Standard Approaches to the Acetabulum Part 3: Intrapelvic Approach

Standardní přístupy k acetabulu. Část 3: intrapelvický přístup

A. GÄNSSLEN, S. GRECHENIG, M. NERLICH, M. MÜLLER, W. GRECHENIG, J. LINDAHL

Klinik für Unfallchirurgie Orthopädie und Handchirurgie, Klinikum der Stadt Wolfsburg, Germany

A. Introduction

The intrapelvic approach was originally described by Hirvensalo et al. from Finland in the early 90ies (8) and a further comparable description was published shortly thereafter by Cole et al. (5). Since then, various modifications have been described.

Whereas the ilioinguinal approach was used until then to treat acetabular fractures with relevant anterior column involvement from an extrapelvic view, the intrapelvic approach was developed to address the often accompanied central hip dislocation in these fracture types with relevant fractures of the quadrilateral surface. With this approach a complete different view to the antero-medial acetabular pathology was possible. The view from more medial allows a better direct access to joint structures "below" the pelvic brim in the true pelvis (intrapelvic) in contrast to the extrapelvic access with the ilioinguibnal approach.

Meanwhile, the surgical technique has been described in detail and some modifications and tricks have been published (5, 8, 10, 13, 19).

The intrapelvic approach offers several advantages compared to the ilioinguinal approach:
- lower invasiveness without substantial muscle detachment,
- direct view of the superior pubic rami from superior and medial, the inferior anterior column and the quadrilateral surface up to the posterior border of the posterior column at the greater sciatic notch,
- reduction and fixation of the anterior column and the quadrilateral surface under direct visualization,
- reduction of antero-superior marginal impactions under direct visualization,
- low risk of heterotopic ossification,
- low risk of lesions to the lateral cutaneous femoral nerve.

The aim of the third part of "standard approaches of the acetabulum" is to report on the special topics indication, positioning, exposure, incision, dissection, the anatomical basis of osteosynthesis and present results using the via the intrapelvic approach.

Indications

Indications for the intrapelvic approach correspond largely to those for the ilioinguinal approach. The main indications are fracture types involving the anterior column, where a direct visible reduction is advantageous. Typical fracture types which can be addressed by the intrapelvic approach are (1, 3, 5, 8–10, 14–16, 19, 21, 24):
- isolated fractures of the anterior column
- isolated fractures of the anterior wall
- associated fractures of the anterior column with a posterior hemitransverse fracture
- several transverse fractures with predominantly anterior displacement (23)
- T-type fractures
- both column fractures, ideally with a large monofragmentary fracture of the posterior column (AO type C1.2)
- isolated tear drop figure fractures (6)
- isolated fractures of the quadrilateral surface (25)
- selected fractures involving the posterior column

Positioning

Surgery is performed on a radiolucent carbon table in the supine position. Before surgery, checking the possibility of standard X-ray evaluation of the affected hip joint is mandatory (e.g. AP-view, Judet-views, inlet- and outlet views, combined views).

The affected leg must be movably draped. The knee and the hip joint should be slightly flexed by using supporting aids to release tension to the iliopsoas muscle and to the iliac external neurovascular bundle. Additionally, the contralateral hemipelvis can be lifted up slightly by an inflatable pillow to allow better visualization (13). A urinary catheter should be placed to protect the bladder.

Draping integrates the entire affected leg (movable), the entire anterior and lateral pelvic regions and the abdomen up to the xiphoid. Surgery is performed from the contralateral side to obtain an optimal visualization of the medial true pelvis.

Exposure

In contrast to the ilioinguinal approach, the intrapelvic approach offers a more direct view to the medial acetabular structures with more extensive visualization of the upper pubic ramus, parts of the anterior column and the quadrilateral surface up to the posterior border of the posterior column and the medial/inferior part of the SI joint (Fig. 1a). An additional anterolateral incision at the iliac crest (1st window of the ilioinguinal approach) allows superior access to the entire iliac fossa, the sacral shoulder and the SI-joint from superior (Fig. 1b).

