JBJS ESSENTIAL Surgical Techniques

Two-Incision Minimally Invasive Approach for the Treatment of Anterior Column Acetabular Fractures

Steffen Ruchholtz, MD, Benjamin Bücking, MD, Ralph Zettl, MD, Rene Aigner, MD, Carsten Mand, MD, and Christian Kühne, MD

Based on an original article: J Orthop Trauma. 2013 May;27(5):248-55.

Introduction

We describe an alternative to the Letournel ilioinguinal approach for anterior column acetabular fractures that is performed with a unique retraction device that decreases the rate of soft-tissue complications.

The ilioinguinal approach described by Letournel[1] is the classic procedure for fractures of the anterior column of the acetabulum. This approach respects the anatomical structures of the pelvis and allows broad visual and tactile exposure of the entire anterior aspect of the ilium, the linea terminalis (pelvic brim), and the inner aspect of the posterior column[1-4]. However, the entire anterior part of the abdominal wall has to be detached from the ilium or the inguinal ligament to open the "second window," and this may result in soft-tissue complications. Furthermore, the ilioinguinal approach is associated with an approximately 10% rate of complications, including hernias, thromboses, lesions of the femoral vessels, lymphedema, meralgia paresthetica, hematoma, and impaired wound-healing[2,5-8]. Because of these risks, we developed an alternative to the ilioinguinal approach that offers the same exposure as the middle window of the ilioinguinal approach1. With the help of a unique retraction device (SynFrame; Synthes, Umkirch, Germany), a high level of fracture reduction can be achieved with a low rate of postoperative soft-tissue complications.

This two-incision minimally invasive approach allows all anterior column fractures and concomitant hemitransverse fractures to be reduced and stabilized (Video 1).

Step 1: Position the Patient and Identify the Sites for the Incisions

Identify the sites for both incisions with the help of an image intensifier.

- Position the patient supine on a radiolucent operating table, with the ipsilateral extremity draped free. For enhanced manipulation, place the ipsilateral leg on an additional small table with adjustable height. The hip should be slightly flexed during the procedure to relax the iliopsoas muscle (Fig. 1).
- For reduction of the fracture only, traction to the ipsilateral side may be applied by the assistant. No manipulation of the contralateral side or the operating table has to be performed during the procedure. Therefore, the patient can be placed on a normal table that enables radiographic visualization of the fractured area.
- Identify the fracture under fluoroscopy, and mark two incisions: the first anteriorly over the linea terminalis (pelvic brim) and the second above the symphysis pubis (Figs. 2-A through 2-D). Medical/anesthesiological relaxation of the patient is critical for this procedure.

Step 2: Make the First Incision to Expose the Anterior Column and the Linea Terminalis (Pelvic Brim)

Make the first incision to expose the central area of the fracture.

- Make the first vertical incision exactly above (anterior to) the pelvic brim in the area of the acetabular dome, as was identified with the image intensifier and marked on the skin (Figs. 2-A and 2-B). Make an incision approximately 3 to 4 cm in length to expose the external oblique muscle and divide the muscle in line with its fibers.
- Bluntly dissect the internal oblique and transversalis muscles in line with their fibers. Perform further blunt retroperitoneal dissection toward the surface of the iliopsoas muscle.
- Using Langenbeck retractors, retract the tissue, exposing the iliopectineal fascia. Using a peanut swab (or another soft instrument for blunt dis-

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section), mobilize the iliac vessels medially.

- Incise the iliopectineal fascia toward the pubis and mobilize the iliopsoas muscle laterally together with the femoral nerve, while the hip is flexed.

Step 3: Make the Second Incision to Expose the Symphysis and the Ipsilateral Pubic Bone

Make the second incision to expose the area for the distal plate fixation.

- After identification of the location for the second incision by palpation or with the help of the image intensifier (Fig. 2-C), make an oblique 3-cm incision over the symphysis. Through this incision, split the fascia of the rectus abdominis muscle horizontally and then notch the insertion of the muscle medially and mobilize it laterally, exposing the pubis.
- Carry out blunt dissection underneath the vascular bundle of the external iliac artery and vein. For this step, follow the arc of the pubic bone from distal to proximal with your index finger, with which you can move aside the soft tissue over the periosteum below the vessels. When your finger reaches the pelvic brim in the area of the lateral incision, insert a long clamp bent at the tip through the lateral incision and set it with its tip on your index finger, already placed through the second, medial incision. Guide the clamp below the vessels from lateral to medial with your finger, moving your finger backward. When the tip of the clamp appears in the medial incision, pass a vascular loop or tape below the vascular bundle by pulling the instrument carefully back. The vessels can be eventually lifted with this tape during the operation (Fig. 3).

Step 4: Maintain Exposure of the Linea Terminalis Using a Soft-Tissue Retraction System

For better visualization, use a soft-tissue retraction system.

- A table-mounted retraction system (SynFrame [Synthes], Omni-Tract Surgical, or Bookwalter [Symmetry Surgical]) greatly facilitates exposure of the pelvic brim. We use the SynFrame, which is inserted through the first, lateral approach with use of three, four, or five retractors.
- Retract the tissue from the fracture site. Place the first retractor—a long (approximately 14-cm [5 to 6-in]-long) Langenbeck-style paddle—medially, holding vessels and the soft tissue of the small (true) pelvis aside. Place the second (Langenbeck or Hohmann-style) retractor in the proximal-lateral part of the iliac wing, holding the iliopsoas muscle and the femoral nerve laterally. Use an additional one or two retractors depending on the need for visualization of different fracture areas. All retractors have to be fixed to the SynFrame (Figs. 4-A, 4-B, and 4-C).
- Pay attention to the obturator nerve that passes close to the fracture.

