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Surgical treatment of chronic vertically unstable pelvic ring injuries

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ABSTRACT

BACKGROUND: The initial severity of patients with vertically unstable pelvic injuries often does not allow to perform timely reconstructive surgical intervention. Thus, the number of chronic injuries increases. Treatment of patients with long-term pelvic ring damage (after 3 weeks from injury) with significant vertical displacement (over 20 mm) is a problem of its own.

AIM: To analyze the immediate and long-term results obtained in patients with unresectable and chronic vertical unstable pelvic ring injuries.

MATERIALS AND METHODS: The results for 58 patients treated at the Priorov National Medical Research Center with chronic vertically unstable damage to the pelvic ring in the period from 2017 to 2022 were analyzed. Clinical and radiological diagnostic methods, as well as the Majeed questionnaire, were used to assess the treatment results.

RESULTS: The follow-up period for the patients ranged from 1 to 3 years (2.1 years on average). All patients after surgical treatment showed pain syndrome regression in the posterior pelvic area, decreased pain in sitting and standing positions, which improved their quality of life. All patients were able to move independently, to self-care after the treatment. Excellent results according to Majeed questionnaire one year after surgery were achieved in 4 (8.2%) patients, good — in 40 (81.6%), acceptable — in 5 (10.2%), there were no unsatisfactory results.

CONCLUSION: The vertebral-pelvic fixation technique allows specialists to effectively treat long-standing vertically pelvic ring unstable injuries and perform one-stage repositioning and stable fixation of the posterior pelvic ring.

Keywords: pelvis; posterior pelvic ring injuries; sacrum; sacrum fracture; spino-pelvic dissociation.

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Оперативное лечение застарелых вертикально-нестабильных повреждений тазового кольца

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АННОТАЦИЯ

Введение. Исходная тяжесть состояния пострадавших с вертикально-нестабильным повреждением таза зачастую не позволяет выполнить своевременное реконструктивное оперативное вмешательство. Таким образом растёт количество застарелых повреждений. Лечение пациентов с застарелым повреждением (после 3 недель с момента травмы) тазового кольца с выраженным вертикальным смещением (более 20 мм) вызывает отдельную сложность.

Цель. Проанализировать ближайшие и отдалённые результаты лечения пациентов с несвежими и застарелыми вертикально-нестабильными повреждениями тазового кольца.

Материалы и методы. Проанализированы результаты лечения 58 пациентов ФГБУ «НМИЦ ТО им. Н.Н. Приорова» Минздрава России с застарелым вертикально-нестабильным повреждением тазового кольца в период с 2017 по 2022 г. Для оценки результатов лечения применяли клинические и лучевые методы диагностики, а также опросник Majeed.

Результаты. Отдаленный период наблюдения за пациентами составил от 1 года до 3 лет (в среднем 2,1 года). У всех пациентов после оперативного лечения отмечается регресс болевого синдрома в области заднего полукольца таза, уменьшение боли и дискомфорта в положениях сидя и стоя, что привело к улучшению качества жизни. Все пациенты после проведенного лечения были способны самостоятельно передвигаться, самообслуживаться. Отличные результаты по Majeed через год после операции были достигнуты у 4 (8,2%) пациентов, хорошие — у 40 (81,6%), удовлетворительные — у 5 (10,2%), неудовлетворительных результатов не было.

Заключение. Методика позвоночно-тазовой фиксации позволяет эффективно проводить лечение застарелых вертикально-нестабильных повреждений тазового кольца и выполнять одномоментную репозицию и стабильную фиксацию заднего полукольца таза.

Ключевые слова: таз; повреждение заднего полукольца таза; крестец; перелом крестца; позвоночно-тазовая диссоциация.

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INTRODUCTION

Most pelvic fractures are directly related to high-energy trauma. Of these fractures, vertically unstable pelvic ring injuries account for <1% of all cases [1]. Such injuries are mainly caused by traffic accidents and falls from heights [2].

The severity of these injuries makes stabilization and treatment challenging. Owing to the severity of the injury and the inaccessibility of specialized hospitals in the vicinity of the injury in some cases, patients may not always receive timely and quality medical care. Thus, the treatment of chronic pelvic ring injuries is relevant.

