Avens Publishing Group
J Orthopedics Rheumatol
May 2017 Vol.:4, Issue:1

Open Access Review Article

Journal of Orthopedics & Rheumatology

Femoroacetabular Impingement and Labral Tear Management: Review of Current Literature and Techniques

Charles J Cogan*, John Tuttle, Vehniah K Tjong and Michael A Terry
Department of Orthopaedic Surgery, Northwestern University Feinberg School of Medicine, Chicago, Illinois, USA

***Address for Correspondence**
Charles J Cogan, Department of Orthopaedic Surgery, Northwestern University Feinberg School of Medicine, Chicago, Illinois, USA, Tel: 630-212-0324; E-mail: Charles.cogan@northwestern.edu

Submission: 06 April, 2017
Accepted: 08 May, 2017
Published: 20 May, 2017

Keywords: Hip pain; Femoroacetabular impingement; CAM; Pincer; Labrum; Arthroscopy; Repair

Abstract

The incidence of hip pain in the adult is fairly common, accounting for roughly 10% of visits to sports medicine physicians annually, and the origin of the pain is often elusive. For the active patient, femoroacetabular impingement (FAI) is a common cause of hip pain, and related labral pathology further contributes to impairment. It is thought that bony overgrowth of the acetabular rim (pincer lesion) and femoral neck (CAM lesion) are responsible for impingement symptoms, which can evolve into a labral tear over time. The standard approach for treating these bony overgrowths for many years has been osteoplasty of both CAM and pincer lesions, but evidence is emerging that treatment of pincer lesions alone may be just as efficacious. Both FAI and labral pathology are treatable conditions by the orthopaedic surgeon with the goal being restoration of hip joint function, decreasing patient pain, and preventing early osteoarthritis.

Introduction

Hip and groin pain encompass a wide variety of pathology, including both intra and extra-articular injury of the intra-articular injuries FAI, labral tear, and osteoarthritis are amongst the most common in physically active patients, accounting for roughly 40, 33, and 24 percent of hip pain, respectively [1]. Annually, roughly 10 percent of patient seeking care with a sports medicine physician present with hip or groin pain [2]. Furthermore, even with the exclusion of osteoarthritis, nearly 14 percent of patients over age 60 report significant hip pain on a weekly basis [3]. Despite their common incidence and frequency these injuries can be easily misdiagnosed or overlooked. One study demonstrated that patients with intra-articular hip pathology saw on average 3.3 healthcare providers, defined in this study as physicians, chiropractors, physical therapists, and nurse practitioners, before definitive diagnosis, thus making recognition and triage of patients with suspected hip joint pathology important for providers who may be encountering this problem [4].

The labrum is a fibrocartilaginous ring of tissue along the circumferential edge of the acetabulum, and it functions to provide stability to the joint by deepening the acetabular socket and creating a negative pressure seal keeping the femoral head in articulation with the acetabulum [5,6]. FAI is a clinical entity characterized by bony overgrowth of the femoral neck (CAM lesion) and/or acetabular rim (pincer lesion), which leads to pain with range of motion at the hip and eventual osteoarthritis development [7]. The relationship of FAI, labral tear, and osteoarthritis is thought to progress along a spectrum, with FAI contributing to an eventual labral tear, and an unstable, injured labrum paving the way for premature osteoarthritis [8]. Thus the treatment of these diseases is centered around not only improving hip joint function and decreasing pain, but also preventing the premature development of osteoarthritis. Over the last decade, the paradigm of treatment has shifted from the once gold standard of open repair to the less invasive modality of arthroscopic surgery, which has aided in providing symptomatic relief of anatomical abnormalities and prevention of premature OA while minimizing complications from surgery. The purpose of this article is to further discuss the evolution and pathophysiology of damage to the hip joint from FAI as well as to elucidate current trends and strategies in arthroscopic treatment.

