REVIEW

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Anatomy of Femoroacetabular Impingement Syndrome

Femoroasetabuler Sıkışma Sendromu Anatomisi

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ABSTRACT

Hip joint; it is a spheroid type joint formed between the head of femur and acetabular fossa. Auxiliary structures such as ligaments and joint capsule are organized to protect the hip joint. When one or more of the structures that form or protect the hip joint are damaged, torn or worn and compressed, the patient experiences significant pain and a decrease or limitation in activities of daily living. Conditions such as walking disturbances, difficulties in sitting or standing up are common. Osteoarthritis and femoroacetabular impingement syndrome (FAIS) the most common joint disorders. It is known that this syndrome is one of the first stage findings of osteoarthritis. The type of treatment is determined by looking at the radiological images of the patients, the findings in the examination and the condition of the surrounding structures. In cases where surgical intervention is required, a physical therapy program is organized according to the need after the invasive procedure as a result of the procedure. If the patient's clinical condition is not suitable for surgery and there is an indication for drug therapy, this method may also be preferred. FAIS has 3 different subtypes as cam, pincer and mixed. In the personalized medical treatments to be performed according to the different types mentioned, it is aimed that the patients continue their lives comfortably. Careful and correct use of information on the anatomy of the hip joint also positively affects the lives of patients with such disorders. Our study aims to provide a detailed guide to the topographic anatomy of the relevant region for those who conduct research in this field, especially clinicians.

Keywords: Art. coxae, femoroacetabular impingement syndrome, osteoarthritis, femur, acetabulum

ÖZ

Articulatio coxae; caput femoris ve fossa acetabuli arasında kurulan sferoid tipte bir eklemdir. Ligamentler ve eklem kapsülü gibi ekleme yardımcı oluşumlar, art. coxae'yı korumak üzere organize olmaktadır. Kalça eklemini oluşturan ya da koruyan yapılardan biri veya birkaçı hasarlandığı, koptuğu ya da aşınıp sıkıştığı zaman hastada önemli derecede ağrı ve günlük yaşam aktivitelerinde azalma veya kısıtlanma meydana gelir. Yürüyüş bozuklukları, oturma ya da yerinden kalkmada yaşanan zorluklar gibi durumlar sıkça görülür. Eklem rahatsızlıklarının en başında osteoartrit ve femoroasetabuler sıkışma sendromu (FASS) gelir ki; bu sendromun osteoartritin ilk evre bulgularından biri olduğu bilinmektedir. Hastaların radyolojik görüntülerine, muayenelerindeki bulgulara ve civar yapıların durumuna bakılarak tedavi şekli belirlenir. Cerrahi girişime ihtiyaç duyulan durumlarda, prosedür gereği invaziv girişim sonrasına yönelik, ihtiyaca göre fizik tedavi programı düzenlenmektedir. Eğer hastanın klinik durumu ameliyata elverişli değil ve ilaçlı tedavi yöntemi için endikasyon varsa, bu yöntem de tercih edilebilir. FASS'nin cam, pincer ve miks olarak 3 farklı alt tipi bulunmaktadır. Bahsedilen farklı türlere göre yapılacak olan kişiye özel medikal tedavilerde hastaların hayatlarını konforlu bir şekilde sürdürmeleri amaçlanır. Kalça ekleminin anatomisine ilişkin bilgilerin dikkatli ve doğru kullanılması, yine bu tür rahatsızlıklara sahip hastaların yaşamlarını pozitif yönde etkilemektedir. Çalışmamız, bu alanda araştırmalarını yürütenlere, özellikle de klinisyenlere ilgili bölgenin topografik anatomisine dair detaylı bir rehber olmayı amaçlamaktadır.

