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ORIGINAL RESEARCH

The Bernese Periacetabular Osteotomy: A Review of Surgical Technique

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ABSTRACT

The Bernese periacetabular osteotomy (PAO) is a powerful technique in the treatment of hip dysplasia and related conditions of the hip. This technique is performed through a single anterior surgical approach. There are three steps in learning to perform the PAO. These include: mastering the surgical dissection required to perform the osteotomy, understanding the individual cuts that make up the PAO, and finally obtaining correction of the orientation of the acetabulum after the osteotomy is complete. The author's technique is reviewed in this work.

Keywords: Periacetabular osteotomy, Hip dysplasia.

INTRODUCTION

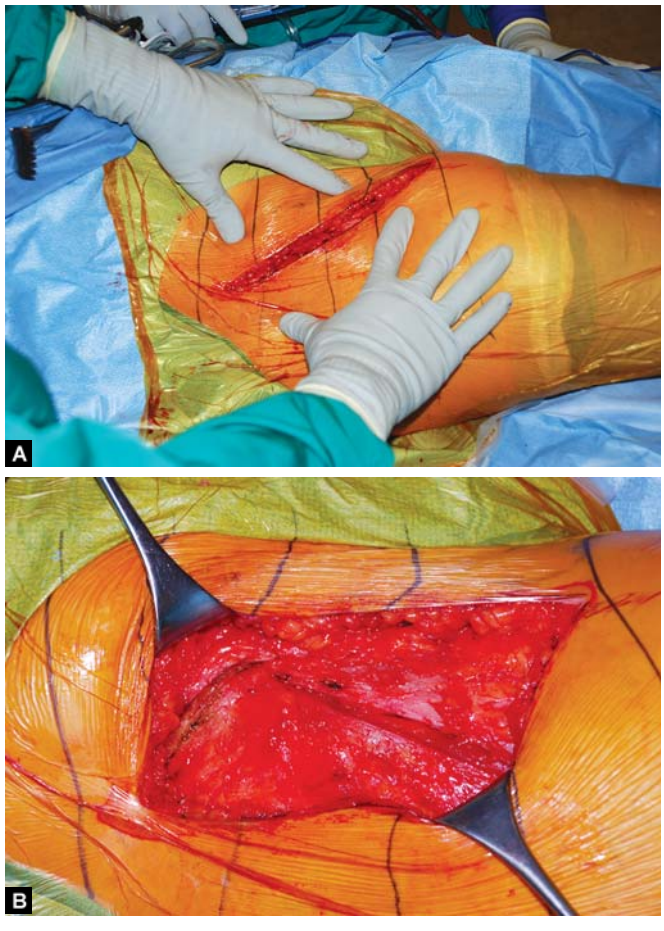
The Bernese pelvic osteotomy, commonly known as a periacetabular osteotomy (PAO), is an elegant surgical procedure that allows complete rotational realignment of the acetabulum through a single incision.[1] The procedure essentially excises the acetabulum from the innominate bone while leaving the posterior column intact.[2] The correction that is possible with a PAO is multidirectional and often quite dramatic in appearance. The procedure can be thought of in three stages: the surgical dissection, performing the osteotomy, and obtaining the desired correction. The procedure is technically demanding for the surgeon with a potentially significant learning curve. A solid grounding in anatomy of the lower abdomen and pelvis is essential.

SURGICAL TECHNIQUE

Surgical Dissection

The patient is placed supine on a flat-top radiolucent table. A bump is not used under either hip. The leg on the operative side is draped free. Generally, two adhesive drapes are used to form an occlusive seal about the hip and perineum with motion of the leg during the procedure. Foley catheter drainage is used in every case. Frequently, epidural catheters are placed preoperatively to enhance postoperative pain control. However, even with the epidural catheter, general anesthesia is most often used. Communication with the anesthesia team preoperatively is key as hypotensive anesthesia during the osteotomy is important to limit blood loss during the procedure. The procedure begins only after both sterile prep and drape, and a formal operative time-out have occurred.

The incision was originally described by Ganz et al, as extending along the anterior portion of the iliac crest and turning at the anterior superior iliac spine (ASIS) to follow the course of the tensor fascia lata (TEL) muscle.[2] This incision results in a relatively broad expansion of the healed surgical incision as the incision line runs across the hip flexion crease. This is particularly concerning for young female patients. The original incision is now reserved for larger patients (either very muscular or obese patients).