Numerous techniques for stabilizing pelvic fractures in the acute period have been described [3–7]; however, repositioning in pelvic ring deformities combined with long-standing fractures is much more challenging. Surgical treatment in such cases is mainly difficult.

Vertically unstable pelvic ring injuries are frequently combined with pelvic injuries [8]. Thus, combined pelvic ring and urogenital tract injuries account for 20% of all genitourinary injuries. In 85% of cases, anterior pelvic ring fractures damage the pelvic diaphragm, which includes the membranous urethra. In addition, erectile dysfunction frequently occurs in men with anterior pelvic ring damage. Any form of urinary disorders sharply reduces the quality of life and induces psychological problems, which may lead to the destruction of family and work relationships and social isolation.

Chronic vertical unstable pelvic ring injuries are characterized by the instability of the anterior and posterior pelvic rings [2, 9, 10]. Radiologically, anterior ring injury is represented by rupture of the pubic symphysis, fractures of the inferior and superior pubic branches, and transacetabular fractures [10, 11]. Vertical sacral fractures, fracture dislocations of the sacroiliac joint, and iliac fractures,

which are grouped under spinopelvic dissociation and combined with damage to the pelvic diaphragm, iliac vessels, and lumbosacral plexus, are among the variants of posterior ring damage [10]. Cicatricial processes in the fracture area complicate repositioning [12, 13]. Surgical treatment requires good understanding of the spatial anatomy of the pelvis and careful preoperative planning.

The aim of the study was to analyze the immediate and long-term treatment results of patients with chronic vertically unstable pelvic ring injuries.

MATERIALS AND METHODS

Treatment results of 58 patients with chronic vertically unstable pelvic ring injuries admitted to the Priorov National Medical Research Center of Traumatology and Orthopedics between 2017 and 2023 were analyzed. Most of the patients were men ($n=34$, 58.6%). The average patient age was 37.7 (14–65) years, and 97% of the patients were of working age (up to 65 years). The circumstances of the injuries were falls from heights ($n=27$, 46.6%), traffic accidents ($n=25$, 43%), and compression injuries ($n=6$, 10.4%)

The main criterion for inclusion in the study was the presence of a vertically unstable injury of the posterior pelvic ring. Longitudinal sacral fractures accounted for most of the cases. All patients (100%) had polyfocal injuries, that is, combined with injuries of the anterior pelvic ring. The characteristics of pelvic injuries are shown in Table 1.

The study was approved by the Local Ethics Committee of the Priorov Scientific and Research Center of Traumatology and Orthopedics (Session No. 4, April 07, 2022). All patients signed a written consent form to participate in the study.

The distribution of the surgical treatment time according to the duration of injury is presented in Table 2.

Table 1. Characteristics of posterior pelvic ring injuries

Number of patients	Types of posterior pelvic ring injuries					
	Longitudinal sacral fractures (Denis)			Combined sacral fractures		Sacroiliac joint rupture
	Area 1	Area 2	Area 3	U-shaped	H-shaped	
58	34	3	2	3	7	9

Table 2. Distribution of patients according to the duration of injury based on the Cherkas-Zade classification [12]

Duration of injury	Number of patients
Stale injuries (10–14 days)	12
Long-standing injuries (3–6 weeks)	18
Chronic injuries (>6 weeks)	28
Total	58

To assess the stability of the pelvic ring, all patients underwent functional pelvic X-ray imaging with alternating loading of the left and right lower extremities (Fig. 1).

Moreover, all patients underwent computed tomography (CT) to clearly verify the pelvic ring damage, particularly, its posterior parts. In 15 (26%) patients, a solid three-dimensional model of the pelvic bones and lumbar spine was constructed for preoperative planning (Fig. 2).

Magnetic resonance imaging was also performed in all patients to determine the extent of damage to neural structures and assess compressions.

For the assessment of treatment results, the Majeed score was used [14], with a maximum score of 100 points in working patients and 80 points in non-working patients.