Femoroacetabular Impingement

FAI is the clinical syndrome resulting from abnormal articulation of the anterior femoral neck and the acetabular rim, often leading to compression of the acetabular labrum. This process occurs as a result of bony overgrowth on either the femoral neck or the acetabulum. There are three types of impingement lesions: pincer, CAM, or mixed. The underlying etiology of the osseous deformities contributing to FAI remains unclear, but both genetic and acquired causes have been proposed in recent literature [9-13]. The basis for the genetic investigation of a cause for FAI stems from studies that have shown a much larger propensity for white as compared to Asian populations to develop osteoarthritis [14-16]. A variety of genetic studies exist analyzing single nucleotide polymorphisms related to hip development and morphology [9,10] however, a recent review by Packer and Safran suggests that insufficient evidence exists to confirm the genetic influence of developing FAI, and the primary cause, particularly for CAM type lesions, seems to be related to an acquired risk from high level athletic participation from a young age [13]. One study by Kapron et al. examined radiographs of 134 hips in Division I NCAA football players and found that 95 percent of hips had evidence of FAI [17]. Similar studies have identified a high prevalence of CAM type lesions for athletes participating in ice hockey, basketball, and soccer [12,18,19]. Based upon these and similar other studies,

ISSN: 2334-2846

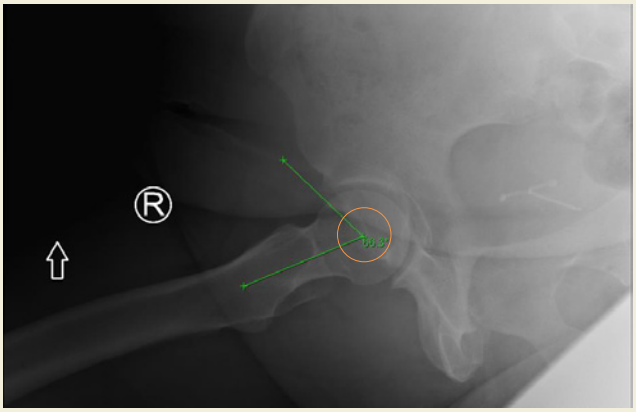

Figure 1: CAM impingement with a measured alpha angle on frog-leg lateral radiograph.

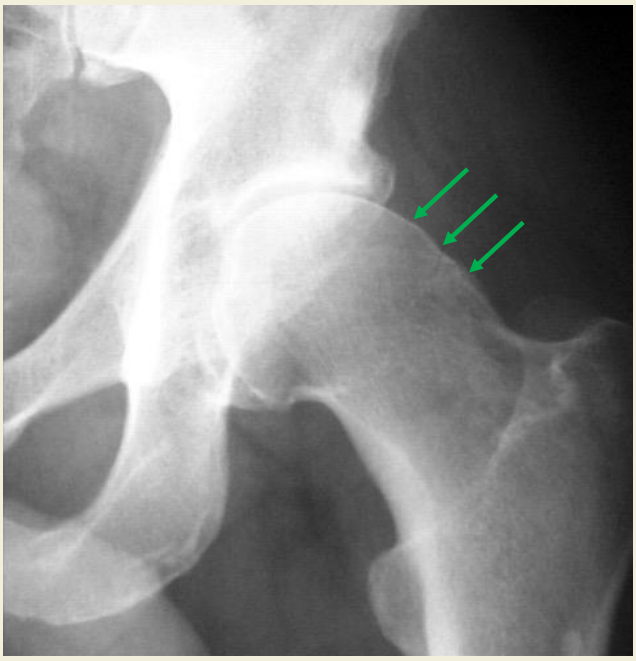

Figure 2: Pistol grip deformity shown by green arrows.

Packer and Safran suggest CAM lesions development during physeal development throughout adolescence [13].

CAM impingement results from a non-spherical articulation of the femoral head with the acetabulum, most often due to bony abnormality at the femoral head-neck junction [20]. In CAM impingement, there is articulation of an abnormal femoral head-neck junction with the anterior superior portion of the acetabular rim causing symptoms of impingement, particularly in flexion and internal rotation [21,22]. Damage to the labrum occurs in a distinct pattern in CAM impingement. Shearing forces of the non-spherical femoral head abutting against the chondrolabral junction lead to separation of the labrum from the acetabular cartilage, while the labrum remains grossly unharmed [23]. Certain radiographic signs can also clue the clinician in to CAM lesions in a suspecting case of FAI. Reduced femoral head-neck offset, defined as the maximal anterior radius of the femoral head compared to that of the adjacent femoral neck, is a hallmark of CAM type impingement, best seen on frog-leg lateral views (Figure 1) [24, 25]. This reduced offset is classically measuredwith the "alpha angle", which is defined as the angle between the femoral neck axis and a line from the center of the femoral head through the point along the femoral head where asphericity of the head-neck junction begins (Figure 1) [22]. A normal "alpha angle" has been considered between 55 and 60degrees, though a cut-off of 55 degrees is more commonly accepted [26]. Another common finding in CAM impingement, known as the "pistol-grip deformity" can best be seen on AP view, which is due to the reduced femoral head-neck offset resembling the smooth handle of a pistol (Figure 2) [25].

