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ORIGINAL PAPER

Selection of Treatment Method for Pelvic Ring Fractures

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Introduction The pelvis is the central part of the body that receives the weight from the vertebral column and transfers it to the lower extremities. It protects the internal organs with its specific structure and shape. **Objective** The study aims to compare the clinical outcomes of emergency non-surgical and surgical treatment of such patients, to analyze the types and severity of complications and final functional outcome. **Material and methods** We present a series of 47 patients treated in the period between 1999 and 2009 at the Traumatology Clinic, CHC Banja Luka. According to Marvin Tile's classification, fractures were distributed as follows: Type A fractures occurred in 19 patients (40.6%), Type B in 18 (38.1%) and Type C in 10 (21.3%). 30 patients (63.8%) were polytraumatised, with craniocerebral injuries in 12 patients (25.5%), chest cavity injuries in 5 (10.6%) and abdominal organ injuries in 13 patients (27.6%). 27 patients (57.4%) had clinical and laboratory signs of hemorrhagic shock on admission, while 26 patients (56.2%) received conservative treatment and 21 patients (43.8%) were treated using surgical methods of stabilization of the pelvic ring. **Results** The analysis of the outcomes of treating pelvic ring fractures in our series of patients by using radiography (x-rays according to Slatis) showed that out of 47 treated patients, the outcomes were excellent in 28 (60%), good in 7 (15%), fair in 5 (12%) and poor in 7 (14%). The functional outcomes in all patients were evaluated according to the D'Aubigne-Postel scale, on average 18 months after the trauma. The outcomes were excellent in 22 patients (45%), good in 15 (31%), fair in 4 (9%) and poor in 6 (14%). The chi-square test showed that there was no significant statistical difference between the outcomes monitored using x-rays and functional outcomes monitored using the D'Aubigne-Postel scale (p=0.097). The surgical treatment efficiency coefficient was introduced for the purpose of comparative evaluation of treatment outcomes. The surgical treatment efficiency coefficient, compared with conservative treatment, showed that all evaluated parameters were between 1.56 and 16.33 times lower in surgical treatment, which represents the more favorable outcome. **Conclusion** We can conclude that conservative treatment is the treatment of choice for Tile's Type A fractures, external fixator for treating Type B fractures (including all subtypes), and internal fixation, as mono therapy or in combination with external fixator, for treating Type C2 and Type C3 fractures. Surgical treatment, compared with conservative treatment, allows faster mobilisation of the patient and it shortens the recovery period, which in turn lowers the total treatment costs. **Key words:** fracture, pelvis, fixator, polytrauma, outcome

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1. INTRODUCTION

The pelvis is the central part of the body that transfers weight from the vertebral column to the lower extremities, with its specific structure and shape it protects the internal organs, while the external side, the upper and lower brims of the pelvic ring serve to connect muscles and sustain body stability (1). The pelvic bones fuse together and do not articulate with each other, thereby forming a semi-ring structure i.e. one half of the pelvis each. The two halves are fused together anteriorly at the pubic symphysis, and are articulated posteriorly with the sacrum. The sacroiliac joints are placed vertically and are exposed to the shear force due to the weight of the upper body part. The sacroiliac complex with the sacroiliac, sacrotuberous and sacrospinous ligaments resists this and this way they maintain the normal position of the sacrum in the pelvic ring. From the centre of the pelvic ring, there is a strong and compact bone arch which spreads along the internal side and is made up of the promontory, linea terminalis on the lateral sides of the sacral bone and lateral iliac bone and the upper brims of the upper pubic bone. This crest is extremely important for the stability and biomechanics of the pelvic ring as it serves to transfer dispersed pressure from the pelvic column to the hip joint. All loads use this route and thus it make sense to try to repair it in case of a pelvic injury – that is why all fractures that disrupt any plane of this crest are unstable pelvic fractures (2). The load forces go along the iliopectinal line up to the acetabulum, and then transfer to the

neck and trochanteric mass of the femur. The basics of pelvic biomechanics entail the understanding that the pelvis is a ring-like structure. Traumatic forces, depending on their direction and strength, cause from most basic to complicated avulsion fractures (single or double fractures), with or without vertical shifts, internal or external rotation of the pelvis, or with or without dislocation of the pelvic ring (2-4). The vital organs of the digestive and urogenital tracts, terminal blood vessels and nerves are located in or pass through the pelvic region. Pelvic injuries are accompanied by considerable bleeding and potential neurological prolapses, and injuries to the urogenital organs. It is for that very reason that everything must be considered on a case-by-case basis, especially unstable pelvic fractures.