Skin incision

There are two possibilities of skin incisions. The standard skin incision is longitudinal and starts at the umbilicus going down shortly inferior to the pubic symphysis. Alternatively, a Pfannenstil incision can be chosen two fingerbreadth superior to the symphysis. (Fig. 2a). The superficial dissection is thereafter identical.

Dissection

After skin incision the subcutaneous tissue is dissected until identification of the anterior abdominal fascia (Fig. 2b+c).
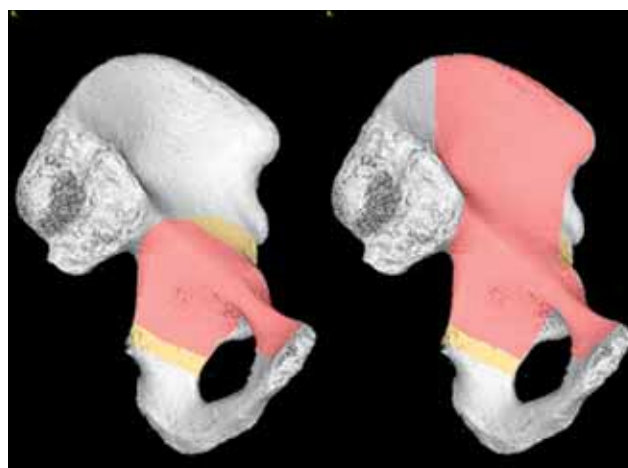

Fig. 1. A – the intrapelvic approach offers a more direct view to the medial acetabular structures with more extensive visualization of the upper pubic ramus, parts of the anterior column and the quadrilateral surface up to the posterior border of the posterior column and the medial/inferior part of the SI joint. B – an additional anterolateral incision at the iliac crest (1st window of the ilioinguinal approach) allows superior access to the entire iliac fossa, the sacral shoulder and the SI-joint from superior.
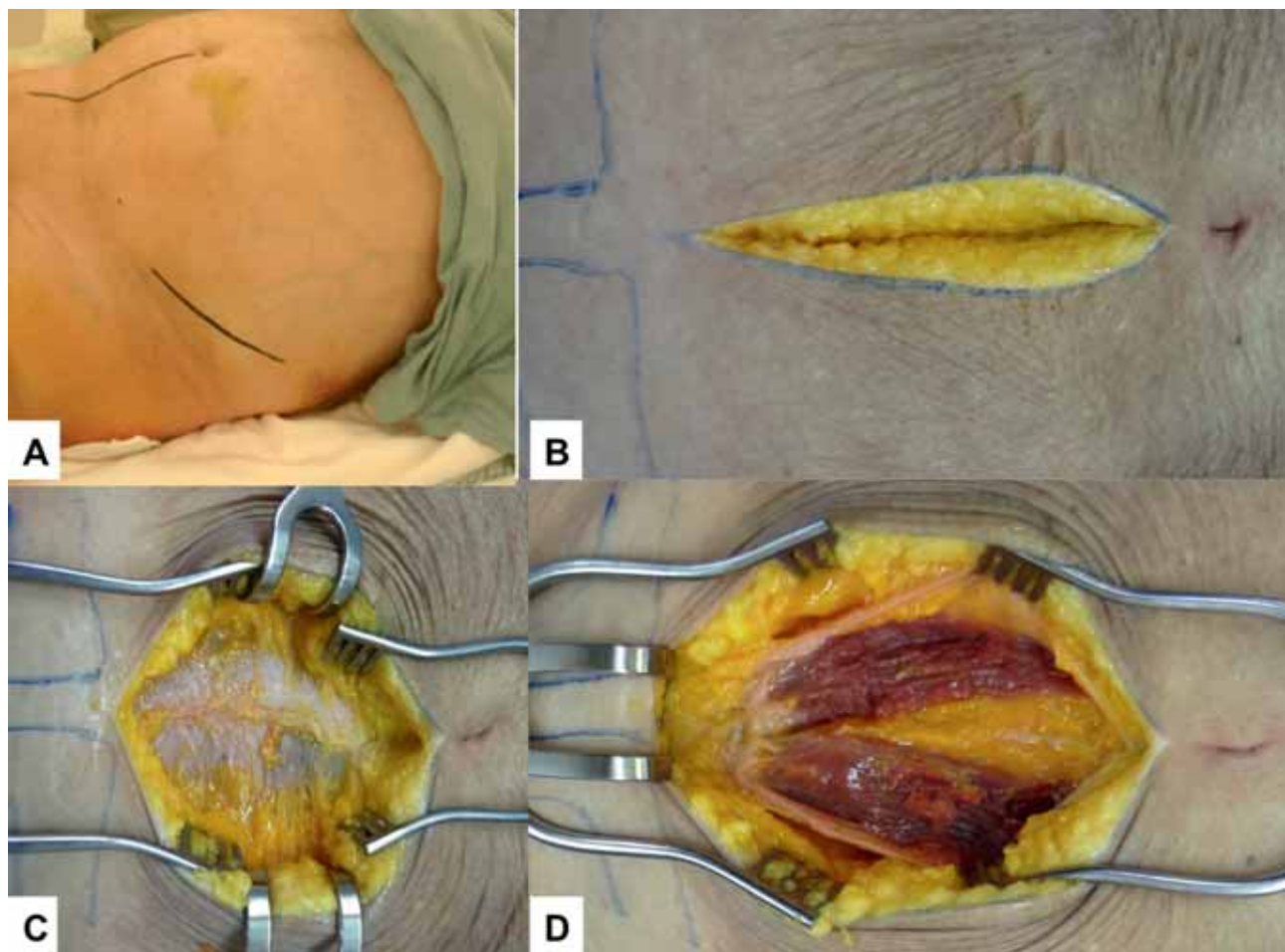