Pincer type impingement results from either a focal or global over-coverage of acetabular rim over the femoral head, which results in abutment (Figure 3) [8]. In a pincer type lesion, the labrum itself is not spared because it is being compressed between the femoral neck and the acetabular overhang, especially at extremes of movement. Multiple studies have shown that eventual ossification of the labrum can ensue as a result of such repeated microtrauma, which further contributes to the acetabular over-coverage [23,27,28]. Chronic impingement of the femoral neck with the anterosuperior acetabular rim, especially when ranged through forceful flexion, classically leads to a 'countre-coup' chondral lesion at the posteroinferior acetabulum [8]. As impingement occurs over time, the femoral head begins to sublux posteriorly, increasing pressure between the posteromedial femoral head and the posteroinferior acetabulum [23]. The combination of these forces, primarily the compressive force at the anterosuperior labrum, ultimately lead to labral tearing and damage (Figure 4). Radiographic evidence of pincer type lesions can also support the diagnosis. The "crossover sign" can be seen in pincer type impingement. This is when tracing the anterior and posterior edges of the acetabulum shows an intersection prior to the superior-most aspect of the acetabular rim (Figure 5). The degree of acetabular overcoverage is typically measured by the lateral center-edge angle,

Figure 3: Pincer impingement seen on AP radiograph. Bony overgrowth highlighted with green arrow.

ISSN: 2334-2846

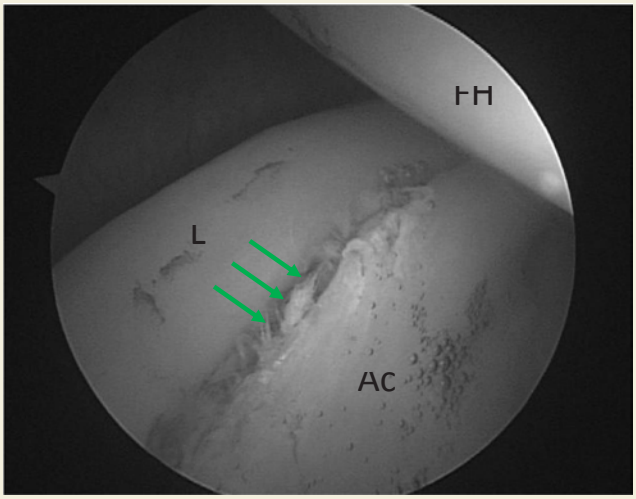

Figure 4: Intraoperative picture of anterior labrum tear. Green arrows mark labral tear. Labrum (L), acetabulum (Ac), femoral head (FH).

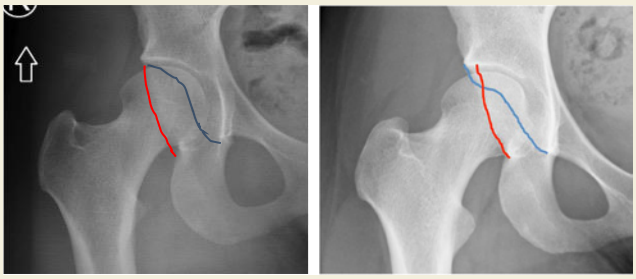

Figure 5: Normal hip on left. Crossover sign on right. Blue line is anterior wall, red line is posterior wall.

first described by Wiberg in 1939, which is the angle between a vertical line and a line connecting the center of the femoral head to the lateral edge of acetabular rim from an AP radiograph [29]. A center edge angle less than 25 degrees is considered dysplastic, whereas a center edge angle greater than 39 degrees is suspicious for acetabular overcoverage [29].

