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Features of surgical treatment of combined gunshot wounds of the hip joint

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A retrospective analysis of surgical treatment is given 7 patients with combined gunshot wounds pelvis and hip joint. Objective. Analyze the results and determine the features of treatment of victims with gunshot wounds to the pelvis and hip joint. Methods. Patients with combined gunshot wounds to the pelvis and hip joint were distributed according to age, the nature of the fracture of the bone, current of the pelvis and proximal thigh, the nature of injuries to the internal organs of the abdominal cavity and pelvis, main nerves, the duration of the total hip arthroplasty (THA), the presence of infectious complications during treatment with the release of pathogen, the period of observation and the assessment on the scale Harris Hip Score (HHS). Analysis of combined firearms wounds of the pelvis and hip joint were carried out comprehensively with the involvement of a multidisciplinary team of specialists (abdominal and vascular surgeons, traumatologist, urologist, proctologist). Results. On the basis of statistical analysis, it was found that among 7 patients with average age 41.1 years, THA was completed in 5/7 (71 %). Medium term to THA (among those who underwent arthroplasty) was 17.0 months. Infectious complications were observed in 57 % of patients: Klebsiella pneumoniae and Klebsiella pneumoniae, Pseudomonas aeruginosa. In case of detected infection or questionable sterility, a two-stage treatment strategy is needed, that has better performance infection control after eradication of infection. Conclusions. In our opinion, the treatment algorithms in the case of gunshot wounds joint injuries of the hip joint will make it possible to reduce the level of infectious complications and improve the reproduction of results of treatment in this category of victims.

Наведено ретроспективний аналіз хірургічного лікування 7 пацієнтів із поєднаними вогнепальними пораненнями таза та кульшового суглоба. Мета. Проаналізувати результати й визначити особливості лікування постраждалих із вогнепальними поєднаними пораненнями таза та кульшового суглоба. Методи. Пацієнти із поєднаним вогнепальними пораненням таза та кульшового суглоба були розподілені згідно з віком, характером перелому кісток таза та проксимального відділу стегна, характером ушкоджень внутрішніх органів черевної порожнини та малого таза, магістральних нервів, терміном проведення ендопротезування кульшового суглоба (ТЕКС), наявністю інфекційних ускладнень протягом лікування з виділенням збудника, терміном спостереження й оцінкою за шкалою Harris Hip Score (HHS). Дослідження поєднаних вогнепальних поранень таза та кульшового суглоба проводилося комплексно зі залученням мультидисциплінарної команди спеціалістів (абдомінальний і судинний хірурги, травматолог, уролог, проктолог). Результати. На основі статистичного аналізу встановлено, що серед 7 пацієнтів із середнім віком 41,1 рік, ТЕКС виконано в 5/7 (71 %). Середній термін до ТЕКС (серед тих, кому виконано ендопротезування) склав 17,0 міс. Інфекційні ускладнення спостерігалися у 57 % випадках, серед яких переважали: Klebsiella pneumoniae та Pseudomonas aeruginosa. У разі виявленої інфекції або сумнівної стерильності необхідна двоетапна стратегія лікування після ерадикації інфекції, яка має кращі показники її контролю. Висновки. На нашу думку, використання наведених алгоритмів лікування в разі вогнепальних поєднаних поранень кульшового суглоба дасть можливість зменшити рівень інфекційних ускладнень і покращити результати лікування в цієї категорії постраждалих. Ключові слова. Вогнепальне поранення, кульшовий суглоб, таз, ендопротезування кульшового суглоба, рівень медичної допомоги

Keywords. Gunshot wound, hip joint, pelvis, hip arthroplasty, level of medical care

Introduction

Gunshot wounds (GSW) to the joints are considered a complex, combined trauma that involves direct mechanical destruction of the cartilage and subchondral bone, massive soft tissue damage, and a high probability of wound contamination. This defines a distinct clinical entity with its own management principles [1, 2].

In particular, gunshot wounds to the pelvis present a unique challenge for orthopedic surgeons due to the high frequency of concomitant injuries to the abdominal organs, urinary system, and hip joints [3, 4].

A clinically significant aspect is that wounds penetrating the joint cavity increase the risk of septic arthritis and subsequent post-traumatic osteoarthritis. Therefore, treatment should aim not only at restoring anatomy but also controlling contamination [5, 6]. Death within the first 24 hours after trauma is mostly due to acute blood loss and associated injuries [7].

Infectious complications (wound infection, septic arthritis, osteomyelitis) are among the main determinants of long-term outcomes for gunshot wounds to the joint. The risk correlates with the level of contamination, the presence of foreign bodies, the time to primary debridement, and the quality of soft tissue coverage [1, 8].