Fig. 2. A – the standard skin incision is longitudinal and starts at the umbilicus going down shortly inferior to the pubic symphysis. Alternatively, a Pfannenstil incision can be chosen two fingerbreadth superior to the symphysis. B + C – after skin incision the subcutaneous tissue is dissected until identification of the anterior abdominal fascia. D – sharp incision is performed in the midline of the fascia between the rectus muscles (linea alba) and the rectus muscle bellies are then bluntly mobilized laterally.

A straight, longitudinal incision is favoured to avoid a too lateral dissection with the potential risk of damaging the rotundum ligament or the spermatic cord. A sharp incision is performed in the midline of the fascia between the rectus muscles (linea alba) and the rectus muscle bellies are then bluntly mobilized laterally (Fig. 2d).

The posterior part of the fascia, the transversus abdominis fascia, is opened by blunt dissection at the symphyseal level to reach the retropubic space.

The urinary bladder is then identified. Palpation of the urinary catheter can be helpful. After blunt mobilization, the urinary bladder is positioned posteriorly and protected with a blunt bladder spatula or a special blunt Hohmann retractor. The peritoneum must not be opened, so that the overall preparation is exclusively retroperitoneal. This part of preparation is identical to the dissection for emergency pelvic packing (96).

Some authors recommend complete detachment of the rectus abdominis muscle on the injured side. In our experience only a lateral muscle mobilization is necessary by anterior subperiosteal incision. After mobilization of the muscle and the anterior abdominal wall a blunt small Hohmann-retractor is inserted just lateral to the pubic tubercle on the upper pubic rami getting access to the superior and medial upper pubic rami.

The following dissection needs a periostal incision just inferior at the edge of the linea terminalis (pelvic brim, Fig. 3a).