Surgical treatment

The patients were divided into two groups depending on the degree of posterior pelvic displacement according to the classification proposed in 2004 [15].

Group 1 consisted of 31 patients with grade I–II asymmetry of the hip joints (≤ 20 mm), who underwent closed repositioning of the posterior pelvic ring and iliosacral blocking with cannulated screws.

Group 2 included 27 patients with grade III asymmetry of the hip joints (>20 mm), who underwent open

repositioning of the posterior pelvic ring and bilateral spinopelvic fixation (PTF) using the L4–S2Al technique. The patients were divided by design into three subgroups: subgroup A included bilateral PTF with parallel unconnected rods ($n=13$), subgroup B included bilateral PTF with an additional transverse connector between the rods ($n=7$), and subgroup C included bilateral PTF using an L-shaped rod ($n=7$) (Fig. 3).

The metal fixator arrangement in subgroup A was characterized by less traumatization of soft tissues and possibility of placing the structure with minimal invasiveness. In 3 of 13 patients, PTF was performed transcutaneously to reduce soft tissue trauma and prevent problems with postoperative wound healing. Subgroup B was also fitted with a transverse connector to increase the rigidity of the metal structure. Seven patients in subgroup C underwent L4–S2Al PTF using an L-shaped curved rod. The vertical part of the rod was fixed in the lumbar and pelvic screws on the side of the sacral fracture. The vertical displacement of half of the pelvis was eliminated using the distractor. The horizontal part was bent along the relief of the posterior sacral surface and fixed in the lower pelvic screw on the opposite side. Compression in the fracture area was performed on this part. This fixation method

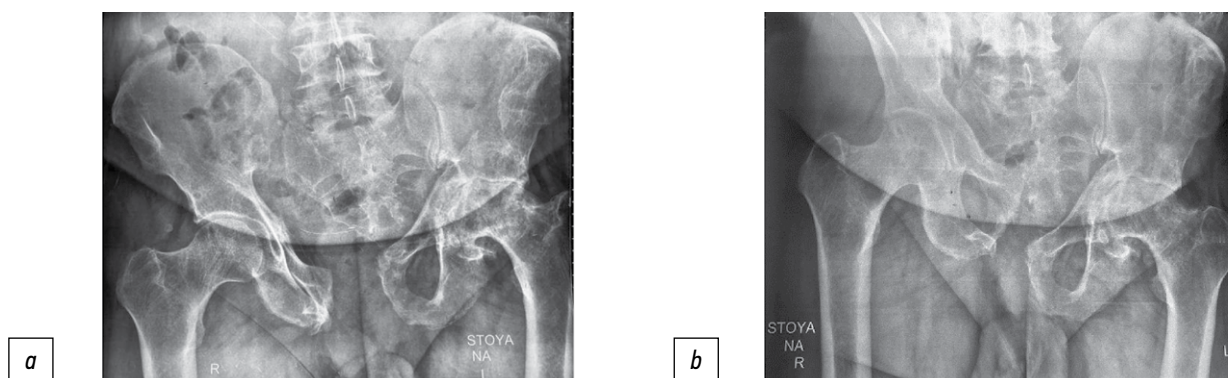


Fig. 1. Functional radiography from the pelvis with alternating load on the left and right lower extremities. *a* — standing on the left leg; *b* — standing on the right leg.

