



## Minimally Invasive Osteosynthesis in the Treatment of Associated Pelvic Trauma

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### Abstract

**Introduction:** Associated injuries of the pelvic ring and the organs of the pelvic cavity are a complex problem in emergency surgery. The difficulties are explained by the fact that these lesions develop as a result of severe trauma, accompanied by significant injury of the organs and tissues within this area and traumatic shock development, that require the active participation of a multidisciplinary team, such as traumatologist, urologist, surgeon and anesthesiologist reanimatologist.

**Aim:** To determine the particularities of minimally invasive external osteosynthesis in the treatment of pelvic fractures with associated urinary tract injuries.

**Materials and Methods:** Prospective study included the analysis of treatment outcomes in 59 trauma patients with fractures of the pelvic ring and urinary organs lesions. There were 55 males and 4 females, including a pregnant woman in the third trimester of pregnancy. Mean patient age was  $41,34 \pm 2,66$  years ( $p < 0,05$ ). At hospitalization, 52 patients were diagnosed with shock. 47 patients suffered traffic accident, 9 - fall from height and 3 - massive wall collapse. According to the AO/ASIF classification pelvic fractures, type A were identified in 6.77% ( $n = 4$ ) cases, type B - in 31 (55.93%) patients, type C - in 22 (37.3%) patients, all of them being hemodynamic unstable. Urinary organs were damaged in all 59 cases. Urinary bladder contusion was diagnosed in 21 (35,59%) patients, bladder wall lesions - in 30.58% ( $n = 38$ ), urethral ruptures - in 18.64% ( $n = 11$ ), in 7 cases bladder rupture was associated with kidney injury. Long tubular bone fractures were found in 54.23% ( $n = 32$ ) cases. Associated chest trauma - in 35 patients, craniocerebral trauma - in 27 patients, abdominal organ injuries - in 10 patients. The severity of lesions according to ISS scale ranged from 17 to 51 points (mean  $35,03 \pm 14,97$ ).

The initial management of the patients with pelvic fractures included antishock measures - bleeding stopping, perfusion and transfusion therapy, pelvic ring stabilization.

**Results:** In this study the main tactical aspects in trauma patient care were identified, such as patient stabilization, preliminary fixation of the pelvic ring with an external device, urinary bladder repair and drainage and control over pathological accumulation of urine in the pelvic cavity.

**Conclusion:** The sequence of urgent treatment measures in trauma patients with pelvic injuries associated with urinary tract lesion was identified; in addition, the problems that require further investigations and may improve the clinical outcomes were determined. Preventive treatment outcomes in these patients indicated that adequate and early surgical correction of the pelvic ring with an external fixation device and urinary bladder repair is possible in almost all cases. Realization of this goal requires special equipment, qualified and properly trained personnel.

**Keywords:** Pelvic Fracture; Osteosynthesis; Associated Injuries

## Introduction

Associated injuries of the pelvic ring and internal organs are a complex problem in emergency surgery. The difficulties are explained by the fact that this association develops as a result of a severe trauma [1], accompanied by a significant lesion of the organs and tissues within this area, with the development of traumatic shock and strong need of active participation of a multidisciplinary team: traumatologist, urologist, surgeon and anesthesiologist re-animatologist. According to the literature, the main trauma mechanism in which such severe injuries of the pelvic ring are possible are traffic road accidents [2-4]. The patient mortality at the site of the accident and during transportation in this case reaches up to 60% [5,8,10]. The main cause of early death is uncontrolled hemorrhage from the pelvis vessels, which are undiagnosed and undetected associated injuries of the urinary bladder and intestines, that may cause septic-purulent complications [6-8]. The association of urinary tract injuries and pelvic ring fractures varies from 4.4% to 17.26% of all associated lesions. Despite specialized medical care providing, some patients remain disabled [11-13].

## Aim of the Study

To determine the peculiarities of external osteosynthesis in the treatment of pelvic fractures associated with urinary tract injuries.

## Materials and Methods

**Prospective study:** We analyzed treatment outcomes of 59 trauma patients who were admitted to our trauma clinic with fractures of the pelvic ring and urinary organs lesions. All the patients gave their approval to be included in this study and to respect all the necessary recommendations. There were 55 males and 4 females, including a pregnant woman in the third trimester of pregnancy. Mean patient age was  $41,34 \pm 2,66$  years ( $p < 0,05$ ). At hospitalization, 52 patients were diagnosed with shock. 47 patients suffered traffic accident, 9 - fall from height and 3 - massive wall collapse with compression of the pelvic region.

