Technical Note

Arthroscopic Shelf Acetabuloplasty in the Treatment of Acetabular Dysplasia Combined With Cam-Type Femoroacetabular Impingement

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Abstract: Acetabular dysplasia is a hip condition characterized by abnormal development of the acetabulum, which can be present from birth or develop during childhood and may persist into adulthood. Mild or borderline acetabular dysplasia frequently is associated with cam-type femoroacetabular impingement in adults. Over time, the association of impingement and abnormal contact can lead to hip pain, cartilage damage, labral tears, and an increased risk of developing hip osteoarthritis. Several surgical treatments have been proposed: arthroscopic capsular plication, periacetabular osteotomy, or shelf acetabuloplasty. As mini-invasive shelf acetabuloplasty procedure has already proven its effectiveness, an arthroscopic shelf acetabuloplasty represents a less-invasive, less-risky procedure and allows during the same procedure to perform intra-articular resection of the femoral cam, labrum repair and capsular plication. This Technical Note describes an original technique of arthroscopic shelf acetabuloplasty that combines an outside-in arthroscopic approach for the intra-articular procedure (labral repair, femoroplasty, capsular plication) and an endoscopic shelf acetabulopasty with a tricortical iliac crest autograft secure with a single cannulated screw.

Hip dysplasia is a deficit of coverage of the femoral head by the acetabulum due to its abnormal shape. It contributes to microinstability of the hip and may lead to osteoarthritis. It can be responsible for pain in the groin area and apprehension in hip-involving activities. Its radiologic definition relies on several parameters, such as the lateral center-edge angle (LCEA; <25°), the acetabular roof angle, or Tönnis angle (>10°), or the anterior center-edge angle (<25°) and can be classified according to the LCEA into severe hip dysplasia (LCEA <18°) or borderline hip dysplasia (BHD; LCEA between 18° and 25°).[1] In addition, hip microinstability linked to BHD often is associated with femoroacetabular impingement (FAI) and labral tears, which both participate in the patient's pain.[2]

After failure of the functional treatment, several surgical treatments of BHD have been proposed, such as periacetabular osteotomy (PAO), shelf acetabuloplasty, and capsular plication.[3] Arthroscopic treatment of borderline dysplasia with FAI produces good functional results, comparable with those obtained after PAO, but with a tendency toward conversion to total hip replacement, whether compared with PAO or arthroscopic treatment of isolated FAI.[4,5] Although PAO is the most common procedure for severe hip dysplasia, it is a risky and demanding surgery. Shelf acetabuloplasty

Table 1. Indications and Contraindications of the Technique

Indications	Contraindications
• Hip pain	• No functional physiotherapy
• Activities limitations	• LCEA <5°
• LCEA between 18° and 25°	• Tönnis 2 or more
• Positive FEAR index	• Broken Shenton line
• Tönnis 0 or 1	

FEAR, femoroepiphyseal acetabular roof; LCEA, lateral center-edge angle.

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Received October 3, 2023; accepted February 1, 2024.

