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FEMOROACETABULAR IMPINGEMENT: A LITERATURE REVIEW

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Background. Femoroacetabular impingement is believed to be one of the causes of hip joint pain and coxarthrosis in young adults.
Aim. The aim of the present study was to review the concept of femoroacetabular impingement, its causes, pathogenesis, diagnosis, and methods of treatment to raise awareness among practitioners.
Materials and methods. Literature data available from medical databases were analyzed using online search.
Results. English language publications were reviewed, and key points for practitioners were identified.
Conclusion. Femoroacetabular impingement is a condition with non-specific clinical signs. The radiographic signs of this condition are well known, and the diagnostic algorithms and methods for treatment are available.

Keywords: femoroacetabular impingement, diagnosis, treatment.

Femoroacetabular impingement (FAI) is not a "pure" disease but a pathomechanical process. It is believed to be one of the main causes of hip joint pain and coxarthrosis in young adults [1, 2, 3, 4].

FAI was first described by German physicians more than a century ago [5]. The problem was subsequently addressed by French and American physicians who studied patients with symptoms of juvenile *slipped capital femoral epiphysis* [6, 7]. The rapid development of the topic was initiated by studies of Prof. R. Ganz and colleagues who used surgical hip dislocation to treat patients with improperly fused femoral head fractures and described pathogenesis in detail [8, 9]. Many researchers subsequently devoted their work to the study of etiology, biomechanics, diagnosis, and treatment.

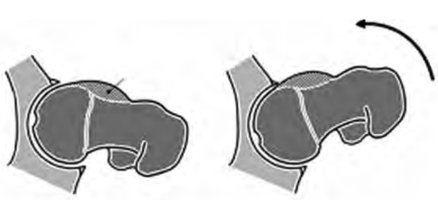

Fig. 1. Cam type

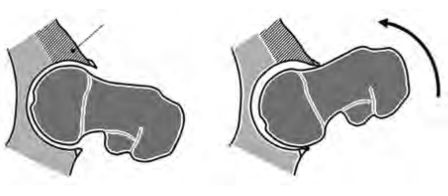

Fig. 2. Pincer type

FAI is characterized by a cam type, which is caused by an impaired shape of the proximal femur with the loss of sphericity (Fig. 1), and a pincer type, in which the impingement is caused by femoral head overcoverage (Fig. 2). A combination of these types occurs in > 90% patients. Therefore, in practice, if one type of FAI is detected, possible signs of the other type should be assessed [10, 11, 12, 13].

Table 1 shows the characteristics of each type.

Clinical examination of the patient is performed using provocative tests. To identify impingement of the anterosuperior part of the acetabulum and the femoral neck surface, the leg is flexed at the hip joint to 90°, adducted, and rotated internally and then externally. Pain is usually associated with impingement of the joint components that occurs at the endpoint of the motion. To assess the involvement of the posterior wall, the patient's leg is extended as much as possible and rotated externally, and the emergence of pain serves as a diagnostic criterion. Furthermore, testing of the C-sign is used as follows: the examiner cups the supra-acetabular region with the thumb and forefinger in the shape of a "C," and the pain caused by applying pressure indicates pathology of the acetabular component.

The Drehmann sign is pathognomonic for the presence of retroversion of the proximal femur. Thus, the ability to perform hip joint flexion is possible only with obligatory external rotation of the hip.

Radiographic examination is obligatory if FAI is suspected. In addition to the standard anteroposterior view, other views are as follows: lateral, Lowenstein, Dunn (standard 90° hip flexion and additional 45° hip flexion), and Lequesne-de Seze (false profile). Proper positioning is very important to assess the spatial relationship of the acetabulum in the anteroposterior view: an image should capture both joints, the distance between images of the pubic symphysis and tailbone should not exceed 3 cm in males and 5 cm in females (no excessive pelvic tilt), and both structures should be aligned (no pelvic rotation). A study by Siebenrock et al. demonstrated that only 9° of excessive pelvic tilt leads to radiographic signs of acetabular retroversion in 100% of patients [14]. Simultaneous radiography using the frontal and lateral views does not require changing the patient's position, and a lateral X-ray of the pelvis is used as a control.