Adequate resuscitation therapy and complex trauma patients' evaluation were performed in all cases. Diagnostic assessment of trauma patients included past history, physical examination, laboratory tests, pelvic X-Ray in direct view and computed tomography in "polytrauma" regime. The retrograde cystography with Zeldovich test was performed to find the urinary bladder injuries. X-ray films were realized in direct and lateral views. In addition, another radiograph was done after bladder evacuation for evaluation of pathological urine distribution. In case of posterior wall lesion,

the last X-ray film revealed the contrast agent distribution within the paravesical space. If pelvic ring reconstruction was necessary, "inlet" - "outlet" pelvic X-ray, "Judet" incidence for acetabulum and 3D-CT of the pelvic bones were performed.

The type of pelvic fracture was determined according to the AO/ASIF classification. The fractures of pelvic bone, that form the anterior semi-ring, type A, were identified in 6.77% ( $n = 4$ ) cases, including two cases with associated transverse fracture of the sacrum. The general condition of the patients at hospitalization was stable in all cases. Rotationally unstable fractures, type B, were determined in 31 (55.93%) patients. Lesions of the pelvic ring with vertical instability, type C, were determined in 22 (37.3%) patients, all of them being hemodynamic unstable required immediately transfer to the intensive care unit. Pelvic ring fractures were associated with acetabular fractures in 9 patients.

Urinary organs were damaged in all 59 cases. Urinary bladder contusion was diagnosed in 21 (35,59%) patients, clinically manifested by pain and hematuria for 3 - 5 days. Bladder wall lesions were diagnosed in 30.58% ( $n = 38$ ), urethral ruptures in 18.64% ( $n = 11$ ). In 8 (5.8%) cases the association of urethral and bladder lesions was determined, in 7 cases bladder rupture was associated with kidney injury. Frequently, bladder wall lesion presented as a small longitudinal slit located on the apex of the posterior wall. Bladder wall lesions with a size of approximately 10 mm or more were diagnosed easily during the revision. For punctual lesions determination, we used the injection of 4 - 5 ml of 1% methylene blue solution and physiological solution into the bladder cavity through the urethra. It allowed identification of multiple bladder lesions in three cases.

Long tubular bone fractures were found in 54.23% ( $n = 32$ ) cases. Associated chest trauma was diagnosed in 35 patients, craniocerebral trauma with mild and moderate severity in 27 patients, abdominal organ injuries - in 10 patients. The severity of lesions according to ISS (Injury Severity Score) scale ranged from 17 to 51 points (mean  $35,03 \pm 14,97$ ).

The initial management of the patients with pelvic fractures included antishock measures - bleeding stopping, perfusion and transfusion therapy, pelvic ring stabilization. The surgery type was determined according to the fracture pattern, the character of bladder lesion and presence of other organs injuries. Bladder contusion and incomplete rupture were treated conservatively. In these cases bed regime, hemostatic, analgesic and anti-inflammatory drugs were recommended. In 8 cases permanent urinary catheter was

applied for 7 - 10 days to remove blood clots and prevent 2-stage bladder rupture. Treatment of massive bladder wall lesions was performed by prompt surgery with restoring the integrity of the bladder and stabilizing the pelvic ring. In the case of extraperitoneal rupture of the bladder, lower median laparotomy was performed with the bladder ruptures suturing in two rows, without mucosal involvement, in addition, epicystostomy was made with a Foley catheter for urine removal and drainage of the paravesical tissue. The epicystostoma was functional for 2 - 3 weeks, until the bladder wound healed. In the case of ruptured urethra, the intervention was limited to the application of the suprapubic fistula. In three cases, catheter was applied in the form of a "donut" with a positive effect. The restoration of urethral permeability was delayed for 2 - 4 months, until the integrity and endurance of the pelvic ring were restored. During laparotomy, partial or even complete correction of the bone fragments of the anterior pelvic ring was performed under visual control, it greatly simplified the technique of additional osteosynthesis.

Patients with pelvic fracture type B<sub>2</sub>, with lateral compression and a slight displacement and transverse fracture of the sacral bone (n = 7) were treated conservatively, placed in Volkovich position.

The device for reposition and fixation of the pelvic bones was applied for pelvic ring stabilization simultaneously with the treatment of the urinary bladder injuries. In pelvic fractures type A<sub>2,3</sub> and B<sub>1,1</sub> with insignificant displacement of bone fragments, fixation of the pelvis with external device with wires was the most acceptable and effective method. The correction and stable fixation of the bone fragments was obtained on the operating table and optimal conditions were created for damaged tissues regeneration. In one case a secondary displacement of the pubic bone fragment was determined, it required later the combination of external and internal (by plate) osteosynthesis. Prolonged (step by step) compression and distraction measures were indicated in cases of pelvic fracture type B with a fixed displacement of the fragments, as well as their association with acetabular fractures (n = 3), in combination with reconstructive operation directly in the site of the injury.