Anahtar Kelimeler: Art. coxae, femoroasetabuler sıkışma sendromu, osteoartrit, femur, acetabulum

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Introduction

Acetabulum

The acetabulum is a cavity formed by the joint participation of 3 parts (ilium, ischium and pubis) of the hip bone that is the largest bone in the human body. When we look at these three parts in terms of participation rates in the acetabulum; ilium; superior 2/5, pubis; superior-anterior 1/5, ischium; it forms the posterior inferior 2/5 and the floor of the cupping. The peculiarity of this region is that it is the region where the hip bone articulates with the femoral head (Figure 1). The lunate surface (half moon), located on the inner surface of the acetabular fossa, is where the articular surface of the femoral head coincides. As a result of the mentioned half-moon shape, there is an acetabular notch inferior to the acetabulum and transverse acetabular ligament, which creates a hole by joining this notch surface to the lunate surface. The acetabular branch of the obturator artery and medial circumflex femoral artery pass through the mentioned hole (1). Except for the lunate surface, the region corresponding to the base of the acetabulum is not included in the insertion and the cartilage tissue is located here. It has been reported that various ossicles can be found in the acetabular fossa. Usually, this happens within the context of a varied and unexpected ossification process. The appearance of these ossicles mimics osteochondritis dissecans, post-traumatic bone fractures or degenerative disorders in the bones (2). Depending on the outer edge of the acetabulum, the acetabular labrum, which can be observed as 66% triangular, 11% round and 9% flat, is thought to contribute to joint stabilization by deepening the acetabulum with its fibrocartilaginous structure. Having these functions is a result of the fact that it increases the contact surface area for the hip joint and causes the most ideal distribution of the synovial fluid to the joint surfaces, as it provides a leak-proof structure. With a general evaluation, this situation facilitates the nutrition of the articular cartilage and helps to reduce the intra-articular friction. Additionally, the acetabular labrum may be hypoplastic or absent in 10% of the cases. From a clinical point of view, sublabral sulcus was observed in 25% of cases with suspected acetabular labrum tear. It is reported that 44% of these observed sulci are in the anterior-upper, 48% posterior-lower, 4% anterior-lower and 4% posterior-upper regions. The presence of the perilabral dead end, another potential space between the joint capsule and the acetabular labrum, can also mimic a labrum tear. A complex arterial relationship around the hip joint consists of some articular branches that come from the obturator, medial circumflex, femoral, superior gluteal, and inferior gluteal arteries (1,2).

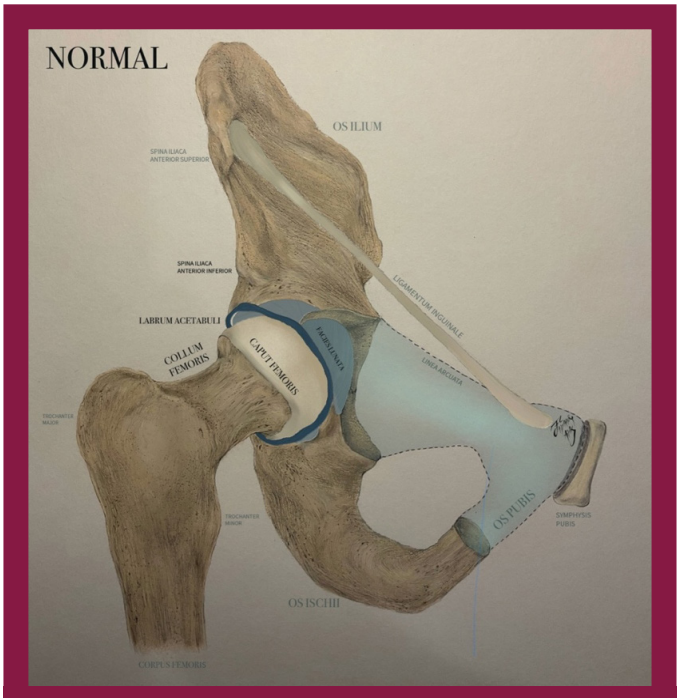

Figure 1. Normal view of the hip joint. Joint structures are femoral head and acetabulum

Femur

The other part of the hip joint other than the acetabulum is the femur, the strongest and longest bone of the human body. The part of the femur that articulates with the hip bone proximally is the femoral head. The proximal part of the femur, including the femoral head, undergoes complete fusion between the ages of 15-20. Considering the projection of this section, when we connect the superior of the greater trochanter and the pubic tubercle with a horizontal line, it can be marked approximately 2-4 cm superior to the midpoint of this line. The entire surface of the femoral head, which has a mutually curved structure with the acetabulum, is covered with cartilage tissue, except for the ligament of head of femur, which connects to the fovea for ligament. The thickness of this cartilage tissue becomes the most voluminous on the anterior-outer surface. The cartilage tissue thickness in the acetabulum, on the other hand, is at its maximum on the anterior-upper surface. As can be seen, these two voluminous surfaces are considered as the main load bearing areas in the hip joint.