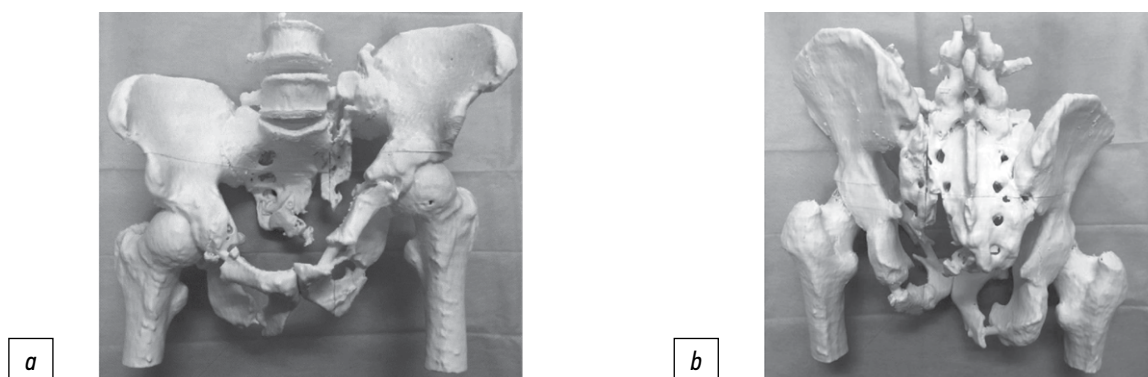


Fig. 2. 3D model of pelvic and lumbar spine: *a* — front view; *b* — back view.

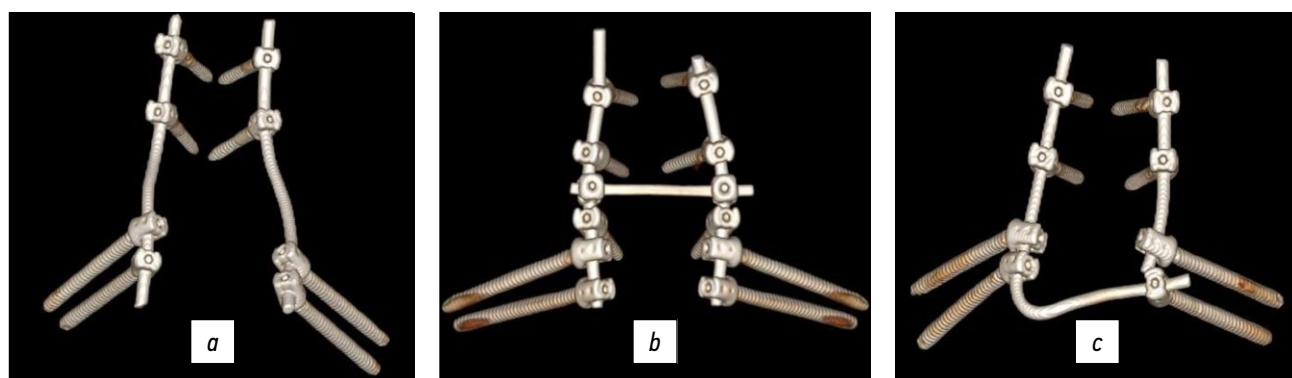


Fig. 3. Three variants of spino-pelvic fixation. *a* — variant 1 with two parallel rods not connected to each other; *b* — variant two with parallel rods connected by a transverse connector; *c* — variant 3 with an L-shaped rod.

gradually replaced that in subgroup B because of the lower profile of the metal structure, which facilitated the suturing of the postoperative wound.

In 39 of 58 patients, the instability of the anterior pelvic ring required fixation with a reconstructive plate.

RESULTS

The long-term follow-up of the patients ranged from 1 to 3 (mean 2.1) years. After surgical treatment, all patients showed regression of the pain syndrome in the posterior pelvic ring and reduction of pain and discomfort when sitting and standing, which led to improved quality of life. All patients could move independently and take care of themselves after treatment. Patients with pelvic organ dysfunction were referred to a neurourologist for further rehabilitation and were trained in intermittent bladder catheterization.

One year after surgery, excellent ($n=4$, 8.2%), good ($n=40$, 81.6%), and satisfactory ($n=5$, 10.2%) Majeed scores were noted. No unsatisfactory outcomes were observed. The average treatment outcomes are provided in Table 3.

In 13 patients of group 1 ($n=31$) with <20-mm vertical displacement of the posterior portions of the pelvic ring, vertical displacement of the hemipelvis was eliminated by closed repositioning and iliosacral blocking. In 11 patients, the displacement was eliminated by >50%. In seven patients, repositioning of the hemipelvis was <50%.

The instability of the metal structure such as migration of iliosacral screws occurred in six patients of group 1.

Only one patient of group 1 had soft tissue inflammation in the surgical area on the anterior pelvic ring, which required revision surgery, such as necrectomy and placement of an inflow and outflow drainage system. However, because of a deep infection, the metal structure was removed.