Pelvic fractures type C (n = 22) were the most severe injuries. The fractures were accompanied by horizontal and vertical instability, shock caused by pain and severe blood loss. In 50% of cases chest injuries were found, with multiple rib fractures, hemo- or pneumothorax, blunt abdominal injuries with spleen trauma (n = 3) or renal lesion (n = 1). Limb fractures were determined in 1/3 of patients. After a complex examination of the patients and the

application of resuscitation measures, urgent surgeries were performed with stabilization of the pelvic ring by an external fixation device.

In patients with associated pelvic lesions who suffered massive blood loss and emergency surgery, infusion-transfusion therapy was continued for 3 - 5 days for correction of circulating blood volume and hydro-saline balance, bed position was changed regularly and breathing exercises were recommended. After the operation, the patients were given time to adapt psychologically to their new condition and after a few days, if necessary, a final reposition of the bone fragments was performed, which did not cause a negative reaction. In patients with functional epicystostoma, special attention was paid to the position of its external part, the condition of the soft tissues near the catheter exit and entering of the wires in the pelvic bones, constantly changing the sealing meshes to prevent soft tissue infection.

Multiple limbs fractures were treated surgically. External devices with pins joined in one system were applied in the case of unilateral fractures of the pelvis and femoral shaft. It allowed to obtain the necessary stabilization of the fragments with a minimum number of fixation elements. In leg fractures the Ilizarov apparatus was preferred. Upper limb fractures were treated mainly with internal osteosynthesis by plates and screws. In patients with multiple fractures special mattresses and suspension position of the lower limb by external devices were used to prevent ulcers development.

After general condition improving, patients with residual displacement of the pelvic bone fragments were reassembled by a fixation device and a gradual reposition until satisfactory adaptation of the bone fragments was performed. The reposition period reached 12 - 14 days. Then, the posterior pelvic ring was fixed by two wires with stop ball introduced through the iliac bones and sacrum in the opposite direction meeting each other. Patients with acetabular fractures underwent open reduction and internal fixation. In case of sufficient sealing, the epicystostoma was not a contraindication for performing the osteosynthesis.

## Results

During the hospitalization, a complex of exercises designed for early recovery of the function and breathing restoration, cardiovascular system maintenance and strengthening the muscles of the limbs and pelvis were prescribed to all patients. In 2 - 3 days after the final reposition and stable fixation of the pelvic ring by the external device, patients were allowed to sit in bed, stand up

and walk with additional support with crutches with a partial dose weight-bearing on the traumatized hemipelvis. On discharge, almost all patients moved independently, except the patients with multiple fractures of the upper and lower extremities.

Evaluation of treatment results was performed using the S.A. Majeed (1989) scale, developed for patients with pelvic trauma, based on restoration indices of the function of the pelvic girdle and pelvic organs within twelve months after surgery. Long-term outcomes were studied in 48 patients with pelvic fractures and urinary tract trauma. Positive results were obtained in 67.64% (n = 30), satisfactory in 27.45% (n = 16) and unsatisfactory in 4.9% (n = 2).

Among the postoperative complications, stoma insufficiency was determined and repeated surgery was necessary. In 4 cases inflammation of the soft tissues in the area of fixation elements of the external device was recorded, the inflammation being resolved by conservative methods. In a patient with an "open book" pelvic fracture accompanied by an opened comminuted fracture of the pubic bone, a fistulous form of pubic bone osteomyelitis developed on that side in the late postoperative period. The process was stopped only after resection of the infected area of the bone, the supporting function of the pelvis was not affected. The average length of stay in the hospital was  $49.62 \pm 7.27$  days ( $p < 0,05$ ).

### Clinical Case

Male patient, 18 years old, was transferred to a district hospital from the scene of the traffic accident within 1,5 hours and hospitalized in the surgery department. Ongoing, the general condition of the patient worsened and he required transfer to the Institute of Emergency Medicine. At admission the patient was conscious, with inhibited reaction. Skin and visible mucous membranes were pale. At admission, he presented abdominal pain on the left flank and pelvic region, inability to move his legs and acute pain in the left knee joint. Respiratory system evaluation revealed vesicular breath sounds, no rales and respiratory rate 24 per minute. The heart sounds were clear, rhythmic. Pulse 104 beats per 1 minute with weak filling. Blood pressure 70/50 mmHg. The abdomen was involved asymmetrically in the act of breathing, tense and painful on the left flank and in the lower abdominal regions. Within the Department of Emergency Medicine, the patient was examined by all specialists, in addition clinical and radiological evaluation

was performed. Bladder catheterization was performed, 80ml of urine with blood was obtained. Urine analysis: protein - 0.28 g/l; white blood cells -20 - 30/hpf; erythrocytes - macrohematuria. Blood test: hemoglobin - 99 g/l; RBCs -  $3.2 \times 10^{12}/l$ , WBCs -  $12.4 \times 10^9/l$ . Clinical diagnosis at admission: Polytrauma, severe associated trauma. Closed craniocerebral trauma. Chest blunt trauma, rib fractures V-VI-VII on the left. Blunt abdominal trauma, spleen injury grade III, intra-abdominal hemorrhage. Blunt retroperitoneal injury with left kidney lesion, massive retroperitoneal hematoma, pelvic ring fracture type C (Figure 1), extraperitoneal bladder injury. Shock, grade II-III. ISS score was 29 points, otherwise it was considered severe trauma.



