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ESSENTIAL SURGICAL TECHNIQUES

SUBSPECIALTY PROCEDURES

The Pararectus Approach

A New Concept

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Abstract

Background: Even 50 years after the introduction of the extrapelvic ilioinguinal approach for open reduction and internal fixation of acetabular fractures involving predominantly the anterior column, this approach is still acknowledged as being the so-called gold standard[1]. The pattern of acetabular fractures has changed within the last 10 to 20 years[2,3], with a greater prevalence of quadrilateral plate fractures that is due in part to the increase in elderly trauma. The intrapelvic approach, also called the modified Stoppa approach[4-6], was introduced as a less invasive alternative to the extrapelvic ilioinguinal approach, mostly combined with the first window of the ilioinguinal approach. The Pararectus approach also offers intrapelvic surgical access and has demonstrated safe surgical dissection with enhanced exposure and favorable outcome compared with the Stoppa approach[7-10].

Description: The skin incision runs along the lateral border of the rectus abdominis muscle to develop the anterior rectus sheath. The retroperitoneal space lateral to the rectus abdominis muscle is entered and the inferior epigastric vessels and the round ligament in females or the spermatic cord in males are identified. The superior pubic ramus and the iliopectineal eminence are exposed. If the corona mortis vessels (a vascular anastomosis between the obturator vessels and the external iliac artery) are present, they are ligated. The obturator nerve and vessels are exposed. The dissection is then directed posteriorly under retraction of the external iliac vessels with further subperiosteal exposure of the pubic ramus, the quadrilateral plate, and the posterior column. Any nonessential iliolumbar vessels are ligated. Residual displacement is assessed with fluoroscopic views. For reduction of a medially displaced femoral head, longitudinal extremity soft tissue or lateral skeletal traction (optional), with a Schanz pin in the greater trochanter, is used. For disimpaction of acetabular dome fragments and grafting of a supra-acetabular void (optional), a fluoroscopy unit is used to assess reduction and identify the void; in addition, arthroscopy can be used. The scope is introduced through the fracture gap to

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check for reduction without any water or specific setup. For reduction and fixation of extra-articular components (iliac wing posteriorly and superior pubic ramus anteriorly), the posterior column, and the quadrilateral plate, the fluoroscopy unit is used. The anterior lamina of the rectus sheath is sutured, and a layered closure performed.

Alternatives: The ilioinguinal or modified Stoppa approach might be used instead.

Rationale: The Pararectus approach combines the advantages of the ilioinguinal approach and the Stoppa approach. The Pararectus approach facilitates surgical access directly above the hip joint, which is comparable with the access obtained through the second window of the ilioinguinal approach, but without dissection of the inguinal canal. Moreover, the Pararectus approach provides intrapelvic visualization that is at least equivalent to that offered by the Stoppa approach but without losing any direct access to the hip joint.

Introductory Statement

The Pararectus approach allows for anatomic restoration with minimal access morbidity in the treatment of acetabular fractures involving the anterior column.

Indications & Contraindications

Indications

- Anterior wall fracture.
- Low or intermediate anterior column fracture.
- High or very high anterior column fracture requiring an additional mini-incision on the iliac crest, or full exposure of the first window through the Pararectus approach, or through a separate incision along the iliac crest, for the reduction and fixation of the iliac wing.
- Transverse fracture with displacement predominantly in the anterior column.
- T-shaped fracture with displacement predominantly in the anterior column.
- Associated anterior column-posterior hemitransverse fracture. In high or very high anterior column fractures, additional mini-incision or full exposure of the first window is advised.
- Both-column fracture. In high or very high anterior column fractures, additional mini-incision or full exposure of the first window is advised. An associated posterior wall fracture is fixed percutaneously through the incision along the iliac crest or through a separate posterior approach simultaneously or successively.
- In complex acetabular fractures (T-shaped fracture, associated anterior column-posterior hemitransverse fracture, or both-column fracture) with an additional severe displacement in the posterior column and/or in the dome, which is not reducible through the anterior approach, simultaneous Pararectus and posterior approaches, with or without digastric trochanteric flip osteotomy and surgical hip dislocation in a semilateral (floppy) position, allow an anatomic reconstruction and avoid an extended iliofemoral approach with a high morbidity.

