

Arthroscopic Management for Acetabular Rim Stress Fracture and Osteochondritis Dissecans in the Athlete With Hip Dysplasia



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Abstract: Intra-articular lesions are common in patients with acetabular hip dysplasia. Rim stress fractures (RSFs) have also been described in patients with acetabular hip dysplasia. This lesion is believed to be a result of an unfused secondary ossification center or a stress fracture that could be caused by repetitive impingement of an abnormal-shaped femoral head-neck junction. In addition, osteochondritis dissecans of the acetabulum is a rare condition that can also result from impingement and has been described in patients with hip dysplasia. Here, we describe an arthroscopic technique for internal fixation of osteochondritis dissecans of the acetabulum and concomitant RSF associated with hip dysplasia in a rhythmic gymnast.

Patients with hip dysplasia have significant intra-articular lesions including labral tears, ligamentum teres lesions, and cartilage damage secondary to joint instability, which predisposes them to early symptomatic osteoarthritis and hip joint dysfunction.^{1,2} Acetabular rim stress fracture (RSF) or os acetabuli has been defined as a secondary ossification or a stress fracture resulting from overuse

sports activity and can also be observed in patients with symptomatic hip dysplasia secondary to the acetabular rim syndrome.³ Fixation of os acetabuli has been controversial. Recent studies have shown that arthroscopic removal of os acetabuli fragments can lead to microinstability of the hip and secondary osteoarthritis.⁴ Several studies have shown that arthroscopic os acetabuli fixation with metal screws could provide favorable clinical outcomes following fixation.^{5,6} Pascual-Garrido and Larson have suggested that fixation of the os acetabuli should be performed in patients where removal of the fragment would lead to a lateral center-edge angle (LCEA) $<25^\circ$, to prevent secondary instability. They advise measuring preoperatively or intraoperatively the LCEA as well as the vertical center anterior (VCA) angle to confirm fixation or resection of the fragment.^{5,7}

On the other hand, osteochondritis dissecans (OCD) of the acetabulum is a rare entity. Literature lacks a clear understanding of how to address this pathological entity associated with RSF in the patients with hip dysplasia. Uchida et al.⁸ described an arthroscopic fragment fixation method with hydroxyapatite/poly-L-lactate acid (HA/PLLA) thread pins for treating adolescent throwing athlete with elbow OCD lesions. Similar to the elbow, it was hypothesized that active patients with a symptomatic RSF and OCD lesion secondary to hip dysplasia can benefit from arthroscopic fixation with HA/PLLA thread pins. In this article, a surgical technique of arthroscopic fixation with HA/PLLA thread pins with concomitant

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The authors report the following potential conflicts of interest or sources of funding: S.U. is a consultant for Smith & Nephew and Zimmer-Biomet and receives research funds from Smith & Nephew, Pfizer, and Johnson & Johnson. Full ICMJE author disclosure forms are available for this article online, as supplementary material.

Received November 29, 2017; accepted January 19, 2018.