Step 5: Reduce the Fracture

Clean and reduce the fracture through the first incision.

- Reduction is enabled by longitudinal traction with mild abduction and flexion of the hip joint. The abduction and flexion (between 20° and 30°) is helpful to avoid tension on the iliopsoas muscle and the femoral nerve.
- Pull the femoral head out of the fracture region and clean the fracture in the acetabular region. The retraction system enables nearly the same visualization of the area over the anterior part of the acetabulum as is possible with exposure through the ilioinguinal approach.
- Perform direct reduction with a pusher or forceps through the incision. Typical reduction clamps for pelvic reduction (e.g., asymmetrical Farabeuf forceps, Matta forceps, or Jungbluth forceps [Stryker]) can be used. When larger forceps (e.g., Reduction Forceps, King Tong [Stryker]) are needed to reduce a fracture of the posterior column in hemitransverse fractures, make an additional incision lateral to the anterior iliac wing to percutaneously place the lateral tine of the forceps on the external iliac wing right above the acetabular joint. Place the medial tine on the inner part of the posterior column (e.g., the quadrilateral plate) (Figs. 5-A and 5-B).

Step 6: Fix the Fracture

Perform temporary and definitive fixation according to the standards for anterior acetabular fracture fixation.

- Anatomically reduce the fragments of the iliac wing and the pelvic brim under visual control. After temporary Kirschner wire fixation, fix the fragments with isolated lag screws or small buttressing reconstruction plates. In hemitransverse fractures, the posterior column may be fixed with a cannulated lag screw (4.5 to 7.6 mm) placed percutaneously from the lateral iliac wing toward the small pelvic region. Drill the guidewire for the screw under fluoroscopic control through the supra-acetabular region. Verify the correct position of the drill by digital palpation in the

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inner part of the small pelvis to ensure that the posterior column is adequately captured (Figs. 5-C and 5-D, with Figs. 5-E through 5-H showing the postoperative soft-tissue condition and radiographs of the same patient).

- After anatomical fracture reduction and fixation with lag screws, insert a 3.5-mm reconstruction plate (with twelve, thirteen, or fourteen holes and preshaped on a standard plastic model of the pelvis) through the medial incision (Video 1).
- Tip: Fix the medial part of the plate under fluoroscopic control with a Kirschner wire inserted into its first (most distal) hole and running parallel to the symphysis. With a second Kirschner wire, secure the position of the proximal end of the plate directly to the pelvic brim. Then place at least two distal screws in the symphyseal region. Set the supra-acetabular screws starting with the screw that is closest to the pelvic joint. Use of fluoroscopic control prevents intra-articular screw placement.

Step 7: Close the Wound

After radiographic documentation in three views, close the wound.

- Document the osteosynthesis on three standard views (anteroposterior, obturator, and iliac oblique).
- After hemostatic control of potential bleeding vessels, irrigate the wounds with at least 500 mL of normal saline solution or Ringer lactate solution and remove the retractor carefully.
- Before closing the layers of the wound, place a closed drain adjacent to the plate.

Results

We reported the results of a case-control study of the first twenty-six patients operated on with the two-incision minimally invasive technique[8]. The main advantage of the procedure is a substantial reduction of the operation time and postoperative soft-tissue complications. The duration of the operation averaged 109 ± 30 minutes, and there was primary healing of all incisions. As seen on radiographs made postoperatively, twenty patients had anatomical reduction of the fracture and six had a satisfactory reduction. No patient had a local soft-tissue complication or a revision. Nineteen (73%) of the patients were followed for at least twelve months, and they had a mean Harris hip score of 86.6 ± 8 points. Their quality of life was comparable with that of individuals of the same age.

To date, we have performed the procedure in a consecutive series of sixty-nine patients, who have remained pleased with the outcome.

What to Watch For

Indications

- Fractures of the anterior column comprising the anterior aspect of the ilium, the linea terminalis, and the inner aspect of the posterior column—i.e., the same indications as for the classic ilioinguinal approach.
- Periprosthetic fractures involving the anterior column with a stable cup.
- For severe acetabular fractures involving both the anterior and the posterior wall and column, the two-incision minimally invasive approach can be successfully combined with the posterior Kocher-Langenbeck approach.

Contraindications

- Acetabular fractures with displacement of the posterior wall and column—i.e., the same contraindications as for the classic ilioinguinal approach.
- Pathological anterior column fractures with severe loss of bone in the acetabular region should not be treated with osteosynthesis.