The corona mortis that typically crosses the upper pubic rami approximately 5 cm lateral to the pubic symphysis and has to be identified (Fig. 3b). Depending on the size of these vessels ligation, clipping or coagulation is performed. The incised periosteum is then mobilized superiorly and laterally from the pubic bone (Fig. 3c). If necessary, the obturator internus muscle can be dissected
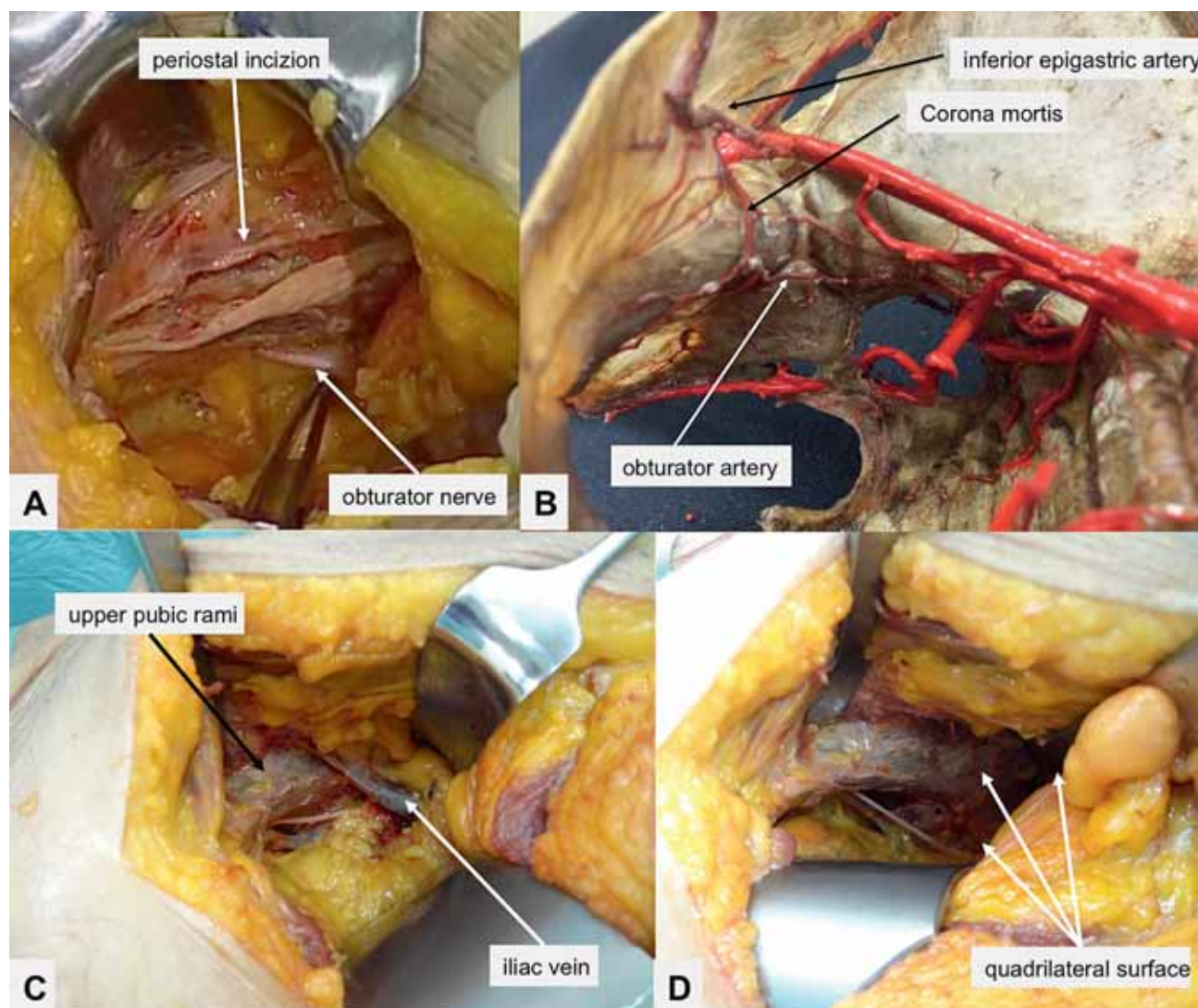

Fig. 3. A – the following dissection needs a periostal incision just inferior at the edge of the linea terminalis (pelvic brim). B – the corona mortis that typically crosses the upper pubic rami approximately 5 cm lateral to the pubic symphysis and has to be identified. C – the incised periosteum is then mobilized superiorly and laterally from the pubic bone. D – he obturator neurovascular bundle must be identified and protected by inserting a blunt retractor at the level of the ischial spine.

and mobilized inferiorly to visualize the anterior part of the quadrilateral surface and the obturator canal. Anterior parts of the acetabular fracture can now already be identified.