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2212-6287/171465

<https://doi.org/10.1016/j.eats.2018.01.007>

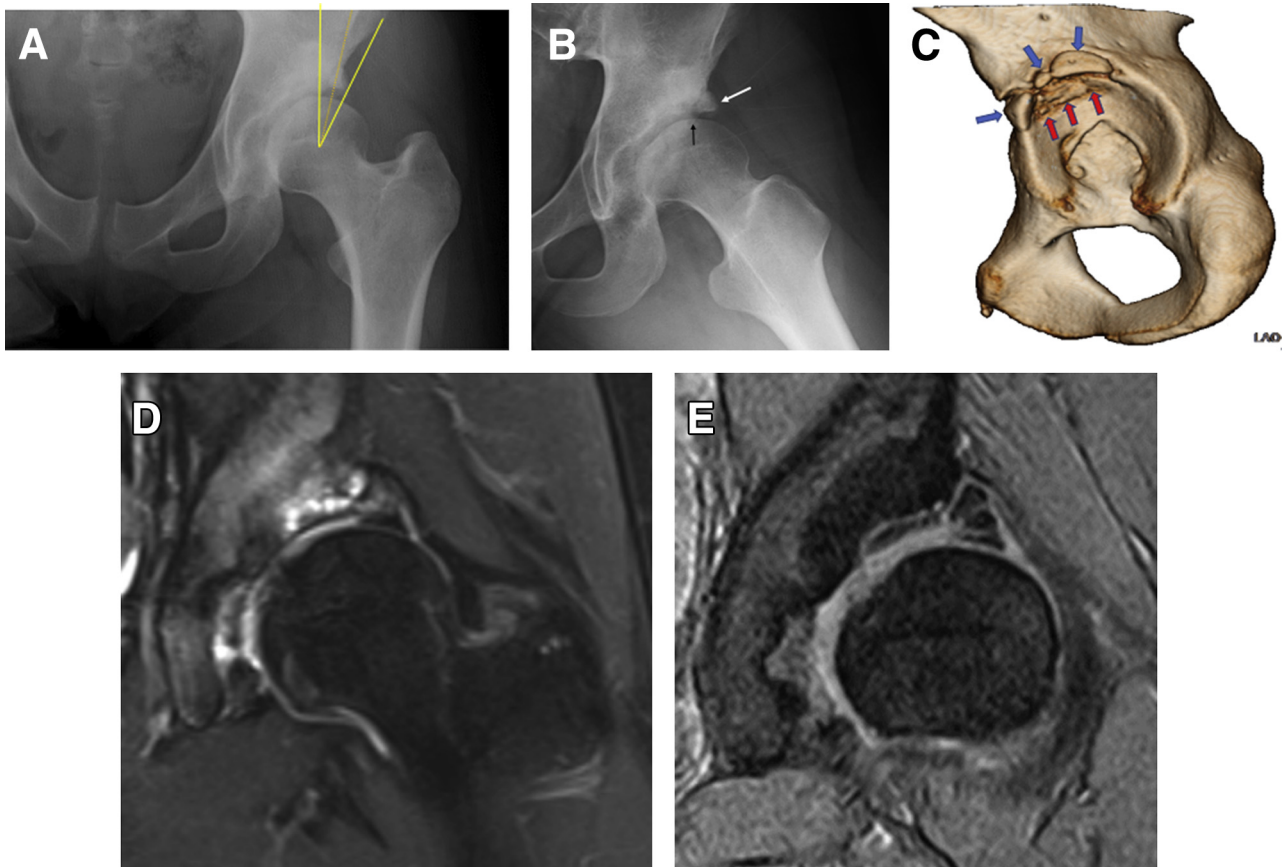


Fig 1. Radiographic features of RSF and OCD of the acetabulum of the left hip joint. (A) AP pelvis radiograph showing left lateral center edge angle (LCEA) of 20° including the fragment and 8° without including the fragment, a sharp angle of 50°, and a Tönnis angle of 17.3°. (B) A modified Dunn view shows the aspherical shape of the femoral head and the osteolytic changes surrounded by osteosclerotic changes along the acetabular surface (black arrow). The RSF is also evident (white arrow). (C) A 3DCT of the left hip with subtraction of the femur shows that the RSF comprises 3 fragments (blue arrows). An associated osteolytic lesion on the acetabular articular surface adjacent to the RSF is also evident. (D, E) MRI of the left hip shows subchondral edema at the acetabulum, a torn labrum, and associated RSF. (AP, anteroposterior; MRI, magnetic resonance imaging; OCD, osteochondritis dissecans; RSF, rim stress fracture; 3DCT, 3-dimensional computed tomography.)

shelf acetabuloplasty for the treatment of symptomatic RSF and OCD associated with hip dysplasia is presented.

Algorithm for Treatment Decision

Commonly, the patient will complain of hip pain associated with a positive flexion-abduction-external rotation (FABER) test, a positive anterior impingement sign, and a positive hip dial test. An anteroposterior (AP) pelvic radiograph and Dunn view will confirm the RSF. A radiolucent area of subchondral bone along with articular surface of the acetabulum suggests the presence of an OCD lesion (Fig 1 A and B). A 3-dimensional computed tomography is invaluable to assess the osteolytic change and precise location of RSF and OCD (Fig 1 C). Magnetic resonance imaging can confirm the unstable os fragment and associated labral tear, if present (Fig 1 D). If the patient had failed non-operative treatment including conservative oral non-steroidal anti-inflammatory therapy and physiotherapy, hip

arthroscopic surgery should be considered. LCEA and VCA angle should be measured on the AP pelvis and false-profile views, respectively. If fragment removal results in an LCEA greater than 25° on the AP pelvis view and a VCA angle greater than 20° on the false-profile view, the os fragment can be removed. If removal of the fragment results in an LCEA less than 25° on the AP pelvis view and a VCA angle less than 20° on the false-profile view, the fragment fixation should be attempted to prevent secondary instability. In addition, if the patient has an LCEA with fragment less than 25° on the AP pelvis view and a VCA with fragment less than 20°, a shelf acetabuloplasty can be performed as a part of hip arthroscopic management for treating concurrent hip dysplasia (Fig 2).