Figs 1A and B: The incision. (A) The orientation of the skin incision is demonstrated and (B) the orientation of the deep dissection is shown.

The current incision used for the majority of patients begins at the gluteal tubercle, extends to a point 2.5 cm lateral to the ASIS, and extends in line distal to the hip flexion crease (Fig. 1A). Once the incision is made, the deep dissection follows the Smith-Peterson interval (Fig. 1B).

Deep dissection begins with elevation of the abdominal wall muscular from the iliac crest at the ASIS and extends posteriorly to the gluteal tubercle. Care should be used to ensure the abductor musculature on the external aspect of the iliac wing is not disturbed during this dissection. The iliacus is not elevated from the internal aspect of the iliac wing at this point to limit blood loss during the initial dissection.

The fascia overlying the TFL is incised in line with its belly. The incision connects to the ASIS proximally and extends for a minimum of 15 cm distally. The TFL is mobilized laterally from this fascial bed, exposing the sartorius origin proximally and rectus femorus distally. The sartorius origin is elevated by releasing the attachment along the interspinous ridge of the iliac wing, extending between the ASIS and anterior inferior iliac spine (AIIS). The fibers of the iliacus are exposed at this point. With flexion of the hip, a fascial layer separating the iliacus portion of the iliopsoas and the rectus femorus is identified distally. This fascia is transected sharply for approximately 10 cm distally. The fibers of the iliacus are observed originating from the anterior surface of the hip capsule, medial to the rectus femorus tendon and muscle belly.

Electrocautery is used to define the lateral border of the iliacus as it abuts the rectus tendon. Using a curved mayo scissors, the iliacus fibers (referred to as the 'iliocapsularis' fibers by Ganz et al.) are elevated from the underlying hip capsule.[3] The dissection is continued distally to allow palpation of the inferior aspect of the femoral head and neck through the hip capsule, and continued medially to enter the iliopsoas bursa. With continued hip flexion, the iliopsoas muscle and tendon relax. The curved portion of a Hibbs retractor can be used to retract the psoas tendon anteriorly, exposing the distal aspect of the internal iliac fossa as the pelvic brim transitions into the superior pubic ramus. The iliacus is now elevated subperiosteally from distal to proximal. Careful technique will avoid significant muscle damage. Proximally and medially the nutrient foramen of the iliac wing is exposed just proximal to where the pelvic brim joins the distal aspect of the sacro-iliac joint. In many cases there is a distinct vessel running to the foramen. This vessel should be coagulated. In every case there is retrograde venous bleeding from the foramen itself. Bone wax is typically needed to control this bleeding.

An "Eva" retractor (Fig. 2) is placed just over the pelvic brim onto the quadrilateral surface and is used to retract tissues medially. The periosteum along the pelvic brim is scored. A sharp elevator is used to elevate the periosteum from the pelvic brim and quadrilateral surface. It is necessary to be able to palpate the posterior border of the greater sciatic notch later in the procedure. The "Eva" retractor is repositioned at an oblique angle along the quadrilateral surface with the tip near the ischial spine. At this point hip flexion should be at least 70°. Adduction of the femur relaxes the medial tissues.

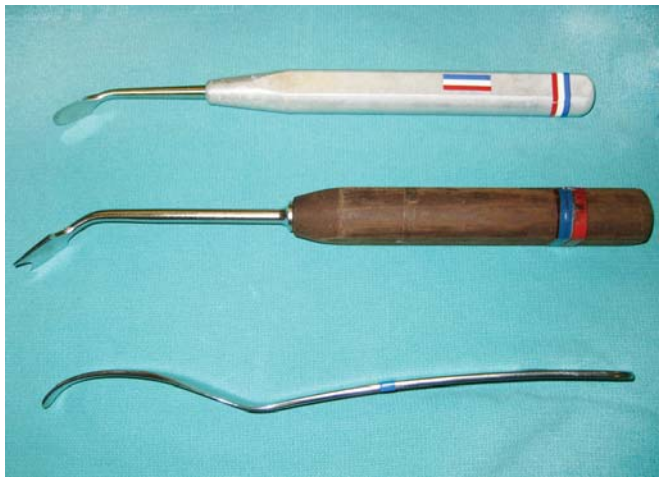


Fig. 2: Specialized instruments for performing PAOs are shown. These include a 30° angled elevator, a 30° angled osteotome and an "Eva" retractor.

