Technique for Combined Hip Arthroscopy and Periacetabular Osteotomy for the Patient with Hip Dysplasia and Intraarticular Pathology

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ABSTRACT

The Bernese periacetabular osteotomy (PAO) is a powerful technique for correcting acetabular coverage in patients with developmental dysplasia of the hip. However, there is increasing recognition of additional intraarticular pathologies that may contribute to ongoing pain. For this reason, for the last 3 years, we have combined hip arthroscopy with PAO to treat intraarticular pathology along with improving acetabular coverage. Our technique is reviewed below.

Keywords: Arthroscopy, Dysplasia, Hip, Osteotomy.

INTRODUCTION

Periacetabular osteotomy (PAO), originally described by Reinhold Ganz in 1984, has become the most common treatment for developmental dysplasia of the hip (DDH, Fig. 1) in adolescents and young adults. Periacetabular osteotomy corrects instability and improves femoral head coverage by realigning the acetabulum while maintaining congruity of the posterior column. Routine inspection of the hip joint was not included in the original description of the PAO, but subsequent studies have shown that there is a high incidence of intraarticular pathology present in patients with DDH undergoing PAO. Additionally, a recent systematic review of the literature showed a much higher incidence of recognized pathology in patients undergoing arthroscopy compared with arthrotomy at the time of PAO. Furthermore, recent literature suggests that some patients, despite bony correction, have residual joint pain presumed to be from intraarticular pathology. Bony correction may also lead to iatrogenic femoroacetabular impingement (FAI), and this residual impingement may negatively affect the results of PAO surgery. We have routinely performed hip arthroscopy with treatment of intraarticular pathology along with PAO since December 2012 due to the aforementioned literature and our own clinical observations.

TECHNIQUE

Standard supine arthroscopy technique is used with the patient positioned on either a Hana or ProFx fracture table (Mizuho OSI, Union City, CA, USA) with the use of traction with an arthroscopy perineal post to allow access to the central compartment. The surgical field is prepped and draped from the rib cage proximally to the mid thigh distally, from 2.5 cm to the anterior superior iliac spine (ASIS) medially to several centimeters posterior to the greater trochanter laterally. The surgical field is then covered with an iodine-impregnated adhesive barrier. After the arthroscopy is completed, the table allows for controlled hip flexion later in the procedure for the PAO. This allows both procedures to be performed with one surgical prep and drape.

HIP ARTHROSCOPY

A spinal needle is used to establish the appropriate position and orientation for the anterolateral portal (ALP). Due to the incidence of large, oversized labrums in the dysplastic population, the needle routinely enters the joint at a slightly more oblique angle than for standard arthroscopy (parallel to the lateral aspect.

Fig. 1: Anterior portal pelvis demonstrating preoperative lateral center edge angle of 18° and Tonnis angle of 17°.
of the femoral head). The stylet is removed and an air arthrogram demonstrates appropriate intraarticular position. The needle is removed and repositioned to ensure that this portal is not placed through the labrum. Direct visualization from the ALP is used to identify the anterior femoral triangle. A spinal needle is then used to establish the modified anterior portal (AP). A long handle double-sided blade (Stryker, Kalamazoo, MI, USA) is used to create the interportal capsulotomy. The capsulotomy may also be extended more medially if further central compartment access is needed. Retention sutures are then placed in the medial and lateral ends of the proximal capsule using a suture-passing device (Stryker, Kalamazoo, MI, USA). These sutures are then snapped in tension against the skin with a medium forceps.