In eight patients of group 2 ($n=27$), vertical displacement of the hemipelvis was eliminated using the PTF technique. In 12 patients, the displacement was eliminated by >50%. In seven patients, hemipelvis repositioning was <50%.

COMPLICATIONS

In three patients of group 2, metal structure instability occurred, which required remounting with bone grafting. One case was reported in subgroup A and two in subgroup B. No instability cases that required revision surgery occurred in subgroup C.

In group 2, five patients had soft tissue inflammation in the surgical area (subgroup B, $n=4$; subgroup C, $n=1$), which required revision surgical intervention, such as a necrectomy and placement of the vacuum-assisted wound therapy system. In group 2, two patients required metal structure removal because of deep infection.

In four patients of group 2, postoperative CT revealed partial malposition of the pelvic screws of the dorsal metal structure with perforation of the external cortical wall of the ilium, which did not affect the surgical outcome. No cases of screw malpositioning accompanied by clinical manifestation occurred.

Table 3. Results of assessing the quality of life and pain syndrome in patients with long-standing vertically unstable pelvic ring injuries

Questionnaire	Before surgery ($n=54$)	Six months after surgery ($n=52$)	One year after surgery ($n=49$)	<i>p</i> value
Majeed	48±6	68±8	76±12	<0,05

In our observations, the more elements of the metal structure placed, the higher the risks of soft tissue inflammation in the surgical area. In addition, the configuration of PTF with an L-shaped rod has an advantage over that with a transverse connector in the number of inflammatory complications.

No complications were noted with the placement of the rod connecting the iliac screws with the superior ones and with the suturing of the postoperative wound. One case of subcutaneous protrusion of the iliac screw heads in a patient in group 2 was observed. At the patient's request, the structure was removed a year later after the consolidation of the fracture. No complaints or other clinical manifestations from the iliosacral joints were observed.

Case history

A patient aged 56 years presented 11 months after an injury (fall from the 5th floor). CT showed fractures of the pubis and ischium on both sides, and a longitudinal fracture of the lateral sacral masses on the left side in the Denis 2 area (Fig. 4).

Grade III vertical displacement according to Shlykov classification (45-mm asymmetry of the hip joints) was noted. The patient was on bed rest from the moment of injury, and no verticalization was done. Open repositioning of the left hemipelvis and bilateral PTF were performed. The surgery resulted in a 35-mm displacement and a residual displacement of 10 mm (Fig. 5).