Pitfalls & Challenges

- The two-incision minimally invasive technique requires a good knowledge of acetabular surgery and the accompanying anatomy in order to properly expose the fracture with use of the retraction device. Once the fracture is exposed, the surgical steps are carried out with the standard procedures.
- It is helpful to practice the procedure on cadavera if an experienced surgeon is not assisting with the first operations.
- Although every patient undergoes a postoperative vascular Doppler ultrasound study, we have not seen any vascular problems (e.g., thrombosis of the iliac arteries or veins). However, one of our patients had a temporary palsy of the femoral nerve, which resolved fully. Thus, the surgeon should keep in mind that the retractor can cause excessive tension on the neurovascular structures. For as long as the retractor is in place, the hip joint should be flexed to prevent undue stress on these structures.
- A table-mounted retraction system and a radiolucent operating table that allows fixation of the system to the table greatly facilitates the procedure.
- The two-incision minimally invasive approach can be used under all soft-tissue conditions. However, the procedure can be more difficult in obese patients. For these patients (especially for

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those with more complex fractures), it might be helpful to make the incisions 2 to 3 cm longer. As of the time of writing, we have not had to convert intraoperatively from the two-incision minimally invasive approach to any other approach because of obesity. Nevertheless, the procedure might not be suitable for morbidly obese patients.

- If an intraoperative complication requires better visualization, we think that connection of the two incisions with direct exposure of the vessels might give sufficient access to the structures of the anterior aspect of the pelvis. For reduction of severely displaced fractures of the iliac wing, an additional lateral incision can be used.
- To date, previous operations with local scar formation (e.g., hernia repair or appendectomy) have not caused problems with the two-incision minimally invasive approach. The soft tissue in the subfascial layers can usually be mobilized by blunt dissection.

Clinical Comments

- What is the main benefit of the two-incision minimally invasive procedure?
  - We believe that minimizing the trauma to the soft tissue is a major benefit of the procedure, especially in geriatric patients with a displaced fracture of the anterior column. This substantially reduces the risk of the problems associated with the ilioinguinal approach, such as postoperative infection, meralgia paresthetica, venous thrombosis, and hernia.
- Can every type of fracture of the anterior wall be addressed with this approach?
  - Yes. We believe that once the retraction system is placed properly the visualization of the central fracture area is excellent. We think that, because of the direct visualization and manipulation in the central region of the fracture, the surgical reduction and fixation is as good as or superior to that achieved with the ilioinguinal exposure.
- What are the benefits of the two-incision minimally invasive approach compared with the Stoppa approach[9]?
  - The Stoppa approach has the advantage of facilitating direct access to the linea terminalis, but the access to the iliac wing is limited by the internal iliac vessels. Therefore, most surgeons use an additional lateral incision for proximal reduction and plate fixation. We believe that an advantage of the two-incision minimally invasive approach is the preservation of the abdominal wall insertion on the iliac wing (Figs. 6-A through 6-E) while providing adequate exposure.

Steffen Ruchholtz, MD
Benjamin Bücking, MD
Rene Aigner, MD
Carsten Mand, MD
Christian Kühne, MD
Department of Trauma, Hand and Reconstructive Surgery, University of Giessen and Marburg, Location Marburg, Baldingerstrasse, 35033 Marburg, Germany. E-mail address for S. Ruchholtz: ruchholt@med.uni-marburg.de. E-mail address for B. Bücking: buecking@med.uni-marburg.de. E-mail address for R. Aigner: raigner@med.uni-marburg.de. E-mail address for C. Mand: mand@med.uni-marburg.de. E-mail address for C. Kühne: kuehnec@med.uni-marburg.de

Ralph Zettl, MD
Unfallchirurgie Kantonsspital Frauenfeld, Pfaffenholzstrasse 4, 8501 Frauenfeld, Switzerland. E-mail address: ralph.zettl@stgag.ch

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Fig. 1

Intraoperative setting with the ipsilateral extremity draped free and placed on a small additional table.

Fig. 2-A

Preoperative three-dimensional (3D) reconstruction of a computed tomography (CT) scan of an anterior column fracture.

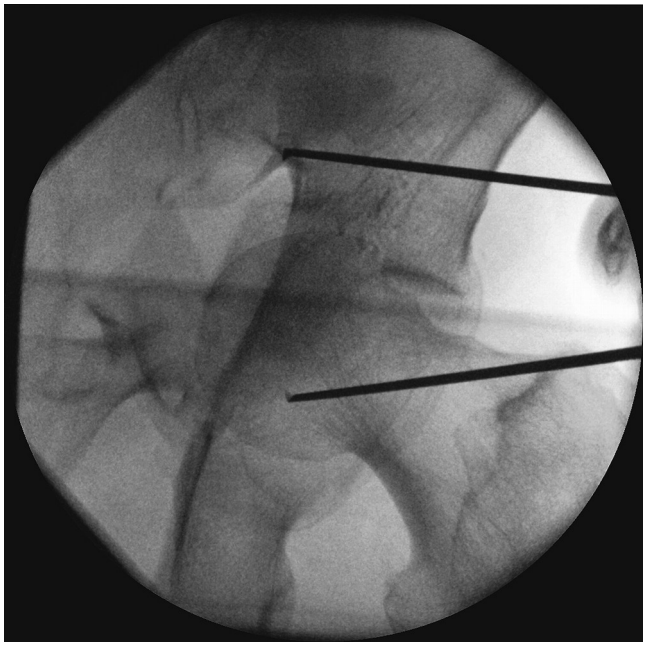

Fig. 2-B

Identification with the image intensifier of the optimal location—directly over the fracture area—for the first incision.