The central compartment is then inspected. In dysplastic patients, the labrum is often hyperplastic with evidence of chondrolabral disruption (Figs 2 and 3). If torn and/or unstable, labral repair is performed. A combination of a shaver and radiofrequency (RF) ablater (Arthrocare) is used to separate proximal capsule from labrum and expose the acetabular rim. As this is done, the retention sutures often require retensioning to maintain tension and lift the capsule away from acetabular rim and anterior inferior iliac spine (AIIS), thereby minimizing damage to the proximal limb of the capsule and increasing visualization. Once exposed, the acetabular rim is prepared for labral fixation using a combination of RF, shaver, and 5 mm high-speed burr with goal of minimal bone resection. Based on preoperative three-dimensional (3D) imaging, an area of focal acetabular prominence may be resected to leave a smooth, continuous rim in place. Preoperative 3D imaging is also used to assess the character of the AIIS. It is rarely symptomatically prominent initially; once PAO has been performed it may become prominent. In cases where this is a concern, the AIIS is recessed in order to prevent postoperative subspinous impingement. Following completion of the bony work to the AIIS and acetabular rim, labral repair is performed (Fig. 4). The ligamentum teres is commonly hypertrophic and partially torn in patients with hip dysplasia (Fig. 5). A combination of RF and arthroscopic shaver is used to debride the torn ligamentum when necessary. Following treatment of all central compartment pathology traction is released. If there is evidence of CAM deformity or focal area of femoral neck prominence on preoperative 3D imaging, traction sutures are placed in the distal limb of the interportal capsulotomy to allow access to the area of femoral neck prominence. Femoral osteochondroplasty

Fig. 2: Intraoperative arthroscopy demonstrating a labral tear and wave sign in a patient prior to undergoing PAO

Fig. 3: The probe demonstrating labral diameter greater than 10 mm. Labrum size is often larger in dysplastic patients

Fig. 4: Labrum following repair

Fig. 5: Ligamentum teres tear. Also, commonly found in dysplastic patients during hip arthroscopy prior to PAO
is performed with the use of a high-speed burr. The hip is often flexed to 30 to 45° to allow access to the distal portion of the femoral neck if needed. Fluoroscopy is used to assess the femoral osteochondroplasty. Once all central and peripheral compartment pathology is addressed, all arthroscopic instruments are removed from the joint. Closure of the arthroscopy is completed at the end of the PAO.

PERIACETABULAR OSTEOTOMY

The leg is brought into slight flexion for the initial approach for the PAO. No redraping is required. Traction is released from both the operative and nonoperative leg. The arthroscopy equipment is passed off the field. Cell saver suction and electrocautery are brought onto the leg as far as the classic Smith-Peterson approach. Dissection is performed through subcutaneous tissue over the iliac crest. The external oblique fascia is released off the lateral edge of the iliac crest extending medially to preserve the attachments of the oblique muscles to the iliac crest. The release is performed 6 to 8 cm proximal to the ASIS and extended distally to the ASIS. From the ASIS, dissection is continued distally through subcutaneous tissue to expose the fascia overlying the tensor fascia lata (TFL). Tensor fascia lata fascia is incised sharply from the iliac wing distally to the extent of the skin incision. This incision is performed over the mid-portion of the TFL muscle belly. The hip is brought back into an approximately 40° of flexion using the fracture table. From inside the TFL fascia the inguinal ligament is released sharply from its attachment to the ASIS, allowing medial retraction of the lateral femoral cutaneous nerve and providing access to the internal iliac fossa. Other authors have described an osteotomy of the ASIS rather than release inguinal ligament from the medial aspect of the ASIS. Both options are acceptable.

The deep fascia of the TFL and rectus femoris are incised and the rectus tendon is retracted laterally. Iliacus muscle is then released from the internal iliac fossa to the pelvic brim. Continuing dissection distally allows identification of the hip capsule lateral to the iliocapsularis muscle. Often the arthroscopic capsulotomy is apparent at this stage. The proximal origin of the iliocapsularis is identified along the acetabular rim. The origin is released with scissors and the interval between the iliocapsularis and the hip capsule is opened. Dissection is continued medially onto the superior pubic ramus. Location on the superior pubic ramus is confirmed using fluoroscopy. The periosteum overlying the pelvic brim is incised with electrocautery. A Cobb elevator sweeps periosteum off of the pelvic brim and quadrilateral surface mobilizing the medial structures for the use of an Ava retractor to expose the deep pelvis. A Cobb elevator is used to further release the iliacus muscle and to sweep over the pelvic brim and onto the quadrilateral surface with care taken that the tip is always pointed distally and hugging bone. A radiolucent Ava retractor is placed over the pelvic brim to retract soft tissue medially. The periosteum over the superior ramus is scored. A curved elevator is used to elevate periosteum circumferentially around the superior ramus taking care to mobilize the obturator neurovascular bundle to allow a retractor to protect these structures during the superior ramus osteotomy. This also aids the pubic osteotomy to move freely once the osteotomy is made.

