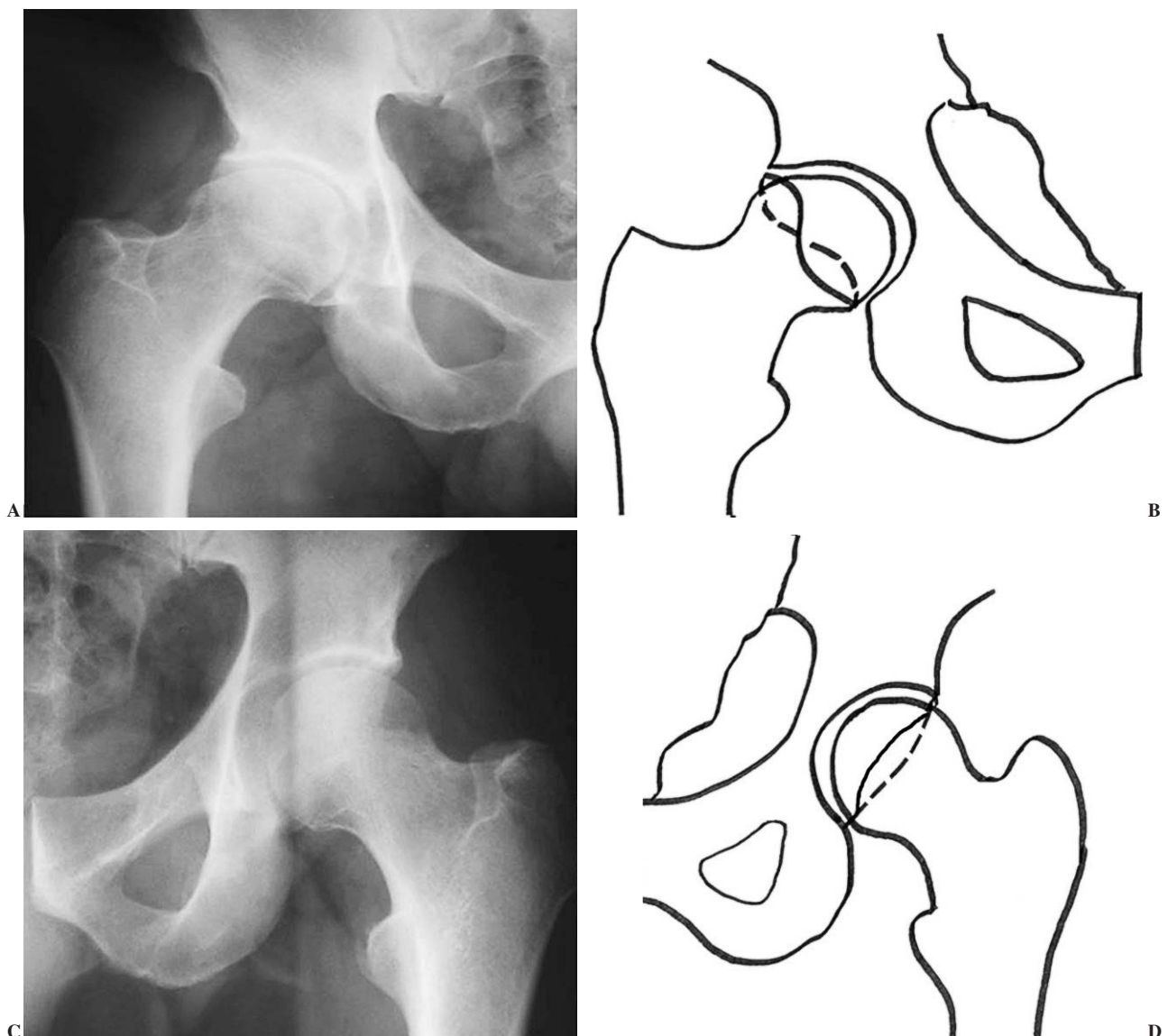
Palabras clave: cadera, coxartrosis, atrapamiento fémoro-acetabular, adultos jóvenes, signos radiológicos.