Femoroacetabular Impingement Syndrome (FAIS)

The fibrous joint capsule, which surrounds the femoral head and collum femoris laterally, extends to the intertrochanteric line anteriorly, femoral neck base superiorly, intertrochanteric crest posteriorly, and attaches

at a level that coincides with the greater trochanter inferiorly, attracts attention with its dense and strong structure. attracts. In addition to the mentioned density, it is noticeably thicker in the anterior-upper region, where it is subjected to high loads. In the opposite direction, it has a thinner and looser attachment in the posterior-lower region. This relationship in the hip region can cause 2 different syndromes. The first of these; it is FAIS that causes stress to the joint due to pathology at the junction of the acetabulum and the femoral head and femoral neck (3). Developmental anomalies and variants of the femur and acetabulum can also cause FAIS. This can lead to diseases such as osteoarthritis or degenerations when the acetabular labrum and joint cartilages (2,4,5). The other pathology is; ischiofemoral impingement syndrome. This is a condition characterized by the compression of the soft tissue between the ischium and the area where the lesser trochanter is located, characterized by severe pain. Among the common causes of the two pathologies; it can be said that they constantly rub against each other during movement and that their mutual anatomical structures cannot fully adapt to each other (3). This condition, which is frequently seen in young adults, can lead to degenerations and diseases such as osteoarthritis when it is not detected and treated in the early stages, when the acetabular labrum and joint cartilage are in the advanced stages. Arthroscopy and magnetic resonance imaging are generally used in this pathology as radiological imaging. There are three subgroups of FAIS: Cam, pincer and mixed (combined). Cam type; it is the most common species and occurs when the femoral head separates from the acetabulum (Figure 2). Usually, the ligament of head of femur is ruptured and a smooth movement within the joint is not possible. An accessory bone structure in the form of a bridge is formed around the femoral head, and this structure can be damaged by grinding the articular cartilage, especially during walking. In pincer-type impingement, the femoral head is over articulated to the acetabular fossa (Figure 3). Therefore, due to this excessive attachment, it can be seen in the collum femoris and the acetabulum, and gait disturbances and pain occur. Problems arise to the flexion movement or abduction movement of the hip joint. An image similar to the clinical picture may occur in coxa vara. In combined types; both cam-type impingement and pincer-type impingement occur simultaneously on the ipsilateral joint (Figure 4). The accessory bone structure formed by arthroscopic surgery can be removed from the environment, the soft tissue deformity can be eliminated and the pain phenomenon in the patient can be eliminated (6).

Result

Hip joint is a synovial type joint that is basically formed between the femoral head and the acetabulum. Its structure supported by ligaments allows wide range of motion. In addition to this feature, hip jointis also one of the most

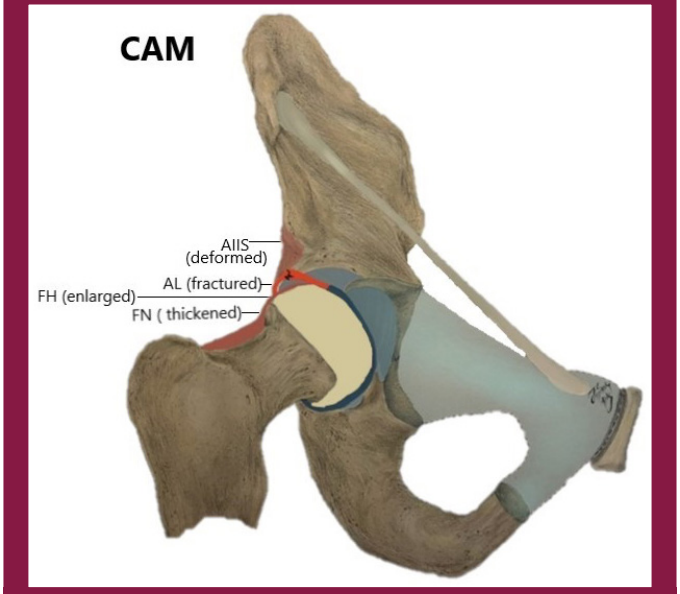

Figure 2. Cam-type FAIS. The femoral head is not perfectly round. It cannot perform rotation in the acetabulum