The periosteum along the pelvic brim and lateral aspect of the superior pubic ramus should be scored in line with the superior pubic ramus. Often the lateral extent of the pectineus muscle belly comes into view during this dissection. A sharp, curved tip elevator is used to elevate the thick periosteum from the pelvic brim and superior pubic ramus. Dissection begins at the superior border of the superior pubic ramus. A sharp, round tie, curved periosteal elevator angled to 30° (Fig. 2) is needed to dissect the obturator neurovascular bundle from the under surface of the obturator canal, immediately posterior to the superior aspect of the root of the superior pubic ramus.

The final stage of the dissection is begun by elevating the periosteum from the inferior margin of the root of the superior pubic ramus. Once elevated, the 30° angled osteotome (Fig. 2) is used to mobilize the inferior aspect of the superior pubic ramus. The tip of the elevator can be used to palpate the anterior ridge of the ischium. An opening of the fascia at the inferior margin of the superior pubic ramus must be increased in size to approximately 15 mm to allow placement of the osteotome to gain access to the ischium.

Osteotomy

The osteotomy is begun at the ischium (Fig. 3). An incomplete cut is made here. This allows the posterior column of the innominate bone to remain intact when the osteotomy is complete. A 30° forked osteotome is required for this procedure. This osteotome is available in wide and narrow widths. Typically the narrow blade is used for this procedure. The osteotome is placed with the hip flexed to at least 70°. The iliopsoas tendon is retracted anteriorly. The blade of the osteotome is inserted through the elevated portion of the periosteum, along the inferior border of the superior pubic ramus. The osteotome runs under the psoas tendon, distal to

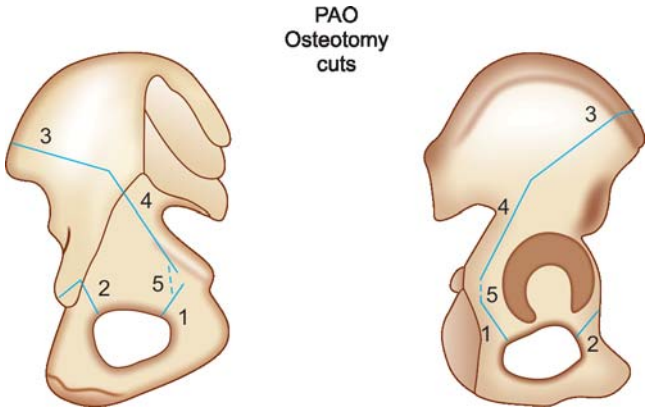
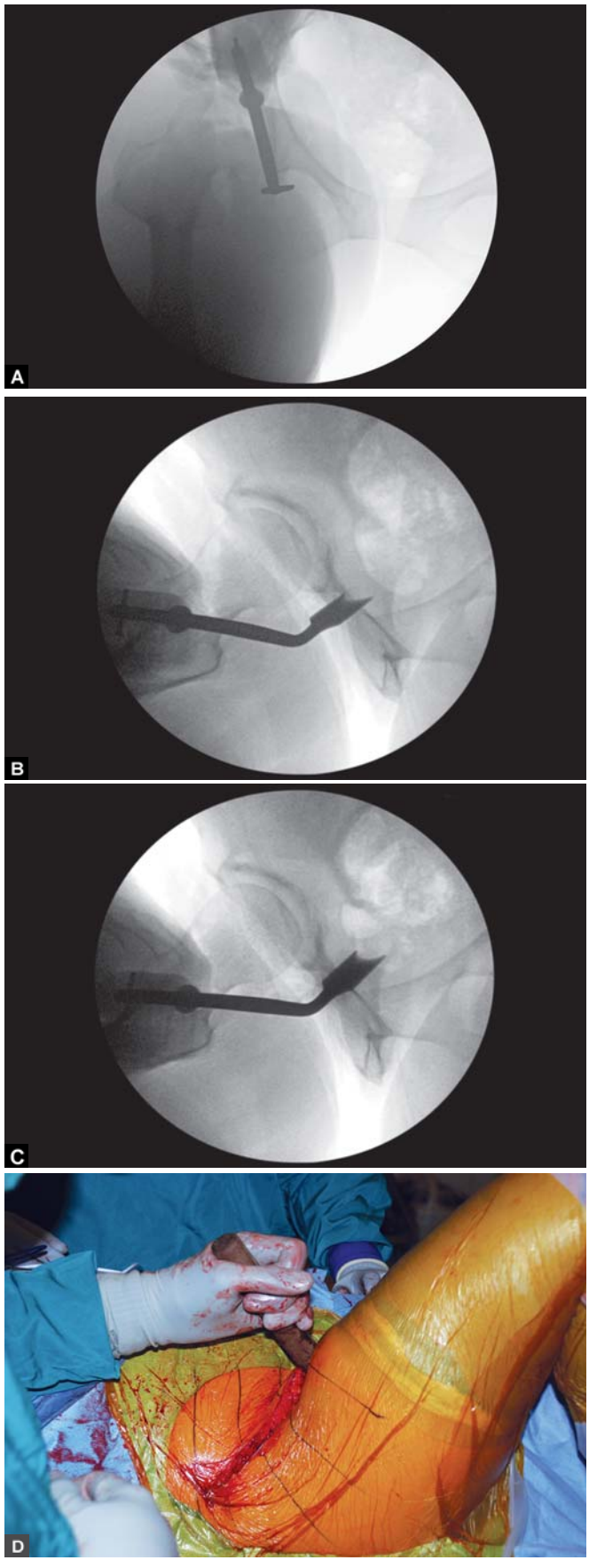