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2212-6287/231427

https://doi.org/10.1016/j.eats.2024.102971

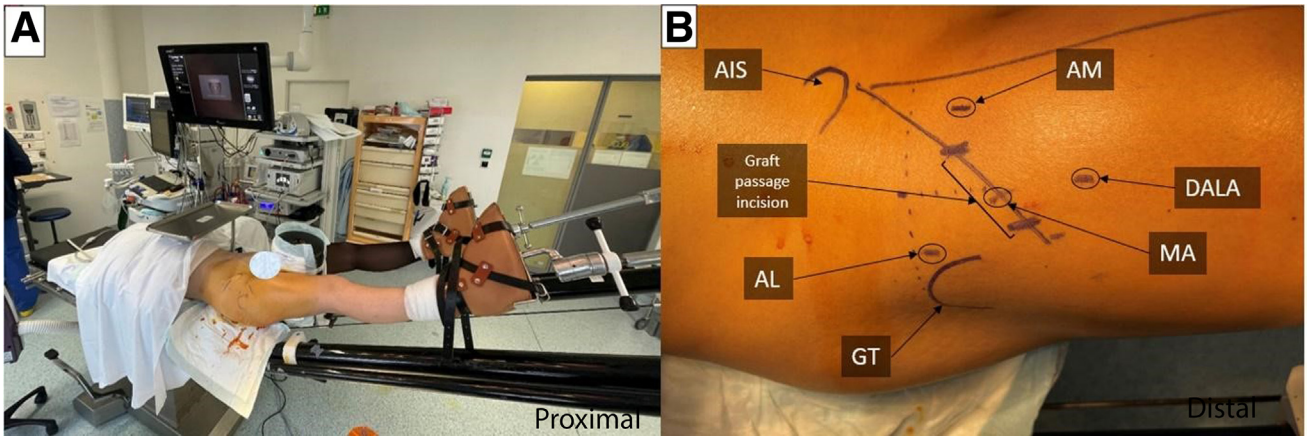

Fig 1. Installation and landmarks for the shelf acetabuloplasty technique. (A) Patient is positioned supine, on a traction table with the feet placed into traction boots and 20° hip flexion. (B) Skin landmarks. (AIS, antero-iliac spine; AL, anterolateral portal; AM, anterior modified portal; DALA, distal anterolateral accessory portal; GT, great trochanter; MA, midanterior portal.)

represents a simpler and less-risky procedure for BHD. As proposed in PAO, a concomitant hip arthroscopy can be performed to practice a femoral cam resection or a labrum repair.[6,7] Thus, Uchida et al.[8] first described the combined treatment with endoscopic shelf acetabuloplasty and hip arthroscopy followed by Maldonado et al.[9] Performed endoscopically, a shelf acetabuloplasty could provide a better view of the acetabular roof to improve the bone graft position while keeping the benefits of a safe and minimally invasive approach. It also could offer the opportunity to treat intra-articular conditions in the meantime, such as femoral cam, labral tear, and joint instability. Our reference technique was described by Chiron et al.[10] in 2007 as a minimally

