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Assessment of Outcomes of the Modified Stoppa Approach in the Treatment of Acetabular Fractures: A Retrospective Cohort Study

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Abstract

Aims. To evaluate the efficacy of the modified Stoppa approach for surgical treatment of pelvic bone injuries based on clinical (sex distribution, fracture type), surgical (duration of operation, intraoperative blood loss, incision length, quality of reduction), and functional outcome (hip joint function).

Materials and methods. A total of 31 patient were included in a retrospective cohort study from 2019 until March 2022 with various injuries of acetabulum in the N.D. Batpenov National Scientific Center of Traumatology and Orthopaedics (NSCTO).The inclusion criteria for this study were: patients with acetabulum injuries, and who underwent surgical interventions using one of two surgical approaches (modified Stoppa, ilioinguinal approaches), patients over 18 years old. Exclusion criteria: other operative approaches to pelvic bones and patients under 18 years of age. 21 patients underwent surgery with the use of modified Stoppa approach (group A) and 10 surgeries were performed using the ilioinguinal approach (group B). Efficiency was evaluated by comparison of duration of surgical procedures, amount of blood lossbetween groups, size of skin incision, quality of reduction and functional outcomes.

Results. There are males – 18(58.1%), females – 13(41.9%) in the study. The clinical study results showed that average volume of intraoperative blood loss and size of skin incision were significantly less during Stoppa approach then ilioinguinal approach though average duration of surgical procedures did not reveal significant differences between two groups. Average duration of surgical procedures did not reveal significant differences between two groups – 109.5 min (±54.7) among group A and 126 min (±58.9) in group B. The volume of intraoperative blood loss averaged 338±254.5 ml of blood for the total sample. The volume of intraoperative blood loss was 525.0 ±322.5 ml of blood in group B, which is more than twice the estimated blood loss for group A (250 ±157.3 ml). When using a Stoppa approach, the length of the cutaneous surgical incision averaged at 8.8 ± 1.5 cm, while with an ilioinguinal approach, this value was estimated at 20.6 ± 8.5 cm, which suggests a favorable cosmetic effect of Stoppa approach.

Conclusion. The positive results obtained with the modified Stoppa approach, which are reflected in a reduction in the length of the skin incision and the amount of intraoperative blood loss, suggest that the use of this approach in clinical practice provides an opportunity to improve the surgical treatment of acetabular fractures by obtaining variability in the study of surgical approach. Nevertheless, the frequency and complexity of the occurring pelvic bone injuries dictate the need for further search and improvement of more optimal access options for surgical treatment.

Keywords: acetabulum, osteosynthesis, Stoppa approach, ilioinguinal approach.

Introduction

Introduction. Acetabulum fractures are among the most challenging to treat due to the intricate nature of the required surgery, making them some of the most difficult procedures for orthopedic surgeons [1]. Achieving an accurate anatomical reduction of fractures and reconstructing the joint are fundamental to treating acetabulum fractures, a consensus shared by most orthopedic surgeons [2]. Selecting the appropriate surgical method for treating fractures of the anterior pelvic ring and acetabulum is crucial for ensuring accurate fracture realignment and minimizing complications [2, 3]. Since Letournel introduced the ilioinguinal approach (IA) [4], it has become a widely adopted method for addressing pelvic ring and acetabulum fractures. The IA approach offers several advantages, including excellent visibility of the acetabulum fracture, minimal risk of sciatic nerve damage, a discreet postoperative scar, and a swift recovery [5]. It is noted that the rate of anatomical recovery reaches from 45% to 74% [6, 7]. Only from early 1990s the modified Stoppa approach, introduced by R. Stoppa, was initially employed in pelvic surgery as a less traumatic alternative [8-10].

Comparison of operative approaches in acetabulum fractures was previously carried out using the AO/ASIF classification system for fractures [11] or E. Letournel [12-15]. The type of fracture determines the selection of approach to the acetabulum.M. Erem et al. (2019) argue that to enhance functional outcomes, the selection of one or two approaches should be based on the fracture's type and location [13]. The literature suggests that specialists, having gained experience in treating acetabulum fractures, primarily considered fractures of the acetabulum columns when selecting operative approaches.