Most patients with transabdominal gunshot wounds to the hip joint (80 %) experienced infectious complications with poor functional outcomes [9].

During military conflicts, multi-drug-resistant gram-negative pathogens such as *Acinetobacter baumannii, Pseudomonas aeruginosa*, and carbapenem-resistant enterobacteria are increasingly dominant. The risk of infection rises with high-energy injuries, the retention of foreign bodies (bullet fragments), delayed surgical debridement, and intestinal injury [10].

Gunshot combined injuries to the hip joint remain a relevant topic today due to the difficulty in diagnosing and treating this pathology, the high percentage of infectious complications, and the significant number of unsatisfactory outcomes, requiring the search for new diagnostic and treatment methods.

Objective: To analyze the results and determine the peculiarities of the treatment of patients with combined gunshot wounds of the pelvis and hip joint in the context of a full-scale war with the Russian Federation.

Materials and Methods:

A retrospective analysis of the surgical treatment of 7 patients with combined gunshot wounds to the hip joint, who were hospitalized in medical facilities of the Ministry of Defense and the Ministry of Health of Ukraine, was conducted.

The work study was performed at the Military Medical Clinical Center of the Northern Region. The study was approved by the local bioethics committee (Protocol No. 4/05, dated 17.09.2025) of the relevant institution in accordance with ICH GCP, the Helsinki Declaration of Human Rights and Biomedicine, as well as the current legislation of Ukraine. All participating patients were informed of the study plan and conditions and provided written informed consent.

Inclusion criteria: combined gunshot penetrating wound of the hip joint with a fracture of the walls of the acetabulum and femoral head, with a follow-up period of 6 months or more.

Exclusion criteria: isolated gunshot non-penetrating soft tissue injury in the hip joint area, as well as patients who died within 72 hours after being admitted to the third-level medical care facility due to the severity of their injuries and the development of complications.

All patients sustained their injuries during the full-scale war between Ukraine and the Russian Federation and underwent surgical treatment in medical institutions of the Ministry of Defense of Ukraine and the Ministry of Health of Ukraine.

The evaluation and analysis of combined gunshot wounds of the pelvis and hip joint were conducted comprehensively with the involvement of a multidisciplinary team of specialists (abdominal and vascular surgeons, traumatologists, urologists, proctologists).

In cases of unstable hemodynamics, the patient was examined in the emergency department, where mobile digital radiography (uDR 370i, China) and ultrasound diagnostics using the FAST protocol (Venue Go, USA) were performed, and hemodynamic parameters were stabilized. After stabilizing the patient's condition, a CT scan of the head, chest, abdominal organs, and pelvis was performed on a Revolution CT scanner (USA) (64 slices with and without contrast).

In suspected injury to major blood vessels, patients underwent CT angiography [11]. In cases of uncontrolled bleeding from major pelvic vessels or gluteal area, with defects in soft tissues or pelvic organs, resuscitative endovascular balloon occlusion of the aorta (REBOA) was used to stabilize hemodynamics. This minimally invasive procedure, which does not require thoracotomy, ensures distal control of hemorrhage, increases afterload on the heart, and thus supports coronary and cerebral perfusion pressure until definitive hemostasis is achieved.

In case of suspected damage to the rectum, an examination by a proctologist was carried out, along with rectosigmoidoscopy. For the kidneys, ureters, bladder, and urethra, ultrasound of the kidneys, triphasic excretory CT-urography, cystography, and cystoscopy were performed.

After stabilizing the patient's condition and completing the examination, priority surgical interventions were performed on the abdominal and pelvic organs, followed by stabilization of the bones and hip joint using external fixation devices (EFD) according to the principles of "*damage control surgery*" [12].

Results and Discussion

The distribution of patients with combined penetrating gunshot wounds to the hip joint was carried out based on the following indicators: age, type of fracture of the pelvic bones and proximal femur, nature of internal organ damage in the abdominal cavity and pelvic region, damage to major nerves, timing of total hip replacement (THR), presence of infectious complications during treatment with identification of the causative agent, observation period, and evaluation according to the Harris Hip Score (HHS) scale (Table 1).

All patients had combined damage to internal organs in the abdominal cavity, pelvic organs, and genitalia in combination with injury to the structures forming the hip joint. Special attention was paid to controlling the time of surgery, as prolonged surgical time in cases of combined trauma worsens treatment outcomes due to the development of coagulopathy and multiple organ failure.

During the installation of the rod EFDs in cases of gunshot fractures of the proximal femur and unstable pelvic fractures, rods with a diameter of 5–6 mm were used, which were screwed into the iliac wings with the formation of rigid compression. Given the presence of bowel paresis and abdominal distension, the transverse bar should be sufficiently high above the skin surface or positioned in a "tent-like" manner. In cases of rectal injury, the placement of a sigmostomy should be slightly higher than the traditional location to prevent infection at the site where the rods are inserted, which should always be emphasized to the surgeons.

