EXTERNAL FIXATION ROD APPARATUS IN TREATMENT OF UNSTABLE PELVIC FRACTURES IN A COMPLEX INJURY

A.B. Tilyakov, E.Y. Valiyev, B.S. Ubaydullayev

The Republican Emergency Care Research Centre of the Ministry of Health, Tashkent, the Republic of Uzbekistan

SUMMARY

The report is based on the results of examination and treatment of 285 patients with different types of a pelvic injury. Due to clinical and anatomic variants of pelvic injuries and treatment tactics all patients were divided into 3 groups according to classification of "Osteosynthesis" Association Documentations Center. Multispiral computed tomography with 3D modeling was widely used in the diagnosis of pelvic injuries. Extrafocal osteosynthesis of pelvic bones was carried out in patients with complex injuries after elimination of the prevailing pathology. Fixation of pelvic fractures was performed using a rod apparatus offered by our clinic, with simultaneous stabilization and reposition of pelvic bone fragments. Developed minimally invasive method with minimum damage to soft issues allows the osteosynthesis in acute and early stages of traumatic disease in a complex injury to be performed

Keywords: pelvic injuries, complex injury, rod apparatus.

INTRODUCTION

Damage to the pelvis is one of the most severe types of musculoskeletal injuries, first of all because it is accompanied by fatal outcomes, long-term incapacity and disability more likely than the other traumas [1–4]. The reason lies in the anatomy of the pelvis and the organs it contains. The severity of pelvic trauma is determined by severe pain syndrome, massive blood loss and traumatic shock [5, 6].

According to the summary statistics, 3% of patients with polytrauma become disabled due to pelvic injuries. After conservative treatment 22–66,7% of such patients have a permanent disability, and these figures is almost three times higher than that in operated patients [1, 3, 7-9]. Mortality in pelvic injuries reaches 10–46.3%, and it is especially high among patients with complex injury – up to 50% [1, 4, 9, 10].

Recent advances in the solution of this complex problem are inextricably associated with improvement of the diagnosis, tactics, methods and means of surgical treatment of severe pelvic injuries.

Use of highly informative radiological methods (computed tomography, in particular) in the diagnosis of pelvic fractures reduced diagnostic errors to 23.68% in the last decades [5].

Progress in medical care for these patients has been achieved considerably due to numerous researches on polytrauma and traumatic shock, and this fact is resulting in introduction of standardized scales assessing the severity of patient's condition into clinical practice, as well as tactics in diagnostics and treatment under which therapeutic measures for pelvic fractures are the first priority.

Improving of outcomes greatly owes to interpretation of an early external fixation effect of unstable pelvic fractures. Today, most experts agree that fixation provides antishock effect, prevention of hypostatic complications and good functional outcomes [4, 5, 7, 8].

Emergency fixation of unstable pelvic ring injuries using simple devices is included into the algorithm of severe injuries treatment – ATLS (Advanced Trauma Life Support) [9].

Currently developed methods of the pelvic injury treatment are aimed at full restoration of the pelvic ring anatomy. A huge set of fracture fixation and support methods has been created, and the use of these funds has positively resulted in outcomes of pelvic trauma.

However, particular treatment issues, such as clear indications for surgery, the choice of an optimal method and surgical stabilization techniques for different types of pelvic injuries as well as the number of other issues remain poorly understood and controversial.

Lots of unsatisfactory results of operative therapy for pelvic trauma are also related to the fact that offered methods cannot always provide secure fixation of fractures. Decrease of the surgery trauma severity remains one of the main directions of operative therapy development.

As hardware fixation has a small traumatic effect, many experts acknowledge adequacy of its use and perspectives of its improvement in such patients.

Objective: optimization of diagnostics and treatment strategies in patients with unstable pelvic fractures using modern minimally invasive techniques.

MATERIAL AND METHODS

Results of examination and treatment of 285 patients with various types of pelvic injuries are reported. The majority of patients – 180 (76%) were of the most working age, 25–55 years. There were 173 men (73%) and 64 women (27%). As traffic accident and fall from a height were the main causes of pelvic injuries, complex and multiple injuries were observed in 168 patients (71%). Among them 119 patients had brain injury of varying severity, 36 – injuries of a chest and lungs, 47 – injuries of abdominal organs, 31 – injuries of kidneys and bladder, 106 patients had fractures of extremities. Signs of traumatic shock of varying severity were observed in 194 patients admitted to the hospital.

All patients were divided into 3 groups based on clinical and anatomic variants of pelvic injuries and treatment strategies, according to classification of "Osteosynthesis" Association Documentations Center.