In cases of fractures involving the anterior column and the anterior wall of the acetabulum, the authors typically employed the ilioinguinal or Stoppa approaches. Deng C. et al. (2018) used a combination of ilioinguinal and Kocher-Langenbeck approaches in surgical treatment of 31 cases of acetabulum fractures [12].

In 1993, Hirvensalo et al. initially documented the modified Stoppa approach (MSA) for the treatment of pelvic ring or acetabulum fractures. MSA offers the advantage of minimizing surgical trauma, offering excellent visualization, and easing the reduction and fixation of fragments displaced towards the medial side [9, 10, 16].

The modified Stoppa approach is becoming increasingly popular worldwide. This is because it is potentially less invasive than the ilioinguinal approach and provides excellent visualization of the entire pelvic rim from the pubic bone to the sacroiliac joint, including direct visualization of the quadrilateral plate [17]. The adoption of the anterior intrapelvic approach also led to the development of new instruments and implants [18]. It is challenging to compare surgical approaches, but the studies by Rocca et al. and the meta-analysis by Meena et al., both conclude that MSA (anterior intrapelvic approach) is preferable over the iliopubic approach [19, 20].

The objective of this study is to examine Stoppa access in more detail, and to evaluate the efficiency of the modified Stoppa approach in comparison with ilioinguinal approach for the surgical management of pelvic bone injuries. Subsequently, we aim to add knowledge to consider the feasibility of wide application of Stoppa approach as the method of choice in our clinical practice.

Materials and methods

From the beginning of 2019 to March 2022, the Department of Traumatology performed surgery on 63 patients with various injuries of the pelvic bones. The inclusion criteria for this study were: patients with acetabulum injuries, according to the Judet-Letournel classification, except for fractures of the posterior wall of the acetabulum, and who underwent surgical interventions using one of two surgical approaches (modified Stoppa, ilioinguinal approaches), patients over 18 years old, as our clinic only treats adult patients. Exclusion criteria: other operative approaches to pelvic bones, patients with fractures of the posterior wall of the acetabulum, according to the Judet-Letournel classification, and patients under 18 years of age. During the study, according to the exclusion criteria 10 patients underwent surgery utilizing the Kocher-Langenbeck approach. In addition, 22 other patients underwent surgeries due to fractures of other pelvic bones, without involvement of the acetabulum, were not included in this study (Figure 1). Thirty-one surgeries were performed for the various injuries of the acetabulum in the Department of Traumatology. In this study, a retrospective cohort study was conducted. This study design was chosen because we have only started using the Stoppa approach in the last couple of years, and the idea of evaluating and comparing the two approaches came later.

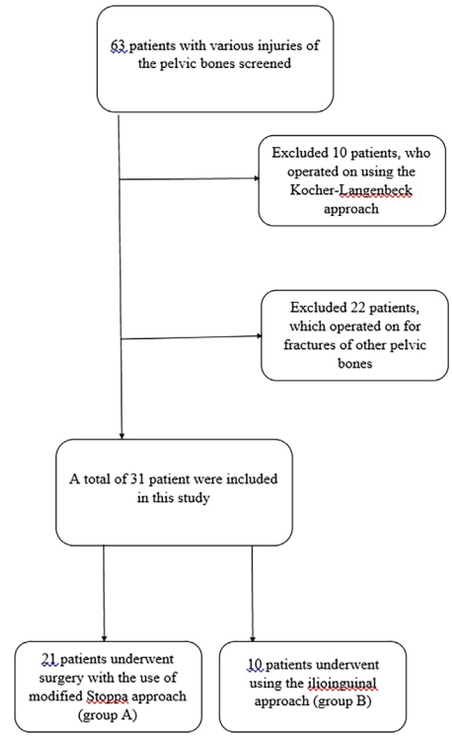

Figure 1 – Flow-chart of inclusion of patients in the study

Pre-operative preparations

Upon the patients' arrival to our emergency department, we ensured that they properly resuscitated and stabilized hemodynamically. We utilized conventional methods of the skeletal traction on their distal femur, and administered low molecular weight heparin subcutaneously as a prophylaxis against deep vein thrombosis. We routinely conducted pelvic X-ray, computed tomography (CT) scan with angiography and three-dimensional (3D) reconstruction. In addition, one day prior to surgery, we reevaluated and prepared for routine procedures such as enemas, urinary catheterization, and blood transfusion.

