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Surgical exposures and options for instrumentation in acetabular fracture fixation: Pararectus approach versus the modified Stoppa

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ABSTRACT

Background: As an alternative to the modified Stoppa approach, the Pararectus approach is used clinically for treatment of acetabular fractures involving the anterior column. The current study assessed the surgical exposure and the options for instrumentation using both of these approaches.
Methods: Surgical dissections were conducted on five human cadavers (all male, mean age 88 years (82–97)) using the modified Stoppa and the Pararectus approach, with the same skin incision length (10 cm). Distal boundaries of the exposed bony surfaces were marked using a chisel. After removal of all soft-tissues, distances from the boundaries in the false and true pelvis were measured with reference to the pelvic brim. The exposed bone was coloured and calibrated digital images of each inner hemipelvis were taken. The amount of exposed surface using both approaches was assessed and represented as a percentage of the total bony surface of each hemipelvis. For instrumentation, a suprapectineal quadrilateral buttress plate was used. Screw lengths were documented, and three-dimensional CT reconstructions were performed to assess screw trajectories qualitatively. Wilcoxon's signed rank test for paired groups was used (level of significance: $p < 0.05$).
Results: After utilization of the Pararectus approach, the distances from the farthest boundaries of exposed bone towards the pelvic brim were significantly higher in the false but not the true pelvis, compared to the modified Stoppa approach. The percentage (mean $\pm$ SD) of exposed bone accessible after utilizing the Pararectus approach was 42 $\pm$ 8%, compared to 29 $\pm$ 6% using the modified Stoppa ($p = 0.011$). In cadavers exposed by the Pararectus approach, screws placed for posterior fixation and as a posterior column screw were longer by factor 1.8 and 2.1, respectively ($p < 0.05$), and screws could be placed more posteromedial towards the posterior inferior iliac spine or in line with the posterior column directed towards the ischial tuberosity.
Conclusion: Compared to the modified Stoppa, the Pararectus approach facilitates a greater surgical access in the false pelvis, provides versatility for fracture fixation in the posterior pelvic ring and allows for the option to extend the approach without a new incision.

Introduction

The "gold standard" for accessing acetabular fractures involving the anterior column is the ilioinguinal approach [1]. However, the access morbidity of this approach is high, particularly when dissecting within the second window. Therefore, the modified Stoppa approach was presented as a less invasive alternative for surgical access [2–12], often resulting in reduced intraoperative blood loss, shortened operative times [13] and more frequently obtaining an anatomic reduction [14].

As a reasonable alternative to the modified Stoppa approach, the Pararectus approach was established for the treatment of acetabular fractures involving the anterior column [15–18]. The Pararectus approach allowed for anatomic restoration with minimal access morbidity, producing outcomes at least paralleling those reported after utilization of the modified Stoppa approach with extension infrequently required [18]. In contrast to the Pararectus approach, the modified Stoppa was frequently used

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with the combination of the 1st window of the ilioinguinal approach [1] (55–93% [3,7,10,12–14]) with others [2,6,8] describing this combination as their standard procedure, possibly as a consequence of the limited surgical exposure. Therefore, the purpose of this study was to (1) compare the amount of the bony exposure of the inner surface of the innominate bone and (2) assess for potential differences in screw trajectories and/or screw lengths after utilization of both the modified Stoppa and the Pararectus approach (without extensions) within human cadavers.

Methods

Surgical dissections

Surgical dissections were conducted on five human cadavers (all male, mean age 88 years (82–97)). The use of the human cadaveric material was performed according to the Guidelines of the Swiss Academy of Medical Sciences. Donors have formally agreed the use of body parts for research purposes by signing the donation forms. Cadavers were embalmed using a technique described previously [19] and provided by the local anatomical department.

All dissections and instrumentations were performed by the senior author (M. J. K.). Cadavers were placed in supine position on a radiolucent operating table with the surgeon on the opposite side to the hip which was to be dissected. Dissection was performed on each cadaver, with the side selected randomly, using either the modified Stoppa [4,11] or the Pararectus approach [15,16,18]. In both approaches the incision length was restricted to 10 cm (Fig. 1). The main difference between these both approaches in terms of the visualization of neurovascular structures was that by utilization of the Pararectus approach the external iliac artery and vein, the vas deferens and the inferior epigastric vessels were identified with exposure of the 2nd window lateral to the vessels whereas by utilization of the modified Stoppa approach these structures were retracted cranially (Fig. 2).