Although studies have shown distinct radiographic and anatomic differences between CAM and pincer lesions, the majority of patients present with a mixed scenario. One study that examined 302 hips showed only 26 with an isolated CAM lesion and 16 with an isolated pincer lesion [23]. The mixed presentation offers a unique challenge to the orthopaedic surgeon as they plan to offer the greatest surgical benefit with as little intervention as necessary. Recent evidence supports the notion that fixing the pincer lesion along with a labral repair while leaving the CAM lesion alone can offer an equal surgical outcome with less associated morbidity. One study of 106 hips with combined-type FAI showed that at 2 year follow-up, patients who received acetabuloplasty and labral repair alone were equivalent to outcomes in the literature for acetabuloplasty and femoroplasty with labral repair [30]. The advantage of an isolated acetabuloplasty for combined-type FAI includes potential avoidance of complications such as avascular necrosis, heterotopic ossification, and femoral neck fractures.

Labral Tear

While FAI is the underlying disease process in patients presenting to clinic, acetabular labral tears are the likely cause of patient pain due to the presence of abundant free nerve endings. Labral tears are the most common indication for arthroscopic surgery [8,31,32]. Much like in the shoulder, the primary function of the acetabular labrum is to stabilize the hip joint. Not only does the labrum deepens the socket for the femoral head to articulate with the acetabulum, but it also functions to create a negative pressure seal, which keeps synovial fluid in the intra-articular space [23,33]. Much like a meniscus in the knee, the labrum also functions as a shock absorber, decreasing stress on the joint itself [34]. Although plain radiographs are routinely obtained when acetabular labral pathology is suspected, the most accurate diagnostic tool remains MR arthrogram [35,36]. One study that compared pre-operative MR arthrogram findings to intraoperative surgical findings showed 92% accuracy for labral lesions and 89-94% accuracy for acetabular chondral lesions [37]. When faced with ambiguous symptomatology, MR arthrogram offers the opportunity to inject the hip with local anesthetic for additional diagnostic assistance (Figure 6).

Management

Initial management of a suspected labral tear resulting from FAI is typically physical therapy, anti-inflammatory medications, and activity modification. However, for many patients this does not adequately treat the problem. A recent cost effective analysis has shown that hip arthroscopy is a more cost effective option for 94.5% of patients with an acetabular labral tear, and their risk to develop symptomatic osteoarthritis or require a total hip arthroplasty is cut in half [38]. While the gold-standard of treatment was once open repair, the paradigm over the last decade has shifted to arthroscopic repair. There is still debate about exactly what type of arthroscopic procedures are most effective, but they often involve addressing both the labral

Figure 6: MR arthrogram showing tear of the superior labrum.

ISSN: 2334-2846

Figure 7: Preoperative positioning showing hip traction.

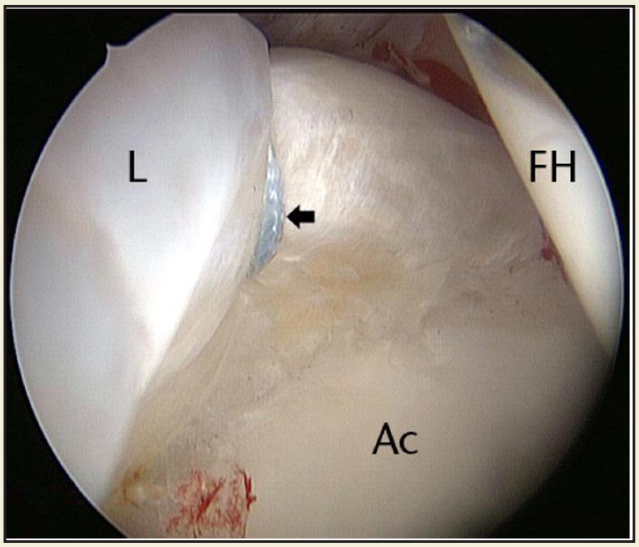

Figure 8: Intraoperative photo of anterosuperior labral repair. Labrum (L), Acetabulum (Ac), Femoral Head (FH).

