Technical Note

Arthroscopic Fixation of Os Acetabuli Technique: When to Resect and When to Fix

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Abstract: Acetabular rim fractures, or os acetabuli, are hypothesized to occur as a result of an unfused ossification center or a stress fracture from repetitive impingement of an abnormally shaped femoral neck against the acetabular rim. When treated surgically, these fragments are typically excised as part of the correction for femoroacetabular impingement. However, in some patients, removal of these fragments can create symptoms of gross instability or microinstability of the hip. In these cases, internal fixation of the fragment is necessary. The purpose of this technical note is to describe indications, the arthroscopic technique, and postoperative care for fixation of acetabular rim fractures.

Acetabular rim fractures, or os acetabuli, are an intra-articular condition characterized by formation and separation of an osseous fragment originating from the anterolateral acetabular rim. Some authors have suggested that these fragments are the result of an unfused ossification center or fatigue fracture due to rim overload in hip dysplasia, whereas others postulate that the fragment results from femoroacetabular impingement (FAI), as a morphologically abnormal femur contacts the acetabular rim.[1,2] The latter condition is the most commonly found pathologic presentation, and can be explained by the chronic impingement of the cam deformity with the acetabulum, thereby producing a stress fracture.[3,4] Orientation of the fragment can help differentiate the causative entities.[1] A true os acetabuli is of cartilaginous growth plate origin and is oriented parallel to the joint surface.[1] On the contrary, when an acetabular rim fragment has been avulsed because of fatiguing of the acetabulum due to FAI morphology, the separation line is more perpendicular to the joint surface.[1]

Treatment of these lesions should be carefully evaluated because it is important in determining the prognosis. Patient-specific intervention depends on multiple factors, including size of the fragment, degree of hip instability on physical examination, and presence of osteoarthritis.[1] In patients with instability at the time of presentation, or in patients with large fragments where removal will result in instability or iatrogenic dysplasia, as determined by the lateral center-edge angle (CEA) and anterior center-edge on radiographs, reduction and fixation is indicated.[5] In this regard, when removal of fragments lead to CEAs of less than 25° on coronal imaging (anteroposterior [AP] pelvis) and less than 20° on a false-profile view, partial rim resection and internal fixation of the remaining portion is recommended to avoid the creation of iatrogenic acetabular dysplasia and subsequent poor outcomes.[6] The purpose of this technical note is to present our preferred approach to perform refixation of traumatic or unfused os acetabuli in patients where excision of the fragment would result in undercoverage of the hip and possible joint instability.

Diagnosis

Clinical diagnosis of a symptomatic os acetabuli can be challenging, especially in the setting of concomitant intra- or extra-articular pathology of the ipsilateral hip. Physical examination findings can be similar to those found with symptomatic FAI, as patients typically present with anterior hip and groin pain that increases

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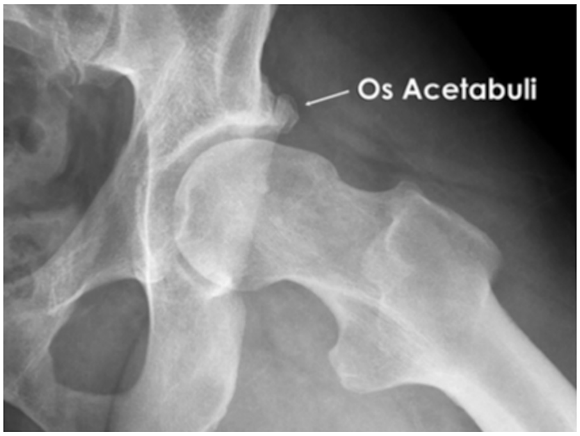

Fig 1. Radiographic Dunn view of a symptomatic left hip. The radiograph reveals a large os acetabuli and associated cam lesion.

Fig 3. Intraoperative view of a patient positioned in a supine position on the surgical table in preparation for hip arthroscopy. Note the patient positioned with no post and 15° of Trendelenburg in preparation for postless traction. The x-ray image intensifier is positioned between the legs for best radiographic visualization.

with sport activity, a positive flexion adduction internal rotation anterior impingement test, a positive flexion abduction external rotation test, and limited internal rotation and flexion.[7] Some patients may also present with pain and discomfort during abduction of the hip, which creates impingement of the femoral head-neck junction against the acetabular rim fragment.

Radiologic examination will confirm the presence of the os. To fully characterize the femoral and acetabular anatomy AP pelvis, false profile, and Dunn[8] views of the hip should be obtained (Fig 1). Assessment of the lateral CEA, anterior CEA, and Tönnis angle should be also evaluated (Fig 2).[9,10] Magnetic resonance imaging is performed adjunctively to rule out cartilage defects, labral injuries, and other associated soft tissue pathologies. Computed tomography with 3-dimensional reconstruction sequences is also of significant benefit to improve preoperative planning and to evaluate the size, quality, and location of the fragment.