Despite the availability of modern methods such as multislice computed tomography (MSCT) and magnetic resonance imaging (MRI), radiography is indispensable and heads the list. According to a study by Nepple et al., the sensitivity of this method compared with that of MSCT reaches 90% if X-ray imaging is performed in all the above views [15].

When evaluating radiographs of patients with FAI, the diagnostic criteria used are as follows: a sign of general acetabular overcoverage is that the acetabular floor is medial to the ilioischial line, which is accompanied by a decrease in the extrusion index of the femoral head (coxa profunda) (Fig. 3). However, the study by Nepple et al. demonstrated that this X-ray pattern is not the absolute diagnostic sign and can be considered normal for females [15]. The situation should be considered to be more serious when the femoral head projects medially to the ilioischial line (protrusio acetabuli) (Fig. 4).

Table 1

Characteristics of FAI types

Criterion	Pincer type	Cam type
Cause	Focal or general overcoverage	Aspherical femoral head
Mechanism	Linear contact between acetabular rim and femoral neck	Jamming of aspherical head portion into acetabulum
Occurrence rate (M:F)	1:3	14:1
Mean age of patients	40 (40–57)	32 (21–51)
Typical location of cartilage damage	Over the entire circumference, including the posteroinferior portion	The anterosuperior portion (at 11–15 o'clock)
Mean depth of the defect	4 mm	11 mm
Associated conditions	Bladder exstrophy, congenital shortening of the femur, post-traumatic changes of the acetabulum, residual hip dysplasia, Legg-Calve-Perthes disease, *juvenile slipped capital femoral epiphysis* (a condition after reorienting surgery of the acetabulum), and idiopathic retroversion	*Juvenile slipped capital femoral epiphysis*, Legg-Calve-Perthes disease, posttraumatic retrotorsion of the proximal femur, coxa vara pistol grip deformity, multiplanar deformity of the proximal femur, femoral retrotorsion, and dysplasia of the femoral epiphysis
Radiographic signs (anteroposterior view)	Coxa profunda, acetabular protrusion, crossover sign, Wiberg angle > 39°, reduced extrusion index, acetabular index < 0, and posterior acetabular wall sign	Pistol grip deformity, CCD angle < 125°, and horizontal growing plate sign
Radiographic signs (lateral view)	Linear indentation on the femoral neck	Alpha angle > 50°, reduced femoral neck offset < 8 mm, offset index < 0.18, and retrotorsion of the proximal femur