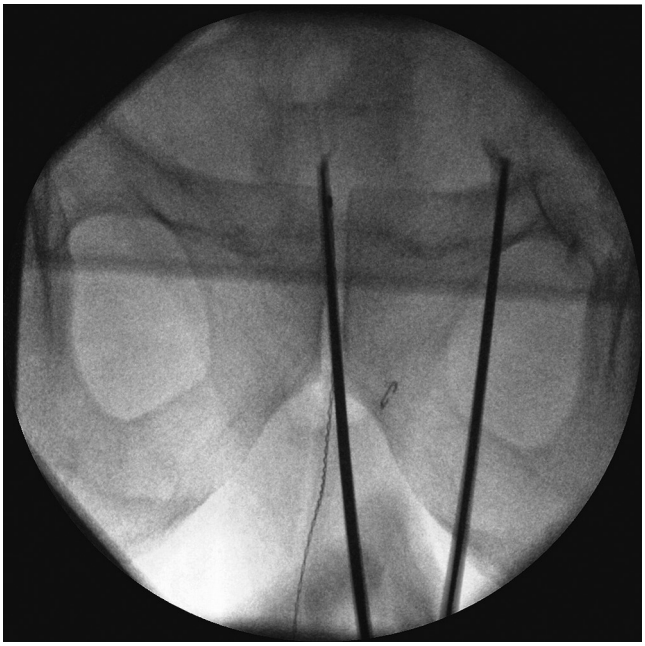

Fig. 2-C

Identification with the image intensifier of the symphyseal area for the second incision.

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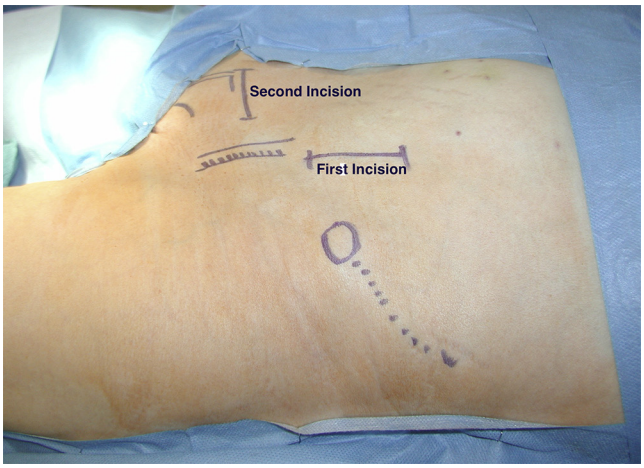

Fig. 2-D

The two incisions, the external iliac artery, and the iliac crest are marked. (Reproduced, with permission, from: Ruchholtz S, Taeger G, Zettl R. Der Zwei-Inzisions-Zugang in der Versorgung von Acetabulumfrakturen. Unfallchirurg. 2013 Mar;116[3]:277-82.)

Fig. 3

Photograph showing a tape below the external iliac vessels.

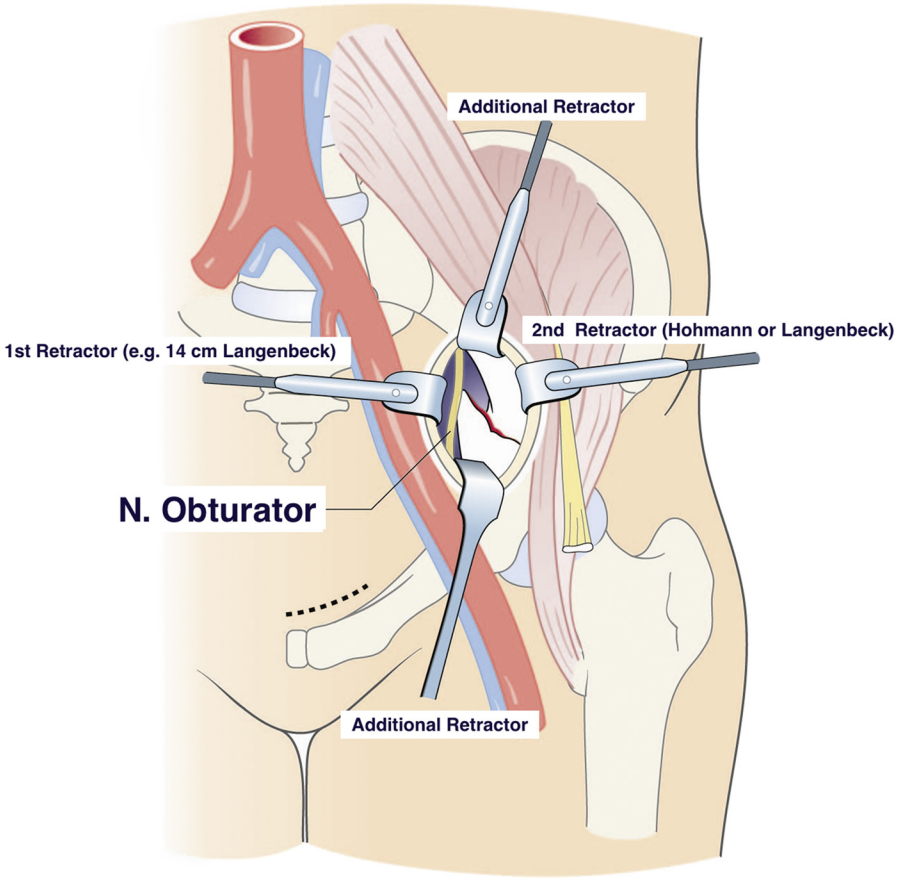

Fig. 4-A

Anatomical drawing of the positions of the retractors of the SynFrame. (Reproduced, with modification, from: Ruchholtz S, Buecking B, Delschen A, Lewan U, Taeger G, Kuehne C, Zettl R. The two-incision, minimally invasive approach in the treatment of acetabular fractures. J Orthop Trauma. 2013 May;27[5]:248-55. Reproduced with permission.)