Surgical interventions

Patients in group A underwent surgery using a modified Stoppa approach. The operation is performed under endotracheal anesthesia. A soft tissue incision measuring 9.0 cm in size

was made transversely 2 cm above the symphysis. The skin-subcutaneous layer was mobilized from the fascia at a distance of 6 cm from the edges of the wounds. The rectus abdominis fascia was dissected vertically along its fibers. The Retzius space was dissected bluntly. Subperiosteal dissection was performed alongside the pubic bone. An elevator was installed. The left and right pubic bones were exposed for 4 cm along the upper, posterior, and anterior surfaces. A sharp Hohmann retractor was positioned over the pubic tubercle to facilitate retraction of the rectus muscle. The superior iliac crest fascia, inferior obturator fascia were separated from the pelvis to expose the pubic bone, the terminal line, and the quadrangular surface. Consequently, a square space was allocated, while the obturator nerve was mobilized (Figure 2).

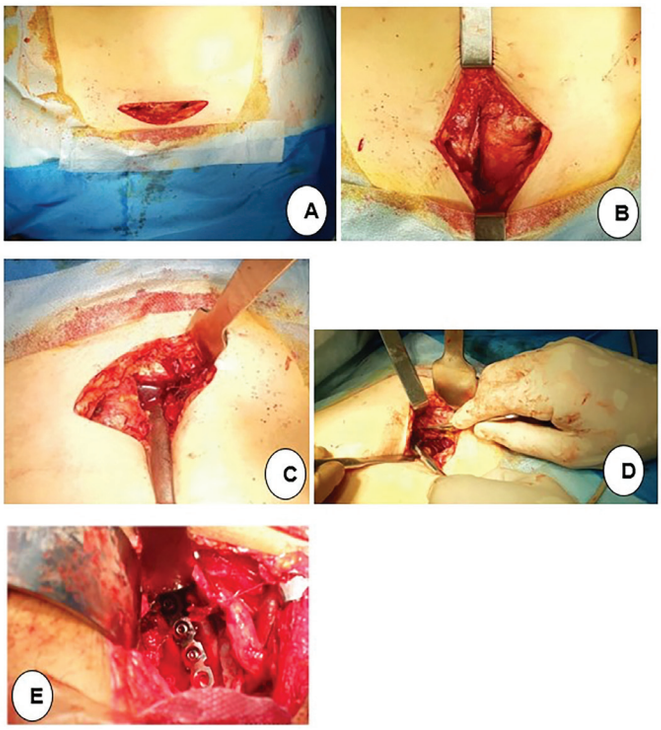

Figure 2 – Stages of modified Stoppa approach to an acetabular fracture: 9,0 cm skin incision 2 cm above the symphysis (A). The rectus abdominis fascia is dissected vertically along its fibers. Blunt dissection of the Retzius space is performed. Subperiosteal dissection is performed along the pubic bone (B). Blunt dissection of the Retzius space is performed. An elevator is installed (C). A sharp Hohmann retractor is placed over the pubic tubercle to retract the rectus muscle. The superior iliac crest fascia and inferior obturator fascia are separated from the pelvis to expose the pubic bone, the terminal line, and the quadrangular surface (D). Intraoperative reduction and fixation of fracture (E).

Next, the terminal line and the revision of the fracture site were highlighted. The fracture ends were cleaned, the fragments were repositioned using pelvic clamps and a picador. At the end, the plate was adapted and placed along the terminal line on the pelvic bone. The plate was fixed with cortical screws (Figure 3).

Patients in Group B underwent surgery utilizing the ilioinguinal approach. Unlike the Stoppa approach, this approach usually requires a larger incision. The incision site begins at the intersection of the lateral and medial quarter lines connecting the umbilicus to the anterior superior iliac spine (ASIS), continuing in a slightly convex curve towards the distomedial direction to the intersection of the medial and medial thirds of the line joining the ASIS to the symphysis. The ilioinguinal approach provides an overview of the anterior and posterior sections of the acetabulum.