Fig. 3: A drawing of the innominate bone illustrates the locations of each of the cuts of the PAO. The osteotomy will often be complete with cuts 1 through 4 in many cases. The 5th cut (shown in dashed line) is required in a minority of cases.

the superior ramus, and on the anterior surface of the ischium. Typically this cut is located in the subcotyloid groove, just inferior to the posterior horn of the acetabulum.[4] This portion of the ischium has a broad cortical surface and generally requires two separate cuts. The first cut is on the medial cortical surface and the second cut on lateral surface. The hip should be extended slightly and abducted during this stage of the osteotomy. The osteotome can be visualized on the AP view with intraoperative fluoroscopy to ensure that the osteotome is in the correct position (Fig. 4A). The tip of the osteotome can also be palpated on the ischium by feeling the contour of the obturator ring along the inferior aspect of the quadrilateral surface. An ilioischial view can be used to ensure the ischial cut remains extra-articular and does not violate the posterior border of the innominate bone. Rotating the fluoroscopy unit away from the operative side results in an iliac oblique projection that can be used intra-operatively for this cut (Figs 4B and C). With moderate effort, the osteotome can be positioned so that the handle of the osteotome is vertical (perpendicular to the operating table), which places the blade at a 30° proximal inclination (Fig. 4D).

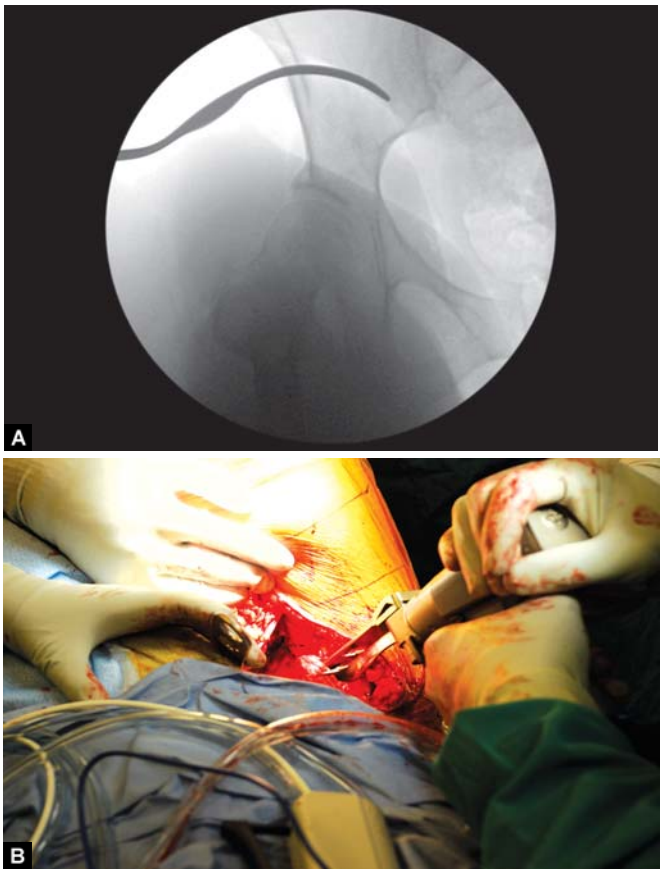
A complete cut of the superior pubic ramus is performed next. An Eva retractor is placed under the superior pubic ramus in the area of the obturator canal in order to protect the obturator neurovascular bundle. A straight lambott osteotome is used to perform this cut. The tip of the osteotome is placed at the level of the teardrop of the acetabulum, as seen on the AP view of the hip (Fig. 5). The osteotome is directed at a 45° angle from anterolateral to posteromedial in line with the superior pubic ramus.