Group 1: Type A – a minimum displacement of fragments without breaking the dorsal part of the pelvic ring; pelvic diaphragm is intact; the pelvis is able to

counteract the usual physical load without displacement of bone fragments. The group included 99 patients.

Group 2: Type B – rotationally unstable but vertically stable fractures resulting from exposure to lateral compression or rotational forces. Posterior group of pelvic ligaments and pelvic floor remain intact, rotational instability is possible. The group included 106 patients.

Group 3: Type C – rotationally and vertically unstable fractures, characterized by a complete rupture of the pelvic ring, including rear sacroiliac complex. The damage may be either unilateral or bilateral. The group included 80 patients.

All patients with injuries of pelvic bones were examined and treated according to the standard scheme, in view of the prevailing pathology. All patients with complex injuries were admitted to the shock unit upon arrival where they were examined by experts – traumatologist, neurosurgeon, resuscitator, surgeon, urologist and, if necessary, other specialists. In the presence of hemodynamic instability, anti-shock measures were performed. Simultaneous examination included sampling (general blood test, urine test, blood group and Rh factor, blood biochemistry and coagulation), radiography and ultrasonogrphy of internal organs and echoencephaloscopy. Computed and multispiral computed tomographies were performed if there were indications.

Indications for operative therapy using external fixation devices were considered as follows:

– Double pubic bones fractures with displacement of bone fragments;

– Double ischial bones fractures with displacement of bone fragments;

– Various combinations of such injuries;

– Rupture of the pubic symphysis;

– Fractures of the acetabulum with central dislocation of the hip.

In patients with injuries of the chest and abdomen requiring emergency surgery, laparotomy and extrafocal osteosynthesis were performed consistently.

Osteosynthesis of pelvic bones using a rod device given by our clinic, with simultaneous stabilization and reposition of bone fragments was carried out after elimination of the prevailing injury.

Total of 205 surgeries were carried out. Operative therapy using external fixation was performed in 103 patients, plate osteosynthesis of anterior part of the pelvis – in 23 patients, acetabular fixation – in 38 patients, and combined osteosynthesis – in 60 patients. External fixation devices developed at the Republican Emergency Care Research Centre (RECRC) were used for the treatment of patients with pelvic fractures.

OSTEOSYNTHESIS PROCEDURE

Rods are screwed into pelvic bones using closed method, after preliminary formation of holes with a flexible awl, in the supine position of a patient under regional or general anesthesia.

The skin incision of up to 1 cm is made parallel to the inguinal fold in the supra-acetabular area at some distance from the anterior superior iliac spine and downward and inward at 3–3.5 cm. An access to the bone is created in the supra-acetabular area using a trocar to prevent damage to soft tissues and blood vessels. A hole is formed in the ilium using the awl. The first threaded rod is screwed into the hole perpendicularly to a horizontal plane and at the angle of 10° to the sagittal plane involving the full length of a threaded part (the inserted part of the rod is 4.5–5 cm whereas the whole working part is 12 cm.). The second rod is similarly introduced into the opposite side of the pelvis.

Next is a 0.5 cm-long skin incision at the anterior superior iliac spine bone projection. The second pair of rods is screwed into the holes formed with the awl, at the angle of 5° to the sagittal plane and at 10° to the front plane. The rods are installed into both pubic tubercles in a similar way. Inserted part of the rods is 4.5–5 cm and the working part is 9 cm. Insertion of the rods is being monitored

with an image intensifier. Apparatus modules collected into a single frame system are mounted onto the inserted rods.

Vertical and diagonal displacement of the pelvis fragments is eliminated by traction along the axis of the lower limbs under image intensifier monitoring. Then, skin incisions are made at the projections of posterior superior spines of iliac bones, bone holes are formed with an aid of the awl, third pair of threaded rods is horizontally screwed into the bone at the angle of 15° to the frontal plane (from front to back, from outside to inside). The device is stabilized by adjusting the nuts, so lateral compression is created by means of bars of anterior pelvic module after elimination of pelvic bones displacement under the control of an image intensifier, providing stable fixation of bone fragments and both halves of the pelvis in anatomical reposition.

It should be noted that early surgical intervention using the device allows us to cure damaged structures and reduce displacement without much difficulty.

When full single-stage reduction was impossible due to severity of patients general condition, the adjustment of fragments position was performed gradually by moving the device modules relative to each other in the postoperative period. The device was stabilized by tightening the nuts. Residual displacements were eliminated under the control of an image intensifier. The hip joint immobilization with the apparatus averaged 6–8 weeks. Further treatment of patients was performed using a full range of rehabilitation measures.