AIIS: Anterior inferior iliac spine, AL: Acetabular labrum, FH: Femoral head, FN: Femoral neck

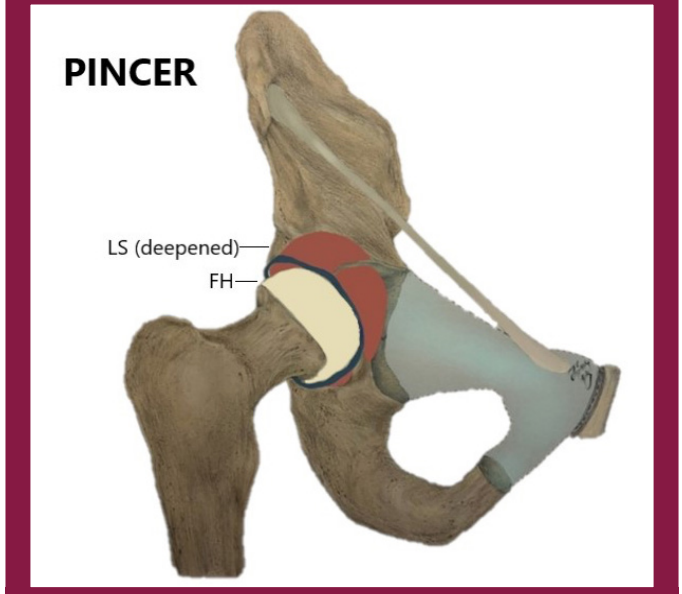

Figure 3. Pincer type FAIS. The acetabulum overly grasps the femoral head

LS: Lunate surface, FH: Femoral head, FAIS: Femoroacetabular impingement syndrome

common complaints in terms of pain due to its pathology in the body. Pain may develop due to a problem that sometimes occurs in the intracapsular region of the joint and sometimes in the extracapsular region of the joint. In any situation that causes injury or rupture of the sciatic nerve, obturator nerve and femoral nerve around the joint, the joint may be affected and the pain is felt most often in the femoral region. In addition, it is possible to feel pain in the anterior-posterior thigh, knee joint, and leg anterior-posterior regions. In addition to the damage of the mentioned nerve structures, the cause of the pain is; there may also be osteoarthritis, iliopsoas muscle compression, damage to the proximal structures of the femur, or hip compression. In addition to the pain that can be diagnosed by palpation in the physician examination, radiographic imaging methods are also used when necessary. In hip osteoaritis, which is one of the hip joint problem, the pain may start from the lumbosacral part of the spinal cord and continue to the lower part of the knee. In a study conducted with pain mapping method on 60 patients, pain distribution due to osteoarthritis in the lower extremities was examined. It has been determined that the most common pain in osteoarthritis is felt around the groin and hip; groin pain has the highest rate with 84.3%. Hip pain with osteoarthritis, which spreads due to the branching of the saphenous nerve during its downward course, is characterized by its manifestation in the lower region of the knee (7).