Anterior femoroacetabular impingement (AFAI) is a relatively unknown condition in our specialty, given the fact that its clinical characteristics have been described only recently, and a potential cause of osteoarthritis in young adults¹. AFAI consists in an impingement of the head-neck area of the femur on the anterior region of the acetabulum.

The typical clinical symptom is pain on carrying out activities that require flexion of the hip with simultaneous internal rotation and adduction. Pain can also appear when standing up after a long period of sitting. On examining the patient, the physician normally elicits by means of the «impingement test,» whereby the hip is placed in 90 degrees of flexion, internal rotation and adduction.

Radiologically, the condition is characterized by two typical signs, which to some are pathognomonic², i.e. the crossover sign (fig. 1A)^{3,4} and the pistol-grip sign (fig. 2)^{5,6}. The crossover sign is associated to a relative retroversion of the acetabulum. Its name comes from the fact that radiologically the anterior rim of the acetabulum crosses over the posterior rim. If the head-neck interface is convex, we are in the presence of a pistol-grip sign.

For many years, many of the patients that came to us to consult about inguinal pain associated to their activity, and who did not present with conspicuous symptoms or x-rays showing a clearly involved hip, tended to be diagnosed with early idiopathic hip arthritis or with an extraosseous pathology (for eg. an inguinal herniation). We believe that cur-



Figures 1. A and B. Simple anteroposterior x-ray and sketch showing the crossover sign. C and D. Simple anteroposterior x-ray and sketch of a normal hip.

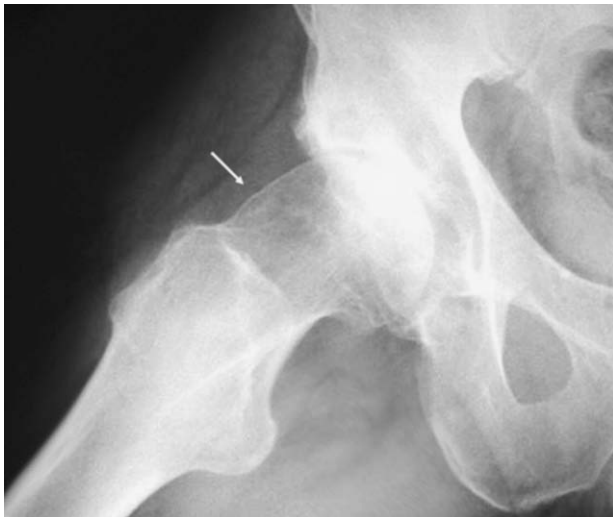


Figure 2. Axial hip x-ray showing the pistol-grip sign (arrow).

rently some of these patients could have presented with AFAI not diagnosed at the time because the condition was as yet unknown.

The purpose of this study is to describe the incidence of the radiological signs that characterize this condition in young patients diagnosed with idiopathic hip arthritis.

MATERIAL AND MÉTHOD

We performed a retrospective study of patients diagnosed with hip arthritis in our Center over a 5-year period (1995-2000). We reviewed their clinical records using the criteria outlined in table 1.

We collated all the data in the clinical records: personal data, anamnesis and physical exam. Hip function was determined by means of the Merle D'Aubigne score⁷. We meticulously analyzed the radiological signs in the patients evaluated, trying to establish the presence (or absence) of the characteristic signs of this condition (the crossover sign or the pistol-grip sign).

We assessed the degree of hip osteoarthritis using the Tönnis scale (table 2)⁸. We compared the hip ROM (flexion and rotation) of patients who had the radiological signs described with that of patients who did not, using the Student's «t» test with the statistical software SPSS 11.0.