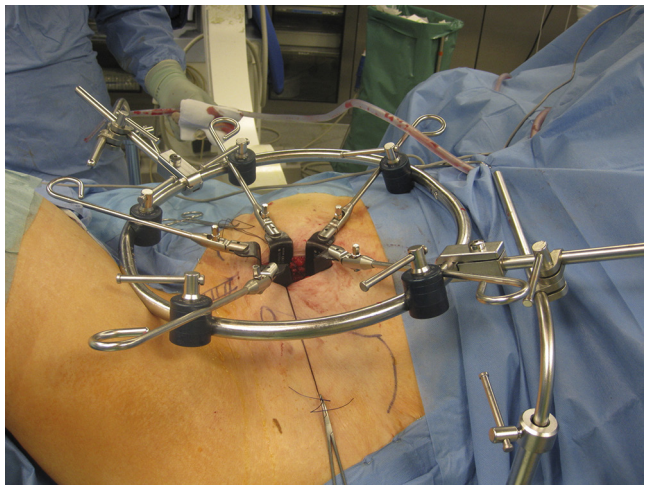

Fig. 4-B

Intraoperative photograph after placement of the SynFrame over the fracture. (Reproduced, with permission, from: Ruchholtz S, Buecking B, Delschen A, Lewan U, Taeger G, Kuehne C, Zettl R. The two-incision, minimally invasive approach in the treatment of acetabular fractures. J Orthop Trauma. 2013 May;27[5]:248-55.)

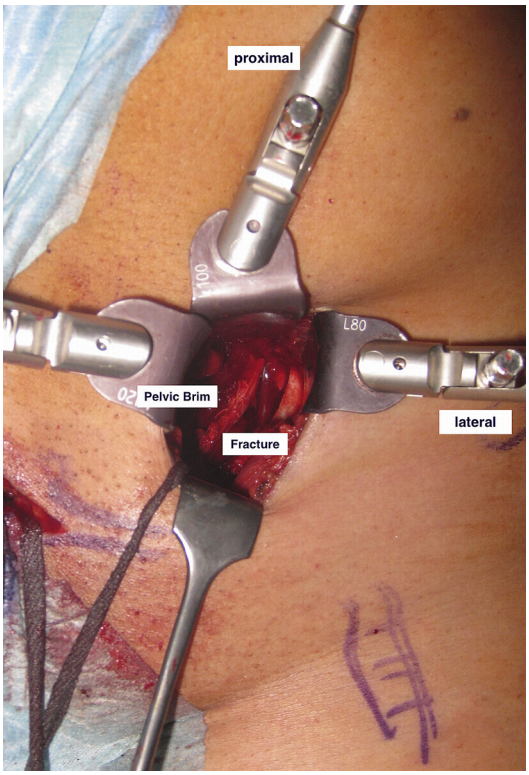

Fig. 4-C

View of the acetabular fracture through the SynFrame. (Reproduced, with modification, from: Ruchholtz S, Buecking B, Delschen A, Lewan U, Taeger G, Kuehne C, Zettl R. The two-incision, minimally invasive approach in the treatment of acetabular fractures. J Orthop Trauma. 2013 May;27[5]:248-55. Reproduced with permission.)

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Fig. 5-A

Preoperative 3D reconstruction of a CT scan of an anterior column and posterior hemitransverse fracture. (Reproduced, with permission, from: Ruchholtz S, Taeger G, Zettl R. Der Zwei-Inzisions-Zugang in der Versorgung von Acetabulumfrakturen. Unfallchirurg. 2013 Mar;116[3]:277-82.)

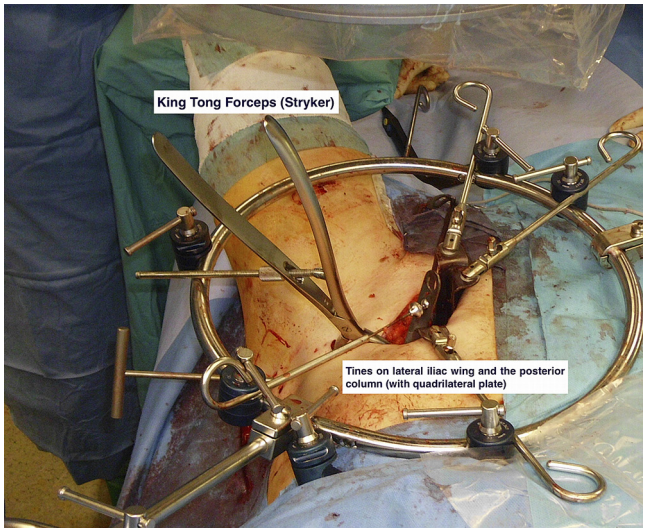

Fig. 5-B

Intraoperative photograph of the SynFrame and King Tong forceps that are placed over the quadrilateral plate and the posterior column.