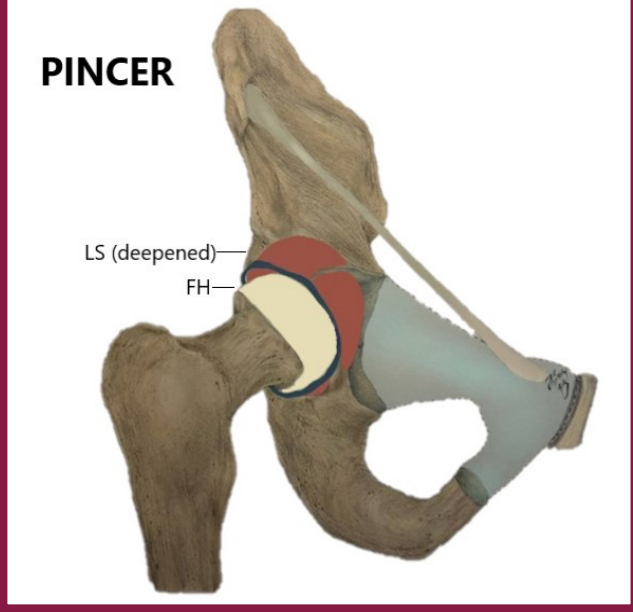

Figure 4. Mix type FAIS. Cam-type and pincer-type are seen together

LS: Lunate surface, FAIS: Femoroacetabular impingement syndrome

Osteoarthritis that can be seen in the gluteal area; it can cause atrophy of the psoas major muscle, one of the strong and important flexor muscles of this region. In such cases, pain occurs in the lower extremity and weakness in hip joint flexion may occur. It has been observed that the pain felt in the early postoperative period is reduced by arthroscopic osteochondroplasty procedures with or without acetabular labrum repair. It is noticed that the improvement followed after the pain is seen on the basis of function starting from the 6th month (8). On the other hand, (hip impingement) (FAIS), which is one of the most common cases in the hip joint, is a condition that occurs frequently due to bone deformity or some other reasons and can be seen in the first step of osteoarthritis. The prevalence of pincer and glass subgroups in asymptomatic FAIS is 67% and 37%, respectively. However, despite the relatively high prevalence of radiographic findings, fewer patients develop symptomatic FAIS syndrome or osteoarthritis than asymptomatic patients (9).

During physiological hip movement, unexpected abnormal situations may occur because the power is not shared equally in the cartilage structure and acetabular labrum (10,11). FAIS syndrome is observed in 3 different types; cam, pincer and mix. First, in the cam type of the syndrome; there is an extra bone formation on the femoral neck, but in the pincer type, various morphological reasons can be mentioned. The person may feel pain in the hip joint, back, thigh and groin areas while sitting or after exercise (12). When FAIS is evaluated on the basis of gender, it is stated that it can manifest itself as a more painful process in women than in men (13). Another study in which asymptomatic individuals were compared with symptomatic individuals; it has been determined that weakness can be observed especially in muscle strength together with the hip joint problem. However, walking problems can still occur (14). In patients with this syndrome, strengthening the damaged muscles and applying additional treatment procedures specifically applied to other muscles is thought to be an approach that has positive effects in the surgical and conservative treatment of FAIS (15). Surgical applications can lead to negative situations in which the bleeding is high volume and the surgeons viewing angles are narrowed from time to time due to the richness of the neurovascular structures in the region. Tranexamic acid, which is used in many of the practical clinical applications, has been shown to effectively reduce blood loss that occurs in arthroscopic operations and restricts surgical vision when used preoperatively (16). While planning these operations, body mass index (BMI) should be considered. According to a study, it was observed that low BMI and advanced age may be the precursors of increased pain in the follow-up

after arthroscopy treatment (17). As it can be seen, although the results of surgical applications such as arthroscopy for the treatment of FAIS in terms of quality of life and functional recovery have been studied extensively, there is a lack of sufficient information about the complications related to surgery due to surgery. In a study covering 36,761 arthroscopy operations, including surgical interventions related to FAIS, the overall complication rate was reported as 3.3%. In addition to this rate, the major complication rate was observed as 0.2% (18). When looking at the general patient group; in addition to FAIS, antalgic gait (the patient's quick movements to throw the load from the painful area to the other extremity as soon as possible) and trendelenburg syndrome (pathological gait usually caused by unilateral weakness of the m. gluteus medius) can be seen. The reason for this may be that the abductor muscles and n. gluteus inferior are affected on the problematic side. In the tests performed for the diagnosis of FAIS, the responses given to the internal rotation, external rotation, flexion and extension movements of the patient's hip joint are evaluated. However, the patient's feeling of pain in the inguinal region when the hip joint is in 90° flexion, and difficulty in adduction and internal rotation movements suggest positive anterior impingement. However, the validity of this test is not certain in impingements in the anterior-upper part of the acetabular labrum. Other methods are used for diagnosis. Ligament damage and joint instability have also been observed in the connection thought to exist between another case type, athletic pubalgia (football player's groin) disease and FAIS. In a study on cadaver pelvises, it was observed that dynamic acetabular impingement syndrome increased rotational motion on the symphysis pubis (19).

