Technical Note

Modified Shelf Acetabuloplasty Endoscopic Procedure With Allograft for Developmental Hip Dysplasia Treatment

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Abstract: Hip dysplasia has been identified as one of the leading causes of osteoarthritis. However, hip arthroscopy alone, in the setting of hip dysplasia, remains controversial. In borderline hip dysplasia, with lateral center-edge angle (LCEA) between 18° and 25°, good outcomes have been reported with appropriate capsular and labral management. However, in severe hip dysplasia, with LCEA below 18°, there is an acetabular bony structural deficiency that must be addressed. Even with the potential benefit of hip arthroscopy in addressing intra-articular injuries related to the instability, it cannot be used for soft-tissue procedures. Periacetabular osteotomy remains the gold standard to address that matter; however, its invasive nature along with the long recovery time leaves some patients unwilling to undergo this procedure. New minimally invasive endoscopic procedures, derived from open techniques, describe acetabular autologous bone grafting as an alternative. Donor-side morbidity is always a concern when using autografts; we believe that the use of bone allograft will decrease this potential issue and make the procedure itself less invasive. This Technical Note will describe a type of endoscopic shelf acetabuloplasty using an allograft iliac bone graft.

The shelf procedure is not new; it is in fact the oldest procedure for acetabular dysplasia treatment.[1] It was first described by König in 1891 and modified and popularized by Gill in 1926.[1,2] Afterwards, Wiberg improved the technique and the results of the procedure,[3] with the operative aim to stabilize movement of the femoral head by increasing the acetabular coverage in the weight-bearing position.

The advent of the periacetabular osteotomy (PAO), described by Ganz et al.,[4] was a "game changer" in the treatment of the developmental dysplasia of the hip (DDH) in the young and active patient. Albeit a more complex and technically demanding surgery, it tends to yield good results at long-term follow-up.[5,6]

However, intra-articular pathology is common in the dysplastic patient,[7,8] and a failure to address these potential pain sources could be a major factor in failures or revision rates.[9-16] Different investigators have described the possibility of concomitant PAO and hip arthroscopy with the objective of combining the advantages of both techniques, bone and intra-articular corrections, in a single surgical time.[17-19] Nevertheless, PAO alone or with the addition of hip arthroscopic surgery remains a challenging procedure, and experienced hands are needed to avoid catastrophic complications.[20,21] In addition, long recovery periods may be unappealing for some patients.

In a pursuit of more minimally invasive options that still can correct bony acetabular deficient (Fig 1) and intra-articular joint pathology, Uchida et al. recently reignited interest in the shelf procedure but used endoscopic techniques and an iliac crest autograft.[22] We describe our shelf technique with 2 important variations: first, using bone allograft in order to avoid

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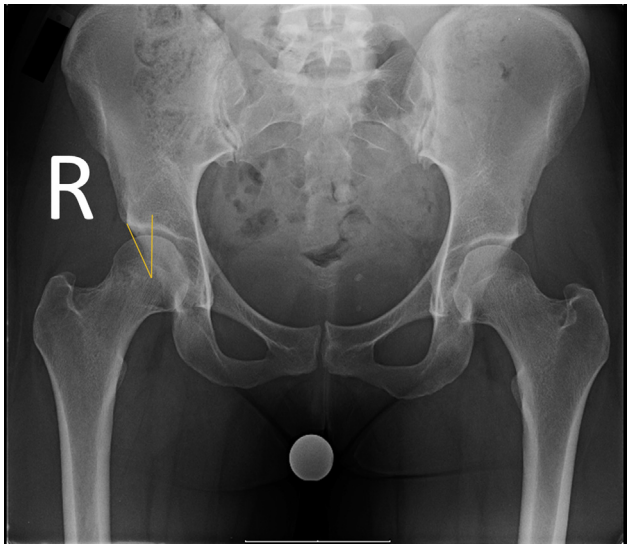

Fig 1. Anteroposterior pelvis preoperative x-ray. Right side (R) shows true acetabular dysplasia with a lateral center-edge angle (LCEA) of 15°.

potential donor-side morbidity risk and second, using cannulated screws for graft stabilization (Video 1).