Table 1. Inclusion criteria

Younger than 50
History of pain on performing an activity
Physical examination of hips
X-ray studies
Diagnosis: hip arthritis

Table 2. Tönnis scale⁸

Grade 1

Minimal sclerosis of the femoral head and acetabulum
Mild decrease in the joint space

Grade 2

Small cysts in the head or acetabulum
Moderate decrease in the joint space
Femoral head deformity

Grade 3

Large acetabular or femoral cysts
Moderate to complete loss of joint space
Severe deformity of the femoral head

RESULTS

Of 714 patients diagnosed with hip arthritis between 1995 and 2000, 121 (16%) were younger than 50. The etiologies of hip arthritis in patients younger than 50 are reflected in figure 3. In 51 (43%) of these 121 patients at the time of diagnosis no known etiology could be established. Mean patient follow-up was 4.2 years (range: 1-10).

Seven patients were excluded from the study since it was not possible to carry out an appropriate analysis of the radiological results. We reviewed 44 patients (45 hips). Of these 44 patients, 32 were male (73%) and 12 female (27%). Mean age was 44.5 years (range: 30-50). 26 right and 19 left hips were evaluated. The mean value obtained on the Merle d'Aubigne scale was 16 (range: 12-17), which denotes very good hip function. In 12 patients (26%) the physical exam, which comprised flexion and internal rotation movements, was painful. Mean hip flexion was 109° (range: 80-130) and mean internal rotation 7° (range: 0-50). The difference between the mean flexion range of patients with and without radiological signs was 3°, i.e. not statistically significant ($p = 0.44$).

The crossover sign was observed in the x-rays of 10 hips (22%) (fig. 1), while 26 (58%) showed a loss of concavity at the neck/head interface (pistol-grip sign) (fig. 2).

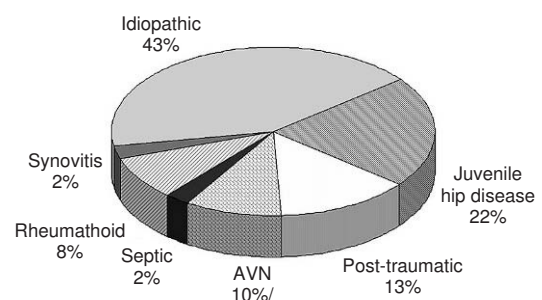


Figure 3. Etiology of hip arthritis in patients younger than 50 diagnosed in our Center between 1995 and 2000. 66% of patients diagnosed with idiopathic hip arthritis presented with a radiological sign associated to femoroacetabular impingement.

In six cases both signs were present (13%). Overall, 30 hips (66%) presented with either of these radiological signs. In 18 of these hips (60%) lytic areas with sclerotic borders were detected in the proximal femur, which were associated to these radiological signs.

According to Tönnis' classification, 60% of hips were grade I, 34% grade II and only 3 hips (6%) grade III. 70% of patients who showed one of the characteristic signs of AFAI had a grade I score on Tönnis' scale; the other 30% were grade II. In hips that did not present with the radiological signs the distribution was different, grade I in 40%, grade II in 40% and grade III in 20%.

DISCUSSION

Around 1% of persons under 55 years of age suffer from hip arthritis. This prevalence has remained unaltered in the last few decades⁹. In most patients it is caused by a specific etiological agent, in which case it is called secondary hip arthritis. The diagnosis of idiopathic or primary hip arthritis is made by exclusion since it is not possible to identify a specific cause for the disease¹⁰. Therefore it could be said that idiopathic hip arthritis is a condition of unknown etiology. Some authors believe this pathology to result from an undetermined cartilage or subchondral abnormality⁶. In 43% of patients in our series, it was not possible to determine an etiological agent at the time of diagnosis.

Anterior FAI results from the impingement of the femoral neck and the anterior acetabulum during the combined flexion, internal rotation and adduction movement that characterizes the hip joint. It is a fairly usual phenomenon that occurs in around 10-15% of the population¹¹. It has recently been included among the causes of hip arthritis in young patients¹. Two basic mechanisms have been described, both of them related to anatomical alterations: cam and pincer impingement. According to Beck et al, morphological hip alterations are predisposing to chondral damage¹².