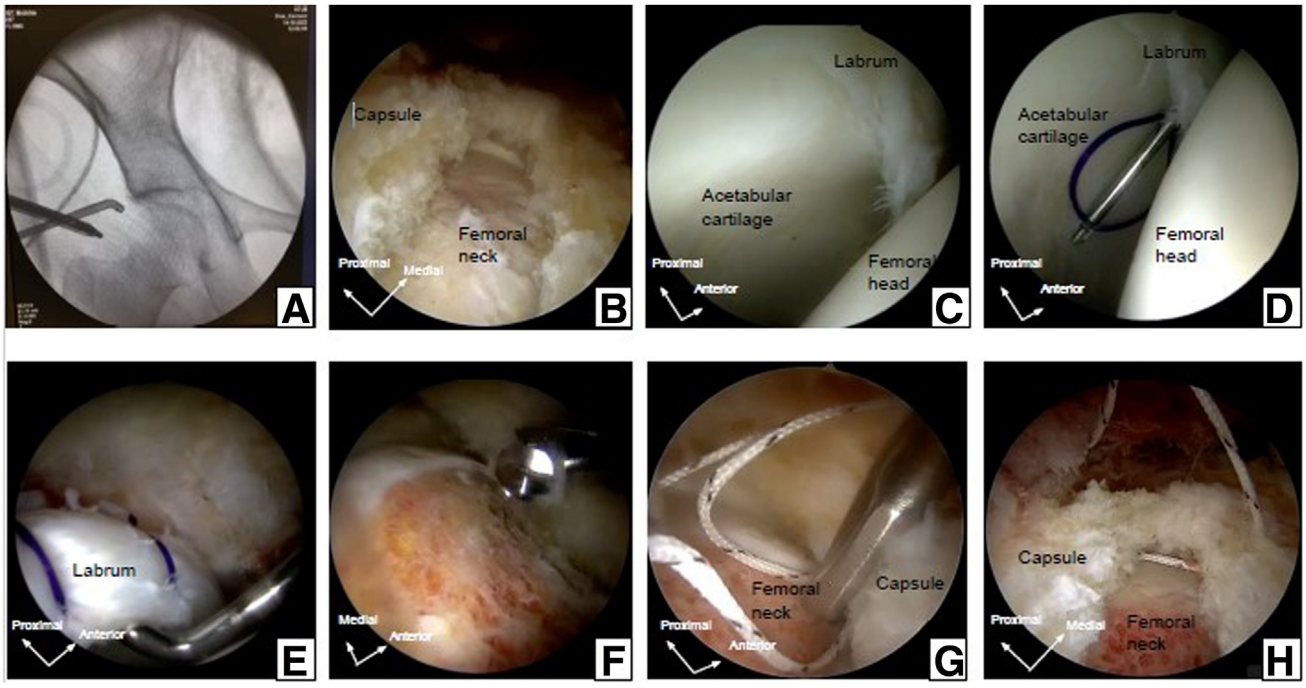

Fig 2. Intracapsular times (all the arthroscopic views are taken here with the optics in the AL portal). (A) Fluoroscopic check of correct positioning before capsulotomy (for more information, read our capsulotomy technique[11]). (B) Outside-in longitudinal capsulotomy, view from above. (C) Intra-articular assessment, with a labral tear on the superior edge of the view. (D) Labral repair with PDS 0 absorbable thread and a suture passer (SwiftStitch; Arthrex, Naples, FL). (E) Extra-articular assessment of the labral repair with 2 PDS 0 absorbable thread attached to 2 anchors implanted via the DALA portal. (F) Femoroplasty using a 5.5-mm motorized burr (to facilitate femoroplasty, the optical (AL) and instrumental (AM) portal can be switched. (G) Passing a first thread into capsule with a CapsuleClose Scorpion suture passer (Arthrex). (H) Capsular plication with a nonabsorbable thread, view from above. (AL, anterolateral portal; AM, anterior modified portal; DALA, distal anterolateral accessory portal.)

Fig 3. A 7.2-mm cannulated screw with a screw washer is placed in the cortical graft taken from the anterior iliac crest.

invasive procedure. It uses an autograft from the iliac crest maintained by a single partially threaded compression screw. A 45° chamfer allows close contact of the graft's inferior edge and strengthens its stability by a superior flying buttress effect. This Technical Note describes the shelf acetabuloplasty endoscopic procedure associated with outside-in capsulotomy hip arthroscopy[11] (Video 1). All patients gave valid consent to participate.

Surgical Technique (With Video Illustration)

Patient Evaluation, Imaging, and Indications

Our indication of shelf acetabuloplasty is based on patients complaining of pain in the groin area with limitations in daily life and sport activities. Patients also must have benefited from a well-conducted medical treatment for 6 months that has failed. Clinical examination shows a highly positive FADIR (i.e., Flexion, Adduction and Internal Rotation) test and radiography shows an LCEA between 5° and 25°, a positive FEAR index,[12,13] and Tönnis grade 0 or 1 (Table 1).

Patient Positioning

The patient is placed supine on a surgical traction table with the feet well-padded and placed into traction boots. A voluminous pubic support is placed to limit the risk of pudendal nerve neuropathy. The hip is placed in flexion (about 20°) without any traction in order to release the anterior capsule and facilitate the arthroscopic instruments' motion. Traction is implemented when necessary (Fig 1).

Arthroscopic Access and Intracapsular Hip Arthroscopy

A systematic diagnostic arthroscopy (Fig 2) is performed with a 70° Direct View Arthroscope (Arthrex, Naples, FL). The hip joint is accessed through the anterolateral, midanterior, and distal anterolateral accessory portals. An outside-in capsulotomy for hip arthroscopy is performed.[12] First, the precapsular fatty tissue is cleaned through the anterolateral and midanterior portals. After an operative fluoroscopic control, a longitudinal capsulotomy following the axis of the neck is performed with a surgical electrode (WEREWOLF COBLATION; Smith & Nephew, Watford, UK) (Fig 2 A and B).

Hip exploration is then performed in a routine manner: traction is applied to expose the central compartment. Labral, chondrolabral junction, and ligamentum teres condition are assessed (Fig 2C).