Surgical Technique

Under general anesthesia, the patient is positioned supine in a traction table with a peroneal post. Traction

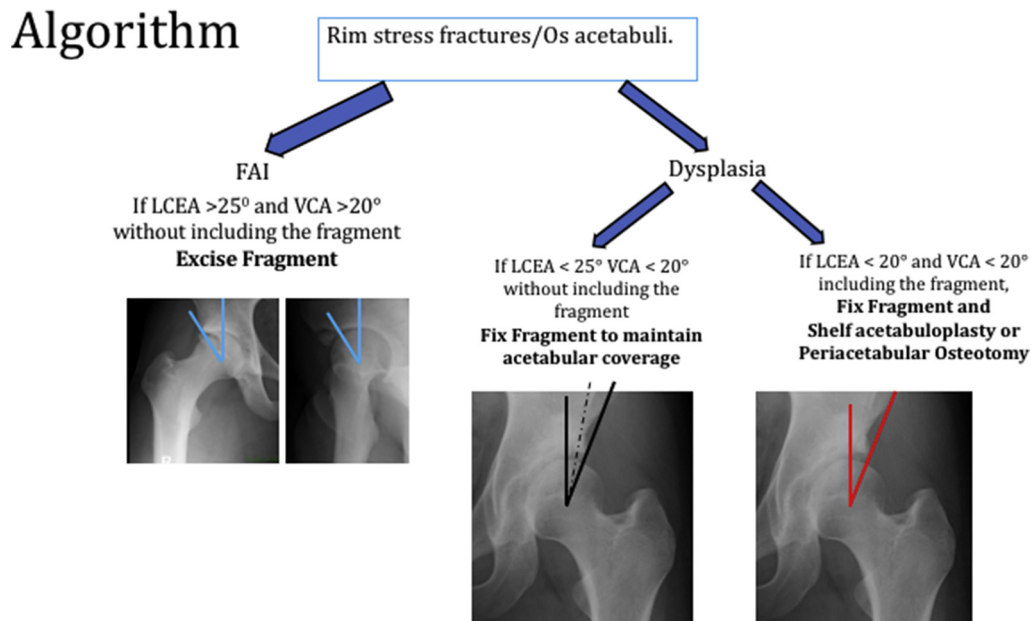


Fig 2. Flow chart of therapeutic algorithm according to lateral center edge angle (LCEA) and vertical center anterior (VCA) angle. Preoperatively, the LCEA and VCA should be measured with or without fragments. If removal of the fragment results in an LCEA greater than 25° on the AP pelvis view and a VCA angle greater than 20° on the false-profile view, the os fragment can be removed. If removal of the fragment results in an LCEA less than 25° on the AP pelvis view and a VCA angle less than 20° on the false-profile view, the fragment fixation should be attempted to prevent secondary instability. In addition, if the patient has an LCEA with fragment less than 25° on the AP pelvis view and a VCA with fragment less than 20°, a shelf acetabuloplasty can be performed as part of hip arthroscopic management for treating concurrent hip dysplasia. (AP, anteroposterior.)