The third cut of the osteotomy is made from the anterior aspect of the iliac wing to a point approximately 2 cm proximal to the pelvic brim. This is the only cut performed with an oscillating saw. The level of the osteotomy is determined on the AP view with intraoperative fluoroscopy. In general, the cut is made to preserve a minimum of 5 cm of intact bone



Figs 4A to D: (A) The AP view of the 30° osteotome in position for the first cut. (B and C) An iliac oblique view of the osteotome placement before and following completion of the cut, and (D) a clinical photograph of the correct placement of the osteotome for the first cut.

Fig. 5: An AP radiograph of the second cut is shown.



Figs 6A and B: The third cut. (A) An AP view indicating the level where the third cut in the iliac wing will occur preserving approximately 5 cm of bone above the acetabulum. (B) The oscillating saw in position to make the cut.

superior to the acetabulum on the AP view (Fig. 6A). Making this cut at the level of the ASIS can be satisfactory in some patients. In more severe cases of dysplasia, the level of this cut will need to be superior to the ASIS on the iliac crest to maintain adequate bone stock above the acetabulum for later fixation. When the level of the cut is determined, a narrow strip of abductor musculature on the external surface of the iliac wing is elevated with cautery to allow passage of a blunt hohmann retractor to protect the soft-tissues when using the oscillating saw (Fig. 6B). In general, it is better to err by extending the cut more posteriorly into the iliac wing, than leaving the cut too anterior. An excessively short or anterior cut can result in difficulty completing the osteotomy proximally, and in extreme cases can lead to an intra-articular osteotomy. In general, venous bleeding is increased from the bone itself upon completion of this cut.

The fourth cut begins at the posterior most extent of the third cut on the internal aspect of the iliac wing. The cut is made by directing a straight lambotte osteotome from this point across the pelvic brim and parallel to the greater sciatic notch. Rotating the fluoroscopy unit away from the operative side results in an iliac oblique projection that can be used intraoperatively to view the trajectory of the osteotome (Fig. 7). During this cut, the bone is strongest at the pelvic brim. In obese patients or in patients with extreme dysplasia, the orientation of this cut may require the osteotome to compress the chest wall. In the original description by Ganz et al, the quadrilateral surface cut was a scoring of the bone.[2] However, the technique has evolved to a formal cut of the bone of the posterior column in this cut. In general, the osteotome is oriented such that the medial border of the osteotome is palpable throughout the cut. In many cases, performing this cut will complete the lateral portion of the osteotomy at the iliac wing. When this occurs there is distal and lateral displacement of the proximal portion of the acetabular segment. The osteotome is driven to the level of the ischial spine. Occasionally, the direction of the osteotome moves in an unwanted direction. In such cases, a curved osteotome can be used to redirect the path of the quadrilateral surface limb of the osteotomy.

In the original description of the Bernese osteotomy a fifth cut was described.[2] This cut is made with an osteotome angled 50° and is intended to connect the quadrilateral surface cuts with the subcotyloid groove cortex. With the use of the lateral cut of the subcotyloid groove of the ischium, it is now common that the fifth cut is unnecessary in the majority of cases. The osteotome is directed from medial to lateral. The orientation is best seen on an iliac oblique view projection. Attention to placement is critical during this step as a posteriorly placed osteotome can unintentionally disrupt the posterior column.