In case of labral tear, labral repair is performed using bioabsorbable suture anchors (PushLock Anchor; Arthrex) through the distal anterolateral accessory portal. After cortical bone preparation with a motorized

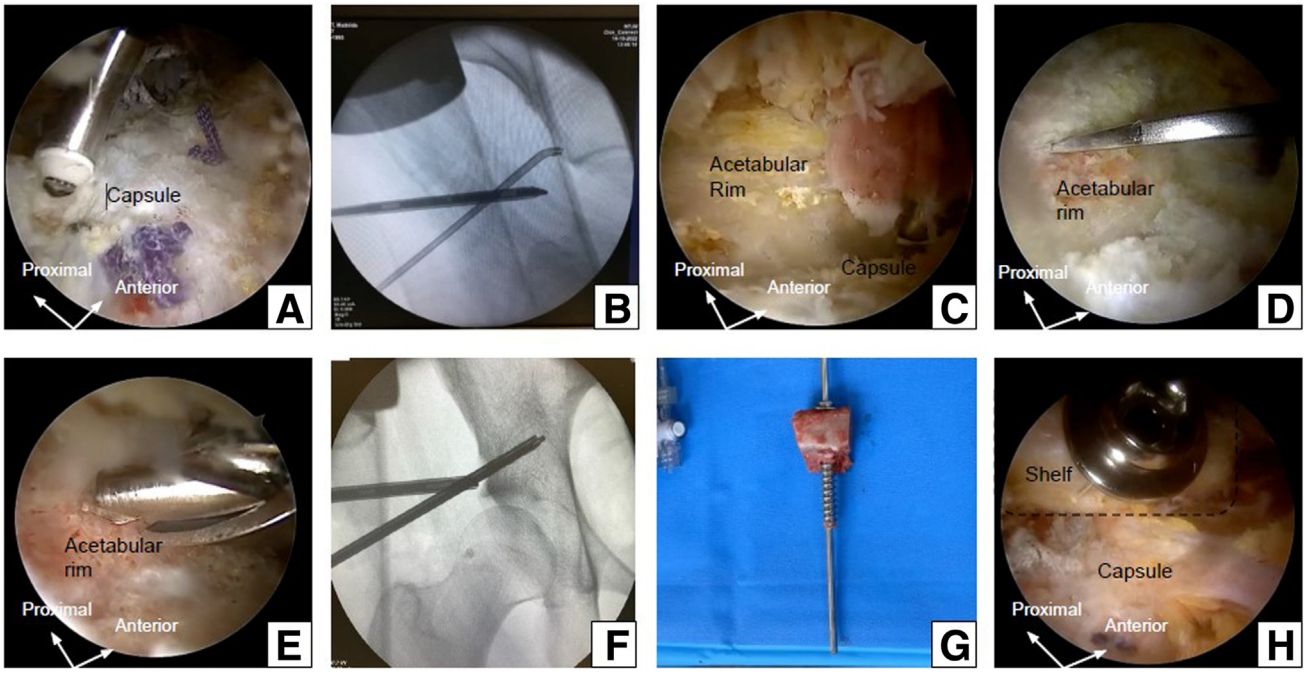

Fig 4. Endoscopic approach (all the endoscopic views are taken here with the optics in the AL portal). (A) View from above of the capsular plication, extra-articular working space is created with a surgical electrode. (B) Fluoroscopy control to confirm correct position: 5 mm above the subchondral bone and 20 mm behind the anteroinferior iliac spine. (C) Anterior acetabular rim view after the use of a surgical electrode to expose the bone. (D) A 5.5-mm burr is used to decorticate the anterior acetabular rim on a 3 × 1.5 cm trough and a chisel to prepared shelf footprint. (E) A 45° ascending guide wire is introduced through the MA portal under guidance of fluoroscopic imaging. The K-wire should be angled 45° anteroposteriorly and proximodistally in the direction of the sacroiliac joint. (F) Fluoroscopy control to confirm correct position, screw path is drilled. (G) A 7.2-mm cannulated screw with a screw washer is placed in the cortical graft taken from the anterior iliac crest, a 45° chamfer if made to ensure stability of the graft. (H) View of the autologous bone graft with the screw already in place, passed through the guide wire and positioned using Kocher forceps. the 45° chamfer is applied to the prepared footprint. (AL, anterolateral portal; MA, midanterior portal.)