Cam impingement is caused by an abnormality in the femoral head further to the loss of concavity of the antero-superior head-neck interface. It can also occur in patients suffering from hip epiphysiolysis or as a sequela of a femoral neck fracture, with residual femoral retroversion. This anatomical alteration has been said to cause the initial chondral damage in the anterosuperior area of the acetabular ring¹². For Goodman this deformity develops in patients who suffered a hip epiphysiolysis that went unnoticed¹³. This means that hip arthritis initially diagnosed as idiopathic would really be a secondary condition since it would be a sequela of an asymptomatic epiphysiolysis.

Pincer impingement occurs as a result of the impingement of the head-neck interface with the anterior rim of the acetabulum, associated to a greater-than-normal anterior coverage. At the origin of this type of impingement there

could be a case of coxa profunda or a relative acetabular retroversion, which would lead to a more circumferential involvement of the labrum than found in cam impingement.

Young patients that consult for hip disease, generally present with unspecific symptoms, their physical exam tends to yield ambiguous results and their imaging studies reveal only minimal alterations if any¹⁴. In these young patients, the greatest difficulty lies in identifying the source and the mechanism of pain¹⁴.

Pain of a coxofemoral origin is usually located in the groin and on the anterior aspect of the thigh and often irradiates to the knee¹⁵. Most patients in our series diagnosed with primary hip arthritis presented on diagnosis very good function of the involved hip and only reported occasional pain on carrying out physical activities.

FAI is always associated with a positive impingement test, i.e. the knee is flexed at 90 degrees, with internal rotation and adduction¹⁶. It is also associated with a decreased ROM¹⁷. In our series we did not observe a ROM difference between patients presenting with radiographic impingement signs and those who did not.

Different authors have defined the radiographic signs directly or indirectly related with FAI. There are two basic ones: the pistol-grip sign⁶ and the crossover sign⁴. Absence of these signs does not preclude FAI¹¹.

Synovial cysts around the hip, labral lesions, articular cartilage degeneration and subchondral sclerosis can be found in association with FAI¹⁸. An increase in the alpha angle (neck-head angle) has also been found¹⁸. This angle is formed by the line that joins the center of the femoral head with the axis of the femoral head and the line that connects the anterior-most point of the neck-head union with the center of the femoral head¹⁹.

The pistol-grip sign presents as a convex bone formation of the proximal and superior femoral neck. The loss of concavity of the interface can be seen in anteroposterior and especially axial hip or pelvic x-rays. The lesion can also be studied on MRI and CT¹⁶. For Beaulé et al, the use of 3-D CT-scans makes it possible to quantify this deformity²⁰.

Presence of this sign is associated to a decreased difference between the largest diameter of the femoral head and the diameter of the femoral neck³. Goodman found this alteration in between 7-8% of the hips studied in skeletons of human beings younger than 55¹³. Although this incidence did not increase with age, the incidence of acetabular degenerative changes did increase in the older cadaver groups. This deformity could result from a deviation from normalcy, a developmental alteration or a subclinical disease²¹.

Several studies have analyzed the incidence of the pistol-grip sign in arthritic hips. Harris reported an incidence of 40% in patients diagnosed with idiopathic hip arthritis⁶, whereas Tanzer et al observed this sign in 100% of their cases diagnosed with idiopathic hip arthritis²¹. In turn, Marín Peña et al reported a 70.9% incidence of the pistol-

grip sign in patients in their series. However, these last authors did not exclude patients afflicted by secondary hip arthritis, i.e. juvenile hip disease, post-traumatic arthritis and inflammatory arthropathy²². In our series, the sign was identified in 59% of patients.

On the other hand, Reynolds et al reported that a retroverted acetabular morphology could be associated to this condition⁴. Although retroversion refers to the sagittal pelvic plane, it is possible to study this alteration through a centered anteroposterior pelvic x-ray, where the coccyx should be aligned with the pubic symphysis²³.