Once the cuts are made, a 5 mm Schanz pin is placed at the level of the AIIS, directed into the intact bone of the acetabular segment. In severely dysplastic hips, confirming placement of the Schanz pin on fluoroscopy is useful, as occasionally the AIIS will be at an intra-articular level in advanced dysplasia. If the proximal portion of the acetabular fragment did not displace with the quadrilateral surface cut, the proximal portion of the osteotomy should be completed next. A wide flat osteotome is inserted into the full length of the third cut made in the iliac wing. A farabeuf clamp or pliers are used to rotate the osteotome to mobilize the proximal portion of the osteotomy. With use of this technique it is generally not necessary to perform a cut on

Fig. 7: The position of the osteotome while making the quadrilateral surface cut. An iliac oblique view is used intraoperatively to monitor the cut.

the lateral surface of the iliac wing. The osteotome is then replaced into the full length of the quadrilateral surface cut. The osteotome is rotated with simultaneous gentle flexion stress to the acetabular fragment with the Schanz pin. Generally, this combination of maneuvers completes the osteotomy. The completion can be confirmed with motion of the acetabular fragment with the Schanz pin. If the osteotomy is not free, gentle inspection of all cuts is reconfirmed with osteotome and intra-operative fluoroscopy until it is freely mobile.

Correction

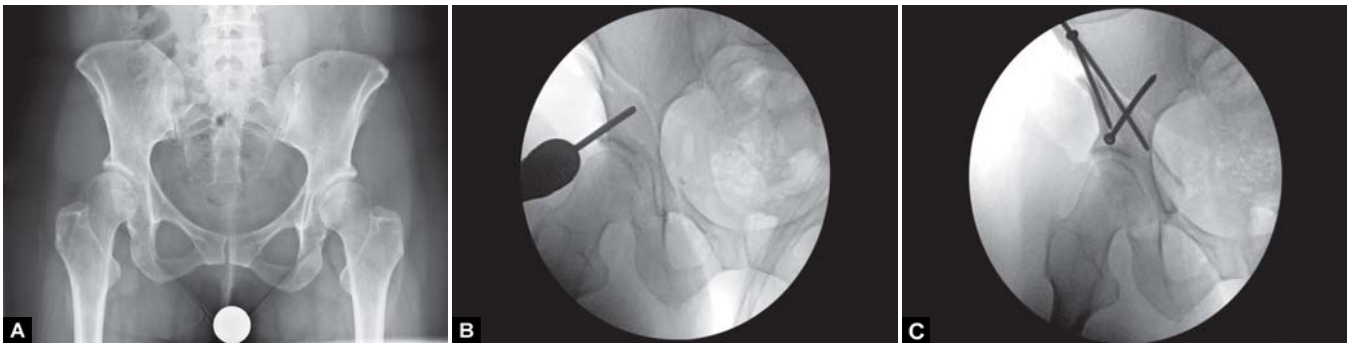
Following completion of the osteotomy, the correction begins by confirming radiographic imaging. Typically, this involves moving the fluoroscopy unit to view the AP pelvis. The rotation of the pelvis is moved until at neutral rotation of both sides of the pelvis and the caudad/cephalad orientation is adjusted to recreate the position of the pelvis on preoperative AP pelvis view. The fluoroscope is moved into an AP view of the operative hip. The image is rotated 5° towards midline to simulate the radiographic projection of an AP pelvis radiograph.

Once imaging is confirmed, an image of the original position is saved. (Fig. 8A) The correction begins with anterior rotation or flexion of the acetabular fragment, followed by lateral rotation, and finally version correction. In general for correction of dysplastic hips without retroversion, the pubic root of the acetabular fragment will rotate to a position superior to the intact remnant of the superior pubic ramus. The radiographic features of an adequate correction include: the teardrop is elevated or moves superiorly, the acetabular roof or sourcil is horizontal, the anterior rim is medial to the posterior rim or the socket is not retroverted, and the hip center has medialized.[2,5] Once in this position, the acetabular fragment is held in position with three screws. Typically two screws from the iliac wing into the acetabular fragment, and a third screw from the acetabular fragment into the intact posterior iliac wing (Figs 8B and C).