The obturator neurovascular bundle must be identified and protected. These structures lie in the fatty tissue on the obturator internus muscle and pass through the obturator canal from inside the pelvis to the outer side. Mobilization of these structures is performed as far as necessary (Fig. 3d). Protection can be performed by inserting a blunt retractor at the level of the ischial spine. Typically, the obturator nerve is the first structure identified directly below the pelvic brim, followed deeper by the artery and the vein (Fig. 3d).

The next dissection step is now the identification of the fracture of the quadrilateral surface and if necessary the exposure of the posterior part of the quadrilateral surface, which is part of the posterior column (Fig. 3d).

Identification of marginal impactions in the anterior and superior region, that are common especially in the older population group, is mandatory ("gull sign" according to Anglen et al. (2)). Therefore, fracture fragments of the quadrilateral surface must be mobilized medially allowing direct visualization of the femoral head and to parts of the articular surface. Reduction of these impacted fragments and removal of incarcerated fragments can now be performed under direct visualization (13). This is supported by lateral traction of the femoral head out of its often medialized position by percutaneously inserting a Schanz screw into the femoral neck. This additionally leads to a reduction of the tension on the obturator neurovascular bundle and allows easier reduction of medial displaced fracture components from the posterior column and the quadrilateral surface fragments.

A blunt retractor can be inserted posterior to the anterior part of the greater sciatic notch.

Further dissection is performed posteriorly up to the SI joint and the inferior iliac fossa. The iliac vessels must be protected. This is performed by inserting a Hohmann or Deaver retractor into the iliac fossa and thereby lifting-up the vessels. This is supported by flexing the hip joint to release tension to the vessels and the iliopsoas muscle. The whole true pelvis can now be visualized up to the SI-joint and the anterior cortex of the sacrum.

Modifications

In fracture types extending to the iliac crest (high anterior column fractures, both column fractures, anterior column + posterior hemitransverse fractures), the first window of the ilioinguinal approach is additionally opened to address this fracture pathology.

Anatomical basis of osteosynthesis via the intrapelvic approach

The intrapelvic approach offers a different way for reduction and osteosynthesis of especially acetabular fractures with anterior pathology compared to the ilioinguinal approach.

The main structures at risk are the obturator neurovascular bundle, which can be found predominantly at least 1,5cm distal to the linea terminalis (Fig. 3a+c).

An anatomical study of the possible visual exposure stated, that 79% of the bony pelvis, the entire linea terminalis and 80% of the quadrilateral surface can be directly visualized intraoperatively (4). On average an anatomical area of 2 cm above (lateral) the pelvic brim and a 5 cm wide area below (medial) to the pelvic brim can be visualized. Additionally, the anterior parts of the sacrum can be seen.

The typical plate position, known from the ilioinguinal approach, is the suprapectineal plating with the plate on top of the pelvic brim. With the intrapelvic approach, additionally an infrapectineal (medial) plating is possible (Fig. 4) allowing medial buttressing of fractures at the quadrilateral surface. Buttressing is optimized with using an overcontured plate. After initial plate fixation near the SI-joint, secondary anterior fixation creates a resulting force vector laterally to press quadrilateral fragments as well as the femoral head laterally (5, 8, 17).

Guy et al. identified the safe zone inside of the pelvis for screw application to avoid intraarticular hardware (7). Depending on the size of the femoral head, 4–6 plate holes have to be left free periarticular (Fig). This safe zone is especially relevant at the medial posterior column area and highly depending on femoral head diameter. Several special designed anatomical plates were developed and are in clinical use. Beside standard reconstruction and pelvic plates (Fig. 5), infrapectineal and suprapectineal plate systems are available.