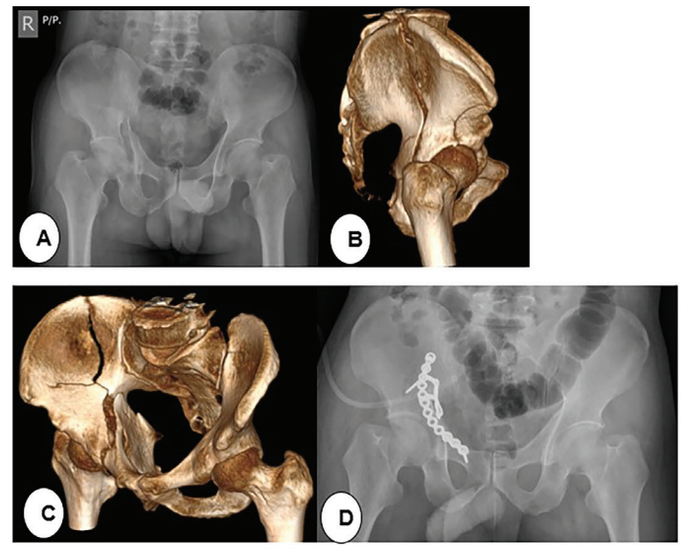

Figure 3 – Acetabular fracture after falling from a height was present in a 53-year-old male patient. The patient was operated on the 10th day after trauma with a modified Stoppa approach. Preoperative x-ray and CT sections: A) preoperative direct x-ray, B,C) preoperative axial CT section, D) X-ray on postoperative day 1. The postoperative reduction was assessed as an anatomical reduction.

Efficiency was evaluated by comparison the average duration of the operation and length of incision, the median amount of blood lost during surgery between the groups. Quality of reduction was evaluated according to the Matta reduction criteria on pelvic X-rays by measuring the diastasis between bone fragments according to the method: 0-1 mm displacement was classified as anatomical, 2-3 mm as imperfect, and >3 mm as poor. [21].

The functional assessment of the patients was carried out by applying the Harris Hip Score (HHS) postoperativelyby clinical examination and testing of the hip joint. [22, 23].

Statistical analysis was carried out using STATA statistical software. Quantitative variables were described using the mean and standard deviation. Frequency and percentage were employed to describe qualitative variables. The distribution of quantitative variables was assessed using the histogram and Shapiro-Wilk test. The distribution of patients by gender with different operative accesses was compared using a Chi-square test. Parameters such as the incision length, the duration of the operation and the quantity of intraoperative blood loss were compared utilizing the Student's t-test. Proportion of patients with missing data was negligible and did not require statistical handling.

Results

The range of age in our study was 19-77 years. Two groups did not differ on their ages with mean age for groupA being 39.4 years (±13.3) and 42.5 years (±18.2) among group B. No statistically significant difference in the distribution of sexes was observed. Both groups are slightly more represented by males, 57.1% in group A and 60% in group B (Table 1).

Table 1 text

Variable	Total (N=31)	Group A (N=21)	Group B (N=10)	p-value
Age, mean (±SD)	40.4 (±14.8)	39.4 (±13.3)	42.5 (±18.2)	0.6
Gender, N (%) Female Male	 13 (41.9%) 18 (58.1%)	 9 (42.9%) 12 (57.1%)	 4 (40%) 6 (60%)	0.88

Twenty (64.5%) fractures were classified as simple and 11 (35.5%) fractures were classified as complex acetabular fractures. Among the simple fractures, there were 11 (35.48%) fractures of the anterior column, 5 (16.13%) fractures of the anterior wall of the acetabulum, 2 (6.45%) cases of transverse fractures, and 2 (6.45%) posterior column acetabulum fractures. Also, two (6.45%) anterior semitransverse fractures, 2 (6.45%) transverse plus posterior wall fractures, 6 (19.35%) cases of two-column acetabulum fractures, 1 (3.23%) T-shaped fracture were classified as complex fractures (Table 2).