Contraindications

- Posterior wall fracture.
- Posterior column fracture.
- Associated posterior column and posterior wall fractures.
- Transverse fracture with displacement predominantly in the posterior column or associated posterior wall fracture.
- T-shaped fracture with displacement predominantly in the posterior column or associated posterior wall fracture.

Step-by-Step Description of Procedure

Step 1: Preoperative Planning and Patient Presentation

Assess the acetabular fracture pattern, select the ideal patient according to the indications for the Pararectus approach, and plan the steps for reduction and methods of fixation.

- Review radiographs (Fig. 1) and perform additional computed tomography (CT) (Figs. 2-A and 2-B) for preoperative planning (Video 1).
- Determine the acetabular fracture pattern according to the system of Judet et al.[1]. Assess for the main direction of displacement and for any medial displacement. Assess for involvement of the quadrilateral plate, dome impaction, a displaced iliac wing, or low anterior column fractures (Video 1).
- Exclude patients indicated for open reduction and internal fixation who have substantial comorbidities or major complicating factors, such as comminution, abrasion, femoral head fracture, or delayed surgery.
- Plan the steps of the reduction (e.g., lateral traction, disimpaction of the acetabular roof, and extension of the modified Stoppa approach) and methods for stabilization (e.g., infrapectineal buttress plating, infra-acetabular screws, and locking plates).

Fig. 1

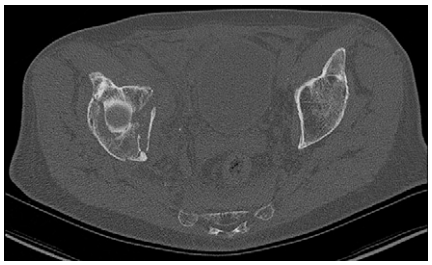

Fig. 2-A

Fig. 2-B

Fig. 1 Preoperative anteroposterior radiograph of the pelvis of a 77-year-old patient with a low anterior column fracture and an associated posterior hemitransverse fracture.

Figs. 2-A and 2-B Preoperative images. **Fig. 2-A** Axial computed tomography (CT) scan on the dome level showing the medialized quadrilateral plate and the mostly intact dome. **Fig. 2-B** Coronal CT scan showing the impaction of the dome.

Video 1 Case presentation, patient positioning, description of the anterior approaches, anatomic landmarks, and skin incision. (Illustration in video reproduced from: Keel MJ, Bastian JD, Büchler I, Siebenrock KA. Anterior approaches to the acetabulum. Unfallchirurg 2013;116(3):213-20. With permission of Springer © 2013.)

Step 2: Patient Positioning, Setup, and Skin Incision

Place the patient in the supine position and ensure that a Foley catheter is placed in the bladder and that the ipsilateral leg is prepared and draped freely, facilitating reduction maneuvers. After sterile preparation and draping, identify the 3 landmarks for the incision (umbilicus, anterior superior iliac spine [ASIS], and symphysis) and palpate the lateral border of the rectus abdominis muscle.

- Position the patient supine on a radiolucent operating table. The ipsilateral extremity is draped freely (Video 1).
- Ensure that a pillow is placed underneath both knees for slight flexion in the hip joint to reduce tension of the iliopsoas muscle.
- Administer intravenous antibiotics preoperatively and place a Foley catheter for decompression and monitoring of potential iatrogenic bladder injuries.
- The surgeon and the scrub nurse are positioned on the uninjured side of the patient, and an assistant and the image intensifier are placed on the injured side. An autoclavable ring retractor (SynFrame; DePuy Synthes) may be mounted to the operating table.
- Identify the landmarks for the incision (Fig. 3). The umbilicus, ASIS, and symphysis pubis form a triangle. Additionally, palpate the lateral border of the rectus abdominis muscle (Video 1).
- Start the incision cranially at the junction of the lateral and middle thirds of the line connecting the umbilicus with the ASIS and continue in a curved distal-medial direction toward the junction of the middle and medial thirds of the line connecting the ASIS with the symphysis (Fig. 3). The approach was named *Pararectus* because of the direction of the skin incision alongside the palpable lateral border of the rectus abdominis muscle (Video 1).