is first performed. As previously described, an anterolateral portal, a midanterior portal, a proximal midanterior portal, and a distal anterior lateral accessory portal are established.^{9,10} After interportal capsulotomy is performed, intra-articular pathologies are assessed using a probe. The OCD and RSF lesions are confirmed. Associated labral tear must also be ruled out (Fig 3 A and B). If a torn labrum is present, labral refixation should be performed first using suture anchors (Suture Fix; Smith & Nephew, Andover, MA) obtaining good refixation of the labrum (Fig 3 A and B). Then, the RSF and the OCD lesion are arthroscopically assessed. After arthroscopic assessment, the fixation footprint is prepared. Rim smoothing is carried out at the border between the capsule and the labrum to expose the rim fracture site and prepare the footprint. A drill guide is introduced through the distal anterior lateral accessory portal while the scope viewing is performed from the midanterior portal. Next, two 2-mm-diameter drill holes (length 25 mm) are made from the RSF site toward the OCD lesion (superficial to deep direction) using a 2-mm Kirschner wire. The dilator is then inserted into the drill guide and tapped to the desired depth. Next, 2-mm-diameter HA/PLLA threaded pins (Superfixorb, Takiron, Kobe, Japan) are inserted through the drill guide with a delivery tamp to fix the rim fracture as well as the OCD lesion (Fig 3 C and D). The direction of fragment fixation with HA/

PLLA pins is estimated by preoperative magnetic resonance imaging and 3-dimensional computed tomography. Intraoperative fluoroscopy is used as well. After the central compartment procedure is finalized, the traction is released. Then, attention is turned to the peripheral compartment. Dynamic impingement test can confirm impingement between the cam lesion (or head-neck area) and the acetabular rim. Then, osteochondroplasty is performed as described previously.¹¹ In patients with associated hip dysplasia or instability, a shoelace capsular plication should be also performed to provide soft tissue stability. This last one should be performed as previously described using UltraTape (Smith & Nephew) (Fig 3E).¹² Concomitant endoscopic shelf acetabuloplasty can be performed, in patients with dysplasia, with the use of autologous iliac bone graft harvested from the ipsilateral iliac crest as described previously and in the figure legends as well as in Video 1 (Fig 3 F-I).¹³ Iliac bone plate is placed above the shelf graft and fixed with HA/PLLA screws. Postoperative plain radiographs should show improvement of the LCEA by shelf graft covering the RSF lesion (Fig 4) (Video 1).

Postoperative Recovery

The patient is instructed to remain nonweightbearing for the first 3 weeks. During this time, the patient is provided with a hip brace for 3 weeks to limit hip range