The traditional approach to the ischium involves release of the direct head of the rectus femoris followed by dissection down the anterior hip capsule to allow placement of the osteotome. In our approach, the rectus femoris tendon is left intact and access to the ischium is made slightly medially. The hip is flexed to at least 70°, and the iliopsoas tendon is mobilized and retracted anteriorly. A Cobb elevator is used to raise periosteum distally along distal aspect of the superior pubic ramus as it transitions from the anterior acetabular rim. A curved rounded tip elevator is used to elevate the periosteum of the distal aspect of the superior ramus to gain access along the inferior border of the quadrilateral surface and onto the ischium. This opening is enlarged to allow placement of the curved osteotome onto the ischium. As with the standard techniques the placement of the osteotome can be confirmed with palpation over the pelvic rim along the quadrilateral surface, as well as with palpation with elevator and osteotome, and c-arm imaging. Care must be taken to ensure the elevator is not placed laterally along the hip capsule or intraarticularly.

With the curved osteotome placed on the anterior aspect of the ischium the c-arm is positioned opposite to the surgeon. The AP view is used to confirm correct placement of the osteotome on the ischium. The image intensifier is then rotated away from the surgeon 40 to 45° to visualize an iliac oblique view to assess the orientation of the osteotome blade in the ischium. Appropriate position is distal to the joint surface in the subcotyloid groove and aimed toward the ischial spine. This is confirmed fluoroscopically on both AP and iliac oblique views. This is an incomplete cut of the ischium extending from 50 to 75% of the way through the bone of the ischium (Fig. 6A). The first cut made is often along the medial aspect of the ischium and quadrilateral surface.
Depending on the width of the ischium, the ischial cut may take more than one pass of the osteotome to ensure the cut extends from the medial aspect of the ischium all the way through the cortex of the subcotyloid groove laterally. While this cut is not complete through the ischium from anterior to posterior, the cut must extend from the medial to lateral cortex of the anterior surface of the ischium bone. If this cut is not complete at this stage it will not allow the acetabular fragment to move freely once the subsequent cuts are made.

An Ava retractor is placed posterior to the superior pubic ramus in the obturator canal, where the neurovascular bundle was mobilized in the earlier dissection, to protect the iliac vessels during the pubic ramus osteotomy. Fluoroscopy is used to confirm placement of the retractor and assess the starting point for the superior pubic ramus cut. A straight osteotome is used to make this cut obliquely from anteromedial to posterolateral (Fig. 6B). This may require more than one pass with the osteotome to ensure that the cut is completed across the pubic ramus.

The level for the supra-acetabular portion of the iliac wing osteotomy is determined using fluoroscopy. This may be at or just distal to the ASIS, although it is often proximal to the ASIS when the dysplasia is more severe. The level of the osteotomy is determined to ensure there is adequate bone stock in the acetabular fragment to correct the acetabular position and obtain adequate fixation. The gluteal muscles are elevated from the external iliac wing along only in the area where the iliac wing cut will be made, and then in an area just wide enough to place a Hohmann retractor deep to the muscles prior to making the iliac wing cut. An iliac oblique fluoroscopy view is used to target the appropriate posterior point to end the iliac wing cut. The posterior point is selected to the cut across the quadrilateral surface to connect with the initial ischial cut, and ideally to be made equidistant from the acetabulum and the posterior border of the innominate bone (Fig. 6C). An Ava retractor is placed over the pelvic brim and an oscillating saw is used to perform the iliac wing cut.

A straight osteotomy is positioned at the distal end of the iliac wing cut and angled in order to connect the iliac wing cut just made with the previously made ischial cut (Fig. 6D). This cut begins along the internal iliac fossa and crosses the pelvic brim as the cut progresses. It is important that the surgeon ensures the direction of the osteotome is correct as the pelvic brim is crossed. Care must be taken that the osteotome does not enter the joint as the osteotome passes between the acetabulum and the quadrilateral plate. Direct palpation of the osteotome edge along the quadrilateral surface ensures that the osteotome is in the bone – cutting the posterior column, but not straying laterally toward the sciatic nerve. Fluoroscopy is used to ensure that the osteotome connects with the initial ischial cut (Fig. 6E). Often a rotational osteolysis will complete the osteotomy when the quadrilateral and ischial cuts meet.

