Efficiency and Accuracy of Bernese Periacetabular Osteotomy for Adult Hip Dysplasia

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Bernese periacetabular osteotomy (PAO) has several advantages dealing with adolescents and adults acetabular dysplasia. The authors introduced the details and steps performing PAO, with attached video and schematic diagram which demonstrates a perfect PAO in efficiency and accuracy. The patient is an 18-year-old girl, complaining hip pain on the left side for 6 months. Physical examination shows normal gait and range of motion (ROM) of the left hip. Pelvic anteroposterior X-ray shows acetabular dysplasia on the left, and post operation on the right. She is very satisfied with the PAO on the right one year before, so we recommend PAO for the left hip dysplasia again. The key point of PAO includes 4 cuts: ischial cut, pubic cut, acetabular roof cut, and quadrilateral bone cut, and the four cuts should be accomplished accurately. Then the acetabular fragment should be turned to ideal position with the lateral CE angle (LCE) > 25°, the Tönnis acetabular angle 0°, the anterior CE angle (ACE) > 20°, good congruence joint space, and with the hip center medialized slightly. At lastly the acetabular fragment is fixed with proper nails and instruments. The patient is very happy to the surgery with no hip pain, with normal gait, ROM, and Harris hip scores (HHS). In summary, PAO is a relative new and efficient procedure for adult hip dysplasia, requiring accurate techniques. Cadaveric practice and familiar with the local anatomy can help the surgeon overcome the learning curve quickly.

Key words: Bernese periacetabular osteotomy (PAO); Tönnis acetabular angle; Central edge angle; Hip dysplasia

Introduction

The Bernese periacetabular osteotomy (PAO) was originally introduced in 1988 by Ganz et al.1 for the treatment of adult hip dysplasia. Since then, the surgical technique is widely recognized and it has become the most common surgery performed worldwide. This surgical technique is beneficial in improving acetabular coverage, optimizing the hip rotation center, reducing stress on the articular cartilage and preventing or postponing the hip osteoarthritis progress. The mid-term and long-term clinical results are excellent2–4. However, due to the complex anatomical deformities of hip dysplasia, the complexity of PAO techniques, the danger of surrounding neurovascular structures and the long learning curve in PAO, many surgeons believe that PAO is too challenging to perform and thus keep away from using this technique. This video demonstration of the PAO surgical procedure aims to emphasize the key points related to the efficiency and accuracy of this technique.

Case Presentation

Preoperative condition: An 18-year-old woman with a bilateral hip dysplasia had a right hip PAO 12 months ago. She is very satisfied with the result of the right hip. Six months previously she started to complain about mild hip pain and discomfort in the left hip. A physical examination showed she had normal gait, a normal range of movement (ROM), positive C sigh, a positive flexion adduction internal rotation test, and a negative Trendelenburg sign on the left hip. The Harris hip score was 96 on the left and 100 on the right.

An anteroposterior pelvic X-ray showed the post-PAO surgery changes on the right hip. On the left hip, the Tönnis acetabular index was 20.4°; the lateral central edge (CE) angle was 5.3°; the anterior CE angle (ACE) was 7.9° and the acetabular index of containment was 60.6%.

With no contraindications for this patient, we performed a PAO accordingly.
Surgical Techniques

General anesthesia with controlled hypotension is recommended. Intraoperative salvage autotransfusion is used. The patient is positioned supine on the operating table. The entire lower extremity of the left side was sterilized so that the leg can move freely during the procedure. A modified Smith–Petersen approach is used. The incision length is about 12 cm. The fascia of the tensor fascia lata is incised. The anterior superior iliac spine (ASIS) is exposed laterally, and a 3-cm length fragment is cut off with an oscillating saw. The ASIS with the soft tissue on medial side intact is retracted medially with a narrow Hohmann retractor to protect the lateral femoral cutaneous nerve. The medial aspect of ilium is then exposed subperiosteally. Going inside, the anteroinferior parts of the hip capsule and the pubis are exposed with the hip in slight flexion and adduction. The reflected head of the rectus femoris is kept intact. Dissection with scissors to open the space between the psoas tendon and the medial joint capsule, then a narrow Ganz osteotome (a special osteotome that has a 15 mm blade with two points and a 30° angle to the shaft) is sent into this space to reach the body of the os ischium and the infracotyloid groove (Fig. 1a). Under the 30° oblique image intensifier, a 10–15 mm ischium cut (starting from infracotyloid groove to the direction of ischial spine) is made (the first cut, Fig. 1b).

Then the pubic ram is exposed with a subperiosteal dissection, a transverse osteotomy of the pubis immediately medial to the iliopubic eminence is performed with a straight osteotome (the second cut, Fig. 1c).