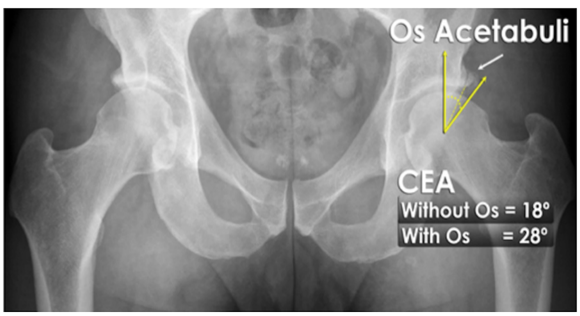

Fig 2. Radiographic anteroposterior pelvis view of the bilateral hips demonstrating the presence of an os acetabuli on a left hip. Also note the associated femoroacetabular impingement anatomy with an associated cam lesion in the ipsilateral hip. The center-edge angle (CEA) has been measured incorporating the os fragment (solid line) and taking into consideration possible removal of the fragment (dashed line). As is seen in the figure, removing the os fragment would introduce iatrogenic undercoverage.

Indications and Contraindications

For diagnostic purposes, and to provide appropriate surgical indications, CEAs are measured on well-aligned AP pelvis and false-profile plain radiographs and 3-dimensional computed tomography when contemplating management of rim pathology, associated os acetabuli, and rim fractures. If removal of these fragments results in a CEA of less than 25° on coronal imaging (AP pelvis) and less than 20° on a false-profile view, partial resection and internal fixation of the remaining portion are recommended. Contraindications for this procedure include the presence of osteoarthritis in a hip with a joint space <2 mm, inability of the patient to comply with postoperative instructions, and incidentally noted lesions in otherwise asymptomatic patients.

Surgical Technique

Operative Room Preparation

The patient is positioned for a hip arthroscopy procedure using a standard traction table (Hip Bed, Spider 2 Limb Positioner; Smith & Nephew, Andover, MA) with the patient in the supine position without perineal post as described by Mei-Dan et al. (Fig 3).[11]

The patient is typically placed under general anesthesia; however, spinal or epidural anesthesia has also been used with success. Regardless of the anesthetic choice, a preoperative discussion with the anesthesiologist regarding the use of hypotensive anesthesia is warranted, as this methodology allows a lower pump pressure and improves arthroscopic visualization.[12] The patient is placed on a hip arthroscopic bed (Hip Bed, Spider 2 Limb Positioner; Smith & Nephew) and moved down the table such that the perineum is located 7 to

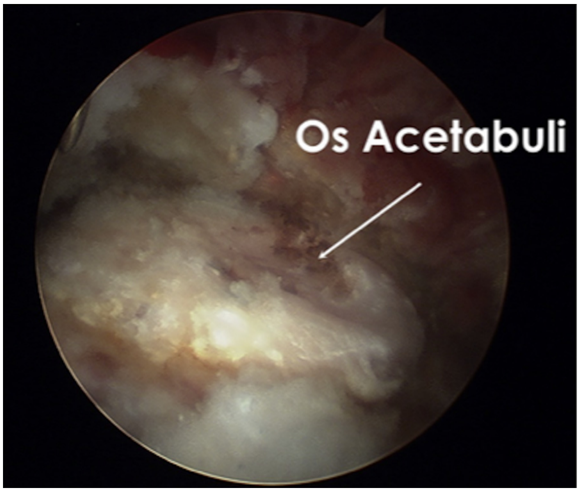

Fig 4. Arthroscopic image of a left hip as viewed through the midanterior portal. An os acetabuli fragment is seen near the superior acetabular rim.

10 cm proximal to the location to the end of the bed. The patient is placed in 15° of Trendelenburg (Fig 3). The operative extremity is positioned in adduction, with the hip flexed to 10° and the femur internally rotated. The contralateral leg is abducted in 45° and the foot externally rotated to allow the x-ray image intensifier (C-arm; Ziehm Imaging, Orlando, FL) in between the legs (Video 1).