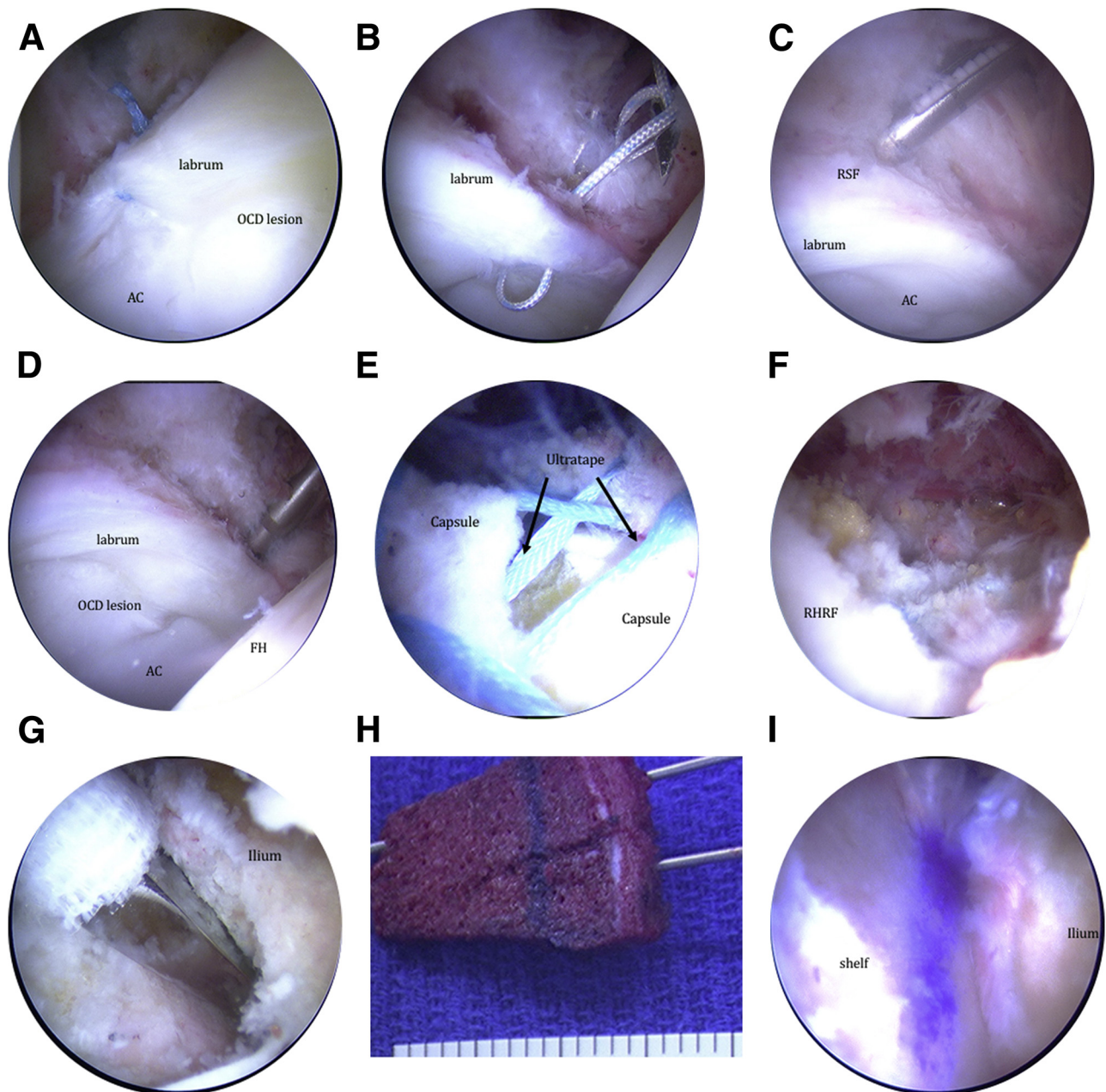


Fig 3. Arthroscopic findings of surgical technique: Supine hip arthroscopy is performed for the left hip joint on a traction table. Viewing from the ALP, a torn labrum and OCD lesion was seen. (A) The labrum is repaired with a suture anchor. (B) Viewing from the MAP, the posterior torn labrum is fixed with a suture anchor. (C) Viewing from the ALP, the drill guide is placed on the RSF lesion through the DALA portal, and the HA/PLLA threaded pins are inserted. (D) Cam osteoplasty (osteochondroplasty) is performed viewing from the MAP. (E) Viewing from the ALP, a shoelace capsular plication using UltraTape is performed. (F) A 30° arthroscope is placed outside the capsule for performing endoscopic shelf acetabuloplasty. Viewing from the ALP, the reflected head of the rectus femoris (RHRF) is first identified. (G) Viewing from the ALP, a 10-mm-wide osteotome is introduced through the MAP to make the transverse slot for shelf graft. (H) A wedge-shaped corticocancellous graft is harvested from the ipsilateral iliac crest. Two 1.5-mm Kirschner wires are introduced in 1.8-mm-diameter drill holes, helping to control the graft position during endoscopic insertion into the aforementioned anterolateral periacetabular slot. (I) Finally, the free bone graft is secured into the appropriate position, with the cortical surface facing the femoral contact with the intervening capsule, using a press-fit technique with a cannulated bone tamp (Smith & Nephew, Japan). (ALP, anterolateral portal; DALA, distal anterior lateral accessory; HA/PLLA, hydroxyapatite/poly-L-lactate acid; MAP, midanterior portal; OCD, osteochondritis dissecans; RSF, rim stress fracture.)