Fig. 3

Fig. 3 Intraoperative photograph showing the landmarks for the incision. The umbilicus, the anterior superior iliac spine (ASIS), and the symphysis are marked (dashed line). The incision (thick line) starts cranially at the border between the lateral and middle thirds (1/3) of the line connecting the umbilicus with the ASIS. The incision is curved and directed toward the border between the middle and medial thirds (1/3) of the line connecting the ASIS with the symphysis.

Step 3: Superficial and Deep Dissection

Incise the abdominal wall fascia and the anterior lamina of the rectus sheath and identify the inferior epigastric vessels and the spermatic cord (or the round ligament).

- Dissect the subcutaneous fatty tissue and superficial fascia (fascia of Camper). Incise the deep layer of the abdominal wall, the fascia of Scarpa, and the external oblique muscle aponeurosis (Video 2).
- The incision must be medial to the fibers of the external oblique muscle to avoid postoperative abdominal wall hernia. In patients with severe fracture displacement, a subfascial hematoma is often observed (Video 2).
- Incise the anterior fascial layer of the rectus sheath. In the distal quarter of the muscle, a posterior fascial lamina is generally absent. For a cranial extension of the approach, the posterior wall of the sheath is dissected cranially to a thin curved margin, the semilunar fold of Douglas (linea arcuata).
- Enter the extraperitoneal space by incision of the transversalis fascia in a longitudinal direction; avoid perforation of the peritoneum medially.
- Identify and encircle with a vessel loop the inferior epigastric vessels crossing the extraperitoneal space from caudolaterally to craniomedially into the rectus muscle (Fig. 4, Video 2).
- Identify and encircle with a vessel loop cranially the spermatic cord in male patients, or the round ligament in female patients, which is connected medially with the peritoneum (Fig. 4, Video 2).
- Gently mobilize the peritoneum and retract it craniomedially. The extraperitoneal space in the true pelvis is easily exposed with a prebent malleable retractor. Place the retractor distal to the inferior epigastric vessels and medial to the obturator nerve and vessels on the quadrilateral plate, near to the ischial spine.

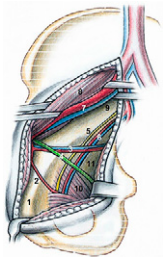

Fig. 4

Fig. 4 Schematic drawing demonstrating the anatomic structures in the Pararectus approach. 1 indicates the pubic ramus; 2, corona mortis; 3, inferior epigastric vessels; 4, spermatic cord (vas deferens) in men or round ligament in women; 5, obturator nerve; 6, obturator vessels; 7, external iliac vessels; 8, iliopsoas muscle including, between the iliacus and the psoas muscle bellies, the femoral nerve; 9, iliac fossa; 10, internal obturator muscle; and 11, quadrilateral surface (Reproduced from: Keel MJ, Bastian JD, Büchler I, Siebenrock KA. Anterior approaches to the acetabulum. Unfallchirurg 2013;116 [3]:213-2. With permission of Springer © 2013.)

Video 2 Description of the anatomic structures and superficial dissection. (Illustration in video reproduced from: Keel MJ, Bastian JD, Büchler I, Siebenrock KA. Anterior approaches to the acetabulum. Unfallchirurg 2013;116(3):213-20. With permission of Springer © 2013.)

- With the help of a mounted ring retractor device (SynFrame), a stable exposure of the key anatomic structures and the fracture can be achieved with a low rate of postoperative soft-tissue complications (Figs. 5-A, 5-B, and 5-C).

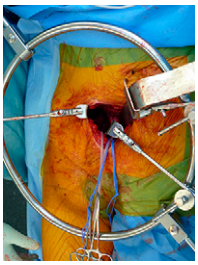
Fig. 5-A

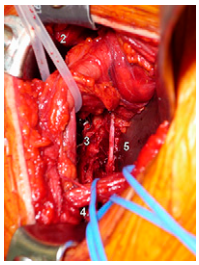

Fig. 5-B

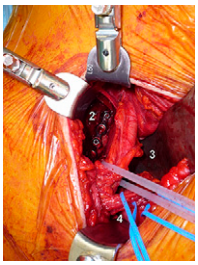

Fig. 5-C

Figs. 5-A, 5-B, and 5-C Intraoperative photographs showing the application of the retractor device and views of the windows. **Fig. 5-A** The surgical field with the ring retractor device (SynFrame). The second window is developed by retracting the external iliac vessels medially and the iliopsoas muscle laterally.

