Para-acetabular Radiopaque Densities in Patients With Femoroacetabular Impingement

A Retrospective Assessment of Prevalence and Characteristics

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Background: Femoroacetabular impingement (FAI) syndrome is a common source of hip pain associated with chondrolabral injury. There is a subset of patients with FAI syndrome who present with radiopaque densities (RODs) adjacent to the acetabular rim.

Purpose: To evaluate the prevalence, characteristics, and patient-specific factors associated with RODs adjacent to the acetabulum in patients treated with hip arthroscopy for symptomatic FAI.

Study Design: Case series; Level of evidence, 4.

Methods: Between November 2014 and March 2018, a total of 296 patients who underwent hip arthroscopy for FAI with a labral tear were reviewed retrospectively. Patient-specific variables were collected, including age, sex, lateral center-edge angle (LCEA), and alpha angle. Imaging (computed tomography) and surgical reports were reviewed for the location and characteristics of RODs, as well as subsequent labral treatment technique. Patients were excluded if they were treated for extra-articular hip pathology, had a revision procedure, or had a diagnosis other than FAI with a labral tear. No patient was excluded for any history of systemic inflammatory disease. Binary logistic regression was used to compare age, LCEA, and alpha angle for patients with or without radiopaque fragments. An alpha level of 0.05 was used to indicate statistical significance.

Results: A total of 204 patients met inclusion criteria; 33 patients (16.2%; 16 males, 17 females) had para-acetabular RODs. There were no statistically significant differences in age ($P = .82$), sex ($P = .92$), LCEA ($P = .24$), or alpha angle ($P = .10$) among patients with or without an ROD. Of the 33 patients, 29 (87.9%) had fragments in the anterosuperior quadrant. Overall, 31 patients (93.9%) were treated with labral repair in addition to correction of the underlying bony impingement, while 2 patients (6.1%) underwent focal labral debridement owing to poor labral tissue quality around the RODs. Twenty-five patients (76%) had identifiable RODs, which were excised at the time of surgery. The mean (± SD) ROD size measured on axial and coronal computed tomography imaging was 6.3 ± 5.5 mm and 4 ± 4.5 mm, respectively.

Conclusion: Age, sex, LCEA, and alpha angle were not predictive of the presence of para-acetabular RODs. Approximately one-sixth of all patients with FAI had RODs identified on computed tomography, which were typically located at the anterosuperior acetabulum. The majority of hips with para-acetabular RODs were amenable to labral repair. The relative prevalence and lack of predictive patient-specific indicators for these fragments suggest that a high degree of suspicion is necessary when evaluating patients with FAI.

Keywords: femoroacetabular impingement; acetabular fragment; ossification; os acetabulum; pincer

Femoroacetabular impingement (FAI) is an increasingly recognized cause of hip pain and a precursor to hip osteoarthritis.[9] Pincer impingement is the result of acetabular overcoverage or retroversion, resulting in repetitive abutment of the acetabular labrum. Cam impingement is due to abnormal morphology of the femoral head-neck junction

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that causes shearing forces to the acetabular cartilage, resulting in chondrolabral separation and acetabular chondral delamination.[1] In patients who fail to improve with nonsurgical management for symptomatic FAI, hip arthroscopy has been shown to be an effective treatment to correct the underlying bony impingement and labral damage with good short- and long-term outcomes.[4,17]

As our knowledge continues to evolve regarding the pathophysiology of FAI, the literature investigating other potential factors contributing to hip dysfunction has grown significantly.[5,14,18] In addition to pincer and cam morphology, associated anatomic and biomechanical characteristics of the hip can contribute to pain, limited range of motion, and decreased function. There is a subset of patients with FAI syndrome who present with radiopaque densities (RODs) adjacent to the acetabular rim.[11] Whether these densities further contribute to bony impingement or develop as a result of it is currently unknown. Various etiologies of ossific para-acetabular densities have been described, including labral ossification, unfused acetabular physes, acetabular rim fractures, and amorphous calcifications of the labrum.[2,3,6,9,18]

Thorough evaluation of the location and structural characteristics of para-acetabular RODs and patient-specific variables in affected individuals have not been well described. The purpose of this study was to evaluate the prevalence, characteristics, and patient-specific factors associated with RODs adjacent to the acetabulum in patients treated with hip arthroscopy for FAI syndrome. Additionally, we aimed to define characteristics of these fragments, including patient-specific factors, radiographic characteristics, fragment location on the acetabular clockface, and material properties noted at the time of arthroscopy. We hypothesize that para-acetabular RODs will be increasingly prevalent in patients with more substantial features of FAI (greater lateral center-edge angle [LCEA] and alpha angle) and will be located in the most common area of impingement: the anterosuperior acetabulum.