Acetabular fractures occurred as isolated injuries in 18 patients, while 27 had associated injuries, including 7 head injuries, 4 rib fractures, 7 upper limb injuries, and 3 lower limb injuries, and 6 had associated spinal injuries (Table 3).

In 2 cases, patients had complications in the form of post-traumatic neuropathy of the sciatic nerve.

Average duration of surgical procedures did not reveal significant differences between two groups – 109.5 min (±54.7) among group A and 126 min (±58.9) in group B. The volume of intraoperative blood loss averaged 338±254.5 ml of blood for the total sample. The volume of intraoperative blood loss was 525.0 ±322.5 ml of blood in group B, which is more than twice the estimated blood loss for group A (250 ±157.3 ml). Also note worthy is a cosmetic defect when using two approaches, which was estimated by the length of the skin incisions. Thus, when using a Stoppa approach, the length of the cutaneous surgical incision averaged at 8.8 ± 1.5 cm, while with an ilioinguinal approach, this value was estimated at 20.6 ± 8.5 cm, which also shows a statistically significant difference (Table 4).

Table 2 text

Type of fracture	Number of cases	Percentage
Anterior wall	5	16,13
Anterior column	11	35,48
Transverse	2	6,45
T-Shaped	1	3,23
Posterior column	2	6,45
Transverse with posterior wall	2	6,45
Anterior column with posterior hemi transverse	2	6,45
Associated both column	6	19,35
Total	31	100

Table 3 text

18	isolated acetabular injuries
7	head injuries
4	rib fractures
7	upper limbs
3	lower limbs
6	spine

Table 5 text

_____	Group A (N=21)	Group B (N=10)
Radiological outcome (Matta)		
Anatomical (<1 mm)	8 (38.1%)	3 (30%)
Imperfect (2-3 mm)	10 (47.6%)	5 (50%)
Poor (>3 mm)	3 (14.3%)	2 (20%)
Harris Hip Score		
Excellent (90-100)	7 (33.3%)	3 (30%)
Good (80-89)	10 (47.6%)	4 (40%)
Fair (70-79)	3 (14.3%)	2 (20%)
Poor (<70)	1 (4.8%)	1 (10%)

Table 4 text

Variable	Total (N=31)	Group A (N=21)	Group B (N=10)	p-value
Incision length in cm, mean (±SD)	12.6 (±7.4)	8.8 (±1.5)	20.6 (±8.5)	0.001
Duration of operation in min, mean (±SD)	115 (±55.7)	109.5 (±54.7)	126 (±58.9)	0.44
Blood loss in ml, mean (±SD)	338 (±254.5)	250 (±157.3)	525 (±322.5)	0.003

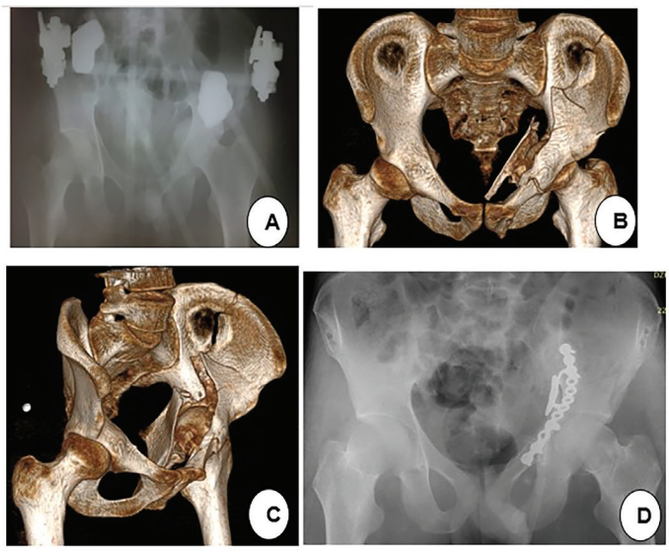

Figure 3 – A 26-year-old patient with a both column fracture of the acetabulum. Preoperative x-ray and CT sections: A) preoperative direct x-ray, B,C) preoperative CT sections, D) X-ray on postoperative day 1.