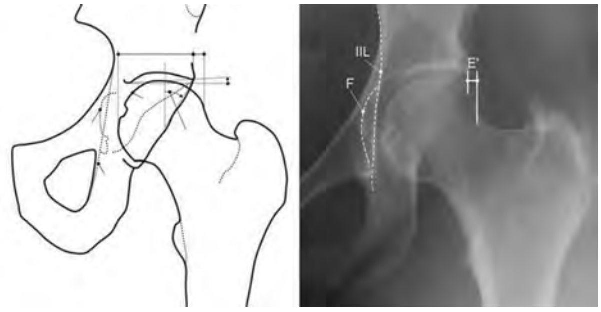

Fig. 3. Coxa profunda

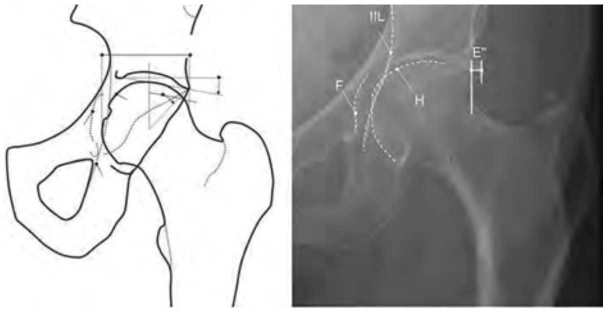

Fig. 4. Protrusio acetabuli

Focal acetabular overcoverage is associated with the crossover sign. Normally, the contour of the anterior acetabular wall does not intersect the contour of the posterior wall or is separated by no more than one-third of its size. In case of an increase in anterior coverage, both walls form a figure "eight" on a radiograph (Fig. 5). The posterior wall sign means that the contour of the posterior wall is lateral to the center of the femoral head, indicating an increase in posterior coverage (Fig. 6). Isolated anterior overcoverage should be distinguished from pathological acetabular retroversion. The presence of the "eight" sign combined with the lack of the posterior wall sign favors the latter case.

For radiographs performed using the anteroposterior view, the cam type is characterized by the following features: pistol grip deformity of the proximal femur, Klein line tangent to the femoral head circumference, horizontal growth plate, and sagging rope sign (Fig. 7).

Axial radiographs are used to evaluate the alpha angle formed by the axis of the femoral neck and a line drawn from the center of the femoral head to a point where the circumference of the femoral head changes to the contour of the femoral neck. Pathological conditions are accompanied by an increase in this indicator, and a value > 50° (65° according to some authors) is a poor prognostic sign (Fig. 8).

The femoral neck offset is the distance between a line drawn on the anterior surface of the femoral neck and a tangent to the femoral head circumference drawn in parallel to the former line. A value >10 mm is abnormal (Fig. 8).

MSCT, which retains the advantages of radiography, can be used to generate a three-dimensional model and using appropriate software, can test the joint for impingement, plan the extent of surgery, and evaluate the result of virtual implementation [16, 17]. Moreover, MSCT facilitates evaluation of the significance of the ratio between the anteroinferior iliac spine and anterior acetabular rim in the pathogenesis of FAI [18].

MRI, which requires an instrument with sufficient capacity (≥ 1.5 T), enables the diagnosis of the pathological conditions of the acetabular labrum, the presence of subchondral cysts, thickening of the joint capsule, bone edema, synovitis, and tendonpathies of the middle gluteal and adductor muscles. However, several studies demonstrated that the accuracy of magnetic resonance arthrography is 3-times greater compared with conventional MRI [19].

Introduction of a mixture of iodine- and gadolinium-containing agents into the joint cavity under fluoroscopic control improves accuracy by 22% and provides 100% specificity [20, 21].

A promising method is dGMERIC that identifies patients with the preclinical stage of FAI. Early treatment of these patients would significantly delay manifestations of coxarthrosis [22].

Conservative and surgical methods are used to treat patients with FAI. Conservative treatment