With a reverse Hohmann retractor heading on the ischial spine, the quadrilateral bone is exposed subperiosteally. Marking the cutting line of a supra-acetabular cut (3 cm or more above the anterior acetabular rim) with sharp chisels, the supra-acetabular cut is made with an oscillating saw to reach the turning point of the iliopectineal line (the third cut, Fig. 1d). This cut is similar to Salter’s innominate osteotomy except for the intact posterior column. Then the quadrilateral bone cut (the fourth cut, Fig. 1e) is done with a straight osteotome and a wide Ganz osteotome, 0.5–1.0 cm anterior and parallel to the posterior column rim, from the turning point of the iliopectineal to the anterior portion of the ischial spine.

A Schanz screw is driven into the supra-acetabular bone without entering the hip joint, and fixed with a T-handle. With a Ganz osteotome, connect the fourth cut to the first cut; thereafter, the acetabular bone fragment is mobilized. At this stage, one pelvic clamp is also used to assist the Schanz screw to hold the acetabular fragment and rotate it laterally and inferiorly until the ideal position and ideal coverage are reached.

After a temporary fixation with two 3.0-mm diameter Kirschner wires, the hip ROM, especially flexion and rotation, are tested and the acetabular position is confirmed under an image intensifier. The ideal acetabular position includes the lateral CE angle (LCE) > 25°, the Tönnis acetabular angle 0°, the ACE > 20°, a good congruence joint space between the acetabulum and the femoral head, and with the hip center medialized slightly. Finally, change the Kirschner wires to 2–3 fully threaded long 4.5 mm diameter cortical stainless screws (60–120 mm in length) to fixate the acetabular fragment.

The ASIS is reduced and fixed to its original position with a 3.5 mm long cortical screw. The wound is closed in layers.

Postoperative Care

I.v. antibiotic prophylaxis used for 24–48 hours. The patient is permitted to stand with two crutches the day after surgery. Partial weight bearing with active gluteus medium exercise 6–8 weeks postoperation if the patient can tolerate it, and full weight bearing 10–12 weeks after the bones are united (the posterior part unites first).

At the 3 months postoperation follow up, this young woman can walk normally without pain, without limping, and
with normal ROM. Her Harris hip score is 100 on either side of the bilateral hips. She is very satisfied with the procedures bilaterally.

Discussion

PAO is the most popular and effective surgical technique for the treatment of adult hip dysplasia. Efficiency and accuracy are two important factors for ensuring the best clinical results. How can we perform an efficient and accurate PAO? The key points are as follows:

1. The os ischium cut (the first cut) is the most difficult in the PAO procedure. Explore the space between the psoas muscle and the hip joint capsule, send the Ganz osteotome into this space to touch the infracotyloid groove, make a 10–15 mm cut towards the ischial spine and make sure the entire width of the ischium has been cut.

2. Before making the second, third, and fourth cut, make sure that the surrounding periosteum has been peeled away from the bone cutting line. The bone cut must be completed so the acetabular fragment is completely separated from the pelvis to guarantee the acetabular fragment can move freely.

3. A Schanz screw with a handle and pelvic clamp are the key tools to help move and reposition the acetabular fragment.

4. Repositioning the acetabular fragment into the ideal position is the most important part of the PAO procedure. The following parameters are assessed by the image intensifier: (i) a Tönnis acetabular angle of 0°; (ii) an LCE angle of 25°–40°; (iii) a distance between the medial femoral head to the ilioischial line of 0–10 mm; (iv) the anterior acetabular rim located on the superior medial on 1/3 of the femoral head and the posterior acetabular rim located on the inferior lateral part of the femoral head; (v) an ACE angle of 30° ± 10°. Be sure to use the preoperative morphologic character of the obturator foramen on the pelvic X-ray as a basic reference to avoid the malposition of the acetabular fragment.

Complications, such as neurovascular injuries, massive blood loss, technical faults, and malposition, can be avoided when following the key points of PAO. Cadaveric practice and familiar with the local anatomy can help the surgeon learn the technique quickly.

Highlights and Pitfalls

PAO has several advantages in correcting acetabular dysplasia: the posterior column remains mechanically intact, there is a high potential ability for spatial correction, access to joint pathology is improved, the blood supply of the acetabular fragment is preserved, and the birth canal remains unchanged.

The pitfalls are that learning curve of the PAO is slow, and there are relatively high complications in the first cases.

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Video Image

Additional video images may be found in the online version of this article. Visit http://onlinelibrary.wiley.com/doi/10.1111/os.12202/suppinfo

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