5.5-mm round burr (CrossBlade XL Diamond Burs; Stryker, Kalamazoo, MI) to ensure proper healing, a loop suture with nonabsorbable thread (FiberLink; Arthrex) is made and fixed to the anchor (Fig 2 D and E). If an unstable cartilaginous flap is found, it's either stabilized by coblation or fixed with a suture. The suture with an absorbable thread (PDS 0; Ethicon, Raritan, NJ) is realized through cartilage and labrum with a suture Passer (SwiftStitch; Arthrex). As many sutures as necessary are made and traction is then released to assess that the repaired labrum properly seals the joint.

The cam resection is then performed with the same motorized 5.5-mm burr. Hip flexion is used to enable exposure of the anterior neck (Fig 2F). Then, arthroscopic dynamic examination and fluoroscopic control, in multiple positions, allow to evaluate the cam resection.

The final stage is the capsular plication with an automated Scorpion Suture Passer (Arthrex) associated with a CapsuleClose Scorpion suture passer (Arthrex; Fig 2G and H). Lasso loop knots are made with nonabsorbable thread (FiberWire; Arthrex) or slowly absorbable braided thread (VICRYL; Ethicon).

Preparation of the Graft

An autologous tricortical bone graft is taken from the ipsilateral iliac crest through a minimally invasive approach behind the anterosuperior iliac spine who goes posteriorly. The graft should be 2.5 cm by 2.5 cm deep with a 45° oblique inferior edge. To limit donor-site morbidity, the bone gap is replaced by a piece of bone substitute. A partially threaded cannulated screw 7.2 mm in diameter and 60-mm long (Zimmer Biomet, Warsaw, IN) is placed through the graft with a screw washer (Fig 3).

Endoscopic Approach

Thanks to the arthroscopic portals, an extracapsular working space is created with the surgical electrode and a shaver (Fig 4A). The reflected head of the rectus femoris is identified and debrided to expose the anterior acetabular rim (Fig 4). Fluoroscopy is used to confirm the good position (5 mm above the subchondral bone and 20 mm behind the anteroinferior iliac spine) (Fig 4B). A 5.5-mm burr is used to decorticate the anterior acetabular rim on a 3 × 1.5-cm trough (Fig 4 C and D). A 45° ascending guidewire is introduced through the midanterior portal under guidance of