Fig. 5-B The medial view onto the windows. Medially to the second window (2), the external iliac vessels are encircled with a transparent vessel loop. By traction of those vessels laterally and the placement of a malleable retractor into the true pelvis, the third window (3) along the pelvic brim and the fifth window (5) below the obturator nerve are exposed. Medially to the spermatic cord and the inferior epigastric vessels (encircled with blue vessel loops), the fourth window (4) is visible.

Fig. 5-C The exposure of 3 windows. From lateral to medial, the second window (2) between the iliopsoas muscle and the external iliac vessels (encircled with a transparent vessel loop); the third window (3) between the external iliac vessels, the spermatic cord, and the inferior epigastric vessels (encircled with blue vessel loops); and the fourth window (4) medially to those vessels and the spermatic cord are exposed.

Step 4: Exposure of the Superior Pubic Ramus and Pelvic Brim with Control of Neurovascular Structures and Development of the Windows

Develop the 5 windows of the Pararectus approach after identifying the obturator nerve and vessels and the external iliac vessels.

- The 5 windows are demonstrated in a photograph of a patient in Figure 6. The first window is bordered by the iliac crest and the iliopsoas muscle; the second window, by the iliopsoas muscle and the external iliac vessel; the third window, by the external iliac vessels and the spermatic cord (vas deferens) in males or the round ligament in females above the pelvic brim; the fourth window, medially to the spermatic cord (vas deferens) in males or the round ligament in females; and the fifth window, by the external iliac vessels and the spermatic cord (vas deferens) in males or the round ligament in females below the pelvic brim.
- Start the exposure on the superior pubic ramus. The corona mortis is a vascular anastomosis between the obturator vessels and the external iliac artery or the inferior epigastric vessels. It can be a vein, an artery, or both, and if present, it is ligated with clips and/or sutures. (Fig. 4, Video 3).
- Develop the fourth window medial to the inferior epigastric vessels and the spermatic cord (vas deferens), or the round ligament, along the superior pubic ramus to the pubic symphysis, using a malleable retractor to hold the peritoneum and bladder medially (Fig. 5-B).
- Identify the obturator nerve and vessels distal and lateral within the true pelvis (Fig. 5-B). The obturator vessels can be ligated to avoid secondary bleeding during reduction maneuvers.
- Incise the periosteum and the iliopectineal fascia along the pelvic brim to expose the fracture of the anterior column (Video 3).
- Detach the obturator internus muscle from the quadrilateral surface and develop the fifth window below the obturator nerve to the ischial spine (Fig. 5-B).
- Place a malleable retractor over the inferior epigastric vessels and the spermatic cord (vas deferens) or round ligament, but medially and distally to the obturator nerve. Within this third window, the external iliac vessels, the genitofemoral nerve, and the lymphatic vessels are visible laterally (Fig. 5-C). Encircle these structures with a vessel loop without dissection to avoid lymphatic leakage.

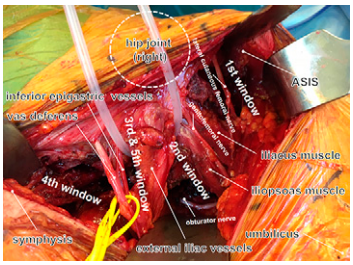

Fig. 6

Fig. 6 A photograph of the surgical field after surgical dissection of the 5 windows of the Pararectus approach. The fifth window is below the pelvic brim and not visible in this photograph. ASIS = anterior superior iliac spine.

Video 3 Development of surgical windows, exposure of the fracture, and assessment of the hip joint. (Illustration in video reproduced from: Keel MJ, Bastian JD, Büchler I, Siebenrock KA. Anterior approaches to the acetabulum. Unfallchirurg 2013;116(3):213-20. With permission of Springer © 2013.)