Surgical Technique

Patient Positioning

Preoperative preparation begins with placing the patient in the modified supine position on the Advanced Supine Hip Positioning System (Smith and Nephew, London, UK), in slight Trendelemburg with a well-padded perineal post. Traction is implemented when necessary.

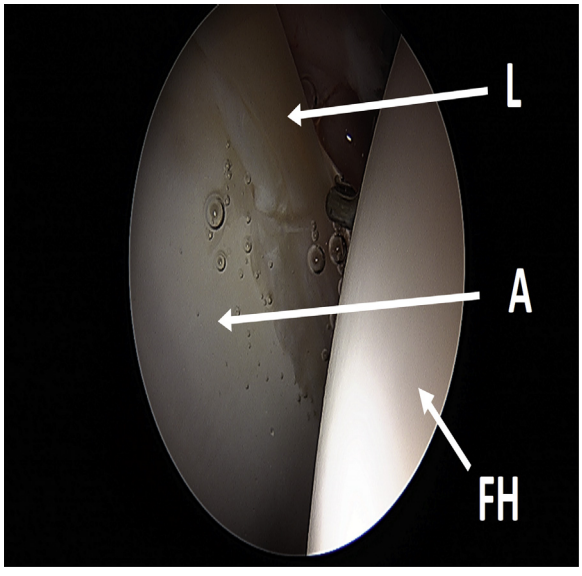

Fig 2. Right hip, supine position, 70° arthroscope, arthroscopic view from anterolateral portal, probe from anterior portal. A, acetabulum; FH, femoral head; L, labrum.

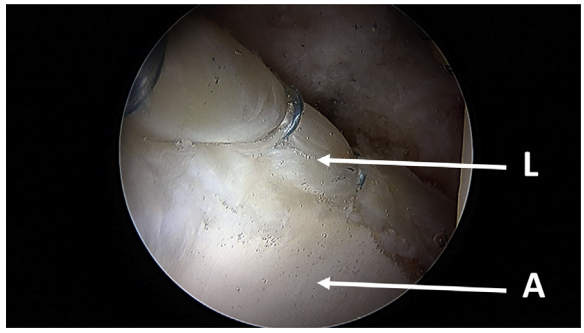

Fig 3. Right hip, supine position, 70° arthroscope, arthroscopic view from anterolateral portal after labral repair. A, acetabulum; L, labrum.

Arthroscopic Access and Portal Placement

A spinal needle is introduced into the joint to vent and allow for distraction. Traction is first applied to the nonoperative leg and then applied as needed to the operative leg at a maximum of 50 pounds. The hip joint is accessed through the anterolateral, midanterior, and distal anterolateral accessory (DALA) portals as described by Domb et al.[14] An interportal capsulotomy is created between the standard anterolateral and midanterior portals with a 4-mm Arthro-Lok Banana beaver blade (Beaver-Visitec International, Waltham, MA).

Diagnostic Arthroscopy

A systematic diagnostic arthroscopy is performed with a 70° Direct View Arthroscope (Smith and Nephew) and a 4.8 mm hook tip probe (Arthrex, Naples, FL). The ligamentum teres, acetabular notch, iliopsoas impingement sign, labral and chondrolabral junction conditions, and acetabular and femoral head cartilage are assessed (Fig 2).