When assessed on radiography, the quality of reduction was rated as anatomical in 8 (%) cases, imperfect in 10 (%) cases and poor in 3 (%) cases in group A based on Matta criteria. Meanwhile in group B, it was rated as anatomical in 3 (%) cases, imperfect in 5 (%) cases and poor in 2 (%) cases (Table 5, Figure 4).

According to the Harris Hip score, the functional results were in group A excellent in 7 (33.3%) cases, good in 10 (47.6%) cases, fair in 3 (14.3%) cases, and poor in 1 (4.8%) cases. Whereas in group B, the results were excellent in 3 (30%) cases, good in 4 (40%) cases, fair in 2 (20%) cases, and poor in 1 (10%) cases at the 1 year follow up (Table 5).

Discussion

Based on the data obtained, it can be concluded that there are advantages of the modified Stoppa approach in contrast to the ilioinguinal approach. It is regarding the shorter length of the surgical incision and the reduced quantity of intraoperative blood loss.

Similar to our result, several studies showed a smaller amount of blood loss when using Stoppa approach [24-27]. However, these studies report a short duration of surgery, which does not correspond to our results. In our study there were no significant differences in amount of blood loss between two groups. This could be due to limited sample size as well as the difference in the quality of technical equipment that was used in this study.

Based on the data obtained during our study, we can conclude that the widespread use of the Stoppa surgical approach in the future is completely justified, since it has a number of advantages over other approaches. However, this does not mean that classical approaches, such as the ilioinguinal

approach, have completely lost their effectiveness. The selection of surgical approach should be considered in accordance with the type and nature of the fracture, the chosen surgical tactics, and the selection of the implant. It is also worth considering the fact that skilled surgeons can achieve a positive result by using both classical approaches and modern minimally invasive approaches.

The modified Stoppa approach has some limitations, including potential challenges associated with reducing and stabilizing fractures involving the posterior column, as well as limitations in visualizing certain areas such as head of femur, labrum, and articular surface of the acetabulum which results insufficient cleansing of the joint. This is due to the fact that this access provides a view of the acetabulum from the inside of the pelvic ring, and anatomically there is no way to fully reach the hip joint. Therefore, for fractures of the posterior column and posterior wall of the acetabulum, it is advisable to consider the use of a combined anterior intrapelvic approach(MSA), as well as the Kocher-Langenbeck approach for detailed visualization of the entire acetabulum and hip joint.

Most of the fractures in our study are associated with damage to the acetabular anterior column, which differs from some studies where damage to both columns was predominant [28].

The modified Stoppa approach offers a viable alternative in situations requiring anterior access to the acetabulum, although it may not entirely replicate the effectiveness of the traditional ilioinguinal approach.

The modified Stoppa approach is suitable for various types of fractures, including anterior wall, anterior column, both columns, anterior column, posterior hemitransverse, and some transverse and T-shaped fractures. This approach is particularly effective for transverse and T-shaped fractures when the fracture line is positioned high and in close proximity to the sciatic notch. It is less invasive than the inguinal approach since it does not involve opening the inguinal canal and its contents.

Based on the above, it can be concluded that the optimal path for the development of surgical treatment for acetabular fractures in our clinical practice involves the widespread adoption of new minimally invasive surgical approaches, such as the anterior intra-pelvic approach and the pararectal approach, as well as the development of new implants that provide better anatomical reduction and are easily contourable. This also requires the improvement of training for trauma surgeons, who should be capable of applying both traditional and new approaches in the treatment of acetabular fractures.

Conclusion

The advantages of using a modified Stoppa approach include a better cosmetic effect compared to other approaches, a reduction in soft tissue injury, a more optimal overview of the surgical field. In summary, this study demonstrates that the modified Stoppa approach is both safe and efficient for fixing acetabulum fractures. Thus, our results confirm the opinion that this minimally invasive method represents a valuable alternative to the ilioinguinal approach for surgical management of acetabulum fractures. All the above determines the prospects for further use of low-traumatic access as a method of choice in the surgery of fractures of the acetabulum, anterior pelvic ring.

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