Portal Placement and Diagnostic Arthroscopy

Standard anterolateral, midanterior, and distal anterolateral accessory (DALA) portals are used for this technique, as described by Robertson and Kelly.[13] A 20-gauge spinal needle is introduced into the intra-articular space under fluoroscopic guidance, and is used to vent the hip during gentle distraction. The spinal needle should be placed at the position for an anterior portal (located at the intersection between the anterior superior iliac spine line and the top of the greater trochanter). Longitudinal traction is then applied to distract the femoral head from the acetabulum. The midanterior and anterolateral portals are then established, and a 70° arthroscope is placed through the anterolateral portal and used throughout the entire case. The midanterior portal is used as a working portal, and a DALA portal is established as an accessory-working portal under direct visualization from the anterolateral portal.[14] Diagnostic arthroscopy is carried out, and intra-articular pathology, including the os acetabuli, is identified.

Preparation of the Os Fragment

Following evaluation of all other intra-articular pathology, including cam or pincer deformity, a blunt arthroscopic probe (Stryker, Kalamazoo, MI) is used to identify the os acetabuli fragment and assess its stability (Fig 4). The os fragment is then prepared using a rotating arthroscopic burr (Stryker), with care taken to resect any lateral prominence and to make a smooth surface adjacent to the intact acetabular rim. In some cases, the fibrocartilage between the os and the subjacent rim can be taken down to allow for improved bone-to-bone healing.

Fixation of the Os

During fixation of the os, all instruments are passed through the DALA portal. Visualization is performed through the anterolateral portal. After preparation of the bony bed, and the decision for surgical fixation, the os fragment is secured in place using a 3.5-mm partially threaded cannulated screw (DePuy Synthes, Raynham, MA). Using the DALA portal, straight guide anchors (CinchLock Drill Straight Guide; Stryker) are used to guide a 1.25-mm Kirschner wire (K-Wire; DePuy Synthes) into the central portion of the os and into the appropriate location on the acetabular rim. The K-wires should have the longest length possible (250 mm). If needed to avoid rotation of the fragment, insert a second guide wire parallel to the first. This step is performed using the C-arm to assess the appropriate location on both AP and lateral views. Following this, using a CinchLock straight 3.0 drill, a hole is drilled through the os over the top of the K-wire with care taken to be in the center of the os fragment. The previously made tunnel is then tapped and a partially threaded 3.5-mm cannulated screw (DePuy Synthes) is then advanced over the K-wire to secure the os fragment in place. It is key to have a long screwdriver that would allow delivery of the screw into the rim. During arthroscopic placement of this screw, it is recommended to secure the screw with a Vicryl suture tied around the head of the screw to avoid loss of the screw in the soft tissues or within the hip joint (Fig 5). When doing this, it is important that the sutures are not tangled when the screw is positioned, and separation of the limbs outside of the skin can facilitate this.

The limbs from this Vicryl suture could then be used to augment or assist in an adjacent labral repair once the screw is positioned. Once the os is reduced and fixed, subspinal decompression, acetabuloplasty, and labral repair is performed if necessary (Fig 6). Pearls and pitfalls and advantages/disadvantages are presented in Tables 1 and 2, respectively.

Associated Lesions

Traction is then released and femoral osteochondroplasty is performed. After osteochondroplasty, a dynamic examination of the hip is performed to assess the range of motion and to ensure that all impinging areas have been adequately addressed. During this examination, it is important to assess the hip in both abduction and extension, as these maneuvers are likely to place the fragment at risk of impinging against the femur.

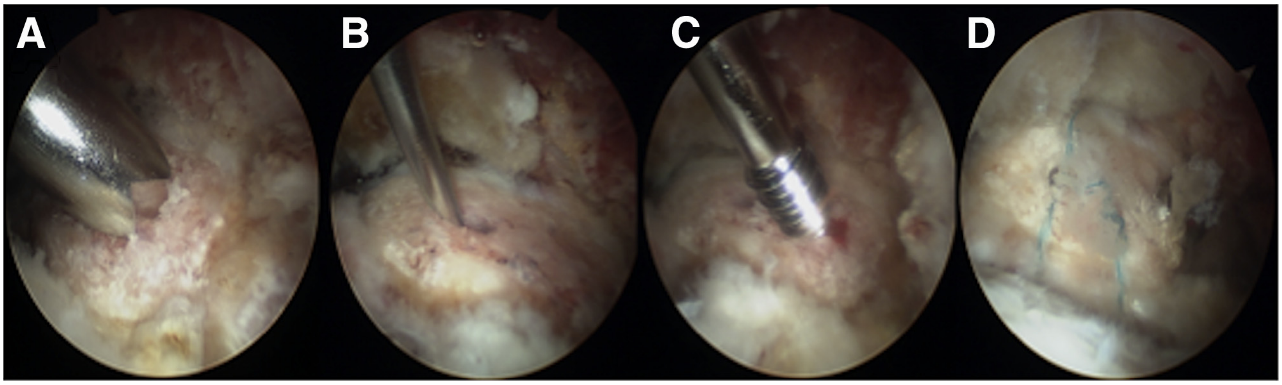

Fig 5. Arthroscopic surgical sequence of an os acetabuli fixation on a left hip as viewed through the anterolateral portal. (A) Using the CinchLock Drill Straight Guide, a hole is drilled in the desired position in the center of the os fragment. (B) A K-wire is placed into and through the previously drilled hole. (C) The previously made tunnel is then tapped to allow for later passage of a screw for fixation, and (D) a 3.5-mm cannulated screw is advanced over the K-wire to secure the os fragment in place.