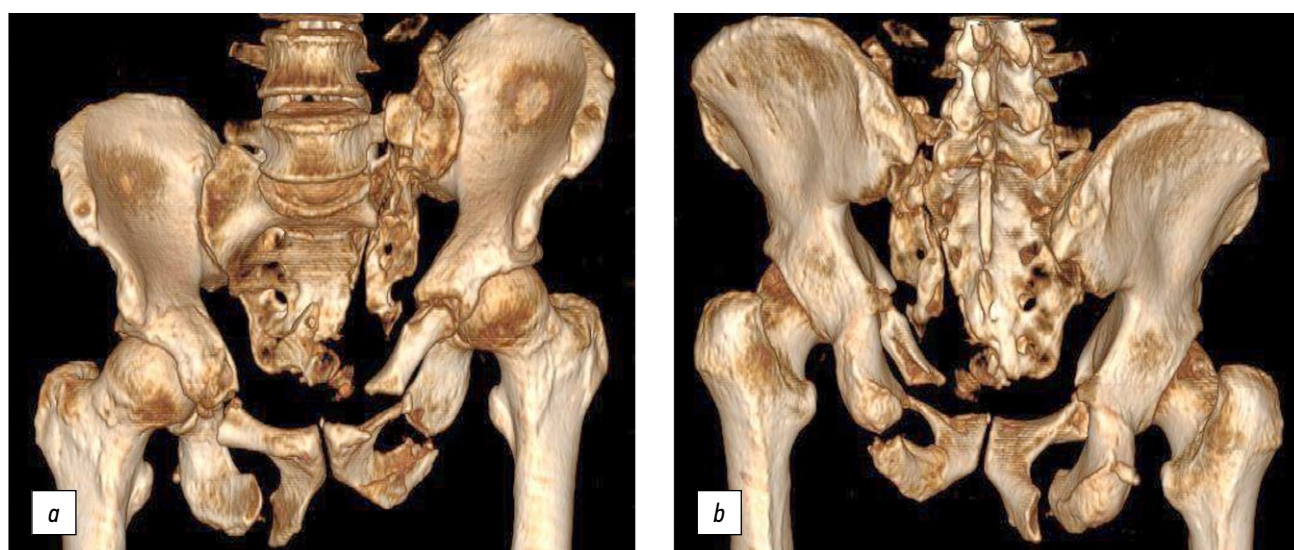


Fig. 4. Computed tomography of the pelvic bones in 3D reconstruction mode: *a* — front view; *b* — back view.

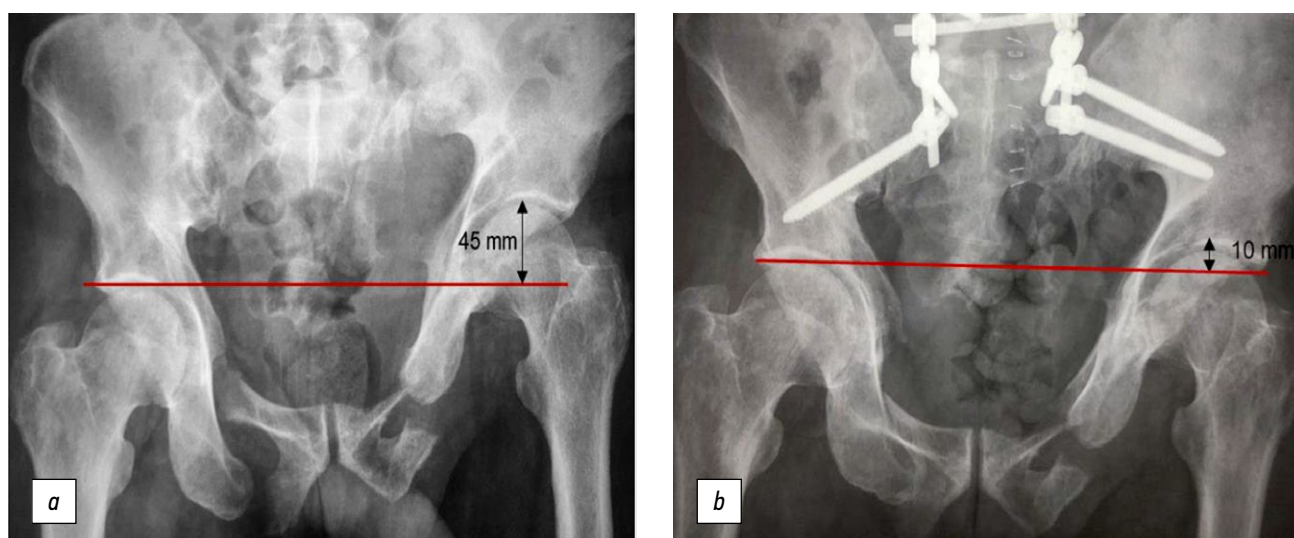


Fig. 5. Overview radiography of the pelvis: *a* — before surgical treatment; *b* — after spino-pelvic fixation with open repositioning of the left hemipelvis.