METHODS

Between November 2014 and March 2018, a total of 296 patients underwent hip arthroscopy by a single surgeon (G.D.D.). Patients were included in this study if they were diagnosed with FAI syndrome and had standard preoperative 3-view hip radiographs (anteroposterior view of the pelvis and Dunn 45° lateral and false-profile views of the affected hip) and computed tomography (CT) with 3-dimensional (3D) reconstruction for preoperative planning. CT scans are performed to better assess the 3D profile of the cam and pincer morphology, which aids in intraoperative decisions. Patients were excluded if they were treated for extra-articular hip pathology, had a revision procedure, or had a diagnosis other than FAI with a labral tear. Pediatric patients with open proximal femoral or acetabular physes and patients who had undergone prior surgery or trauma to the symptomatic hip were also excluded. The study did not screen for or exclude patients with a history of systemic inflammatory disease. This study was approved by our institutional review board.

Indications for Surgery

All patients had symptomatic pain and/or mechanical symptoms of the affected hip. Additionally, each had positive clinical examination findings consistent with intra-articular pathology, including positive anterior impingement testing (FADIR [flexion, adduction, and internal rotation] and/or FABER [flexion, abduction, and external rotation]) and log roll maneuver of the limb.[2]

Before arthroscopic treatment, each patient failed an extensive course of conservative management, commonly including rest, activity modification, physical therapy, and diagnostic/therapeutic intra-articular hip corticosteroid injections.[12] The risks and benefits of hip arthroscopy were discussed with each patient by the senior author (G.D.D.), and informed consent was obtained prior to surgery.

Surgical Technique

Hip arthroscopy was performed in the supine position with a hip arthroscopy distraction device and a well-padded perineal post (Smith & Nephew).[3] Gradual traction force was applied to distract the hip joint and overcome the negative pressure seal. The anterolateral portal was initially created by utilizing fluoroscopic localization with a 17-gauge spinal needle. Subsequent portals, including an anterior portal, a posterolateral portal (in some cases), and a distal anterolateral accessory portal, were created under arthroscopic visualization. Initial joint assessment was performed to identify chondrolabral injury. Para-acetabular bony fragments were identified by arthroscopic visualization and palpation of the acetabular rim and labrum. Calcific densities in each case were located at the acetabular-labral

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Ethical approval for this study was obtained from the University of South Carolina Office of Research Compliance.

Figure 1. Preoperative 3-dimensional computed tomography demonstrates a para-acetabular radiopaque density at the 1-o'clock position.

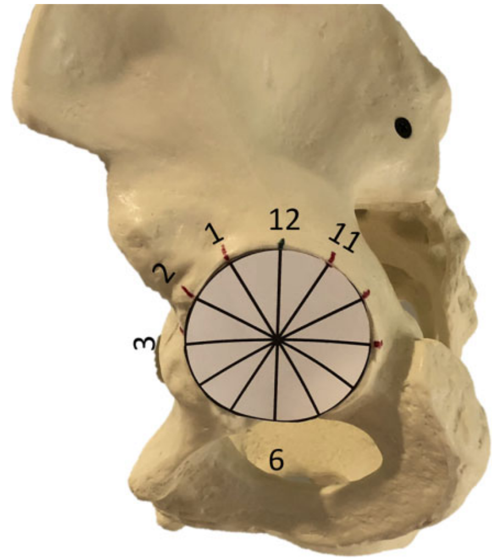

Figure 2. A representative sawbone model demonstrates the acetabular clockface method typically used for identification of labral tear location and size, as well as position of radio-opaque densities in this study.

junction and accessed via the capsulolabral recess. They were then excised with an arthroscopic blade and shaver while preserving the surrounding labral tissue (see online Video Supplement). Similarly, any bony fragments were carefully isolated from the adjacent labral tissue with an arthroscopic blade and then resected with an arthroscopic grasper. Labral repair or debridement was performed according to the type of labral tear identified. Labral repairs were performed with 1.8-mm suture anchors (Q-Fix; Smith & Nephew). Capsular closure of the interportal capsulotomy was performed at the conclusion of the case.