Assessment of treatment results was based on anatomical and functional criteria. Anatomical results were assessed according to repeated X-ray images and CT-scans. The functional outcome was assessed on the basis of complaints of patients, clinical data, and range of movement in healthy and damaged joints. The complete elimination of pelvic fragments and joint displacement was considered as a good anatomical result. The full recovery of the pelvic ring functional capability was considered as a good functional outcome.

Satisfactory anatomic result was an incomplete displacement reduction with good adaptation of bone fragments. Deformation of the pelvis not significantly affecting the supporting function but limiting movement in the hip joints up to 25–30% was considered as satisfactory functional result.

Unsatisfactory outcome was considered as preserving of significant pain syndrome, including at rest, limitation of the hip joint movement by more than 30%, support dysfunction and the occurrence of secondary degenerative diseases – sacroilitis, arthrosis, avascular necrosis of the femoral head, etc.

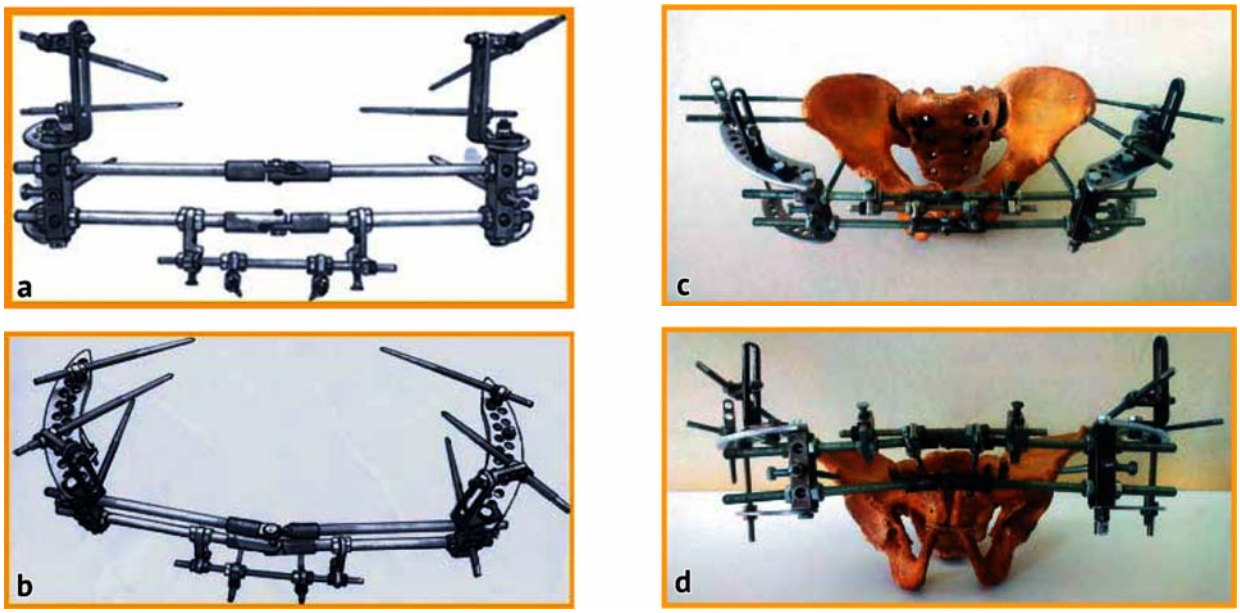

Fig. 1. Reposition rod apparatus for treatment of unstable and polifocal pelvic fractures (a, b – scheme of the device; c, d – apparatus on a model).

RESULTS AND DISCUSSION

Treatment results of patients with injuries of the acetabulum (6–12 months) were studied.

Assessing the quality of displacement reduction and recovery of function in unstable fractures of the pelvis using various surgical options and their combinations, we found that the most qualitative reduction of displacement and stable fixation of bone fragments was achieved in patients with type B fractures in

94 cases (32.9%) and type C in 70 cases (24.5%) when methods of combined external osteosynthesis and plate osteosynthesis were applied.

Long-term results (6–36 months) of surgical treatment of unstable pelvic fractures were studied in 182 patients. All patients were operated on in the early post-traumatic period (up to 10 days). Stability of the pelvic ring has been completely restored in all cases, being confirmed by X-ray imaging of pubic and sacroiliac joints.

Results of treatment undoubtedly depend on the quality of bone fragments displacement reduction. In the whole group of 182 patients who were treated with various surgical options, complete reduction was achieved in 114 cases (62.9%) and these patients demonstrated excellent results. In 48 cases (26%) reduction was incomplete. In this group, 15 patients (31.2%) had excellent functional outcomes and 33 patients (68.8%) had good results. Thirteen patients (65%) had satisfactory outcomes while in 20 cases (11%) reduction was unsatisfactory. 7 patients (34%) with a vertical and rotational instability demonstrated poor results.