Pelvic fractures are painful, accompanied by swelling, hematoma, and prolapse of the function of the pelvis and injured organs. Pelvic fractures occur in approximately 1-3% of all fractures of the osteoarticular system. Pelvic radiography with both hips in the anterior-posterior direction, cranial or caudal x-ray photographs of the pelvis and oblique x-ray photographs, give a good insight into the pelvic injury. Over 90% of all pelvic fractures can be adequately diagnosed by radiography (5, 6). Computerised tomography (CT) provides more precise data on the pelvic injury, while magnetic resonance (MRI) is used to assess deep vein thrombosis and provide accurate data on the pelvic organ injury (7, 8). Having diagnosed the injury, and depending on whether it is a polytrauma or just a pelvic fracture and depending on the general condition and age of the patient, the orthopaedist, in consultation with a team of different specialists, from the beginning takes part in making decisions on the schedule and manner of treatment (8). The first priority is to save the patient's life and that depends on complete diagnosis and understanding of potential injuries: hemorrhage, injuries to the visceral organs of the pelvis, etc. (9). Nowadays Marvin Tile's classification is the most frequently used pelvic fracture classification.

Picture 1. Clinical and x-ray illustration of externally fixated pelvis

2. AIM OF THE STUDY

The study aims to compare the clinical outcomes of emergency non-surgical and surgical treatment of such patients, to analyze the types and severity of complications and final functional outcomes. In addition, we show a pin configuration technique which reduces skin irritation and enables greater mobility in the hip and functionality of the patient.

3. MATERIAL AND METHODS

The material in this research is made up of 47 patients treated at the Traumatology Clinic of Banja Luka Clinical Hospital Centre between 1999 and 2009. According to Marvin Tile's classification, 19 patients (40.6%) suffered Type A pelvic fractures, 18 patients (38.1%) Type B and 10 patients (21.3%) Type C (Table 1).

Tile's pelvic injury type	No. of patients	
	f	%
A	19	40.43
B	18	38.30
C	10	21.28
Total	47	100.00

Table 1. Distribution of patients according to Marvin Tile's classification

There were 30 polytraumatised patients (63.8%), who, in addition to pelvic ring fractures, suffered craniocerebral injuries (12 patients or 25.5%), there were 5 patients (10.6%) with craniocerebral injuries, and 13 patients (27.6%) with abdominal organ injuries (Table 2, Diagram 1).

Polytrauma type	No. of patients	
	F	%
Craniocerebral injuries	12	40.00
Chest cavity injuries	5	16.67
Abdominal organ injuries	13	43.33
Total	30	100.00

Table 2: Distribution of polytraumatised patients by degree of injury to organs

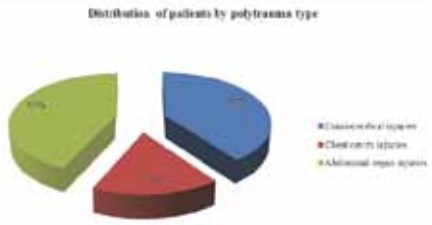


Diagram 1. Distribution of polytraumatised patients by degree of injury to organs

On admission to our institution, 27 patients (57.4%) had clinical and laboratory signs of hemorrhagic shock.

26 patients (56.2%) received conservative treatment (Type A and some patients with Type B1). 2 patients did not accept the proposed indicated surgical treatment.

They were treated conservatively: sling, side-lying and resting. 21 patients (43.8%) with Type B and Type C pelvic fractures were treated surgically (Picture 1). Type C pelvic injuries were treated with internal fixation, AO plates and screws. T

The following approaches were used depending on the location of the pelvic injury: Emile-Letournel's, suprapubic, sacroiliac. There were 6 (12.7%) such patients.

We treated Type B3 injuries with internal fixation and external fixator. 3 patients (6.3%) were treated in this way (Table 3, Diagram 2).