Initial Capsular Management

Capsular management is vital. An effort to preserve capsular tissue is made throughout the entire case. Using a 3-mm 50° radiofrequency wand (Smith and

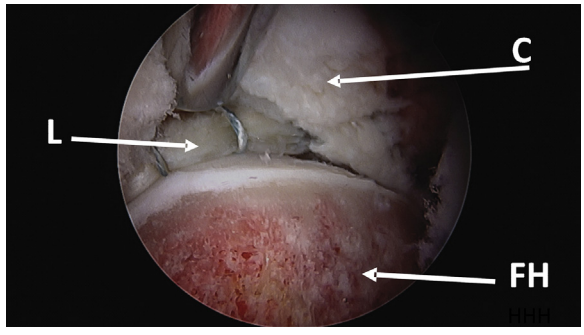

Fig 4. Right hip, supine position, 70° arthroscope, arthroscopic view from anterolateral portal, shaver from anterior portal. C, capsule; FH, femoral head; L, labrum. "Suction seal" restored, and capsular tissue preserved.

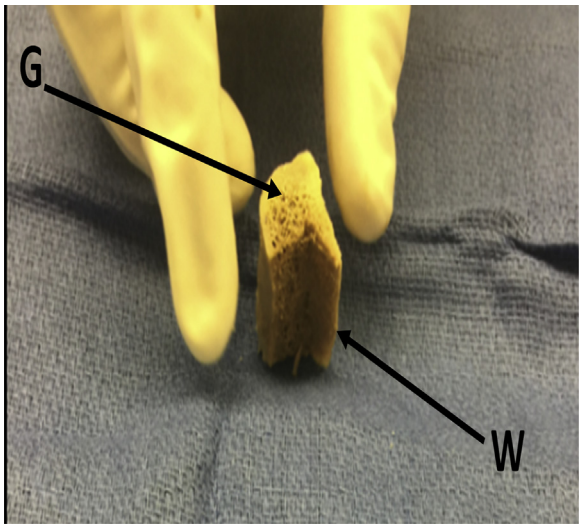

Fig 5. Image showing the final preparation of bone allograft (G) and the wedge shaped wing (W) that is used to mate with the trough created along the anterior acetabular rim.

Nephew), capsular elevation from the acetabular side is performed in order to get the best exposure possible for anchor placement prior to labral repair. To improve visualization, SlingShot Suture Managers (Pivot Medical, Sunnyvale, CA) are used to pierce the acetabular capsule cuff and put a traction stitch with a no. 2 Fiber Wire (Arthrex).

Labral Assessment and Repair

No trimming of the acetabular rim is indicated. The cortical bone is refreshed to ensure proper healing of labral repair with a motorized 5.5-mm round burr (Smith and Nephew). Knotless SutureTak anchors (Arthrex) are placed through the distal accessory portal with 6 to 8 mm of spacing for labral repair using a looped technique with a Nanopass Suture Management System (Pivot Medical; Figs 3 and 4).

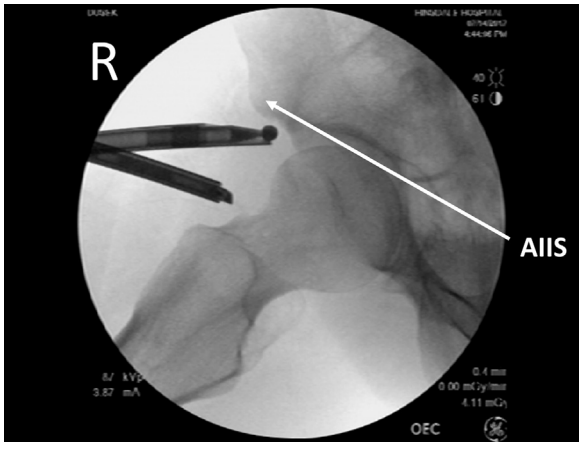

Fig 6. Right hip (R), fluoroscopic view, Dunn view, arthroscope in the anterolateral portal, burr in the anterior portal. AIIS, anterior-inferior iliac spine.