Thus, the rod external fixation device for the treatment of pelvic injuries reduces and fixes bone fragments eliminating the displacement of pelvic halves. Minimally invasive techniques with minimum damage to soft tissues allow the fixation in acute and early periods of traumatic disease to be performed. Rigid fixation and the ability to transfer a load through the structure of the device, bypassing the damaged joint, allows a patient to recommence motion activity 10-14 days after the surgery and this fact significantly reduces the risk of threatening hypostatic complications.

Advantages of using the rod external fixation device for treatment of damage to pelvic ring are following:

– Low traumatic effect of the technique;

– Ability to use the device during the first few hours after the injury;

– The possibility to correct reposition during the treatment;

– Stabilization of the fracture helps stop bleeding, reduces pain, it is one of the options of antishock therapy;

– Early rehabilitation;

– Reduced risk of pulmonary, cardiovascular and other complications.

The case report is presented as an example.

A 28-year-old male patient M. received an injury in a car accident. The patient was moved to RECRC on the 12th day after the trauma from Qarshi branch of RECRC, where he was treated with a diagnosis of "Complex injury. Closed fracture of the right lateral mass of the sacrum with displacement of bone fragments. Closed fracture of the left pubic and ischial bones with displacement of bone fragments and rupture of the symphysis pubis (Type B). Closed fracture of the right transverse process of L_V with displacement of bone fragments. Rupture of mesentery. Traumatic shock of the 3rd stage". In Qarshi branch of RECRC the patient was urgently operated on and underwent laparotomy, suture of ruptured mesentery, partial enterectomy with a single-barrel ileostomy. Reapeted laparotomy and closure of perforated duodenal ulcer were performed on day 7, as the profuse gastrointestinal bleeding happened. Patient's condition has stabilized. Laparotomy wound sepsis has developed. The patient was transferred to RECRC for the further treatment. In RECRC the patient was examined according to the standards. The diagnosis was: “Complex injury. Closed fracture of the right lateral mass of the sacrum with displacement of bone fragments. Closed fracture of the left pubic and ischial bones with displacement of bone fragments and rupture of the symphysis pubis (Type B). Closed fracture of the right transverse process of L_V with displacement of bone fragments. Laparotomy, suturing of ruptured mesentery, small bowel resection with single-barrel ileostomy. Repeated laparotomy on day 7, closure of perforated duodenal ulcer. Laparotomy wound sepsis" (Figs. 2 and 3). The patient underwent surgery on the 3rd day after admission to the RECRC. Osteosynthesis of the pelvis by means of the rod device and secondary laparotomic wound debridement were carried out (Figure 4–7).

Fig. 2. X-ray image on admission

Fig. 3. Position of the patient on an orthopedic table

Fig. 4. Stage of rods insertion at the supra-acetabular area

Fig. 5. After mounting the rod device and secondary surgical debridement of the laparatomy wound

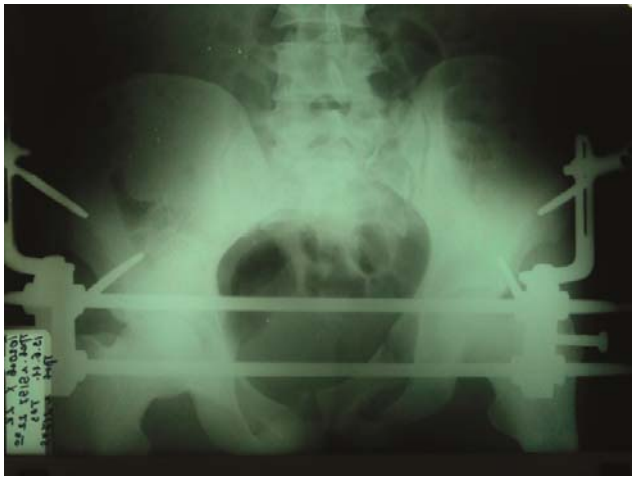

Fig. 6. X-ray image after surgery

Fig. 7. General view on the 3rd day after surgery

Fig. 8. Functional outcome, 14 days after surgery

Fig. 9. Functional outcome, 3 months after surgery

On day 12, the patient started motion activity and trained walking on crutches. After secondary wound healing the patient was discharged on the 16th day. The apparatus was removed 2 months later. Walking on crutches during the next 4 months was recommended. At the repeated examination 6 months later the

patient walked without crutches, gait disturbance was not observed, movements in the hip joint were limited within 10 degrees (Fig. 8, 9).

