Surgical Approach for Periacetabular Osteotomy

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Abstract

The surgical technique for the Bernese periacetabular osteotomy was developed by Prof. Reinhold Ganz in 1984 for the treatment of hip dysplasia (Ganz R, Klaue K, Vinh TS, Mast JW. Clin Orthop Rel Res 232:26–36, 1988). The purpose of the surgical approach is to expose the innominate bone in order to enable an osteotomy which allows for a complete detachment of the acetabulum while leaving the posterior 50 % of the posterior column intact. The dissection resembles the well-known Smith-Petersen approach with a few modifications. Anatomical structures at risk during surgical exposure and osteotomy include the lateral femoral cutaneous nerve, the femoral nerve, the sciatic nerve, the obturator artery and nerve, and the medial femoral circumflex artery. This chapter describes in detail the surgical setup, the planes of dissection, the location of the neurovascular structure at risk, and how to avoid complications.

Introduction

The surgical technique for the Bernese periacetabular osteotomy was developed by Prof. Reinhold Ganz in 1984 for the treatment of hip dysplasia [1]. The purpose of the surgical approach is to expose the innominate bone to enable four separate bone osteotomies

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which allow for a complete detachment of the acetabulum from the intact pelvis while leaving the posterior 50 % of the posterior column intact:

1. Ischial osteotomy just inferior to the posterior horn of the acetabulum at the level of the subcotyloid groove
2. Superior ramus osteotomy medial to the iliopectineal eminence
3. Anterior iliac wing osteotomy
4. An ischial osteotomy posterior to the acetabulum through the quadrilateral surface dividing the posterior column of the acetabulum in half by connecting the iliac wing osteotomy with the infra-acetabular ischial osteotomy

(see Chap. 45, "▸ Surgical Technique: Periacetabular Osteotomy")

Setup and Positioning

After an optional insertion of an epidural catheter for postoperative pain control as well as an insertion of a Foley catheter, the patient is positioned supine on a flattop radiolucent table. Typically, general anesthesia is used. The combination of general and epidural anesthesia optimally allows for a hypotensive anesthetic technique, which significantly reduces blood loss. Some surgeons like to use a bump under the affected hip, while others prefer not to use it in order to keep the pelvis parallel to the floor. This facilitates the intraoperative assessment of the orientation of the osteotomized acetabulum. The surgeon requires at least one and ideally two surgical assistants. Intraoperative imaging is required, and a C-arm is set up on the contralateral side perpendicular to the patient's body at the level of the pelvis. The operative leg is draped free to allow for hyperflexion of the hip during the procedure, and a foot rest can be fixed to the table prior to draping to facilitate hyperflexion of the hip if preferred by the surgeon.
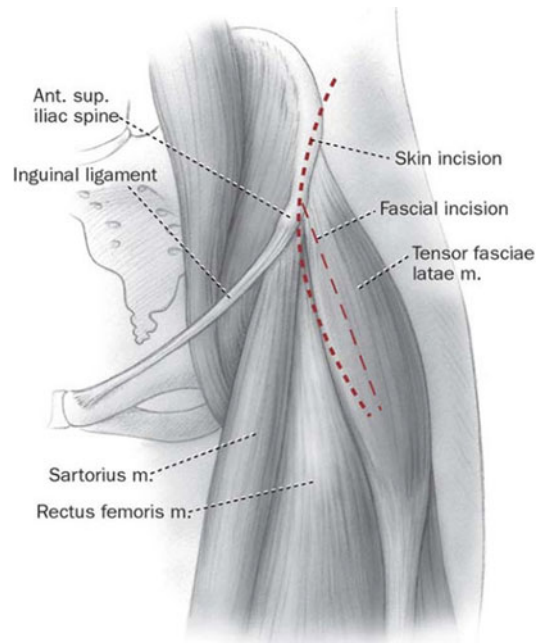

Fig. 1 Overview of skin incision and the underlying muscles (Figure taken with permission from "Periacetabular osteotomy in the treatment of severe acetabular dysplasia. Surgical technique." Clohisy JC, Barrett SE, Gordon JE, Delgado ED, Schoenecker PL. J Bone Joint Surg Am. 2006 Mar; 88 Suppl 1 Pt 1:65–83)

Skin Incision

The landmarks for the incision include the anterior superior iliac spine (ASIS), the iliac crest, and the sometimes palpable interval between the tensor fasciae latae muscle belly and the sartorius muscle belly (Figs. 1 and 2).