In cases of gunshot fractures of the proximal femur with an intact hip socket, it is advisable to use intraacetabular insertion of rods followed by fixation to the distal fragment of the femur. It should be noted that this insertion of rods is recommended to be done under mandatory EOC control. Primary surgical treatment (PST) of gunshot wounds is a critical step in preventing wound infection [3], and the recommended time for its performance is within 6–8 hours after the injury to prevent the transition of the wound from contaminated to infected. Timely and adequate debridement (removal of nonviable tissue with thorough irrigation) is one of the key treatment measures for gunshot wounds. According to the Joint Trauma System War Wounds: Debridement and Irrigation clinical practice guidelines (CPG ID:31), for small wounds, 1–3 liters of saline solution are used, for moderate wounds 4–8 liters, and for large and heavily contaminated wounds, 9 liters or more [13].

For the treatment of gunshot wounds with soft tissue defects, vacuum dressings (NPWT) were used until early wound closure was achieved. These were recommended to be replaced every 2–4 days, depending on the patient's need for serial debridement. Each change of the vacuum dressing should be performed under sterile conditions in the operating room. In our opinion, NPWT should not be used for an extended period as a method for growing granulation tissue. This is a serious mistake that leads to increased treatment duration and the risk of wound infection with anaerobic bacteria. Furthermore, in cases of coagulopathy, the use of NPWT may exacerbate bleeding from the wound, making its application prohibited in these cases.

Currently, in our practice for treating gunshot fractures of the pelvic bones and hip joint in hemodynamically unstable patients, we use the "New Clinical Protocol for the Treatment of Pelvic Bone Fractures (Combat Injuries)" (Figure 1), approved by the Ministry of Health of Ukraine order No. 1237 on 16 July 2024, which is a translation of the JOINT TRAUMA SYSTEM Clinical Practice Guidelines (JTS CPG) for Pelvic Fracture Care (CPG ID: 34).

Implementation of standardized clinical treatment algorithms for patients with pelvic bone fractures has been shown to significantly increase the likelihood of rapid stabilization of the injured patient's condition [10, 15, 16].

The assessment of hip joint function is a key stage in clinical practice in traumatology and orthopedics. The most well-known scales include Harris Hip Score (HHS), Oxford Hip Score (OHS), WOMAC, HOOS, and SF-36 (Figure 2, Table 2).

The Harris Hip Score (HHS) remains the "gold standard" in classical surgical studies due to the combination of objective and subjective indicators. It is simple and comprises 10 items covering four categories: pain, function, absence of deformity, and range of motion in the hip joint. This scale was chosen for analyzing the function of the hip joint in patients

Table 1

Assessment of patient data

№	Date of injury	Type of gunshot injury		Time to DCS after injury, months	Infectious complications and pathogen	Time after injury, months	Harris Hip Score (HHS)
		pelvis and proximal femur	abdominal cavity and pelvic organs, reproductive organs and nerves				
1	04.06.202	Multifragmentary fracture of the neck and head of the right femur; multifragmentary fracture of the right acetabulum with displacement of fragments	Small intestine	21	*Klebsiella pneumoniae Candida krus., A. baumanni*	33	48
2	17.09.2022	Fracture of the acetabular region of the upper third of the right femur with displacement of fragments and marginal fracture of the acetabulum	Rectum with development of phlegmon of the pararectal tissue	25	*Acinetobacter spp., Pseudomonas aeruginosa*	31	80
3	27.12.2022	Multifragmentary fracture of the head and neck of the left femur with fracture of the acetabular floor	Left sciatic nerve	23	"Negative culture" No clinical signs of infection were found	28	36
4	27.04.2023	Fracture of the lef t acetabulum with the presence of a foreign body (metal fragment) in the left sacroiliac joint	Contusion of the extraperitoneal part of the sigmoid colon	9	"Negative culture" No clinical signs of infection were found	24	84
5	24.07.2023	Fracture of the head and upper third of the right femur, right ilium bone	Rectum (with the presence of a metal fragment). Fecal peritonitis. Post-traumatic middle right hemopneumothorax	Not performed	*Pseudomonas aeruginosa, Klebsiella pneumoniae*	21	32
6	08.07.24	Comminuted fracture of the pubic and ischial bones with dislocation fracture of the femoral head, with massive defects of the bone and soft tissues. Adjacent soft tissue injury of the right thigh	Traumatic amputation of the penis. Adjacent injury of the left scrotum with damage to both testicles	7	"Negative culture" No clinical signs of infection were found	"Negative culture" Clinical signs of infection found	34
7	23.09.24	Comminuted fracture of the pelvic basin, ischial bone, pubic bone on the right, and marginal fracture of the femoral head with the presence of a foreign body	Penis and hanging part of the urethra with secondary injury to the right sciatic nerve	Not performed	*Klebsiella pneumoniae Staphylococcus epidermidis*	7	38

with gunshot combined injuries. OHS, WOMAC, and HOOS are more focused on the patient's perception, while SF-36 is used for a general assessment of quality of life.