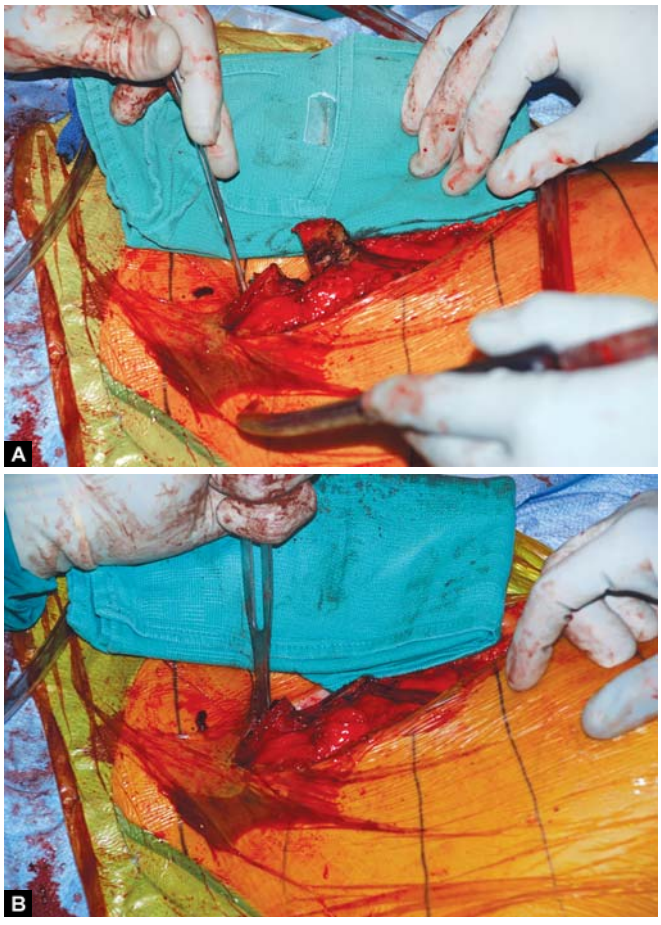
While the dissection and osteotomy are detailed and require technical mastery, it is the orientation of the acetabular segment that ultimately determines outcome. There is less written on the orientation of the acetabulum following PAO. In general a CE angle of 25-40° is desirable. Ganz described impingement of the proximal femur on the corrected anterior rim of the acetabulum following PAO.[6] The practice of capsulotomy following correction and fixation of the PAO is now commonly accepted. This allows both inspection for potential impingement with the proximal femur as well as access to inspect the labrum at the time of the procedure. The ASIS on the acetabular fragment is typically very prominent anteriorly (Fig. 9A). This prominence is trimmed prior to closure (Fig. 9B). A drill hole is placed in the ASIS remnant to reattach the inguinal ligament, sartorius, and TFL.

Postoperative Care

Initial postoperative pain control is with an epidural catheter for 48 hours. All patients have bilateral calf graduated compression stockings placed in the operating room prior to moving to the postanesthesia care unit. Patients are maintained on low molecular weight heparin (begun after discontinuing the epidural catheter) for 2 weeks postoperatively, and then converted to one 325 mg aspirin per day while non-weight bearing. Postoperative limited weight bearing is maintained for 8 to 10 weeks. Physical therapy to focus on abductor strength and core strengthening is begun at 6 weeks postoperatively. A



Figs 8A to C: Before and after. (A) An AP view of a patient with symptomatic acetabular dysplasia, (B) the AP view after osteotomy and before correction during the procedure and (C) the final intraoperative view of the final position and fixation of the osteotomy.



Figs 9A and B: The anterior correction. (A) The prominence of the ASIS after correction of the acetabular fragment and (B) the acetabular fragment after trimming of the prominent ASIS.

majority of patients will have at least mild lateral femoral cutaneous nerve symptoms of decreased or altered sensation postoperatively.

SUMMARY

The primary indications for the PAO continue to be related to acetabular dysplasia.[2] The presentation of acetabular dysplasia has variability in the severity of lack of coverage of the femoral head, version of the acetabulum, and other pertinent aspects of hip morphology. The PAO is unique in its ability to allow correction to the orientation of the acetabulum. For the proper indication, the PAO is an excellent procedure that can restore hip function over many years.[5,7-8] The osteotomy is not entirely intuitive with its complex three-dimensional nature. Performing the osteotomy and obtaining correction is technically demanding, especially for those early in the learning phase of the procedure. The detailed description of the surgical approach and osteotomy described in this work may be helpful to others interested in this technique.

ACKNOWLEDGMENTS

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