The original incision described by Ganz uses the skin incision of the Smith-Petersen approach [1, 2]. The incision is started along the gluteal tubercle of the iliac crest and then turned at the level of the ASIS to follow the course of the underlying tensor fascia latae muscle fibers. Proximally, the incision is made over the iliac crest and just lateral to the ASIS to avoid a painful surgical scar formation over bony prominences and to avoid injuring the lateral femoral cutaneous nerve which runs just medial to the ASIS deep to the inguinal ligament. Some surgeons advocate at this stage to identify and dissect out the lateral
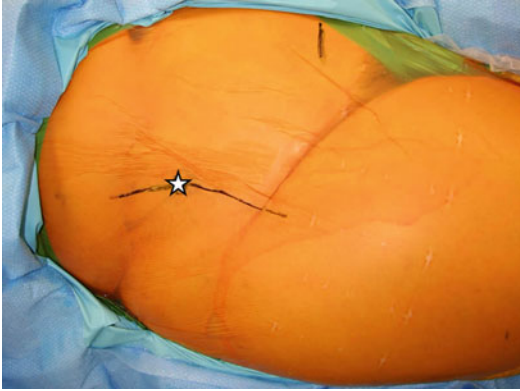
Fig. 2 **Skin incision.** The skin incision is located over the iliac crest proximally and the palpable anterior border of the tensor fascia latae muscle belly distally. *Star*, anterior superior iliac spine; *black line*, skin incision

Fig. 3 **Fascial incision.** Proximally, the facial incision is located over the iliac crest where the abdominal muscle fascia meets the origin of the tensor fascia latae. Distally, the fascial incision lies over the anterior border of the tensor fascia latae muscle belly. *Star*, anterior superior iliac spine; *black line*, fascial incision; *1*, external oblique abdominal muscle; *2*, tensor fasciae latae; *3*, sartorius femoris

femoral cutaneous nerve to avoid its entrapment during closure of the incision; however, it is sufficient to keep the dissection lateral to it so that the nerve remains uninjured in the more medial soft tissues.

Alternatively in thin patients, the incision does not have to angle at the ASIS but can remain straight and follows the course of the inguinal ligament just distal to it. This type of incision allows for a more cosmetic "bikini line" scar but makes the subsequent steps of the surgical approach more difficult especially in more muscular or obese patients.

Deep Dissection

Proximally, the interval between the origin of the tensor fasciae latae muscle and the abdominal muscle aponeurosis consistent of the external oblique, internal oblique, and transverse muscle layers is identified (Fig. 3). As the abdominal muscle aponeurosis wraps around the iliac crest, this interval is located proximally just distal to the iliac crest and at the level of the ASIS right over the iliac crest. The interval is incised down to the periosteum, and dissection is carried out towards the inner iliac table just across the iliac crest leaving the origin of the tensor fasciae latae untouched. In the early developmental phases of
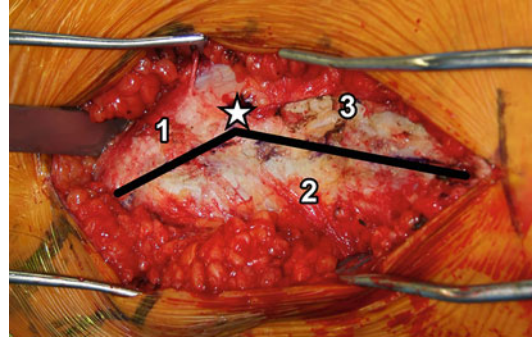
the this approach, Ganz et al. have detached the origin of the tensor fasciae latae of the anterior part of the outer pelvic table [1]; however, they have later on abandoned it as it was deemed unnecessary [3, 4].

Care is taken not to cut into the external oblique muscle belly which forms the superficial layer of the abdominal muscle aponeurosis and to remain subperiosteal to avoid unnecessary bleeding. At this point the dissection of the iliacus muscle from the inner pelvic table is continued. As the periosteum thins out on the inner pelvic table, the dissection of the iliacus origin from the inner pelvic table can be associated with substantial blood loss from blood vessels from the muscle belly as well as the nutrient artery of the ilium which is a branch of the superior gluteal artery and enters the ilium approximately 2 cm anterior to the sacroiliac joint and 2 cm proximal to the pelvic brim [5, 6]. Inevitably the nutrient vessel of the ilium is severed and bone wax is necessary for hemostasis. Dissection is carried out along the inner table of the pelvis until the pelvic brim is visualized. This area can be packed with lap pads to allow hemostasis to occur while the more distal dissection is completed.