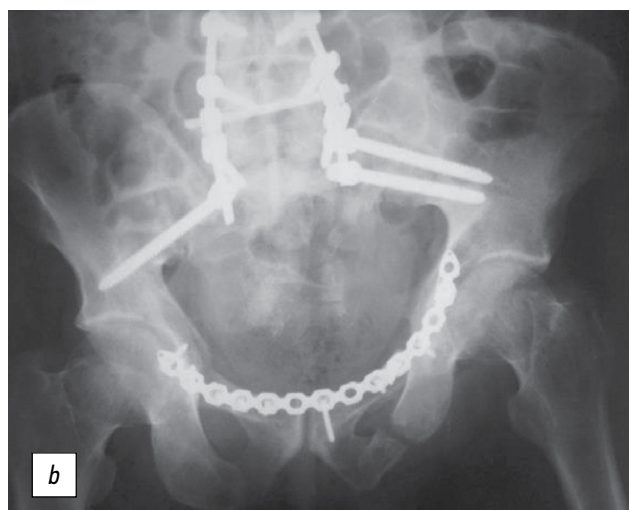
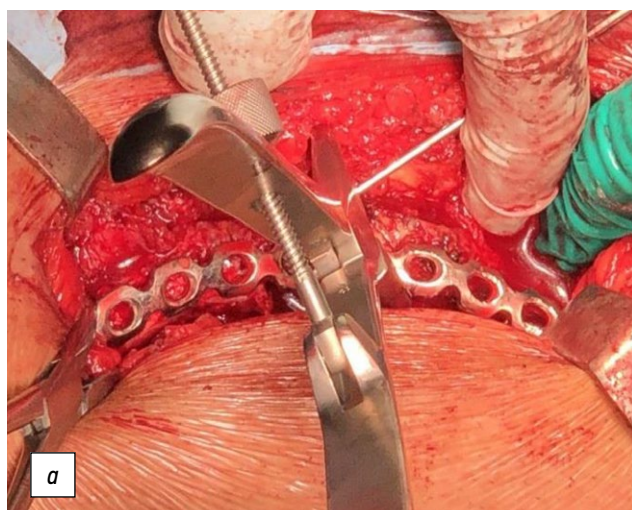


Fig. 6. Fixation of the anterior semicircle of the pelvis with a reconstructive plate: *a* — intraoperative photo; *b* — AP-radiography of the pelvis.

Two weeks later, the patient underwent fixation of the anterior pelvic ring with a reconstructive plate (Fig. 6).

On postoperative day 3, the patient started to sit up and within a week stood up with a walker. In the assessment of the long-term treatment results, the quantitative value of the final index according to the Majeed score was 76 points, which corresponds to a good functional result.

DISCUSSION

Russian and foreign authors emphasize the high complexity of the treatment of patients with type C pelvic ring injuries [16, 17]. The treatment of this injury was described as unsatisfactory [13, 18]. In chronic injuries, the situation is much worse because of multiple scarring and severe pelvic deformities [19, 20]. However, no consensus was reached on the choice of design for the treatment of chronic vertically unstable pelvic injuries. Adequate repositioning and stable fixation of pelvic fractures are one of the most difficult problems. Many authors [20] have suggested using external fixation devices, which require a biomechanically justified individual design, for the treatment of chronic injuries and posttraumatic deformities of the pelvic ring [21]. However, this method has a low degree of fixation stability (particularly in the posterior pelvic structures), has cumbersome designs, reduces the quality of life of the patient, and has a high incidence of local infections [21]. In addition, achieving appropriate repositioning of vertical displacements in the posterior pelvic ring is a difficult task, which requires a more complex apparatus design. The PTF technique is widely used for vertically unstable pelvic ring injuries [3, 5–7, 22];

however, few publications on its use in chronic pelvic ring injuries are available.

CONCLUSIONS

The PTF technique allows effective treatment of chronic vertically unstable pelvic ring injuries and one-stage repositioning and stable fixation of the posterior pelvic ring.

PTF can be minimally invasive or openly performed in combination with bone grafting of the false joint area and decompression of the cauda equina.

- If the vertical displacement is ≤ 20 mm, minimally invasive techniques for the fixation of the posterior pelvic ring are appropriate. If it exceeds 20 mm, open repositioning of the posterior pelvic ring with PTF is necessary.
- In the case of anterior pelvic instability, fixation is needed to restore the integrity of the pelvic ring.
- Minimally invasive techniques should be preferred whenever possible.

ADDITIONAL INFO / ДОПОЛНИТЕЛЬНАЯ ИНФОРМАЦИЯ

Author contribution. Thereby, all authors made a substantial contribution to the conception of the work, drafting and revising the work, final approval of the version to be published and agree to be accountable for all aspects of the work.

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