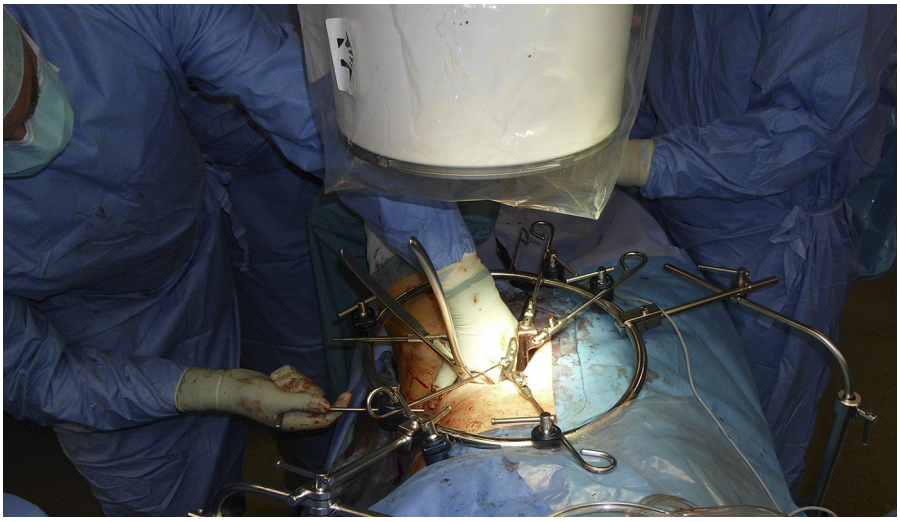

Fig. 5-C

Intraoperative photograph of the insertion of a percutaneous lag screw to fix the posterior column to the iliac wing. (Reproduced, with permission, from: Ruchholtz S, Taeger G, Zettl R. Der Zwei-Inzisions-Zugang in der Versorgung von Acetabulumfrakturen. Unfallchirurg. 2013 Mar;116[3]:277-82.)

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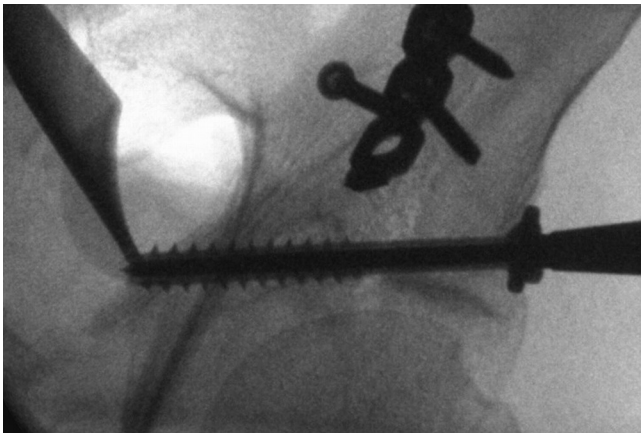

Fig. 5-D

Intraoperative radiograph of a percutaneously inserted supra-acetabular lag screw. (Reproduced, with permission, from: Ruchholtz S, Taeger G, Zettl R. Der Zwei-Inzisions-Zugang in der Versorgung von Acetabulumfrakturen. Unfallchirurg. 2013 Mar;116[3]:277-82.)

Fig. 5-E

Photograph of the skin incisions after surgery. (Reproduced, with permission, from: Ruchholtz S, Taeger G, Zettl R. Der Zwei-Inzisions-Zugang in der Versorgung von Acetabulumfrakturen. Unfallchirurg. 2013 Mar;116[3]:277-82.)

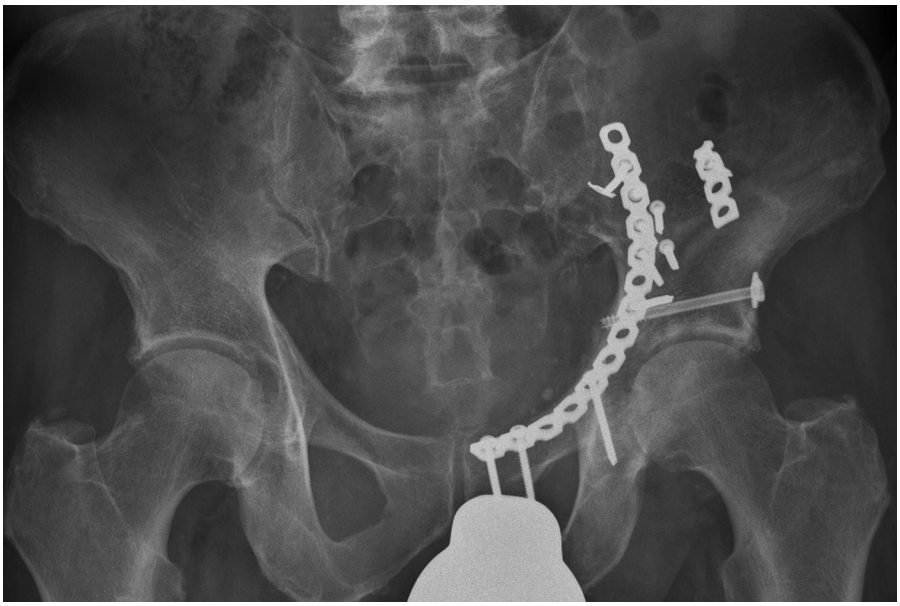

Fig. 5-F

Anteroposterior radiograph of the pelvis two years after surgery.