tear and the bony abnormalities. Treatment of the labral tear initially mimicked treatment of torn menisci in the knee, including some combination of debridement or repair. However, recent evidence supports moving away from debridement alone and moving toward repair of the labrum to the acetabular rim; this leads to improved patient reported outcome measures and decreased conversion to total hip arthroplasty [7,8,39]. Some studies have shown that addressing the labral pathology alone would lead to failure rates of up to 92% if the underlying bony abnormalities causing impingement are not corrected [40,41]. Many treating physicians will debride both the CAM and pincer lesions, but recent evidence shows that debridement of the pincer lesion alone provides equal benefit without the added possiblemorbidity of femoral osteoplasty, including avascular necrosis, heterotopic ossification, and femoral neck fractures [30].

Another aspect of surgical management that has been debated recently in the literature is the outcomes of older patients undergoing hip arthroscopy. Traditionally studies have shown that older age was an independent risk factor for conversion to total hip arthroplasty [42,43]. Recent studies, however, are suggesting that osteoarthritis might be a confounding variable in this prior conclusion, as older patients with minimal or no arthritic changes have demonstrated similar improvements to younger patients after hip arthroscopy [44-47]. Minimal arthritic change is often identified as Tönnis grades 0 to 1 or joint space measurement of greater than 2 millimeters. A recent study examining the outcomes of patients with Tönnis grade 2 showed odds ratio of conversion to total hip arthroplasty of 7.73 as compared to Tönnis grade 0 and 4.36 as compared to Tönnis grade 1 [48]. This data clearly demonstrates the limited role of hip arthroscopy as a joint preservation procedure in patients with Tönnis grade 2 arthritis. Ultimately it seems to be the degree of osteoarthritic joint damage, and not the age of the patient, that determines outcomes from hip arthroscopy.

Arthroscopic Surgical Technique

Patient positioning and setup is an important first step in arthroscopic hip surgery. Patients are typically positioned supine or lateral positioning, and traction is applied to the ipsilateral leg in order to distract the femoral head from the acetabulum (Figure 7). Often general anesthesia is required for the relaxation needed to obtain enough distraction to properly visualize the articular surface. Adequate visualization is obtained with 25 to 50 pounds of traction [49]. Once positioned, proper portal placement is important for visualization and access to the intra-articular space. Three standard portals are used in hip arthroscopy: anterolateral, anterior, and distal anterolateral accessory [50]. The anterolateral portal is primarily used as a viewing portal throughout the procedure, and its placement is in reference to the greater trochanter-1 to 2 cm anterior and 1 to 2 cm superior to the tip of the greater trochanter. The second portal created is the anterior portal, which allows for visualization of the posterior-superior labrum and capsule and tends to be the working portal. The location of the anterior portal is placed at the intersection of a line extending horizontally from the anterolateral portal and a vertical line from the anterior superior iliac spine. It is important that this portal be placed bluntly because of the nearby proximity of the lateral femoral cutaneous nerve [50]. The final portal established is the distal anterolateral accessory portal, which is often used for decompression of bony abnormalities in CAM type impingement but also allows for an appropriate angle for acetabular anchor placement.

After establishing proper distraction of the femoral head from the acetabulum, the anterolateral portal is established-often under fluoroscopic guidance. Confirmation of proper anterolateral portal placement can be achieved by visualization of the anterior triangle, which is the anterior capsule, labrum, and femoral head [50]. Subsequently, the anterior portal can be placed under direct visual guidance through the anterior capsule.

Treatment of an acetabular labral tear is the most common indication for arthroscopic hip surgery, and is a primary target of intervention for pain relief and improved hip function [8]. Following a standard diagnostic arthroscopy of the hip joint, the labral tear should be addressed by first defining the extent of the tear. Depending on the type of impingement occurring, the labrum may still be attached at the chondral junction. If so, the labrum should be released carefully from the articular cartilage sharply. At this point,