Once the final cut has been completed, a 5 mm Schanz pin is placed in the AIIS. If all cuts are complete, the periacetabular fragment should be freely mobile at this point. If it is not, the cuts need to be revisited. The fluoroscopy unit is then repositioned to obtain an AP view and the fragment is positioned to correct acetabular coverage. Correction is a three-step process. First, the fragment is rotated anteriorly. Second, lateral coverage is increased to normalize the lateral center edge angle, the acetabular inclination, and increase superior femoral head coverage. Lastly, acetabular version is set by evaluating the contour of the posterior and anterior acetabular rims. During this process, it should be noted that the center of rotation of the femoral head medializes; if this does not take place, there is likely an area of bone that has not been completely cut that is causing the fragment to hinge rather than freely rotate (Fig. 6F). Once the fragment is positioned appropriately, two 3.2 mm drill bits are placed from the iliac crest across the osteotomy and into the acetabular fragment. These are then measured and two large fragment, fully threaded screws (DePuy Synthes, Paoli, PA, USA) are placed, securing the fragment in place. Correction is assessed again. If correction is still appropriate, the Schanz pin is removed and this track is used to drill from the AIIS fragment into the ilium. A large fragment screw is placed for a total of three screws (Figs 7A and B). The hip is brought into full flexion to reassess the femoral head and acetabular rim for impingement. If further impingement exists, it will be addressed. Once this has been verified or corrected, the capsulotomy is closed using two #2 Ticron sutures.

Patients have an epidural placed preoperatively, which is maintained for 48 hours postoperatively to help with pain control. Patients are mobilized on postoperative day 2. They are touch-down weight bearing on the operative extremity for 8 weeks. The drain is most often maintained for 1 to 2 days postoperative based on output. Most patients are discharged on postoperative day 3 or 4.

DISCUSSION

Periacetabular osteotomy has been a successful operation to treat adolescent and young adult DDH with good long-term outcomes. There is recognition of significant intraarticular pathology with patients with symptomatic acetabular dysplasia. Increasingly there has been recognition that intraarticular pathology is often present in this patient population and may be a cause for persistent pain.
Figs 6A to F: Fluoroscopic images demonstrating the order of acetabular cuts: (A) Incomplete ischial cut with curved osteotome, (B) pubic ramus cut, note Ava retractor deep to the ramus, (C) supra-acetabular portion of the ischial cut, (D) initial position of the straight osteotome to connect the iliac and ischial cuts, (E) completing the ischial cuts, and (F) control of the fragment is obtained using a 5 mm Schanz placed through the (AllS). A Farabeuf forceps may also be used for additional control.

Fig. 7: Postoperative anterior portal pelvis with lateral center edge angle of 35° and Tonnis angle of 4°.

or lower functional outcomes. Albers et al. reported that residual FAI adversely impacted 10 years outcomes after PAO. Intermediate to long-term outcomes of patients with PAO demonstrate approximately 80% success at 10 years. The opportunity to combine techniques of combined arthroscopy and PAO is a compelling tool to attempt to continue to improve clinical outcomes for patients with symptomatic dysplasia.

One of the most controversial areas today is treatment of the patient with borderline dysplasia. Multiple authors...
are reporting outcomes of patients treated arthroscopically with borderline dysplasia.\textsuperscript{7-10} With the advent of 3D imaging to assess the morphology of the acetabular rim, many patients can be found to have asymptomatic borderline dysplasia with FAI symptoms and a prominent segment of the acetabular rim near a type II AIIS. These patients create a vexing problem for the surgeon. An osteochondroplasty of the acetabular rim at time of labral repair may resolve symptoms but at the expense of creating a potentially more significant dysplasia. Longer-term outcomes and a better definition of rim morphology are needed to fully address this issue.

In conclusion, we now perform combined hip arthroscopy and PAO nearly routinely when a labral tear is identified preoperatively in patients with DDH scheduled for a PAO. While this has increased operative time by approximately 70 minutes, there has not been an increase in overall complications. Preliminary outcomes of patients operated in 2013 have been reported. We are in the process of evaluating patient outcomes for those operated in 2014 and 2015.

REFERENCES