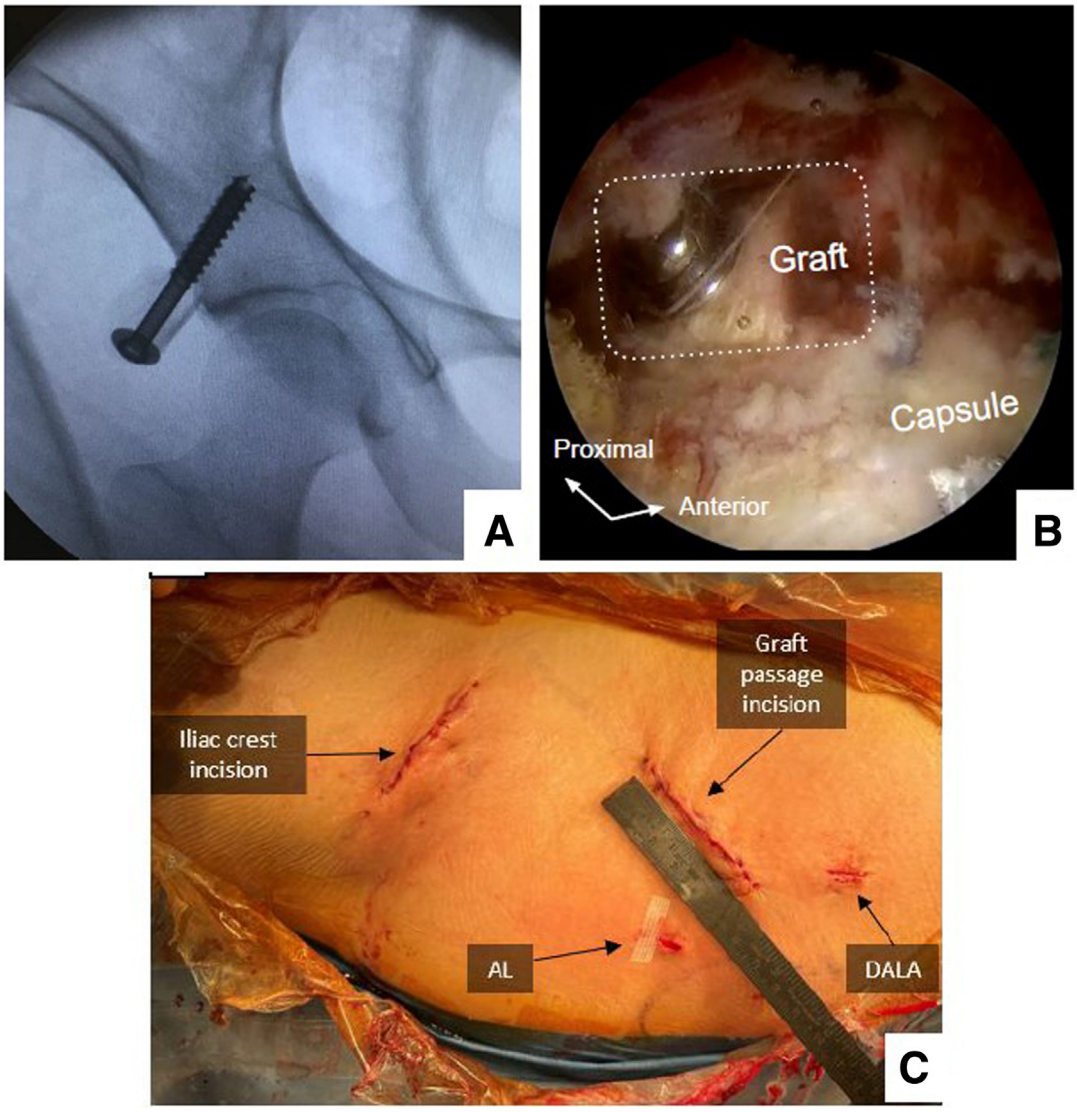

Fig 5. (A) Fluoroscopic control of the graft. (B) Arthroscopic control of the graft. (C) Incisions closure. (AL, anterolateral portal; DALA, distal anterolateral accessory portal.)

fluoroscopic imaging (Fig 4 E and F). The K-wire should be angled 45° anteroposteriorly and proximodistally, in the direction of the sacroiliac joint, in order to obtain the best possible bone fixation and limit the risk of vascular damage. Once the position is confirmed, screw path is drilled.

The midanterior portal is widened by 4 cm. The autologous bone graft with the screw already in place is passed through the guide wire and positioned using Kocher forceps. The use of a single-screw fixation makes it possible to adapt the position of the graft. Once the position is correctly adjusted in accordance with the underlying capsule, the 45° chamfer applied to the prepared footprint ensures the stability of the graft. It is then fixed with the partially threaded 7.2-mm cannulated screw (Zimmer Biomet) and a particular attention must be paid to the tightness of the screw (Fig 4 G and H). The position of the graft is finally checked under endoscopy and fluoroscopy and must be in contact with the capsule and capsular sutures (Fig 5).

Postoperative Management and Rehabilitation

During the first 6 weeks, the patient is allowed to have partial weight-bearing; gentle passive range-of-motion exercise is permitted. After 6 weeks, weight-bearing is increased progressively and active range of motion is allowed. Radiographic controls are done at 6 weeks, 3 months, and 6 months (Fig 6).