Treatment method	No. of patients	
	f	%
Conservative	26	55.32
Surgical	21	44.68
Total	47	100.00

Table 3. Distribution of patients by treatment method

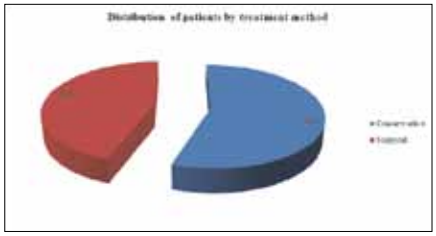
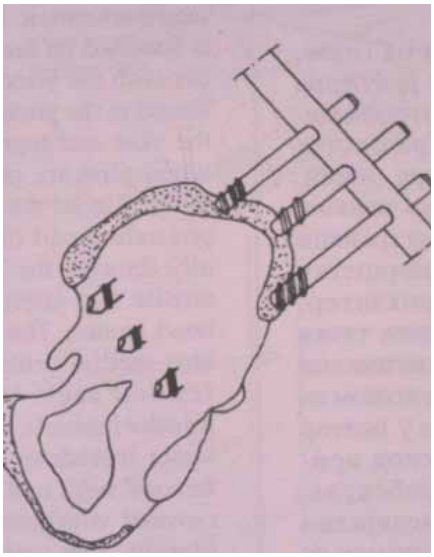


Diagram 2. Distribution of patients by treatment method

We used external fixation in poly traumas, Tile's Type B injuries, i.e. where there was vertical stability with rotational instability. We did not even take iliac bone fractures as a relative counter-indication. We used external fixation mostly in stable "open book" fractures, where both clinical and radiological findings indicated the intact condition of the sacroiliac, iliolumbar, sacrospinous and sacrotuberous ligaments.

We treated 10 patients (21%) with Type B pelvis fractures with Mitkovic's external fixator Type M20, and 2 patients (4.2%) with the Hoffmann external fixator. Pelvic stabilization with M20 fixator is simple and it can be quickly constructed using 2 frames. 4 pins can be placed on 2 movable clamps, and the assembly of movable clamps and articular tourniquet is made possible by the assembly of the necessary number of stabilization pins, for every person regardless of the patient's weight and height. The pins are inserted laterally into the iliac bone, attempting to have the pins „penetrate" the cortex (Picture 2). In the lower third of the fossae iliacae there is the relatively voluminous iliac muscle and the chances of a iatrogenous lesion are thus small. This way the pin will not become loose, it has a double leverage action, it is more stable, and it is thus easier and quicker to perform repositioning and maintain stabilization. The success of treating a pelvic ring fracture is evaluated using radiography, and the functional outcomes are evaluated for all patients using the D'Aubigne-Postel scale.



Picture 2. Schematic illustration of placing M20 external fixator pins

4. RESULTS

The analysis of the outcomes of treating pelvic ring fractures in our series of patients by using radiography (x-rays according to Slatis) showed that out of 47 treated patients, the outcomes were excellent in 28 (60%), good in 7 (15%), fair in 5 (12%) and poor in 7 (14%). (Table 4, Diagram 3).

Treatment outcome according to Slatis	No. of patients	
	f	%
Excellent	28	59.57
Good	7	14.89
Fair	5	10.64
Poor	7	14.89
Total	47	100.00

Table 4. Distribution of patients by treatment outcomes according to Slatis

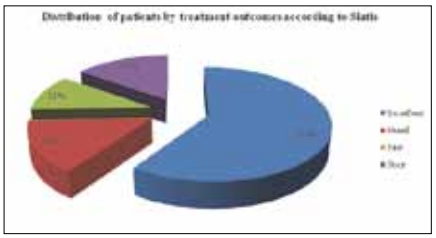


Diagram 3. Distribution of patients by treatment outcomes according to Slatis

The functional outcomes were evaluated using the D'Aubigne-Postel score for evaluating the post-treatment clinical outcomes minimum 18 months after the trauma. The outcomes were excellent in 22 patients (45%), good in 15 (31%), fair in 4 (9%) and poor in 6 (14%) (Table 5, Diagram 4).

Functional treatment outcomes according to D'Aubigne-Postel scale	No. of patients	
	F	%
Excellent	22	46.81
Good	15	31.91
Fair	4	8.51
Poor	6	12.77
Total	47	100.00

Table 5. Distribution of patients by functional treatment outcomes according to D'Aubigne-Postel scale

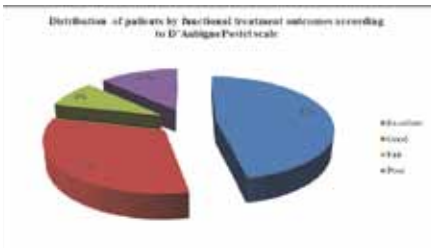


Diagram 4. Distribution of patients by functional treatment outcomes according to D'AubignePostel scale

The chi-square test shows that there is no significant statistical difference between treatment outcomes analyzed using x-rays photographs and functional outcomes monitored using the D'Aubigne-Postel scale (p=0.097).