Data Collection

Data included in the analysis were age, sex, LCEA, alpha angle, intraoperative details, prevalence of para-acetabular RODs, and location of the densities. In addition, 3D CT (Figure 1) was used to identify radiopaque fragments adjacent to the acetabular rim. In patients with RODs, the location was noted according to the acetabular clockface method (Figure 2), with the center of the transverse acetabular ligament acting as 6 o'clock. Operative records were reviewed to determine the material properties of the fragment (bony or calcific density). Preoperative plain radiographs (anteroposterior view of the pelvis and Dunn 45° and false-profile views of the affected hip) of patients with fragments identified on CT were reviewed to determine whether the fragments were visible (Figure 3). The treatment of associated labral pathology (repair vs debridement) was noted for each case. Binary logistic regression was used to compare age, LCEA, sex, and alpha angle for patients with or without radiopaque fragments. An alpha level of 0.05 was used to indicate statistical significance.

Figure 3. Preoperative anteroposterior radiography of a left hip shows a radiopaque density adjacent to the superior acetabulum.

RESULTS

A total of 204 patients met inclusion criteria for the study, including 99 (48.5%) males and 105 (51.5%) females. Of these patients, 33 (16.2%) had RODs identified on 3D CT (16 males, 17 females). Patients with RODs had a mean (± SD) age of 33.7 ± 10.8 years, a mean LCEA of 33.2° ± 6.0°, and a mean alpha angle of 63.1° ± 8.8°. There were no statistically significant differences in age ($P = .82$), sex ($P = .92$), LCEA ($P = .24$), and alpha angle ($P = .10$) among patients with or without RODs.

The mean location of the RODs identified was 12:32 ± 2:12 (hour:minute) on the acetabular clockface. Of the 33 patients, 29 (87.9%) had fragments located in the anterosuperior quadrant (12 to 3 o'clock), and 4 (12.1%) had fragments located in the posterosuperior quadrant (all of which were between 11 and 12 o'clock). Fragments identified on CT were visible on plain radiographs in 22 (66.7%) of the 33 patients. The mean ROD size measured on axial and coronal CT imaging was 6.3 ± 5.5 mm and 4 ± 4.5 mm, respectively.

At the time of arthroscopy, 13 (39.4%) of 33 patients had an identified bony fragment, 12 (36.4%) had amorphous calcific densities, 3 (9.1%) had an acetabular fibrous cleft but no noted loose or unstable fragments, and 5 (15.1%) had no bony or calcific fragment that could be identified at the time of arthroscopy. In addition, 25 patients (76%) had identifiable RODs that were excised at the time of surgery, and 31 (93.9%) were treated with labral repair in additional to correction of bony impingement. Finally, 2 patients (6.1%) underwent focal labral debridement owing to poor labral tissue quality around the RODs.

DISCUSSION

This study describes the prevalence, location, and associated factors of para-acetabular RODs in patients with FAI syndrome. RODs were found in 16.2% of patients, and there were no associations between patient age, sex, LCEA, or alpha angle and the presence of RODs. The fragments were most commonly located in the anterosuperior quadrant between 12 and 3 o'clock according to the acetabular clockface method, which also corresponds to the most common location of bony impingement in FAI. Additionally, RODs identified on CT were visible on plain radiographs in 66.7% of patients. Of 33 patients with fragments noted on CT, 5 (15.1%) did not have identifiable fragments at the time of arthroscopy. These patients had small densities on CT, which may have resorbed before surgery or were simply not found by the surgeon during arthroscopy. Three patients had a partially unfused acetabular physis (os acetabulum). For the 13 patients with bony fragments identified at the time of arthroscopy, we were unable to definitively determine whether these fragments were true os acetabuli or secondary ossifications unrelated to the physeal anatomy. The relative prevalence and lack of predictive patient-specific indicators for RODs suggest that a high degree of suspicion is necessary when evaluating patients with FAI, as RODs can affect labral tissue quality and subsequent surgical management of the labrum during hip arthroscopy.

Para-acetabular bone fragments have previously been evaluated. Martinez et al[16] reported a lower prevalence of ossicles located at the acetabular rim, finding them in only 3.6% of patients. Klaue et al[15] described "acetabular rim syndrome," which proposed an association of para-acetabular bone fragments with acetabular dysplasia secondary to abnormal stresses on the acetabular rim. Our findings suggest, however, that para-acetabular bony and calcific densities are not isolated to patients with dysplasia, given the mean LCEA of 33.2° in our cohort and higher prevalence than previously reported.

Jimenez et al[14] reported the case of a patient with acute onset of hip pain with calcific deposition disease of the labrum. The study proposed that the acute onset of pain could be secondary to rupture of the calcium deposit into the intra-articular space. Patients in our study had ongoing symptoms of FAI that failed nonsurgical treatment, and upon intraoperative assessment, none appeared to have ruptured the calcific deposit prior to arthroscopy. It remains unknown whether some of these patients would have ultimately had relief of symptoms with continued observation to allow the calcific densities to resorb. Additionally, the pain may be related to a stable fragment suddenly becoming unstable yet remaining in the same position within the soft tissues. This could also be due to underrecognition of these calcific deposits owing to chronic impingement in patients with subtle FAI.