ISSN: 2334-2846

in the case of a mixed or pincer lesion, acetabular decompression may be carried out. While removal of the anterolateral edge is important, the concept of volumetric decompression is perhaps more so, thus allowing for unimpeded deep hip flexion while avoiding labral impingement [30]. There is good evidence that labral repair is preferred over debridement whenever possible [7,8,39]. Repair of the labrum is achieved with insertion of suture anchors into the capsular side of the acetabular rim (Figure 8). Anchor position is important to monitor. If the anchor is too proximal, the labrum will be fixed away from the articular surface and may not be optimally functional. If the angle is too steep, the articular cartilage may be damaged or the anchor may be subchondral, leading to articular damage even to the femoral head. If the angle is too shallow, the anchor may not get good bony purchase. Anchors are typically 5-10 mm apart. Multiple suture techniques have been described for labral repair, including looped versus pierced sutures, but recent evidence shows no difference in patient reported outcomes, failure, or revision rates between these different techniques [51].

Conclusion

FAI remains a common cause of pain and impaired function for the adult population. While further research is needed to elucidate the underlying etiology of FAI, understanding of its role as a precursor to osteoarthritis has made appropriate and timely management a key to treatment. A growing familiarity with clinical presentation, radiographic features, and intraoperative findings, along with improved surgical techniques over the last decade has made arthroscopic management of FAI and labral tears a safe, effective, and reliable procedure.