A biomechanical analysis of these new plates in a transverse acetabular fracture model showed comparable fixation stability to conventional osteosyntheses and under certain conditions even better results (12). Comparable results were found with similar plate systems (20, 22, 26).
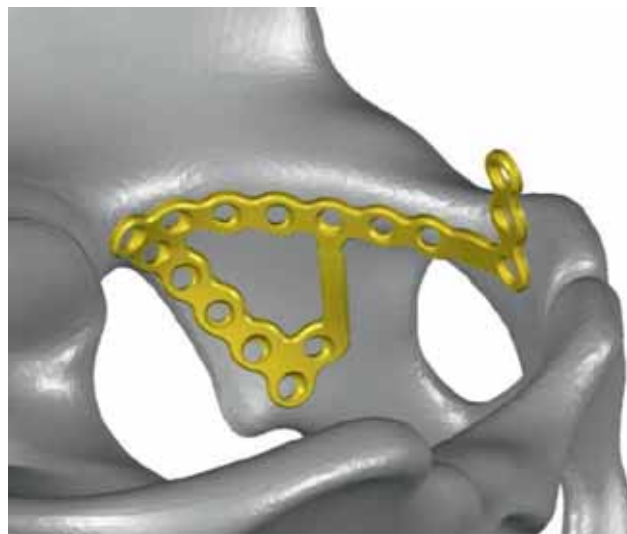

Fig. 4. The typical plate position, known from the ilioinguinal approach, is the suprapectineal plating with the plate on top of the pelvic brim. With the intrapelvic approach, additionally an infrapectineal (medial) plating is possible.

Fig. 5. Several special designed anatomical plates were developed and are in clinical use. Beside standard reconstruction and pelvic plates.

Results

Presently, several clinical results are available focussing on the intrapelvic approach. The most significant limitation of all these analyses are the heterogenity of the patient populations, small case numbers, different fracture types and the use of additional approaches.

- Results of the finnish group showed anatomical joint reconstruction (0-2 mm gap/step) in 84.1% in 164 osteosyntheses (9). Complications were observed having 12.2% lesions of the lateral cutaneous femoral nerve, 3.6% fixation failure, 2.4% intraarticular screw positions and 1.2% superficial infections. In 14% of these patients implantation of a total hip prosthesis was necessary during the further course of these patients.
- In an analysis of 14 patients with 8 both column fractures, 4 T-type fractures, 1 fracture of the anterior column and 1 transverse fracture osteosynthesis was exclusively performed via the intrapelvic approach (24). The mean operative time was 130 minutes, the mean blood loss was 1,020 ml. In average 2 units of blood were administered intraoperatively. According to the Matta criteria an anatomical joint reconstruction was seen 71% (< 1 mm), a good joint reconstruction in 21% (1–3 mm) and insufficient joint reconstruction in 8% (> 3 mm). Complications were 15% infections, 8% of peritoneal openings, 15% deep vein thrombosis and 8% nerve lesions of femoral nerve.
- In 17 patients (9 both column fractures, 3 transverse fractures, 3 fractures of the anterior column with a posterior hemitransverse fracture and 2 T-type fractures) stabilized by the intrapelvic approach together with the anterior-lateral approach (1st window of the ilioinguinal approach), 82% of patients had a perfect joint reconstruction (< 1 mm) and 18% (1–3 mm) showed a good joint reconstruction (1). At follow-up of 16 patients after an average of 10 months two patients experienced irritation of the lateral cutaneous femoral nerve (12.5%), one patient had a seroma and one a deep infection (6.3%). With this approach combination

a significant reduction of the severely displaced fracture /average: 13 mm anterior column, 17.5 mm posterior column) could be achieved.