In the informative study published by the American Physical Therapy Association on the subject; it has been stated that manual therapy, stretching and core exercises can also be applied in people with FAIS. In addition, anti-inflammatory drugs can be used to prevent inflammation that may be caused by the syndrome, which can greatly reduce pain. The most frequently recommended drugs are ibuprofen, diclofenac and meloxicam active ingredients. In addition, hyaluronic acid, which is frequently used in intra-articular injections, is one of the applications that offers the patient a comfortable daily life and reduces pain in varying periods. In addition, corticosteroids, which are also administered with local anesthesia, are among the medical treatments whose duration of action varies for 9-10 days. The need for surgical intervention in patients with FAIS is usually determined by the following criteria: Hip pain and accompanying limitation of motion, positive evidence of impingement, and an alpha angle greater than 50°. In the surgical intervention, the compressed area is rasped or part of it is removed. Femoral neck osteoplasty is performed in the cam compression type. Debridements are used to repair tears in the ligaments around the hip joint (20). Although some patients have the same bone structure in the right and left hip joints in clinical terms; they may complain of pain that starts in only one side (21). Recovery rates of patients after physical therapy procedures are much lower in patients who have undergone arthroscopic surgery and then regained their health (22). So that; according to another study, after 14 months of follow-up of 1.981 patients who underwent total hip arthroplasty, it was determined that 95% of these patients returned to their daily activities and sports without any problems (23). Intraarticular pathology; since it is a condition that requires surgery, patient follow-up is an important factor.

Conclusion

As a result, since FAIS, which is characterized as one of the first steps of osteoarthritis, has been observed to have a different course between the sexes, and since it restricts mobility and greatly hinders daily life activities, the most appropriate treatment step for the patient should be preferred and applied as soon as possible. In this context, it is anticipated that our study will serve as a guide for new studies planned to be carried out with the coordination of clinical and basic sciences.

Ethics

Peer-review: Internally and externally peer-reviewed.

Authorship Contributions

Surgical and Medical Practices: Ö.Ö.K., B.K., F.A., Concept: Ö.Ö.K., B.K., F.A., Design: Ö.Ö.K., B.K., F.A., Data Collection or Processing: Ö.Ö.K., B.K., F.A., Analysis or Interpretation: Ö.Ö.K., B.K., F.A., Literature Search: Ö.Ö.K., B.K., F.A., Writing: Ö.Ö.K., B.K., F.A.

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References

1. Ozan H. Premium Ozan Anatomi. 3rd ed. Nobel Tıp Kitabevleri; 2014. [Crossref]
2. Standring S. Gray's Anatomy- The Anatomical Basis of Clinical Practice. 41th ed. Standring S, editor: Elsevier; 2015. [Crossref]
3. Ahn YS, Kim S, Kim WJ, Lim JH, Jung ST. Characteristics of hip impingement syndrome in patients with multiple hereditary exostoses. BMC Musculoskelet Disord. 2021;22:153. [Crossref]
4. Cesmebasi A, Loukas M. Pelvic Bones. Bergman's Comprehensive Encyclopedia of Human Anatomic Variation; 2016;82-88. [Crossref]