Next, further distal dissection is performed. The fascia over the tensor fascia lata muscle belly is incised just posterior to the anterior edge
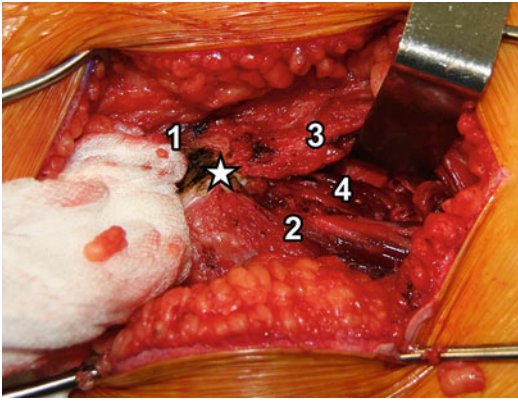
Fig. 4 Deep muscular dissection. Dissection is performed between the tensor fascia latae laterally and the sartorius medially. The sartorius is taken off the anterior superior iliac spine to expose the straight head of the rectus and the iliopsoas. *Star*, anterior superior iliac spine; *black line*, fascial incision; *1*, external oblique abdominal muscle; *2*, tensor fasciae latae; *3*, sartorius femoris; *4*, straight head of rectus femoris

Fig. 5 Exposure of pubic ramus. The pubic ramus is exposed by retracting the sartorius and iliopsoas muscles. *Star*, anterior superior iliac spine; *black line*, fascial incision; *1*, external oblique abdominal muscle; *2*, tensor fasciae latae; *3*, sartorius femoris; *4*, straight head of rectus femoris

of the muscle belly. The tensor fascia lata muscle belly can sometimes be difficult to identify, and it is advisable to err posteriorly. The interval between the sartorius and the tensor fasciae latae is easier to identify proximally near the ASIS. A helpful landmark is a leash of vessels at the posterior aspect of the tensor fasciae latae muscle belly which pierces the fascia to supply the overlying skin [7]. The fascia lata itself is posterior to the tensor fasciae latae muscle belly. The dissection is too posterior if the surgeon encounters increased bleeding or visualizes the fascia lata at this stage. After proper incision of the fascia over the tensor fasciae latae at its anterior edge, the muscle belly is retracted laterally within its sheath. Proximally, a tissue sleeve including the sartorius and the inguinal ligament is dissected off the ASIS (Fig. 4). Alternatively, as originally described by the ASIS can be osteotomized with the origin of the sartorius and the inguinal ligament. The fascia at the floor of the tensor sheath is incised exposing the rectus femoris. The sartorius is retracted medially fully exposing the rectus. Dissection between the rectus femoris and the sartorius is carried out (Fig. 4). After release of the sartorius, exposure of the inner table of the supraacetabular region, iliopectineal eminence, and superior pubic ramus
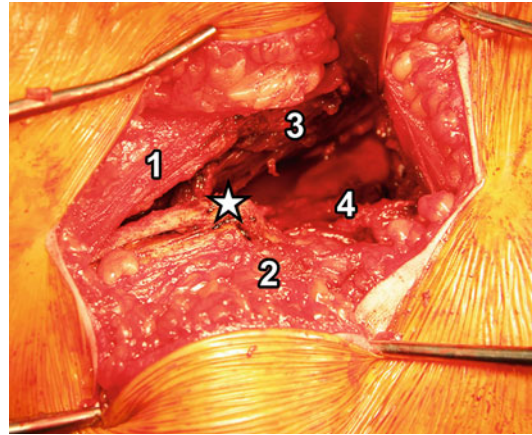
continues from lateral to medial (Fig. 5). It is important to remove all periosteal and soft tissue connections to the brim of the acetabulum, quadrilateral plate, and proximal portion of the superior ramus; otherwise, these will interfere with the mobility of the fragment after the osteotomies are performed. The origin of the straight head of the rectus from the anterior inferior iliac spine is visualized. Medial to the rectus femoris, the iliopsoas is visualized as it comes across the pelvic brim. The fascia overlying the psoas is carefully incised to allow increased mobilization of the psoas. This fascia should be divided under direct visualization distally, as the femoral nerve will lie directly under the fascia. At this point the hip is hyperflexed and adducted to relax the iliopsoas muscle. The iliopsoas has contributing muscle fibers that originate from the anterior hip capsule. Those muscle fibers have been named the iliocapsularis muscle [8]. Dissection is carried out medial to the straight head of the rectus femoris and lateral to the iliocapsularis and iliopsoas. The iliocapsularis muscle fibers are dissected off their origin at the anterior hip capsule. Dissection is carried out between the hip capsule and the iliopsoas proximal to the crossing fibers of the obturator externus down to the subcotyloid groove of the ischium just inferior to