CONCLUSION

Diagnosis of unstable pelvic injuries should be comprehensive, comprising the clinical and instrumental diagnostic methods.

Certain algorithm steps regarding the type and nature of the damage, together with the use of modern technologies allow to reduce the number of misdiagnosis and improves the selection of optimal treatment.

External fixation rods are adequate in stable osteosynthesis being effective and less traumatic method of stabilization of pelvic injuries in the early period of traumatic disease.

Early surgical treatment plan for unstable pelvic fractures using external method in combination with internal osteosynthesis, if having indications, allows to have positive anatomic and functional outcomes in 91.6% of cases.

REFERENCES

1. Bagnenko S.F., Kashanskiy S.F., Rzayev R.S., Kucheyev I.O. Anatomo-klinicheskoye obosnovaniye sposoba lecheniya povrezhdeniy taza s narusheniyem tselostnosti ego kol'tsa [Anatomic and Clinical Background for the Method of Treatment for Pelvic Injures with Breaking of the Pelvic Ring]. Travmatologiya i ortopediya Rossii. 2009: 2: 46–52. (In Russian).
2. Kuzmin V.I., Gomonov V.P., Cherkashov A.M., Lelikov K.S. Osteosintez sterzhnevym apparatom perelomov kostey taza [Rod apparatus in pelvic fractures ostheosyntesis]. Travmatologiya i Ortopediya: Sovremennost' i Budushchee: materialy mezhdunarodnogo kongressa [Traumatology and orthopedics: nowadays and perspectives. Contents of the International Congress]. Moscow, April 7–9, 2003. 248–249. (In Russian).
3. Finamore P.S., Echols K.T., Vakili B., et al. Anatomic relationships of the "top-down" mid-urethral sling. J Reprod Med. 2009; 54 (5): 319–321.
4. Katsoulis E., Tzioupis C., Sparks I., Giannoudis P.V. Compressive blunt trauma of the abdomen and pelvis associated with abdominal aortic rupture. Acta Orthop Belg. 2006; 72 (4): 492–501.
5. Bondarenko A.V., Smaznev K.V., Pelaganchuk V.A. Vozmozhnosti repozitsii i fiksatsii nestabil'nykh povrezhdeniy taza vneshnimi sistemami [Abilities of reposition and fixation of unstable pelvic fractures with external fixation devices]. Travmatologiya i Ortopediya: Sovremennost' i Budushchee: materialy mezhdunarodnogo kongressa [Traumatology and orthopedics: nowadays and perspectives. Contents of the International Congress]. Moscow, April 7–9, 2003. 275. (In Russian).
6. Stelmakh K.K. Lechenie nestabil'nykh povrezhdeniy taza [The treatment of unstable pelvic fractures]. Travmatologiya i ortopediya Rossii. 2005; 4: 31–38. (In Russian).
7. Afaunov A.I., Afaunov A.A., Blazhenko A.N., Ananikov P.I., Polyakov A.V. Analiz grupp bol'nykh s mnozhestvennymi povrezhdeniyami taza i perelomami drugikh lokalizatsiy [The Analysis of Patients With Multiple Pelvic Injures and Other Localization Fractures]. Lechenie sochetannykh travm i zabolevaniy konechnostey: tezisy dokl. na Vseross. yubileynoy nauch.-prakt. konf. [The Treatment of Complex Injuries and Diseases of Extremities: Reports of the all-Russian Jubilee Scientific and Practical Conference]. Moscow, 2003. 28. (In Russian).
8. Dyatlov M.M. Slozhnye povrezhdeniya taza. Chto delat' [Serious pelvic injuries: what we have to do?]. Gomel: Gomel. Gos. Med. Univ. Publ., 2006. 494 p. (In Russian).
9. Totterman A., Madsen J.E., Skada N.O., Roise O. Extraperitoneal pelvic packing: a salvage procedure to control massive traumatic pelvic hemorrhage. J Trauma Injury Infect Crit Care. 2007; 62 (4): 843–852.
10. Ankin L.N., Pipiya G.G., Ankin N.L. Lechenie povrezhdeniy taza u postradavshikh s izolirovannoy i sochetannoy travmoy [Pelvic Injures Treatment in Pa-

tients With Isolated and Complex Trauma]. Vestnik travmatologii i ortopedii im. N.N. Priorova. 2007; 3: 32–35. (In Russian).

Article received March 17, 2014
For correspondence:
Akbar Burievich Tilyakov, Candidate of Sciences (Medicine),
Leading Researcher of Clinical Laboratory for Emergency Biochemical Researches, RECRC
e-mail: akbar-tilak@mail.ru

Перевод: А.П.. Богопольская