5. Ward R. Hip Joint. Bergman's Comprehensive Encyclopedia of Human Anatomic Variation; 2016:176-180. [Crossref]
6. Larson CM, LaPrade RF, Floyd ER, McGaver RS, Bedi A. Acetabular Rim Disorders/Pincer-type Femoroacetabular Impingement and Hip Arthroscopy. Sports Med Arthrosc. 2021;29:35-43. [Crossref]
7. Khan AM, McLoughlin E, Giannakas K, Hutchinson C, Andrew JG. Hip osteoarthritis: where is the pain? Ann R Coll Surg Engl. 2004;86:119-121. [Crossref]
8. Almasri M, Simunovic N, Heels-Ansdell D, Ayeni OR; Fırst Investigators. Femoroacetabular impingement surgery leads to early pain relief but minimal functional gains past 6 months: experience from the FIRST trial. Knee Surg Sports Traumatol Arthrosc. 2021;29:1362-1369. [Crossref]
9. McCrum CL. Editorial Commentary: Lumbosacral Anatomy and Mechanics Influence Femoroacetabular Impingement Syndrome and Surgical Outcomes: The Hip Bone Is Connected to the Back Bone. Arthroscopy. 2021;37:156-158. [Crossref]
10. Amanatullah DF, Antkowiak T, Pillay K, Patel J, Refaat M, Toupadakis CA, et al. Femoroacetabular impingement: current concepts in diagnosis and treatment. Orthopedics. 2015;38:185-199. [Crossref]
11. Bredella MA, Ulbrich EJ, Stoller DW, Anderson SE. Femoroacetabular impingement. Magn Reson Imaging Clin N Am. 2013;21:45-64. [Crossref]
12. Zhang C, Li L, Forster BB, Kopec JA, Ratzlaff C, Halai L, et al. Femoroacetabular impingement and osteoarthritis of the hip. Can Fam Physician. 2015;61:1055-1060. [Crossref]
13. Lewis CL, Khuu A, Loverro KL. Gait Alterations in Femoroacetabular Impingement Syndrome Differ by Sex. J Orthop Sports Phys Ther. 2018;48:649-658. [Crossref]
14. Samaan MA, Zhang AL, Popovic T, Pedoia V, Majumdar S, Souza RB. Hip joint muscle forces during gait in patients with femoroacetabular impingement syndrome are associated with patient reported outcomes and cartilage composition. J Biomech. 2019;84:138-146. [Crossref]
15. Frasson VB, Vaz MA, Morales AB, Torresan A, Telöken MA, Gusmão PDF, et al. Hip muscle weakness and reduced joint range of motion in patients with femoroacetabular impingement syndrome: a case-control study. Braz J Phys Ther. 2020;24:39-45. [Crossref]
16. Li N, Qin LW, Jiang HJ. [Clinical effects of tranexamic acid in arthroscope for femoroacetabular impingement]. Zhongguo gu shang. 2021;34:121-125. [Crossref]
17. Kay J, Simunovic N, Heels-Ansdell D, Bhandari M, Ayeni OR; Fırst Investigators. Lower body mass index and age are predictive of improved pain and health utility scores following arthroscopic management of femoroacetabular impingement. Knee Surg Sports Traumatol Arthrosc. 2021;29:1461-1473. [Crossref]
18. Ohlin A, Simunovic N, Duong A, Ayeni OR; Fırst Investigators. Low rate of adverse events in a randomized controlled trial addressing the surgical treatment of femoroacetabular impingement (FAI) syndrome. Knee Surg Sports Traumatol Arthrosc. 2021;29:2015-2020. [Crossref]
19. Birmingham PM, Kelly BT, Jacobs R, McGrady L, Wang M. The effect of dynamic femoroacetabular impingement on pubic symphysis motion: a cadaveric study. Am J Sports Med. 2012;40:1113-1118.
20. Menge TJ, Truex NW. Femoroacetabular impingement: a common cause of hip pain. Phys Sportsmed. 2018;46:139-144. [Crossref]
21. Swenson K, Erickson J, Peters C, Aoki S. Hip pain in young adults: Diagnosing femoroacetabular impingement. JAAPA. 2015;28:39-45. [Crossref]
22. Gao I, Safran MR. Nonsurgical Versus Surgical Management of Femoroacetabular Impingement: What Does the Current Best Evidence Tell Us. J Am Acad Orthop Surg. 2021;29:e471-e478. [Crossref]
23. Minkara AA, Westermann RW, Rosneck J, Lynch TS. Systematic Review and Meta-analysis of Outcomes After Hip Arthroscopy in Femoroacetabular Impingement. Ame J Sports Med. 2019;47:488-500. [Crossref]