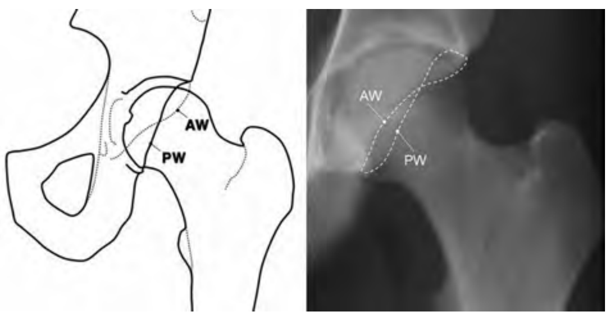

Fig. 5. Crossover sign

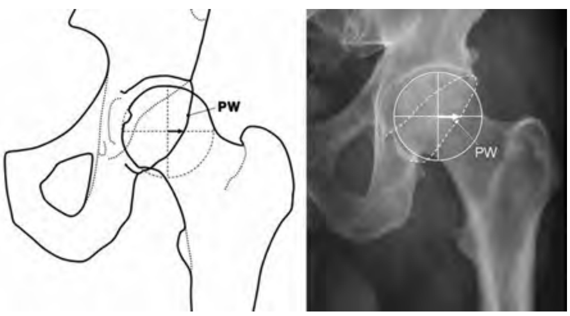

Fig. 6. Posterior wall sign

focuses on limiting the physical activities provoking pain, performing physical therapy, and administrating NSAIDs. This method may be effective in some cases; in a study by Hunt et al., conservative treatment was effective for 44% of patients with hip joint pathology accompanied by clinical signs. Moreover, no significant difference was observed between patients from this group and patients who underwent surgery [23]. Intra-articular injection of corticosteroids is reasonable only if pathology of the cartilaginous region of the acetabular labrum is confirmed, rather than upon detection of the radiographic signs of FAI [24].

Open surgery to cut the greater trochanter and surgical hip dislocation are used in patients with the posterior cam type of FAI, either in the presence of general acetabular overcoverage or idiopathic acetabular retroversion. In the latter case, reorienting operations on the pelvic component are performed [25, 26]. The arthroscopic technique enables modeling the resection to restore head sphericity and increase the neck offset. Moreover, debridement and refixation of the cartilaginous labrum can be performed, which is essential for preserving its retention function and providing hip stability in the acetabulum. If necessary, plasty of the cartilaginous labrum is conducted using a fascia lata autograft [27, 28]. For this purpose, the arthroscopic technique is complemented with a mini approach.

Comparing the two methods, it is worth noting that the number of complications in patients undergoing the open method is greater (≤ 20%). Complications include the formation of a false joint of the greater trochanter, aseptic necrosis of the femoral head, and pain associated with the presence of a metal implant. The duration of hospitalization and rehabilitation is also different. Moreover, when using the arthroscopic technique, it is difficult to control precisely the extent of resection, which sometimes leads to insufficient correction or overcorrection. The outcome mainly depends on the experience of the surgeon. There are no reports of damage to the lateral femoral cutaneous nerve. Application of the mini approach reduces the rate of this complication [29, 30].

The prognosis of outcomes of patients treated conservatively cannot be evaluated because of lack of information about the natural course of the disease. With respect to the timing of surgery, patients with pronounced secondary arthritic

Fig. 7. Pistol grip deformity

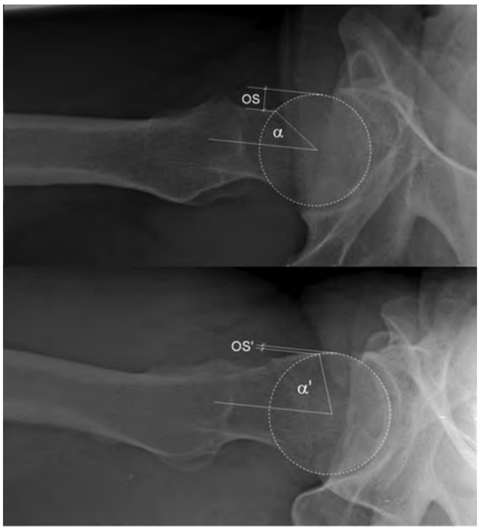

Fig. 8. Increasing the alpha angle and reducing the femoral neck offset

changes have poorer outcomes. Preserving > 50% of width of the joint space, a width of 2 mm, younger age, and a short period of clinical manifestations are good prognostic factors [31, 32]. This situation dictates performing surgery as early as possible after establishing the diagnosis, particularly for young patients who are employed. Long-term studies demonstrate the efficacy of surgery to treat young athletes with FAI, and all patients were provided the opportunity to return to their respective sport without losing strength [33, 34, 35].

In conclusion, FAI is a condition with significant but nonspecific clinical manifestations that are unfamiliar to practitioners. This lack of awareness leads to a delay in the diagnosis and may lead to inappropriate treatment. Currently, the radiographic signs of this condition are well known, and diagnostic algorithms and treatment strategies are available. Therefore, this problem requires more effort to address and solve the remaining issues.

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