Discussion

We present our endoscopic technique for shelf acetabuloplasty (Video 1). The shelf procedure, less invasive than PAO, has already produced satisfactory long-term results in the treatment of dysplasia in young

Fig 6. Example of radiographic assessment of a shelf acetabuloplasty at 3 months' follow-up showing graft osteointegration in progress without bone resorption.

patients.[14] However, the original techniques involved an open surgical approach and control of graft positioning mainly via fluoroscopy, which can be challenging.[15] The addition of endoscopy makes it possible to limit the surgical approach, to control the positioning of the graft, and at the same time allows intracapsular procedures such as cam resection, labral repair, and management of chondral lesions. We list the advantages and disadvantages in Table 2. Labral lesions and FAI frequently are present in patients with hip dysplasia and contribute to patient pain.[2,16] In order to improve the results of surgical treatments, these lesions must be supported by the procedures concerned.

Table 2. Advantages and Disadvantages of the Endoscopic Shelf Acetabuloplasty Associated With Intracapsular Hip Arthroscopic Management

Advantages	Disadvantages
Treat simultaneously hip dysplasia and FAI	Technically demanding
Direct endoscopic assessment	Requires careful patient selection
Early rehabilitation	Outer cover without cartilage
Shorter hospital stay than PAO	Newer procedure than PAO

FAI, femoroacetabular impingement; PAO, periacetabular osteotomy.

Maldonado et al.[9] described an endoscopic shelf acetabuloplasty procedure using two 3.5-mm cannulated screws and Uchida et al.[8] only another one only using pressfit. Osteosynthesis with a single 7.2-mm diameter screw as in our technique is similar to that used by Chiron et al.,[10] which has already proven its worth. In our opinion, the use of this screw provides a very satisfactory fixation, limits the risk of graft fracture, and allows the positioning to be adjusted right up to the final tightening. Moreover a 7.2-mm screw appears to be a resistant screw, avoiding breakage. The angulation of the chamfer ensures significant contact between the cancellous bone and the cortex of the avivated iliac wing, increasing the chances of consolidation. In addition, the 45° angulation of the wire reduces the risk of vascular injury during drilling. The limits of our endoscopic technique are the risk of failure, the learning curve, and other previously reported potential complications inherent in hip arthroscopy (Table 3).

Table 3. Pearls, Pitfalls, and Risks of the Endoscopic Shelf Acetabuloplasty Associated With Intracapsular Hip Arthroscopic Management

Surgical Step	Pearls and Tips	Pitfalls	Risks
Intracapsular hip arthroscopy should be done first	• Labral assessment and preservation/reconstruction as much as possible • The femoroplasty must be checked dynamically and fluoroscopically with various incidences • Capsule plicature using an automated suture passer	• Excessive acetabular preparation with the burr	• Too extensive an acetabuloplasty could destabilize an already dysplastic hip • A femoroplasty that is too extensive could lead to a potential risk of fracture • Poor capsuloplasty carries a risk of microinstability
Shelf acetabuloplasty	• Harvest a tricortical bone graft posterior to the ASIS to avoid the lateral femoral cutaneous nerve • Prepositionning the screw through the bone graft • Guidewire should be introduced on a 45° ascending orientation through the mid-anterior portal and guidance checked with fluoroscopic imaging • The graft should be in contact with the capsule	• Excessive screw tightening leads to graft fracture especially is the graft isn't tricortical shaped • A suspended graft is at risk of lysis, whereas a graft that is too low is at risk of conflict	• There is a risk of vascular damage when positioning the pin and screw, which must be prevented by careful radioscopic monitoring

ASIS, anterosuperior iliac spine.

In conclusion, our technique seems to be a reliable procedure for shelf acetabuloplasty that allows intracapsular associated procedure. In our opinion, this technique may be a surgical option in the management of borderline dysplasia in young patients, as it is less invasive and less risky. Nevertheless, comparative long-term studies are needed to confirm our results.

Disclosure

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: M.T. reports personal fees from Arthrex, outside the submitted work. All authors (P-J.L., A.C., M.S., T.D.V., A.S-E.) declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper. Full ICMJE author disclosure forms are available for this article online, as supplementary material.

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