- An analysis of 57 patients the intrapelvic approach was used in 22 both-column fractures, 12 fractures of the anterior column, 7 fractures of the anterior column with a posterior hemitransverse fracture, 6 transverse fractures and 2 T-type fractures (19). In 60% the anterolateral approach was additionally used. Surgery was performed after an average of 5 days (3–11 days) posttrauma. The mean operative time was 263 minutes, the blood loss was 690 ml. Complications were one lesion of the superior gluteal artery (1.8%), one wound infection, two inguinal hernias (3.8%) and one rectus abdominis muscle atrophy (1.8%). 50 adult patients were followed after 1 year. An anatomical joint reconstruction was observed in 70% (< 1 mm), a good joint reconstruction in 22% (1–3 mm) and an insufficient joint reconstruction in 8% (> 3 mm) using the Matta criteria. According to the Merle d'Aubigné scores the clinical results were excellent in 46%, good in 42%, moderate in 2% and poor in 10%. 26% of patients revealed a relevant weakness of the adductors.
- In an analysis of 21 patients (mean age 64.3 years; 55–82 years) 6 fractures of the anterior column, 6 both column fractures, 6 fractures of the anterior column with a posterior hemitransverse fracture and three T-type fractures were treated via the combined intrapelvic and antero-lateral approach (14). Surgery was performed after an average of 5.3 days (1–10 days). The mean operative time was 167 minutes, the blood loss was 1,376 ml. Complications consisted of one obturator nerve lesion, two patients with temporary adductor weakness (overall 14.2% nerve lesions) and three Brooker type I-II heterotopic ossifications (14.2%). After an average of 4.2 years, using the Harris Hip Score, 70.2% had a good to very good functional outcome. In two patients (9.5%) a total hip prosthesis was implanted and four additional patients (19%) had post-traumatic degeneration of the hip joint.
- Khoury et al. presented preliminary results using the intrapelvic approach in 60 patients (10). Fracture types included transverse fractures, T-type fractures and fractures of the anterior column with posterior hemitransverse fracture, 36% anterior column fractures and 28% both column fractures. The clinical outcome using the Merle d'Aubigne Score averaged 15.22 points. An anatomical joint reconstruction was achieved in 54%, in 43% there was a reconstruction within 2–3 mm and 3% had a malreduction of > 3 mm. However, the complication rate was 25%: e.g. 5% pulmonary embolisms, 5% wound infections, 3.3%thrombosis, 3.3% lesions of femoral nerve and 1.7% inguinal hernias.
- In an analysis of 59 patients with various fracture types, 72% anatomic joint reconstructions were achieved. In patients < 60 years, the anatomical reconstruction rate was significantly better than in older patients. The overall rate of secondary total hip replacement was 16% (3).

- A further analysis in 29 patients showed an anatomic joint reconstruction rate of 96% with negligible complications (15). The mean operative time was 155 minutes, the blood loss was 950 ml.
- In an analysis of 9 patients with 4 fractures of the anterior column, 2 fractures of the anterior column with a posterior hemitransverse fracture, 1 T-type fracture and two both column fractures all with an additional acetabular roof impaction (gull sign), 78% anatomical and good reductions could be achieved. Within 2.8 years posttrauma in one third of patients a total hip prosthesis was necessary (13).
- In an analysis by Kim et al. in 22 different acetabular fractures the intrapelvic approach was used, sometimes in combination with a Kocher-Langenbeck approach (n = 9) (11). Anatomical reconstructions were seen in 77.3% and good reductions in 18.2%. There were two superficial infections (9.1%), one deep infection (4.5%) and one intra-articular screw position (4.5%).