- Retract the iliopsoas muscle laterally and develop the second window lateral to the external iliac vessels (Fig. 5-C). The use of a table-mounted retractor device facilitates the exposure (Video 3).
- Identify and ligate the iliolumbar vessels along the pelvic brim near to the sacroiliac joint. This can be done through the third or second window (Video 3).
- In patients with associated sacroiliac fracture-dislocations, expose the sacroiliac joint and, medially, the lumbar plexus with the L5 and L4 nerve roots.
- Identify the lateral femoral cutaneous nerve on the fascia of the iliopsoas muscle. For the development of the first window through the Pararectus approach, the iliacus muscle is dissected along the inner surface of the iliac crest. The iliopsoas muscle with the femoral nerve, which is protected between the iliacus muscle laterally and the psoas muscle medially, is tagged using a Silastic (Dow Corning) sling after detachment of the iliacus muscle from the inner surface of the iliac wing.
- Acetabular fractures with a high or very high anterior column fracture component may benefit from an accessory mini-incision along the iliac crest at the level of the fracture. This technique facilitates fracture reduction by internal rotation of the iliac wing using a Schanz screw or a Farabeuf clamp. Fixation is then achieved with a screw or a plate along the iliac crest. In comminuted iliac wing fractures, the first window should be developed through a separate incision along the iliac crest (Olerud approach).

Step 5: Fracture Reduction and Fixation

Reduce the dome fragment through the displaced quadrilateral surface, reduce the anterior column by internally rotating the iliac wing, and reduce the quadrilateral plate and the posterior column through lateralization and cranialization.

- Place a subtrochanteric Schanz screw parallel to the femoral neck under fluoroscopic guidance. This allows axial and lateral traction during the reduction maneuvers.
- Alternatively, use a traction table, especially in patients with severe dome impaction or in patients with a planned minimally invasive anterior approach for an acute hip arthroplasty (Video 4).
- Mobilize and reduce the impacted dome fragment through the cranially displaced anterior column and medially displaced quadrilateral plate using a periosteal elevator under fluoroscopic guidance. The femoral head, which is under longitudinal and some lateral traction, acts as a template to facilitate anatomic reduction.
- Reduce the anterior column before reducing the quadrilateral plate and posterior column. In high or very high anterior column fractures, rotate the iliac wing internally and fix it temporarily with a threaded transfixation wire. The references for anatomic reduction are the fracture lines on the superior pubic ramus and along the pelvic brim, near the sacroiliac joint.
- An incomplete anterior column fracture in elderly patients rarely requires an iliac crest osteotomy to complete the fracture. However, in young patients, complete the iliac crest fracture to mobilize the iliac wing for internal rotation, which aids in reduction of the anterior column.
- Use a ball spike pusher or a pointed reduction clamp for direct reduction of the quadrilateral plate. Alternatively, use an infrapectineal buttress plate as an indirect reduction tool (Video 4).
- For fixation, use nonlocking, precontoured, low-profile reconstruction plates. An infrapectineal buttress plate may be applied in addition. Alternatively, a combined anatomic plate for suprapectineal and infrapectineal fixation might be used.
- For the fixation and compression of the anterior column to the posterior column, place an infra-acetabular, or so-called fossa, screw and/or posterior column screw. Use the image intensifier to rule out intra-articular screw misplacement (Video 4).
- To enhance the fixation strength of the osteosynthetic construct and for prevention of secondary medialization of the femoral head, place additional long screws along the quadrilateral plate.
- Definitively reduce the dome impaction under fluoroscopic guidance after reduction of the anterior column, the quadrilateral plate, and the posterior column through a small window in the pelvic brim prepared with a chisel. Fill the osseous defect with allograft (Video 4).

Video 4 Reduction and fixation of the fracture. AIIS = anterior inferior iliac spine.

Step 6: Wound Closure

Suture the anterior lamina of the rectus sheath and perform a layered closure.

- Place a suction drain in the Retzius space routinely and remove if drainage is <40 mL per 24 hours (Video 5).
- Close the anterior lamina of the rectus sheath using absorbable sutures after wound irrigation and if hemostasis and clear urine output is noted (Video 5).
- Perform a layered closure of the subcutaneous tissues and close the skin with staples or intracutaneous suture (Video 5).

Video 5 Wound closure.