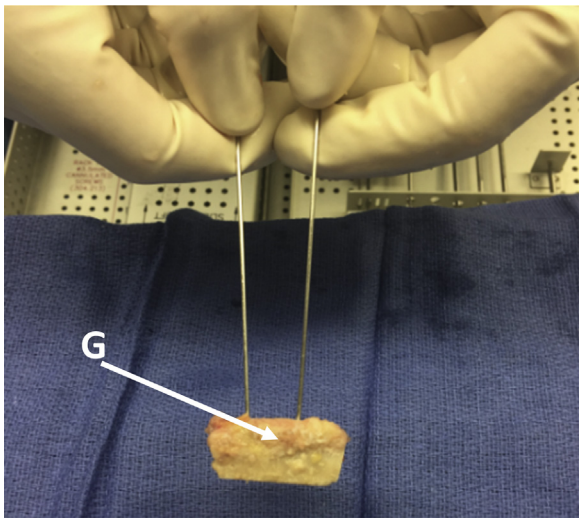

Fig 7. Two parallel 1.25-mm threaded guide wires are place in the allograft (G).

Femoral Osteochondroplasty

For assessment and treatment of cam deformities, traction is released. A traction stitch is placed in the inferior capsule with a SlingShot Suture Manager, and a no. 2 Fiber suture is passed, allowing full exposure of the peripheral compartment without the necessity of a "T" capsulotomy. A cam osteochondroplasty is performed using a motorized round burr.

Capsular Plication

At 45° of hip flexion, the capsule is plicated with 6 no. 2 Vicryl sutures (Ethicon, Somerville, NJ). SlingShot Suture Manager is used to pierce the superior and inferior capsular cuffs. Knot tying is done after all sutures are passed.[23]

Graft Preparation

To avoid donor-site morbidity, an iliac wing bone allograft is selected. The graft size is prepared to 10 mm in width and 20 mm in depth with an additional 3 × 7 mm tapered wing wedge created at the superior

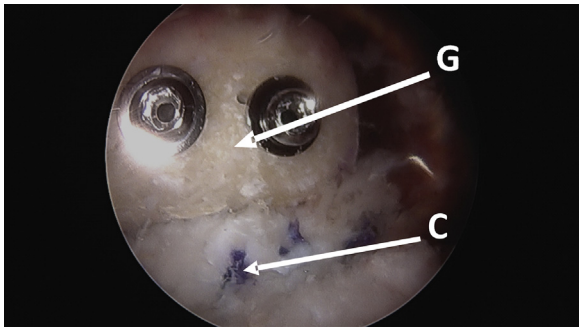

Fig 8. Right hip, supine position, 70° arthroscope, arthroscopic view from anterolateral portal of the final construct. C, capsule; G, allograft.

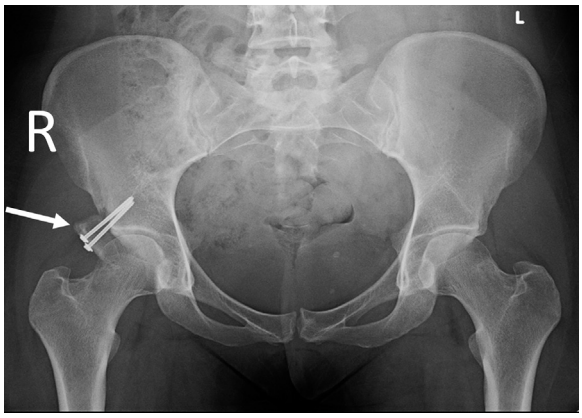

Fig 9. Anteroposterior pelvis postoperative x-ray showing final result on the right (R) hip.

aspect. This wing will mate with a trough created along the anterior acetabular rim (Fig 5).

Endoscopic Stage

By combined use of a 4-mm shaver (Smith and Nephew) and a 3-mm 50° radiofrequency device, a working space is created between the reflected head of the rectus and the anterior acetabular rim to assist in further graft placement. Proper location of the space is confirmed by the use of fluoroscopy (Fig 6). Decortication of the space is performed with a 5-mm burr. A 10-mm osteotome is introduced through the DALA portal, and a trough measuring approximately 10 mm wide and 20 mm deep is created, similar to the method described by Uchida et al.[22] The trough is deepened at the superior aspect to create space for 3 × 7 mm wing wedge fabricated on the allograft bone graft.