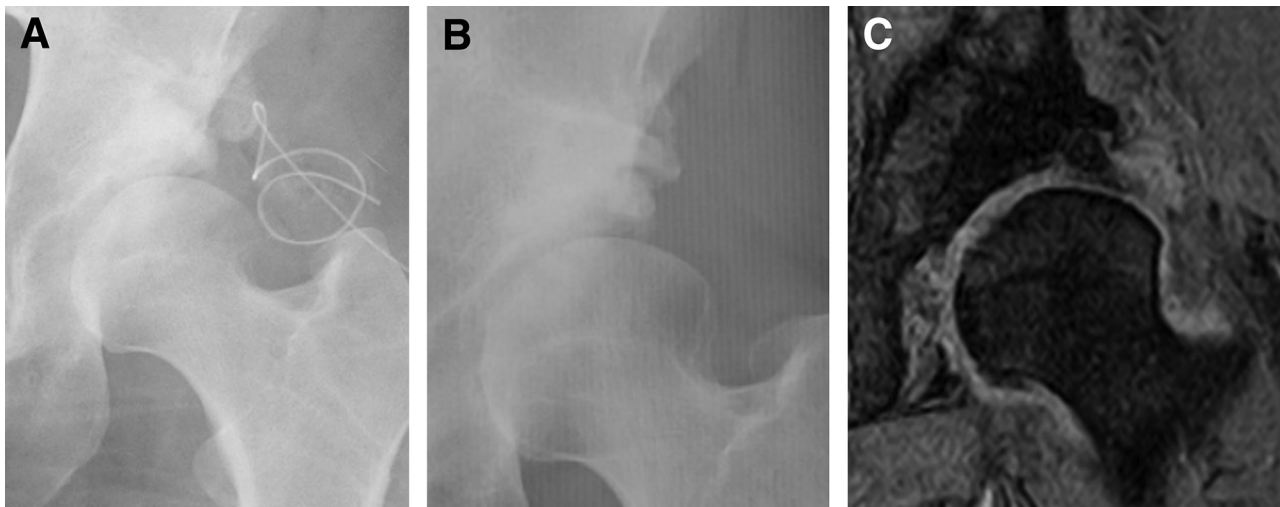


Fig 4. Postoperative radiographic findings of the left hip joint. (A) Postoperative plain AP pelvis view showing the shelf graft and fixation of the os acetabuli. (B) At 5 months postoperation, complete bone union of rim stress fracture and improvement of the osteolucency of the OCD lesion of the acetabulum is evident. (C) MRI at 5 months showing the good healing of the OCD and the rim stress fracture. (AP, anteroposterior; MRI, magnetic resonance imaging; OCD, osteochondritis dissecans.)

of motion. Passive range of motion exercises are initiated during the first week by physical therapists. Stationary bike, with no resistance, is initiated without restrictions few days after surgery. Circumduction exercises are performed for the first 2 weeks to avoid adhesive capsulitis. The patient is allowed to participate in normal activities of daily living over a 2-month postoperative period.

Discussion

In this Technical Note, we showed a surgical technique for arthroscopic internal fixation of RSF as well as concomitant OCD lesion of the acetabulum with use of HA/PLLA threaded pins in the setting of acetabular dysplasia. Several studies have shown that RSFs are associated with femoroacetabular impingement or/and hip dysplasia.

Cuellar et al.⁴ reported a case report of a 42-year-old athletic female patient with mild hip dysplasia and secondary os acetabuli. Preoperative radiographs showed an LCEA of 15° and a Tönnis or acetabular inclination of 7°. Arthroscopic complete resection of fragment was performed. Patient had temporary improvement for the first 5 months, however, the patient progressed rapidly to advanced osteoarthritis that resulted in a conversion to total hip replacement at 10 months after index surgery. The authors proposed that removal of the os acetabuli resulted in secondary instability. On the other hand, Larson and Stone have reported in 2 cases with symptomatic os acetabuli associated with femoroacetabular impingement.⁷ Fragment resection as a part of rim trimming was performed. However, they noted that resection of the os did not result in hip instability as the LCEA remained

>25° after resection. With regard to indications on when to resect or when to fix, Pascual-Garrido et al. additionally described in their Technical Note the indications, surgical technique and postoperative care for treating patients with os acetabuli. They noted that when removal of fragment leads to an LCEA less than 25° and a VCA angle less than 20, partial rim trimming and fragment fixation for remaining fragment should be attempted.⁵ Rafols et al. presented the case of a 20-year-old man with femoroacetabular impingement and a large superior rim fracture. The patient was treated with a partial fragment excision, with the remaining fragment internally fixated with screw. The authors noted that complete excision of the fragment would have led to an LCEA of 18° and instability, prompting fixation of the fragment. At 2 years postoperatively, the patient had no pain with activity and had a negative impingement sign.¹⁴ From the aforementioned evidence, Pascual-Garrido et al. noted that fixation alone of the os should not be performed in patients with associated hip dysplasia. In this scenario, a concomitant orientation of the acetabulum such as