Pararectus approach

For the Pararectus approach, the surgical steps were as follows: landmarks for incision were the navel, the anterior superior iliac spine (ASIS) and the symphysis, as shown in Fig. 1. The skin incisions began cranially at the junction of a line connecting the

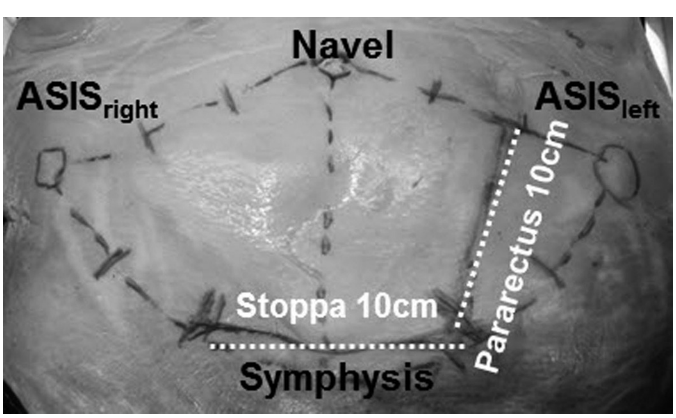

Fig. 1. Intraoperative photograph showing the landmarks on the anterior abdomen including the infraumbilical region, the anterosuperior iliac spine (ASIS) and the symphysis. In this cadaver a modified Stoppa approach was performed for the right hemipelvis with a horizontal skin incision (length: 10 cm) 1 cm superior to the symphysis. The left hemipelvis was exposed by the Pararectus approach with an incision (length: 10 cm) along the lateral border of the rectus abdominis muscle as described previously.

lateral with the medial third of a line connecting the navel with the ASIS, continuing alongside the lateral border of the rectus abdominis muscle towards the junction of the middle and the medial third of a line connecting the ASIS with the symphysis. The extraperitoneal space was entered after subcutaneous dissectionand incision of the anterior lamina of the rectus sheath at the lateral border of the rectus abdominis muscle. The peritoneal sac was mobilised cranially; the inferior epigastric vessels, spermatic cord and external iliac vessels were identified and encircled. Finally, the 2nd up to the 5th "surgical windows" of the Pararectus approach were established (2nd: between iliopsoas muscle and external iliac vessels; 3rd and 5th: between external iliac vessels and spermatic cord at (3rd) or below (5th; "quadrilateral plate window") the level of the pelvic brim; 4th: medial to the inferior epigastric vessels). The 1st window of the Pararectus was not opened.

Modified Stoppa approach

For the modified Stoppa approach, the surgical steps were as follows: essential landmarks were the pubic symphysis. A horizontal Pfannenstiel incision was made 1 cm superior to the pubic symphysis. For superficial dissection, the subcutaneous fatty tissue is mobilised to develop the anterior rectus fascia. The rectus sheath is split in the midline and the transversalis fascia is incised superior to the pubic symphysis to gain access to the retropubic space. The bladder is mobilised and protected by blunt dissection with a swab. A retractor is placed underneath the pubic symphysis to protect urogenital structures. Detachment of the rectus abdominis insertion at the anterosuperior pubic rami was not performed. The spermatic cord, the external iliac vessels and the iliopsoas muscle are identified. An additional 1st window of the ilioinguinal approach [1] was not opened.

Surgical exposure and instrumentation

For standardised soft-tissue retraction, a table-mounted ring retractor was used (Synframe®; DePuy-Synthes, Oberdorf, Switzerland) in both approaches.

The iliopectineal fascia was dissected, and the pectineus and the obturator internus muscles were detached from the pelvis. The superior pubic rami, the iliopectineal eminence, the quadrilateral surface and the posterior column were exposed. During dissection, the frequencies and type (artery vs. vein) of the vascular connections between the external iliac and the obturator systems ("corona mortis") were documented.

For instrumentation, a suprapectineal quadrilateral buttress plate (Stryker Osteosynthesis AG, Selzach, Switzerland), as previously introduced [20], was fixed in cadavers and screws were placed in hole "1" for posterior fixation, in holes "3" or "4" or "5" as a "posterior column screw" (depending on feasibility), in hole "8" as an "infraacetabular–screw", in holes "11" and "12" for anterior parasymphyseal fixation, and in holes "13", "14" and "16" for quadrilateral plate fixation (Fig. 3). The entry point of the "posterior column–screw" was previously determined as being 23.5 ± 3.4 mm anterior and 16.8 ± 2.1 mm lateral to the junction of the anterior border of the sacroiliac joint and the linea terminalis. Depending on the position of the plate, the 3rd, the 4th or the 5th hole was used. If feasible, depending on the soft-tissues and the surgical access, these screws were directed towards the posterior column with an inclination angle of about 120° coronally and 57° sagittally, as determined by Mu et al. [21]. The infraacetabular screw was placed using the infraacetabular corridor, as reported by Culemann et al. [22]. In general, screws were placed with respect to the "safe zones" for extra-articular screw placement as defined by Guy et al. [23], assisted by the use of an image intensifier (Siremobil, Siemens Medical Solutions, Zurich, Switzerland). For placement of the screw in