Two parallel 1.25-mm threaded guide wires (DePuy-Synthes, West Chester, PA) are passed through the graft (Fig 7), and the graft itself goes through the DALA portal. Adequate position and orientation of the graft is confirmed via combined arthroscopic and fluoroscopic views. Once the position is confirmed, both 1.25-mm threaded guide wires are advanced to the previously created bone slot, and final fixation is achieved with 2 partially threaded 3.5-mm cannulated screws (DePuy-Synthes; Figs 8 and 9).

Table 1. Surgical Indications and Contraindications

Indications	Contraindications
Hip pain	Severe dysplasia, LCEA < 12°
Positive anterior and posterior impingement tests	Advanced osteoarthritis
LCEA between 12° and 20°	Associated severe skeletal abnormalities (perthes, coxa magna, slipped capital femoral epiphysis)
MRA evidence of a labral tear	Active infection
No evidence of severe chondral damage evidence on dGEMRIC MRA	Skeletally immature patients (age < 12 years)
Tönnis grade 0 or 1	Bipolar and severe chondral damage

dGEMRIC, delayed contrast-enhanced magnetic resonance imaging of cartilage; LCEA, lateral center-edge angle; MRA, magnetic resonance arthrography.

Table 2. Advantages and Disadvantages

Advantages	Disadvantages
Arthroscopic visualization	Steep learning curve
Treatment of concomitant pathologies such labral tears, femoroacetabular impingement, and iliopsoas impingement	Meticulous technique
No donor-side morbidity	Not applicable for severely dysplastic patients
Minimally invasive surgery	Lack of long-term follow-up

Postoperative Rehabilitation

After surgery, the patient is placed in a brace (Donjoy X-Act ROM Hip Brace, Vista, CA) for 6 weeks in order to protect the hip and limit abduction and rotation. Gentle passive range-of-motion exercise is initiated during the first week under the supervision of a physiotherapist. During the first 6 weeks, the patient remains in 20 pounds of flat foot partial weight bearing. Active hip flexion is not allowed until week 6, and from then weight bearing is gradually increased. Full weight bearing is allowed at 8 weeks after surgery.

Discussion

We present our endoscopic technique for the shelf acetabular procedure for the management of developmental hip dysplasia in the young and active adult. In the pursuit of a more minimally invasive procedure, we use an iliac wing bone allograft to avoid potential donor-side morbidity.[24] To improve fixation stability we also added the use of cannulated screws.

Our current indications and contraindications are reflected in Table 1. Currently in our clinical practice, PAO with concomitant hip arthroscopy is our gold standard for DDH treatment of the young adult.[18] The endoscopic shelf procedure is offered as an alternative

Table 3. Pearls and Pitfalls

Pearls	Pitfalls
Intra-articular work is done first.	Does not address associated intra-articular pathologies.
Labral functional preservation, through repair or reconstruction	Labral debridement
Preserves the capsule for further capsular plication.	Inadequate capsular management: capsulectomy or nonplication
Fluoroscopy use during the case	Improper placement of the allograft

Table 4. Risks

Arthroscopy/Endoscopy Related	Graft Related
Abdominal extravasation	Allograft fracture
Abdominal compartmental syndrome	Allograft nonhealing
Tight compartmental syndrome	Allograft reabsorption

treatment for patients who meet those indications and do not want to proceed with PAO. Even with the potential advantages involved in this minimal invasive surgery (Table 2), we believe that more high-quality studies with follow-up are needed prior to recommending the shelf procedure as an equal surgical alternative to PAO. Pearls and Pitfalls are shown in Table 3. Acknowledging the demanding nature of this endoscopic procedure, the risks must be recognized and considered (Table 4). When incorporating time-consuming arthroscopy techniques to address intra-articular pathologies to the operation, extravasation is a vital concern.[25-27] The surgeon must also factor in other previously reported potential complications inherent in hip arthroscopy.[28-30]

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