References

1. Rankin AT, Bleakley CM, Cullen M (2015) Hip joint pathology as a leading cause of groin pain in the sporting population: A 6-year review of 894 cases. Am J Sports Med 43:1698-1703.
2. Paluska SA (2005) An overview of hip injuries in running. Sports Med 35: 991-1014.
3. Christmas C, Crespo CJ, Franckowiak SC, Bathon JM, Bartlett SJ, et al. (2002) How common is hip pain among older adults? Results from the third national health and nutrition examination survey. J Fam Pract 51: 345-348.
4. Burnett RS, Della Rocca GJ, Prather H, Curry M, Maloney WJ, et al. (2006) Clinical presentation of patients with tears of the acetabular labrum. J Bone Joint Surg Am 88: 1448-1457.
5. Ferguson SJ, Bryant JT, Ganz R, Ito K (2000) The acetabular labrum seal: a poroelastic finite element model. Clin Biomech (Bristol, Avon) 15: 463-468.
6. Crawford MJ, Dy CJ, Alexander JW, Thompson M, Schroder SJ, et al. (2007) The 2007 Frank Stinchfield Award. The biomechanics of the hip labrum and the stability of the hip. Clin Orthop Relat Res. 465:16-22.
7. Ayeni OR, Adamich J, Farrokhyar F, Simunovic N, Crouch S, et al. (2014) Surgical management of labral tears during femoroacetabular impingement surgery: A systematic review. Knee Surg Sports Traumatol Arthrosc 22: 756-762.
8. Fayad TE, Khan MA, Haddad FS (2013) Femoroacetabular impingement: An arthroscopic solution. Bone Joint J 95-B(11 Suppl A): 26-30.
9. Baker-Lepain JC, Lynch JA, Parimi N, McCulloch CE, Nevitt MC, et al. (2012) Variant alleles of the Wnt antagonist FRZB are determinants of hip shape and modify the relationship between hip shape and osteoarthritis. Arthritis Rheum 64:1457-1465.
10. Sekimoto T, Kurogi S, Funamoto T, Ota T, Watanabe S, et al. (2015) Possible association of single nucleotide polymorphisms in the 3' untranslated region of HOXB9 with acetabular overcoverage. Bone Joint Res 4: 50-55.
11. Silvis ML, Mosher TJ, Smetana BS, Chinchilli VM, Flemming DJ, et al. (2011) High prevalence of pelvic and hip magnetic resonance imaging findings in asymptomatic collegiate and professional hockey players. Am J Sports Med 39: 715-721.
12. Gerhardt MB, Romero AA, Silvers HJ, Harris DJ, Watanabe D, et al. (2012) The prevalence of radiographic hip abnormalities in elite soccer players. Am J Sports Med 40: 584-588.
13. Packer JD, Safran MR (2015) The etiology of primary femoroacetabular impingement: genetics or acquired deformity? J Hip Preserv Surg 2: 249-257.
14. Nevitt MC, Xu L, Zhang Y, Lui LY, Yu W, et al. (2002) Very low prevalence of hip osteoarthritis among chinese elderly in beijing, china, compared with whites in the united states: the beijing osteoarthritis study. Arthritis Rheum 46: 1773-1779.
15. Hoaglund FT, Shiba R, Newberg AH, Leung KY (1985) Diseases of the hip. A comparative study of Japanese Oriental and American White patients. J Bone Joint Surg Am 67: 1376-1383.
16. Hoaglund FT, Yau AC, Wong WL (1973) Osteoarthritis of the hip and other joints in southern Chinese in Hong Kong. J Bone Joint Surg Am 55: 545-557.
17. Kapron AL, Anderson AE, Aoki SK, Phillips LG, Petron DJ, et al. (2011) Radiographic prevalence of femoroacetabular impingement in collegiate football players: AAOS Exhibit Selection. J Bone Joint Surg Am 93: e 111(1-10).
18. Siebenrock KA, Kaschka I, Frauchiger L, Werlen S, Schwab JM (2013) Prevalence of cam-type deformity and hip pain in elite ice hockey players before and after the end of growth. Am J Sports Med 41: 2308-2313.
19. Siebenrock KA, Behning A, Mamisch TC, Schwab JM (2013) Growth plate alteration precedes cam-type deformity in elite basketball players. Clin Orthop Relat Res 471: 1084-1091.
20. Ejnisman L, Philippon MJ, Lertwanich P (2011) Femoroacetabular impingement: the femoral side. Clin Sports Med 30: 369-377.
21. Siebenrock KA, Wahab KH, Werlen S, Kalhor M, Leunig M, et al. (2004) Abnormal extension of the femoral head epiphysis as a cause of cam impingement. Clin Orthop Relat Res 54-60.
22. Notzli HP, Wyss TF, Stoecklin CH, Schmid MR, Treiber K, et al. (2002) The contour of the femoral head-neck junction as a predictor for the risk of anterior impingement. J Bone Joint Surg Br 84: 556-560.
23. Beck M, Kalhor M, Leunig M, Ganz R (2005) Hip morphology influences the pattern of damage to the acetabular cartilage: Femoroacetabular impingement as a cause of early osteoarthritis of the hip. J Bone Joint Surg Br 87: 1012-1018.
24. Clohisy JC, Nunley RM, Otto RJ, Schoenecker PL (2007) The frog-leg lateral radiograph accurately visualized hip cam impingement abnormalities. Clin Orthop Relat Res 462:115-121.
25. Beall DP, Sweet CF, Martin HD, Lastine CL, Grayson DE, et al. (2005) Imaging findings of femoroacetabular impingement syndrome. Skeletal Radiol 34: 691-701.
26. Sutter R, Dietrich TJ, Zingg PO, Pfirrmann CW (2012) How useful is the alpha angle for discriminating between symptomatic patients with cam-type femoroacetabular impingement and asymptomatic volunteers? Radiology 264: 514-521.
27. Seldes RM, Tan V, Hunt J, Katz M, Winiarsky R, et al. (2001) Anatomy, histologic features, and vascularity of the adult acetabular labrum. Clin Orthop Relat Res : 232-240.
28. Ganz R, Parvizi J, Beck M, Leunig M, Notzli H, et al. (2003) Femoroacetabular impingement: a cause for osteoarthritis of the hip. Clin Orthop Relat Res : 112-120.
29. Tannast M, Siebenrock KA, Anderson SE (2007) Femoroacetabular impingement: Radiographic diagnosis--what the radiologist should know. AJR Am J Roentgenol 188: 1540-1552.

ISSN: 2334-2846

30. Tjong VK, Gombera MM, Kahlenberg CA, Patel RM, Han B, et al. (2017) Isolated acetabuloplasty and labral repair for combined-type femoroacetabular impingement: are we doing too much? Arthroscopy 33: 773-779.

31. Kim YT, Azuma H (1995) The nerve endings of the acetabular labrum. Clin Orthop Relat Res:176-181.

32. Alzaharani A, Bali K, Gudena R, Railton P, Ponjevic D, et al. (2014) The innervation of the human acetabular labrum and hip joint: An anatomic study. BMC Musculoskelet Disord 15: 41.

33. Ferguson SJ, Bryant JT, Ganz R, Ito K (2003) An *in vitro* investigation of the acetabular labral seal in hip joint mechanics. J Biomech 36:171-178.