**Figure 1:** Male patient, 18 y.o. Pelvic X-ray, AP view. Ds: polytrauma, pelvic fracture type C. Excretory urography reveals subcapsular rupture of the parenchyma of the left kidney.

Urgently the patient was transferred to the operating room, where laparotomy with adequate hemostasis and splenectomy was performed.

Within the abdominal cavity examinations, a massive retroperitoneal hematoma and a subcapsular rupture of the parenchyma of the left kidney, without penetration into the calyx and pelvis were detected, the fact confirmed by the dynamics of intravenous urography (Figure 1). Primary fixation of the unstable pelvic fracture with an external device was performed (Figure 2). In the intensive

care unit continuous antishock therapy with infusion and transfusion of blood products, analgesic drugs and antibiotic was applied, the patient being under the constant observation of a urologist and traumatologist. On the third day after the operation, the abdominal drainage was removed. An additional reposition of the displaced left hemipelvis was performed. On the fifth day after the injury, an additional wire with a stop ball was applied to the posterior pelvic ring. The wire was introduced through the left iliac bone, the sacroiliac joint, the body of the first sacral vertebra, the second sacroiliac joint and the right iliac bone. The ends of the wires were fixed on "z" shaped brackets in meeting-compression mode. After 24 hours, the patient, with the help of the physiotherapist, sat up in bed, lowered his legs and was able to stay alone on the crutches to the end of the day. On the eighth day after the operation, the patient was transferred to the trauma department. The patient was activated, began to move independently with crutches around the room, performed physical exercises to restore joints function (Figure 3). After activation, the epicycstostoma was removed, urine excretion was performed using the Folley catheter. After the restoration of independent urinary function, on the 16<sup>th</sup> day the patient was discharged for ambulatory care. Upon consolidation of the fractures, on the 60<sup>th</sup> day after the trauma, the patient was re-hospitalized in the department of associated trauma. Based on clinical and radiological data, the healing of the pelvic fracture was confirmed and external device was removed. The treatment outcome was estimated by Majeed scale as 80 points. Long-term result was studied after 3 years - no complaints, no limping, unrestricted, painless movements in the hip joints. The function of the pelvic organs was not affected. Laboratory investigations, such as blood, urine and biochemical tests, did not reveal pathological changes.



**Figure 2:** Male patient, 18 y.o. Pelvic X-ray, inlet view. Stabilization of the pelvic ring by the device for external fixation.



**Figure 3:** Photo of the male patient, 18 y.o. Functional result in the rehabilitation period.

## Discussions

In the clinical aspect, detected lesions of the urinary system organs in the patients with multiple trauma are a component of a traumatic disease and have a significant effect during the early recovery period and on the final clinical outcome. The results of the study confirm the literature data regarding the severity and significant complexity of associated lesions of the pelvic bones and urinary tract [1]. The main cause of trauma are car accidents [8].

Large application of the damage control rules allows saving the patient's life in the vast majority of cases [4]. The extensive use of external fixation devices for primary stabilization and pelvic bones reposition permits to prevent possible complications associated with open osteosynthesis and allows maximum activation of patients. Pelvic internal osteosynthesis is possible after the treatment of retroperitoneal hematoma. The main features of the effectiveness of the treatment tactics in patients with associated injuries of the pelvic bones and urinary tract are social and medical rehabilitation, which are determined by three indicators: immediate results of surgical treatment, long-term results, identified errors and complications. During the treatment of patients with severe associated injuries of the pelvic ring and urinary system, difficulties and various complications were identified in a significant number of patients (approximately 11.64%). However, timely adjustments

of the rehabilitation process made their elimination possible and these complications didn't influence at the final result.

## Conclusion

Following our observations, a series of questions regarding the timing, methods of primary and final pelvic osteosynthesis and the restoration of urinary tract function for further studies were presented. The solution to these questions will undoubtedly provide early recovery of the patients with these complicated injuries.

Based on the results of a preliminary clinical analysis of the treatment of patients with associated lesions of the pelvic bones and urinary system, we concluded that adequate surgical correction of the pelvic ring and urinary bladder repair is possible in almost all cases. To perform this, we need modern equipment, properly qualified and trained personnel.

## Declaration of Conflict

Nothing to declare.

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