Postoperative Rehabilitation

The postoperative rehabilitation is patient and pathology specific and depends on concomitant procedures performed in addition to the surgical fixation of the os acetabuli. For the first 2 weeks after surgery, stationary bike with no resistance is started no later than 24 hours postsurgery to prevent adhesions. Patients who are not willing to do stationary bike could use a continuous passive motion device (Furniss Corporation, Grove City, OH) instead. Patients remain non−weight bearing for 6 weeks, and range of motion is limited to 90° of flexion and neutral external rotation for the first 2 to 6 weeks. Moreover, application of an ice machine (Game Ready; CoolSystems, Concord, CA) is indicated for the first 2 weeks to reduce pain and swelling. Patients are also placed on pharmacologic prophylaxis for deep venous thrombosis prevention in the form of oral aspirin (325 mg twice a day) for 3 weeks. Oral indomethacin (75 mg sustained release) is also indicated twice daily for 10 days to prevent heterotopic ossification.[15] Patients are allowed to progress to activity as tolerated within a pain-free zone for the subsequent weeks.

When the patient has progressed to full weight bearing and achieves full range of motion, therapy is advanced. Gentle strengthening exercises begin with a stationary bicycle and isometrics. As strengthening progresses, patients start using an elliptical machine and slide board and perform hip girdle (gluteus medius) strengthening. When range of motion and strength are satisfactory, sport-specific training can be started. Patients are allowed unrestricted activity between 3 and 6 months postoperation.

Discussion

This article details our preferred technique for arthroscopic internal fixation for the treatment of acetabular rim fractures and os acetabuli. Hip arthroscopy

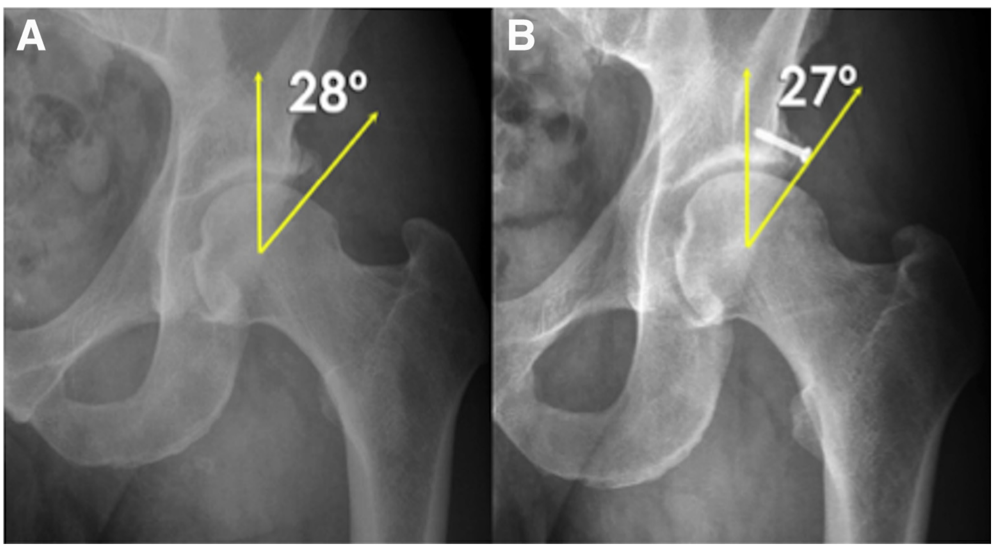

Fig 6. Radiographic anteroposterior view on a left hip comparing the (A) preoperative lateral center-edge angle with the (B) Postoperative lateral center-edge angle. As is shown in the figure, fixation of the os fragment allows for maintenance of the normal acetabular coverage.