34. Ferguson SJ, Bryant JT, Ganz R, Ito K (2000) The influence of the acetabular labrum on hip joint cartilage consolidation: A poroelastic finite element model. J Biomech 33: 953-960.

35. Chan YS, Lien LC, Hsu HL, Wan YL, Lee MS, et al. (2005) Evaluating hip labral tears using magnetic resonance arthrography: A prospective study comparing hip arthroscopy and magnetic resonance arthrography diagnosis. Arthroscopy 21: 1250.

36. Naraghi A, White LM (2015) MRI of labral and chondral lesions of the hip. AJR Am J Roentgenol 205: 479-490.

37. James SL, Ali K, Malara F, Young D, O'Donnell J, et al. (2006) MRI findings of femoroacetabular impingement. AJR Am J Roentgenol 187: 1412-1419.

38. Lodhia P, Gui C, Chandrasekaran S, Suarez-Ahedo C, Dirschl DR, et al. (2016) The economic impact of acetabular labral tears: A cost-effectiveness analysis comparing hip arthroscopic surgery and structured rehabilitation alone in patients without osteoarthritis. Am J Sports Med 44: 1771-1780.

39. Larson CM, Giveans MR, Stone RM (2012) Arthroscopic debridement versus refixation of the acetabular labrum associated with femoroacetabular impingement: mean 3.5-year follow-up. Am J Sports Med 40: 1015-1021.

40. Heyworth BE, Shindle MK, Voos JE, Rudzki JR, Kelly BT (2007) Radiologic and intraoperative findings in revision hip arthroscopy. Arthroscopy 23:1295-1302.

41. Philippon MJ, Stubbs AJ, Schenker ML, Maxwell RB, Ganz R, et al. (2007) Arthroscopic management of femoroacetabular impingement: Osteoplasty technique and literature review. Am J Sports Med 35: 1571-1580.

42. McCarthy JC, Jarrett BT, Ojeifo O, Lee JA, Bragdon CR (2011) What factors influence long-term survivorship after hip arthroscopy? Clin Orthop Relat Res 469: 362-371.

43. McCormick F, Nwachukwu BU, Alpaugh K, Martin SD (2012) Predictors of hip arthroscopy outcomes for labral tears at minimum 2-year follow-up: The influence of age and arthritis. Arthroscopy 28: 1359-1364.

44. Capogna BM, Ryan MK, Begly JP, Chenard KE, Mahure SA, et al. (2016) Clinical outcomes of hip arthroscopy in patients 60 or older: A minimum of 2-year follow-up. Arthroscopy 32: 2505-2510.

45. Bryan AJ, Krych AJ, Pareek A, Reardon PJ, Berardelli R, et al. (2016) Are short-term outcomes of hip arthroscopy in patients 55 years and older inferior to those in younger patients? Am J Sports Med 44: 2526-2530.

46. Griffin DW, Kinnard MJ, Formby PM, McCabe MP, Anderson TD (2016) Outcomes of hip arthroscopy in the older adult: Am J Sports Med.

47. Domb BG, Linder D, Finley Z, Botser IB, Chen A, et al. (2015) Outcomes of hip arthroscopy in patients aged 50 years or older compared with a matched-pair control of patients aged 30 years or younger. Arthroscopy 31: 231-238.

48. Chandrasekaran S, Darwish N, Gui C, Lodhia P, Suarez-Ahedo C, et al. (2016) Outcomes of hip arthroscopy in patients with tonnis grade-2 osteoarthritis at a mean 2-year follow-up: Evaluation using a matched-pair analysis with tonnis grade-0 and grade-1 cohorts. J Bone Joint Surg Am 98: 973-982.

49. Byrd JW (2003) Hip arthroscopy: the supine position. Instr Course Lect 52: 721-730.

50. Kelly BT, Weiland DE, Schenker ML, Philippon MJ (2005) Arthroscopy 21: 1496-1504.

51. Sawyer GA, Briggs KK, Dornan GJ, Ommen ND, Philippon MJ (2015) Clinical outcomes after arthroscopic hip labral repair using looped versus pierced suture techniques. Am J Sports Med 43: 1683-1688.