Seldes et al[19] described the histologic features of the acetabular labrum and described 2 distinct patterns of labral tears. Type 1 tears represent a detachment of the fibrocartilaginous labrum from the articular hyaline cartilage, while type 2 tears consist of multiple cleavage planes within the substance of the labrum. Both types of tears are most commonly located in the anterosuperior quadrant. The location of radiopaque fragments in our cohort is consistent with hip joint damage in this region, with a mean location of 12:32 on the acetabular clockface. A larger proportion of type 1 tears amenable to suture anchor repair were encountered (31/33; 93.9%) in the group of patients with para-acetabular densities. Preoperative knowledge about the presence of a para-acetabular RODs can therefore be important for surgical planning, as these lesions should be identified and excised arthroscopically before repair of the labrum in most cases.

In a histologic study of 20 hips with rim ossification, Corten et al[7] described a natural progression in patients with FAI that begins with displacement of labral tissue by appositional bone formation. The bone further progresses to the extent that newly formed bone cannot be distinguished from the native appositional bone, thus having replaced the native labrum. Though the initial bony deposition appears reactive to the repetitive trauma of FAI, the newly formed bone results in greater impingement and further exacerbates the ongoing pathophysiology. Giordano et al[10] reported on a case-control series of 21 patients treated for FAI and removal of an acetabular rim fragment and noted no difference or improvement in pre- and postoperative patient-reported outcomes as compared with patients without rim fragments. Byrd et al[5] reported on outcomes of hip arthroscopy in a cohort of patients with labral ossification versus a control group of patients with FAI without labral ossification. They noted that patients with labral ossification were more likely to be older and female and have more severe symptoms. Though these patients made similar improvements with hip arthroscopy, their pre- and postoperative patient-reported outcome scores were lower than controls. Furthermore, high rates of labral calcification have been noted in patients with advanced osteoarthritis who underwent total hip arthroplasty.[12] Further investigation is needed to determine whether labral calcifications in the younger patient population with FAI with well-preserved cartilage represent an early step in the osteoarthritic process.

Calcific tendinitis of the rotator cuff has been frequently reported and presents with substantial pain and dysfunction of the shoulder.[8,20] Although not as well documented in the hip, early reports of paralabral calcifications in the hip bear gross morphologic resemblance and similar reports of increased pain as seen in the shoulder. Schmitz et al[18] reported on 2 patients with paralabral hip calcinosis treated with hip arthroscopy to remove the calcific deposits. Both patients reported substantial improvement 4 months after surgery. Jackson et al[13] subsequently reported the clinical, radiographic, histologic, and intraoperative findings in a group of 16 patients with amorphous calcification involving the acetabular labrum. Fifteen patients (94%) in this series were female, and the mean age was 37.3 years. The calcifications in this series were located at the anterosuperior labrum, and the deposits were accessed from the capsulolabral recess, similar to the lesion location and technique in our series.

There are several limitations to the current study. Identification of patients with bony and calcific fragments was done with advanced imaging via 3D CT. While unlikely, it is possible that some para-acetabular ossific or calcific densities were not identified or fully recognized on CT. Some patients who did not have preoperative 3D CT scans were excluded from the study; thus, selection bias is possible. Additionally, only patients with radiographically well-preserved hip joints were indicated for surgery and therefore included in the study. Patients with hip osteoarthritis have been shown to develop acetabular rim calcifications and labral ossification, which likely represent a later stage in the degenerative process. The rates of para-acetabular fragments may be different in aging populations with more degenerative hip joints. Last, although we report on the number of hips amenable to labral repair versus labral debridement, this decision was based on the surgeon's assessment of the labral tissue qualities and could differ among surgeons.

CONCLUSION

Age, sex, LCEA, and alpha angle were not predictive of the presence of RODs. Approximately one-sixth of all patients with FAI had fragments identified on CT, which were typically located at the anterosuperior acetabulum. Advanced imaging such as 3D CT is able to better identify subtle RODs as compared with plain radiographs. The relative frequency and lack of predictive patient-specific indicators for these fragments suggest that a high degree of suspicion for them is necessary when evaluating patients with FAI.

A Video Supplement for this article is available at http://journals.sagepub.com/doi/suppl/10.1177/2325967119892330.

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