The bad outcomes in 6 patients were manifested in the inability to "close the pelvis", i.e. to close the "open book" with external fixator. The reason for the non-closure of the "open book" was pin tract infection in different degrees in 2 patients, and the loosening of pins due to their inadequate placing in 4 patients.

The surgical treatment efficiency coefficient was introduced in order to comparatively evaluate the treatment outcomes; K_{HL} was the coefficient of surgical treatment, P_{KL} was the observed parameter of conservative treatment, and P_{HL} was the observed parameter of surgical treatment (Table 6).

Table 6 shows that hospital treatment of patients who received conservative treatment amounted to 48 days and of surgically treated patients to 12 days. Independent mobilisation with axillary crutches, weight-bearing, amounted to 60 days in conserva-

Parameter	Conservative treatment	Surgical treatment	Surgical treatment efficiency coefficient in comparison with conservative treatment
No. of patients	26	21	-
Length of hospital stay (days)	48	12	4.00
First verticalisation (days)	49	3	16.33
Independent mobilisation with axillary crutches, weight-bearing within pain threshold (days)	60	10	6.00
Respiratory infections (patient)	11	1	11.00
Pulmonary embolism (patient)	5	3	1.67
Average recovery time (months)	14	9	1.56
Total treatment costs (KM)	KM 306 800	KM 98700	3.11
Average treatment costs per patient (KM)	KM 11800	KM 470 0	2.51

Table 6. Efficiency of surgical treatment compared with conservative treatment

tively treated patients and to 10 days post surgery in surgically treated patients. During hospital treatment, respiratory infections occurred in 11 patients treated conservatively and in 1 treated surgically, and pulmonary embolism occurred in 5 conservatively treated and 3 surgically treated patients. There were no patients with an lethal outcome caused by pulmonary embolism. The average recovery time for patients treated conservatively was 14 months, and for those treated surgically 9 months. As for the treatment costs, according to the Health Insurance Fund price list, the average cost of conservative treatment of pelvic ring fractures amounted to KM 11800 and to KM 4700 for surgical treatment. The efficiency coefficient of surgical treatment in comparison with the efficiency coefficient of conservative treatment shows that all given parameters were between 1.56 and 16.33 times lower for surgical treatment, the fact which speaks volumes itself.

5. DISCUSSION

A head-on collision at 45 km/h or a sideways collision at 25 km/h is enough to cause a pelvic fracture. Two thirds of these injuries are caused by traffic accidents, and mostly affect pedestrians and less often drivers or passengers (8). The mortality rate in closed pelvic fractures ranges between 10 and 20% and in open fractures it exceeds 50% (10, 11). In the studies based on the findings of autopsies of 200 patients hurt in traffic accidents, Moed *et al.* show that 45% of them died of the pelvic fractures they sustained (11,12). Pelvic fractures are the result of the effects of strong forces which transfer to the pelvis, abdomen, extremities, chest cavity, head, etc. Complications, combined injuries and relatively high mortality rate pose an additional problem (13-15). Pelvic fractures can be isolated (9-10 %) or combined in polytrauma (60 – 80%) (16). Solomon L.B. states in his series that out of 1479 pelvic fractures, 1029 were poly traumas, while brain injuries were present in 10% and urological trauma in 7% (17). Injuries to the lumbosacral plexus stand at about 3%, and the L5 nerve root, etc. is most frequently affected. Hematoma and swelling often result in reversible prolapses of the n. femoralis in combined fractures of long bones (7%) (18-20). Approximately 20% of pelvic ring fractures are hemodynamically unstable (20, 21). There were 30 such patients (63.8%) in our series of polytraumatised patients and 12 (25.5%) suffered craniocerebral injuries, 5 (10.6%) suffered chest cavity injuries, 13 (27.6%) suffered abdominal organ injuries. On admission to our institution, 27 patients (57.4%) had clinical and laboratory signs of hemorrhagic shock.