Comparative analyses intrapelvic vs. ilioinguinal approach

There are three studies comparing the intrapelvic and the ilioinguinal approach (16, 18, 21).
- The presently largest analysis compared 122 patients stabilized via the ilioinguinal approach with 103 patients stabilized via the intrapelvic approach (21). Patient age was 41.5 years in average. The intrapelvic approach was combined in 55.3% with the first window of the ilioinguinal approach, in 10.9% with a Kocher-Langenbeck approach and in one case with a Smith-Peterson approach. A total of 22 fractures of the anterior column, 12 transverse fractures, 15 T-type fractures, 14 fractures of the anterior column with a posterior hemitransverse fracture, 34 both column fractures, 5 transverse fractures with an additional fracture of the posterior wall and one posterior column fracture were stabilized using the intrapelvic approach. In 75.1% reduction was anatomic, in 22.6% good and 2.2% insufficient. The overall frequency of good and anatomical reconstructions was comparable to the ilioinguinal approach, however, using the intrapelvic approach significantly more anatomical reconstructions could be observed. Based on different fracture types, similar results were observed for fractures of the anterior column with a posterior hemitransverse fracture, whereas using the ilioinguinal approach more anatomical reconstruction were achieved in transverse fractures (88.9% vs. 75%). For all other fractures types the intrapelvic approach provided more anatomic reconstructions. The mean operative time was 240.5 minutes. 10.7% complications occurred after intrapelvic approach: 5.8% infections, 2.9% peroneal nerve lesion and 1.9% heterotopic ossifications.
- In 30 patients there was no difference regarding fracture type and perioperative complications (16). In contrast to other studies, however, an anatomic joint reconstruction could only be achieved in 43.3% vs. 53.3% using the ilioinguinal or intrapelvic approach. The most relevant difference between both approaches was

the shorter operation time (256 min vs. 183 min) and lower blood loss (1,107 ml vs. 776 ml) after an intrapelvic approach.
- Comparing 42 patients and 34 patients after intrapelvic or ilioinguinal approach showed an anatomical joint reconstruction in 48% vs. 65%. Poor reconstructions were seen in 9% vs. 6% (18).

Fracture-type-specific analyses

There is only one analysis reporting fracture-type-specific data after intrapelvic approach (19).

Both Column Fractures

An anatomical joint reconstruction was achieved in 59%, in 27% there was a near anatomic reconstruction (2–3 mm gap/step) and 14% had malreduction of > 3 mm. The clinical outcome was excellent in 55%, in 31% good, in 5% fair and in 9% poor. In 95% the first window of the ilioinguinal approiach was additionally used for reconstruction.

Complications were one secondary total hip replacement, one deep wound infection and on abdominal hernia.

Anterior column fractures

An anatomical joint reconstruction was achieved in 92%, in 8% malreduction was > 3 mm. The clinical outcome was excellent in 50%, good in 42% and bad in 8%. The 1st window of the ilioinguinal approach was necessary in 33%.

Anterior column fractures with a posterior hemitransverse fracture

An anatomical joint reconstruction was achieved in 57% and in 43% there was a near anatomic reconstruction (2–3 mm gap/step). The clinical outcome was excellent 71% and poor in 29%. The 1st window of the ilioinguinal approach was necessary in 29%. One lesion of the superior gluteal artery, one denervation of the rectus muscles and one pulmonary embolism were seen.

Pure transverse fractures

An anatomical joint reconstruction was achieved in 83% and a near anatomical reconstruction in 17%. The clinical outcome was excellent in 67% and good in 33%. In addition, in 33% the 1st window of the ilioinguinal approach was used. One patient developed a hernia.

T-type fractures

An anatomical joint reconstruction was achieved in two patients and a near anatomic reconstruction in one. One patient had an excellent and two a good clinical result. The intrapelvic approach was combined with the 1st window of the ilioinguinal approach in two cases

Analysing these different data in detail, and taking into consideration the above mentioned limitation of these analyses, the results using the intrapelvic approach can be summarized as follows:
- 228 minutes mean expected operation time,
- 883 ml mean expected intraoperative blood loss,

• 69.2% expected rate of anatomical joint restorations,
• 27.2% expected rate of near anatomical joint restorations,
• low complication rate.

Conclusion

The intrapelvic approach offers an excellent alternative to the ilioinguinal approach. The rates of anatomical joint reconstructions are presently not advantageous, possibly due to learning curve using this approach. The operative time is slightly longer, but the blood loss lower. The overall complication rate is low.

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Corresponding author:
Dr. Med. Axel Gänsslen
Klinik für Unfallchirurgie, Orthopädie und Handchirurgie
Klinikum der Stadt Wolfsburg
Sauerbruchstrasse 7
384 40 Wolfsburg, Germany
E-mail: dr.gaensslen@gmx.de