Retroversion may be identified by two characteristic features. The first one is known as the crossover sign and occurs when the elevation of the anterior acetabular rim is located more laterally than the posterior rim, both contours crossing each other. The other feature is determined by the posterior acetabular wall that runs medially to the center of the femoral head⁴.

The result of this retroversion is an overcoverage of the anterolateral femoral head that can be reach 15% or more⁴. Not all retroverted acetabuli are associated to symptoms. In fact, in the series by Reynolds et al, 66% of the 43 patients with retroversion had symptoms with the symptomatic threshold being identified at 15° retroversion⁴.

The increased occurrence of the pistol-grip sign could be attributed to the fact that we are now in a better position to identify it. Disparity with respect to the incidence of both radiological signs may be due to the fact that, during the evolution of the disease, these characteristic signs could get destroyed, which causes the physician to diagnose a primary hip arthritis⁶. In fact, in our series it was not possible to demonstrate the presence of the radiological signs of FAI in patients with Tönnis grade 3 arthritis.

Recently fibrocystic images in the femoral neck have been described in association with this condition. Leunig et al observed these images in 33% of hips with FAI²⁴. In our series we have observed a higher incidence. Identification can be made by means of anteroposterior x-rays, CT or NMRi (fig. 4). Sensitivity of anteroposterior radiographs is 67%, and they have a positive predictive value of 91%²⁴. The key imaging study to locate these fibrocystic cervical lesions is NMRi. For Leunig et al this radiological finding could be related to a pre-arthritis stage, i.e. they consider it a marker of arthritis²⁴.

In NMRi imaging studies we can find associated labral lesions and the formation of adjacent intraosseous ganglions²⁵. A patient in our study was subjected to a NMRi study that revealed the presence of a fibrocystic lesion at the femoral neck.

As far as diagnosis is concerned, the main purpose is the suppression of symptoms, correction of the underlying deformity and prevention of the progression to hip arthritis in those cases in which the latter is not yet present at the time of diagnosis¹¹.

Treatment must be chosen on the basis of the patient's symptoms, the origin and the mechanism of the injury and the articular involvement. It can range from conservative treatment until total hip arthroplasty². Conservative treatment consists of modifications and restrictions to physical activity, symptomatic pharmacological treatment (non-steroidal anti-inflammatory drugs [NSAIDs], pain-killers, etc.) and physical therapy or rehabilitation²⁶.

As regards surgical treatment, several techniques are available. Hip arthroscopy could be indicated in patients presenting with minimal degeneration when there are lesions to the femoral neck (anterosuperior pistol-grip) and to the labrum²⁷. Femoroacetabular repair surgery is performed to increase the hip's range of motion²⁶. This procedure can be performed through a transtrochanteric approach²⁶ or an anterior approach². Corrective osteotomy, femoral and/or acetabular, seeks to improve hip joint mechanics by achieving as much joint conformity as possible. Several types of osteotomy have been described, among them the acetabular reorientation osteotomy²⁸ and the femoral intertrochanteric osteotomy²⁹.

To conclude, some of the patients diagnosed with primary hip arthritis could have suffered from FAI at some point in their lives; so FAI would be at the origin of their hip arthritis. Possibly an accurate diagnosis and an appropriate and timely treatment could have slowed down or even halted the progression of chondral involvement.

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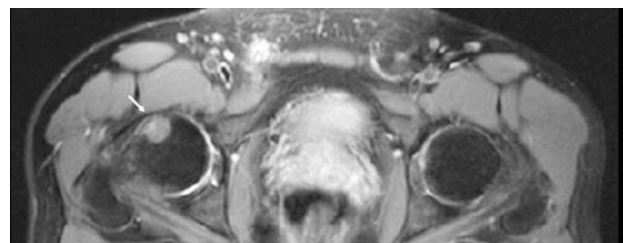


Figure 4. Axial T2-weighted MRI showing a fibrocystic image at the anterosuperior head-neck interface (arrow).

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Conflict of interests

The authors have declared that they have no conflict of interests.