Multidisciplinary approaches to these poly traumas have resulted in the decrease of mortality rate, pain relief, they have made early mobilisation possible, reduced complications, shortened length of hospital stay (21, 22). Hemorrhage has remained the main cause of death in patients with pelvic disruption (23). Arterial hemorrhage may occur in 10-15% of patients with severe pelvic injuries, and only 7-11% require embolization (24, 25).The second mortality peak occurs within the first hour and the reasons are as follows: epidural and subdural hematomas, chest cavity injuries, pelvic fractures, long-bone fractures, liver and spleen injuries (24). That is why in multiple injuries it is important, having surgically stabilized the patient's vital functions, to find the pelvic fracture in a timely manner and to treat it appropriately.

Screws, plates, and external fixators have in recent years been used in the treatment of unstable pelvic ring injuries, for the stabilization of bone fragments. Early on, the Hoffmann trapezoid configuration was mostly commonly used for external fixation. Kallan uses external fixation in pelvic fractures for all Types B and with it he achieves and maintains repositioning in 83% of pelvic fractures, and for Tile's Type C1 fractures in 27%. In 1998, Tile presents his experiences with the treatment of 494 pelvic fractures. In this series he states that unstable fractures (Type C) in 92 injured patients (21%) were treated surgically with external fixators in 68 patients (13.76%) and with internal fixation in 24 patients (8.16%). (24) The external fixator is used to restore stability to the anterior pelvic arch, reposition and stability of the subluxated sacroiliac joint. This reposition and stabilization of the pelvis reduces the mobility of the fracture surface and bleeding is stopped by swabbing, it eliminates pain, makes the treatment of related injuries easier, accelerates mobilisation and verticalization of the patient. Internal fixation with screws and AO plates is used in Tile's Type C fractures. This stabilization method results in anatomic repositioning, it prevents pseudoarthrosis and provides a satisfactory pain-free function (24).

In our series of patients, 19 patients (40.6%) suffered Type A pelvic fractures, 18 suffered Type B (38.1%), and 10 patients suffered Type C (21.3%). 26 patients (56.2%) were treated conservatively (Type A and certain patients with Type B1). 2 patients did not accept the proposed surgical treatment and were treated conservatively. 21 Type B patients (43.8%) were treated surgically, and we treated Type C patients with internal fixation, with AO plates and screws

placed using an appropriate approach; 3 patients (6.3%)

Miranda mentions that in 218 examined patients who were conservatively treated for pelvic fractures (Types A, B, C), 60% of the patients suffered constant pain and 30% of the patients changed their line of work after the completed treatment (12). Lindahl on the other hand maintains that external fixators yield good results in Type B1 pelvic injuries, while in Tile's Type C injuries they do not maintain the stabilization of the broken pelvis in approximately 35% of patients (14). 110 patients with unstable ring fixated by the Hoffmann fixator. Pseudoarthrosis complications occurred in 5%, pin tract infections in 24%, pin loosening in 2%, injuries to the femoral cutaneous nerve in 2 %, skin dehiscence in 3% (14). The use of external fixator in Type B and Type C open pelvic fractures enabled controlling this fracture and reduced potential infections (14, 15). Latenser and Gentilello in their series of 37 patients with unstable pelvic fractures treated conservatively and surgically come to a conclusion that the length of hospital stay was reduced by 37.8% in patients who underwent surgery. Physical therapy was not possible in 60% of the unoperated patients even 6 months after the injury, while that percentage amounted to only 15.7% in the operated group. Thus, they come to a conclusion that early surgical stabilization of the pelvis shortens the length of hospital stay, reduces long-term disability and loss of blood, and results in a better survival rate (16, 17). In our series of patients, the efficiency coefficient for surgical treatment compared with conservative treatment showed that all evaluated parameters (length of hospital stay, first verticalization, respiratory infections, pulmonary embolism, average recovery time, and treatment costs) were between 1.56 and 16.33 times lower for surgical treatment.

Inadequate pelvic fracture treatment results in late complications manifested by chronic pain, unequal leg length, and difficulty in walking accompanied by compensatory scoliosis, difficulty in sitting, heterotopic ossification and potential neurological prolapses (19, 23).

6. CONCLUSION

By analyzing the success rate of pelvic ring injury treatment in our series of patients, we can conclude that conservative treatment is the treatment of choice for Tile's Type A fractures, external fixator for treating Type B fractures (including all subtypes and Type C1), and internal fixation, as mono therapy or in combination with external fixator, for treating Type C2 and Type C3 fractures. Surgical treatment allows faster mobilisation of the patient, it shortens the recovery period, which in turn lowers the total treatment costs as compared to non-surgical treatment.

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