Table 1. Pearls and Pitfalls

Pearls	Pitfalls
Avoid excessive intra-articular debridement before identification of the location and character of the os acetabuli.	Excessive intra-articular soft tissue resection can lead to displacement and possibly removal of the lesion
Treat concomitant femoral asphericity (cam resection) to prevent accelerated osteoarthritis	No correction of impingement could be associated with poor clinical results
Drilling interface acetabular surface os acetabuli to improve bone healing	Excessive drilling could modify anatomic surface and impair fixation
Use long K-wire (at least 250 mm in length)	Regular-length K-wire will not be long enough for the deep hip joint
Secure the screw with suture	Avoid tangling of the suture limbs holding the limbs from outside the skin
Use the longest screwdriver	The short screwdriver will not be long enough to get to the screw

procedures have been increasingly indicated for the treatment of hip pathologies over the past decade.[10,16-19] Femoroacetabular impingement is a disorder associated with chondrolabral injury or dysfunction, and the later development of osteoarthritis.[18] In certain situations, a cam-predominant FAI can produce a fatigue fracture of the acetabulum leading to a traumatic form of an os acetabuli.[1] The true or congenital form can become symptomatic when a concomitant cam impingement morphology is present.

Ability to maintain postoperative hip stability is an important factor in determining whether to perform fixation of the fragment or to simply resect.[20,21] Removal of os acetabuli has been common in the treatment of FAI,[1] although it has been reported that the os acetabuli could serve as a stabilizing factor, and therefore it should not be systematically removed in patients with dysplasia or in patients with potential instability after removal.[6] Careful evaluation of the os acetabuli is important in determining further treatment. To delineate the surgical approach, the CEA should be evaluated preoperatively, and if the lateral CEA falls below 25°, or would be less than this value after removal of the fragment, simple resection of the fragment should not be attempted.

Cuéllar et al.[6] reported on a 42-year-old woman with FAI and os acetabuli. Preoperative radiographs revealed a lateral CEA of 15°; however, the patient was treated with a complete resection of the os acetabuli.[6] Although the patient was pain-free for the early postsurgical time frame, at 10 months after surgery, radiographs demonstrated Tönnis grade III degenerative changes and the patient subsequently underwent a total hip arthroplasty.[6] During the arthroplasty, accelerated osteoarthritis was discovered and was attributed to iatrogenic dysplasia from resection of the os acetabuli. The authors suggested that the os fragment was likely contributing to stability of the hip by enlarging the acetabular surface. This case demonstrates the need for critical evaluation of acetabular coverage, especially with dysplastic hips. In such cases, excessive bone resection or os removal could increase the risk of hip instability.[22]

Larson and Stone[20] presented 2 cases of FAI associated with acetabular rim fractures but with intact cartilage adjacent to the acetabulum. The authors performed a partial excision as part of a rim resection and internal fixation of the remaining fragment in both cases and reported good outcomes.[20] The authors noted the importance of measuring CEAs that accounted for angles both with and without the associated rim fractures or os acetabuli when determining whether to excise or fixate the bony fragments.[20] Fragments can be excised completely when lateral CEAs are >20° to 25° and >20° for the anterior CEA without including the fragments[16] and avoid the high probability of hip instability.[21] When CE angles without these associated rim fragments result in a lateral CEA of <20° to 25° and an anterior CEA <20°, the fragments should be either maintained or partially resected with or without internal fixation as a joint preservation procedure.[20]

Rafols et al.[21] presented the case of a 20-year-old man with FAI and a large superior rim fracture. The patient was treated with a partial fragment excision, with the remaining fragment internally fixated.[21] The authors noted that complete excision of the fragment would have led to a lateral CEA of 18° and a high probability of instability, prompting fixation of the fragment.[21] At the 2-year follow-up, the patient had no pain with activity and had negative impingement signs.[21]

These cases highlight the importance of careful preoperative and intraoperative evaluation when considering treatment of os acetabuli. Surgical refixation could preserve the acetabular surface without

Table 2. Advantages and Disadvantages

Advantages	Disadvantages
This technique allows for complete visualization of the fragment without the need for open procedures	Arthroscopic refixation can be technically challenging, and should be performed by skilled arthroscopists
Arthroscopic refixation limits soft tissue dissection and minimizes incisions and blood loss normally created by open techniques	Arthroscopic refixation should not be performed in severe hip dysplasia (center-edge angle 10°) or advanced osteoarthritis
Refixation allows to preserve os acetabuli and prevent hip instability compared to fragment removal	Challenging technique, longer operative time

accelerating osteoarthritis or increasing instability, and associated sphericity femoral correction would improve hip function.[19,21] Arthroscopic techniques should be avoided in cases of severe dysplasia or hip osteoarthritis as well as large chondral lesions in the loading area based on poor prognosis reported.[16,23] We recommend our arthroscopic approach when fixation of the os actabuli is indicated and encourage other groups to perform and report outcomes of this technique.

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