Step 7: Postoperative Care

Instruct the patient to use toe-touch weight-bearing for the first 3 months postoperatively.

- Check the accuracy of reduction using CT scans (Figs. 7-A and 7-B, Video 6).
- Restrict mobilization to toe-touch weight-bearing for the first 3 months.
- Prescribe low-molecular-weight heparin or rivaroxaban for this time period as prophylaxis against venous thromboembolism.
- If fracture consolidation is evident 3 months postoperatively, allow full weight-bearing, as tolerated with respect to pain, with the assistance of a physiotherapist.
- Follow the patients routinely at 6 and 12 weeks and then at 12 and 24 months after surgery, clinically and radiographically. In the present case, the patient did not show any signs of posttraumatic osteoarthritis during midterm follow-up (Fig. 8).

Fig. 7-A

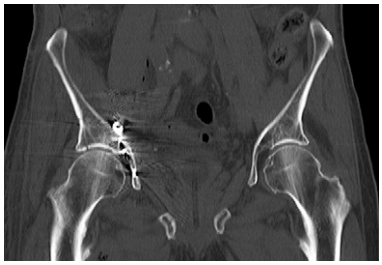

Fig. 7-B

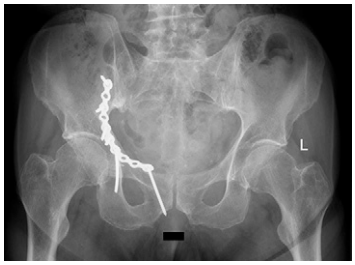

Fig. 8

Figs. 7-A and 7-B Postoperative images. **Fig. 7-A** Axial CT scan showing an anatomic reduction of the dome. **Fig. 7-B** Coronal CT scan showing the anatomically reduced dome and quadrilateral plate with the infra-acetabular screw in the narrow screw corridor.
Fig. 8 Anteroposterior radiograph of the pelvis made 2.5 years after surgery.
Video 6 Postoperative radiographic evaluation of the patient.

Results

The Pararectus approach facilitated safe surgical access above the hip joint with anatomic reduction achieved in 94% of the patients with a mean age of 62 years (range, 16 to 98 years)[9,10]. In comparison with the ilioinguinal approach, the Pararectus approach more commonly achieved anatomic reductions of articular gaps[11]. In comparison with the modified Stoppa approach, the Pararectus approach provided a 10% increase in exposure and a twofold increase in screw lengths of the most posterior screw and the posterior column screw[8]; to obtain this with use of the modified Stoppa approach, the lateral window of the ilioinguinal approach might become necessary. Conversion to total hip replacement was performed in up to 13% of the patients[10]. In all patients with preserved hips, the midterm clinical outcome was excellent or good, and the radiographic outcome was rated as excellent or good for 94% of the patients.

The Pararectus approach allows the creation of multiple windows (if required, depending on the fracture pattern) with direct manipulation of neurovascular structures, which appears cumbersome. However, with the development of these windows, there is no need to change any window (e.g., during reduction maneuvers or fracture fixation) and only minor traction of neurovascular structures is applied.

Pitfalls & Challenges

- The risk of entering the peritoneum is approximately 4%[9,10].
- The risk of minor vascular damage is approximately 4%[9,10].
- Obesity is challenging. The patient with the highest body mass index (BMI) who was treated using the Pararectus approach had a BMI of 48 kg/m^2. However, obesity is challenging per se and is not specific to an approach.
- The Pararectus approach may be unsuitable in patients presenting with abdominal distension, ileus, or bowel obstruction.
- In comminuted high anterior column fractures, an additional mini-incision in the first window of the ilioinguinal approach is advised.
- In patients with delayed fracture fixation, surgical dissection within the second window is challenging because of adhesions.
- The obturator nerve may stretch during exposure of the quadrilateral plate.
- Traction injuries to the lateral femoral cutaneous nerve and/or femoral nerve may occur.
- If a traction table is used, the time in traction should be as short as possible to prevent secondary damage to the pudendal nerve.
- If a ring retractor is used for a stable surgical field, ensure that traction to the external iliac vessels is used both for as short a time as possible and for as minimal a distance as needed to minimize the risk of dissection of the artery or thromboembolism.

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