the posterior horn of the acetabulum. This is done somewhat blindly and is most easily performed by directing a curved Mayo scissors between the capsule over the femoral neck and the psoas until the ischium is encountered. This is typically deeper and more medial than expected. Fluoroscopic guidance is often helpful in locating the anterior edge of the ischium for those with less experience in the procedure. Care is taken not to stray medially as the obturator neuromuscular bundle is close as it exits the inner pelvis underneath the obturator canal and pierces the obturator membrane. In a study of 29 cadaveric hemipelvises, the distance between the inferior ischial osteotomy site and the obturator artery has been shown to be an average of 36mm with a minimum of 22 mm [9]. It is also important to not dissect distal to the cephalad margin of the obturator externus in order to not jeopardize the medial femoral circumflex artery which constitutes the main blood supply to the femoral head [10]. Optionally, the straight head of the rectus femoris muscle can be taken off the anterior inferior iliac spine to facilitate the exposure; however, in our opinion that is not routinely necessary. It can be useful to perform a capsulotomy to assess the labrum and the femoral neck offset for possible impingement after the acetabular correction.

Anatomical Structures at Risk During Exposure

In general, the described approach for the Bernese periacetabular osteotomy is safe if the surgeon is aware of and protects the following anatomical structures:

1. Lateral femoral cutaneous nerve during exposure and closure
2. Obturator neurovascular bundle during dissection for the inferior ischial cut and the superior pubic ramus cut
3. Medial femoral circumflex artery during dissection for the inferior ischial cut
4. Femoral nerve during retraction for the superior pubic ramus exposure

5. Sciatic nerve during ischial cuts (see Chap. 45, "▶ Surgical Technique: Periacetabular Osteotomy")

In a review of 1,760 patients at five institutions, 36 patients (2.1 %) developed a sciatic (1.6 %) or femoral nerve (0.5 %) deficit. Full recovery occurred in 17/36 patients at an average of 5.5 months postoperatively. All cases of none or incomplete recovery involved the sciatic nerve [11]. In a consecutive series of 508 cases by Ganz, postoperative symptoms related to the lateral femoral cutaneous nerve occurred in approximately 30 % of patients [3]. There was one case of femoral head osteonecrosis in a patient who underwent a periacetabular and femoral osteotomy [3]. To our knowledge, obturator nerve injuries have not been reported in literature. Pring et al. used intraoperative electromyographic monitoring in a consecutive series of 140 patients and reported no postoperative obturator nerve injuries [12].

Avoiding Pitfalls

1. Place the skin incision just lateral to the anterior superior iliac spine to avoid injuring branches of the lateral femoral cutaneous nerve and to avoid a painful scar over the anterior superior iliac spine.
2. Place the distal fascial incision over the muscle fibers of the tensor fascia latae, and retract the muscle fibers within its fascial sheet as opposed to dissecting more anterior between the sartorius and tensor fasciae latae.
3. Remain subperiosteal when exposing the superior pubic ramus, and protect the obturator neurovascular bundle with retractors like blunt Hohmanns or Crezos within the obturator canal at the inferolateral aspect of the superior pubic ramus.
4. Flex and adduct the hip and minimize traction on the femoral nerve during superior pubic ramus exposure.
5. Adduct the leg during both ischial osteotomies to increase the distance of the osteotomies to the sciatic nerve.

Summary

In summary, the surgical approach for periacetabular osteotomy is safe as long as the surgeon has a good knowledge of pelvic anatomy and is aware of the neurovascular structures at risk.

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