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Fig. 5-G
Iliac oblique radiograph two years after surgery.

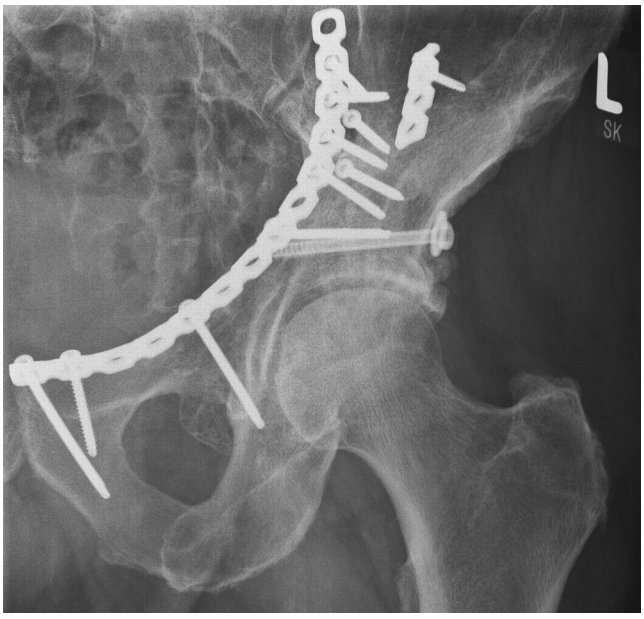

Fig. 5-H
Obturator oblique radiograph two years after surgery.

Fig. 6-A

Preoperative 3D reconstruction of a CT scan of an anterior column fracture. The fracture comprises the entire anterior column. The fracture line starts approximately 1 cm lateral to the symphysis and runs into the medial iliac wing. (Reproduced, with permission, from: Ruchholtz S, Buecking B, Delschen A, Lewan U, Taeger G, Kuehne C, Zettl R. The two-incision, minimally invasive approach in the treatment of acetabular fractures. J Orthop Trauma. 2013 May;27[5]:248-55.)

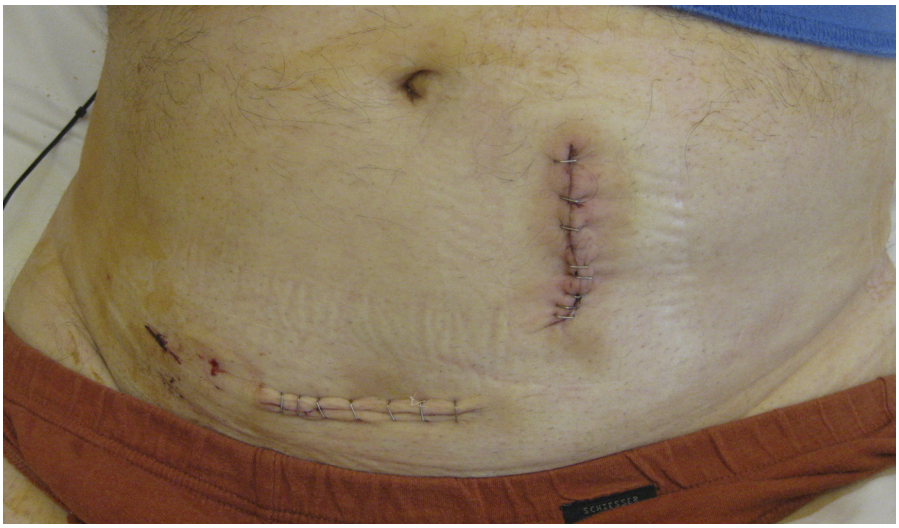

Fig. 6-B

Photograph of the skin incisions after surgery. (Reproduced, with permission, from: Ruchholtz S, Taeger G, Zettl R. Der Zwei-Inzisions-Zugang in der Versorgung von Acetabulumfrakturen. Unfallchirurg. 2013 Mar;116[3]:277-82.)

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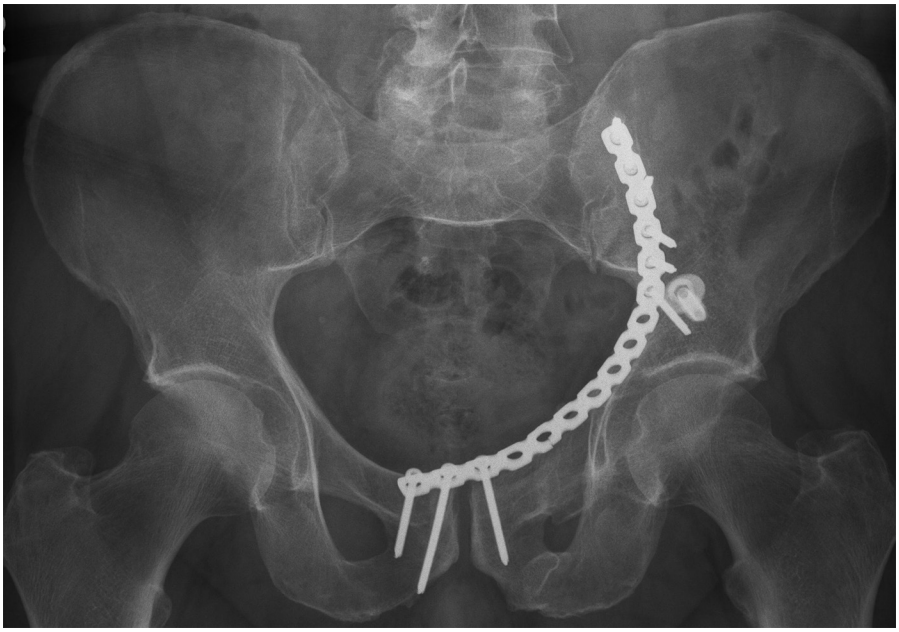

Fig. 6-C

Anteroposterior radiograph of the pelvis two years after surgery.