Table 1. Advantages and Disadvantages

Advantage	Disadvantage
Less invasive	Technically demanding
Rim stress fracture labral tear and osteochondritis dissecans can be addressed at the same time	Steep learning curve
This arthroscopic technique can allow overall visualization	Direction of drilling for fragment fixation is narrow
Shelf acetabuloplasty can support rim stress fracture to reduce mechanical stress resulting from hip dysplasia	This technique should not be performed for severe dysplasia and osteoarthritis (Tönnis grade ≥ 2)

Table 2. Pearls and Pitfalls

Pearls	Pitfalls
Preoperative and intraoperative radiographic measurements should be performed	Immoderate drilling could cause the loosening of the HA/PLLA thread pins
Preoperative 3DCT should be performed to define the location of rim stress fracture and OCD lesions	Regular drill guide for Superfixorb cannot be long enough to reach out to the lesions
Perform concomitant femoral osteochondroplasty and capsular closure	Labral suture using anchors of diameter >2.3 mm could damage the fragment
Intraoperative fluoroscopy is helpful to direct the drill guide	Inappropriate location of shelf graft could damage the HA/PLLA thread pins
Long K-wire is used for fragment fixation	No correction of cam lesion and subspinal impingement can cause poor clinical outcomes
Use the specific drill guide for HA/PLLA (Superfixorb) threaded pins	No capsular closure/plication can be associated with joint instability, resulting in poor clinical outcomes

HA/PLLA, hydroxyapatite/poly-L-lactate acid; OCD, osteochondritis dissecans; 3DCT, 3-dimensional computed tomography.

periacetabular osteotomy or an associated shelf acetabuloplasty should be considered. Uchida et al.¹⁵ showed that endoscopic shelf acetabuloplasty could provide favorable clinical outcomes with higher prevalence of return to sports-related activity as an arthroscopic treatment of symptomatic hip dysplasia. If the patient had associated hip dysplasia, an endoscopic shelf acetabuloplasty can provide wider weight-bearing and support fragment fixation.¹³ During shelf acetabuloplasty, we believe that making a transverse slot adjacent to RSF would stimulate the healing process of the RSF and the OCD lesion of the acetabulum.

The OCD lesions of the acetabulum is one of the pathological entities that is much rarer than the OCD lesions of the femoral head. There are several studies describing OCD lesions of the acetabulum. Berthelot et al. reported 1 case of OCD lesion of acetabulum treated with conservative treatment. Hardy et al.¹⁶ reported 1 case of OCD lesions of the acetabulum undergoing arthroscopic debridement and additional extra-articular bone graft.

Previous studies have shown that fragment fixation with a metal screw can provide excellent healing and clinical outcomes for patients with RSF.^{5-7,17,18} However, when OCD lesions in the acetabulum are also associated with an RSF, metal screws might be too big and could potentially damage the OCD lesion. Thus, we used HA/PLLA threaded pins to stabilize and stimulate both the OCD lesion and the RSF. Uchida et al. reported a series of elbow OCD lesions that were treated with arthroscopic fragment fixation with HA/PLLA pins. The author reported excellent clinical outcomes and high rates of union with this proposed technique.⁸ HA/PLLA threaded pins are widely used

in bone injuries as strong materials, having the long-term benefit of being osteoconductive potential. Thus, we believed that HA/PLLA threaded pins would provide better reintegration of the OCD lesion and the RSF. For the above-mentioned reasons, we additionally performed a concomitant endoscopic shelf acetabuloplasty to reduce the mechanical stress on the fixated RSF and OCD, promoting successful healing of the nonunion of RSF.

The advantages of this procedure are as follows: (1) it is less invasive than an open procedure; (2) it enables early rehabilitation; and (3) makes a second operation for hardware removal unnecessary. In addition, this endoscopic technique allows entire intra-articular visualization and treatment of the intra-articular pathology, including labral re-fixation, os acetabuli fragment fixation, osteochondroplasty, capsular plication, and shelf acetabuloplasty at the same time. The disadvantage of this procedure is that it is meticulous and has a steep learning curve (Table 1). It is also difficult to decide the accurate direction of the drill guide for inserting the drill to fixate both RSF and OCD lesions of acetabulum. The pearls and pitfalls of this technique are detailed in Table 2.

In conclusion, arthroscopic fragment fixation using HA/PLLA thread pins with associated endoscopic shelf acetabuloplasty is a surgical technique that can be used to treat RSF and OCD in patients with acetabular hip dysplasia.

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