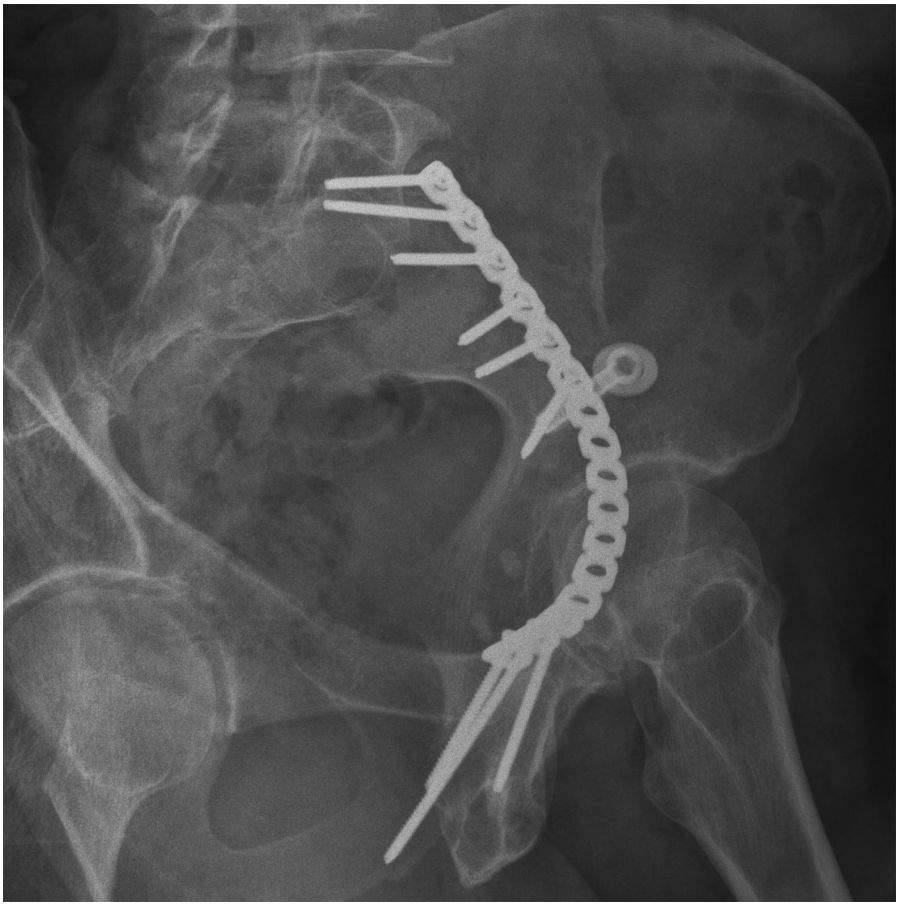

Fig. 6-D

Iliac oblique radiograph two years after surgery. (Reproduced, with permission, from: Ruchholtz S, Buecking B, Delschen A, Lewan U, Taeger G, Kuehne C, Zettl R. The two-incision, minimally invasive approach in the treatment of acetabular fractures. J Orthop Trauma. 2013 May;27[5]:248-55.)

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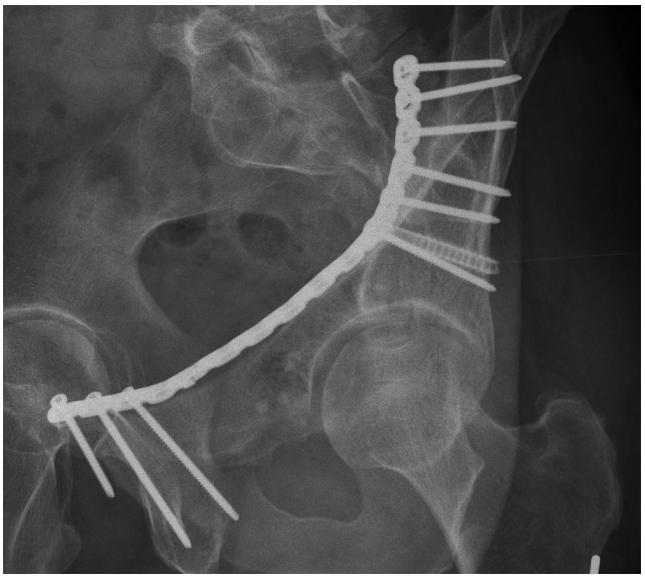

Fig. 6-E

Obturator oblique radiograph two years after surgery. (Reproduced, with permission, from: Ruchholtz S, Buecking B, Delschen A, Lewan U, Taeger G, Kuehne C, Zettl R. The two-incision, minimally invasive approach in the treatment of acetabular fractures. J Orthop Trauma. 2013 May;27[5]:248-55.)

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