Clinical Case No. 1

A 45-year-old male patient was admitted for treatment at the trauma clinic with a gunshot wound causing a combined penetrating transabdominal injury to the right hip joint, accompanied by a comminuted fracture of the neck and head of the right femur, a comminuted fracture of the acetabulum, body, and wing of the right ilium with displacement of bone fragments and formation of a bone defect, small intestine injury, and formation of a massive retroperitoneal hematoma in the pelvic region. The patient was in hypovolemic shock, stage III.

Initially, the patient was hospitalized in the emergency medical department, where an abdominal and

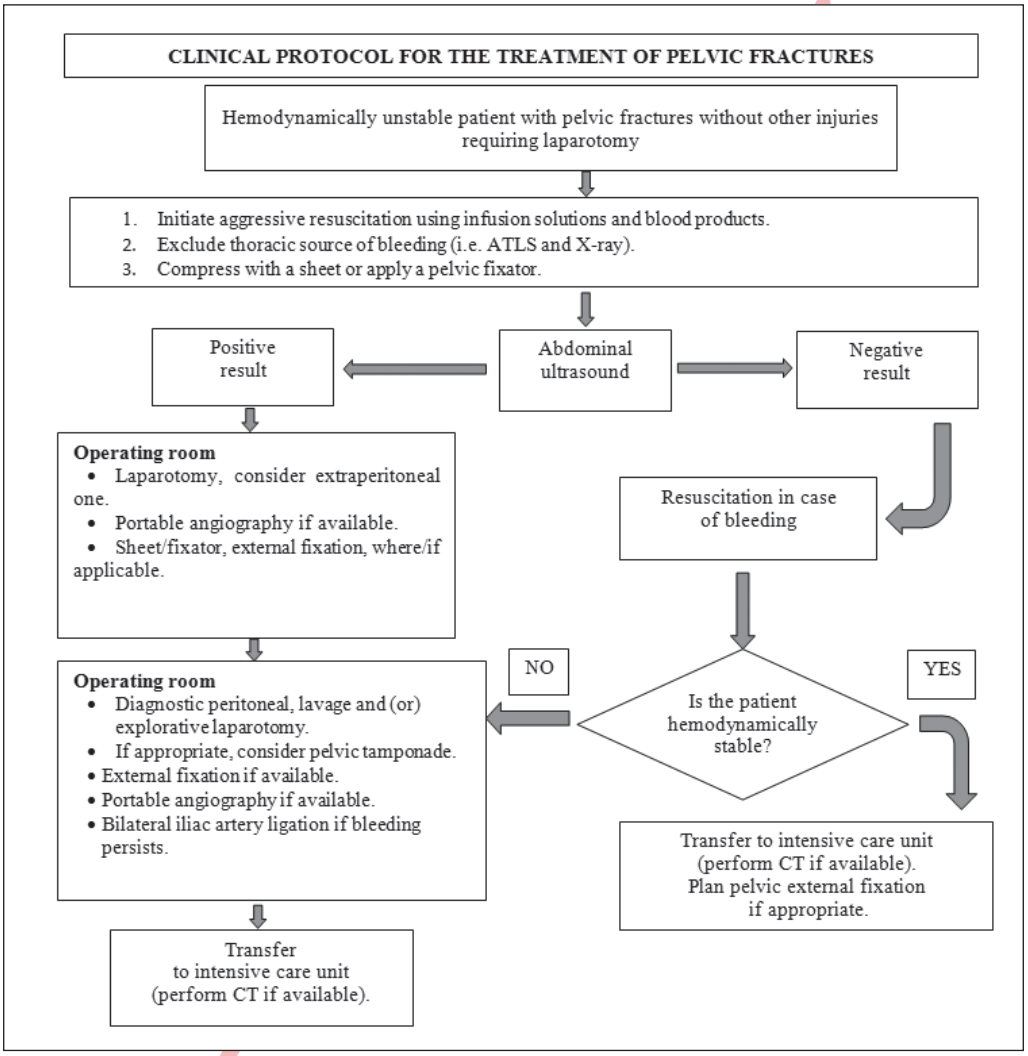

Fig. 1. New clinical protocol for the treatment of pelvic bone fractures (combat injuries)

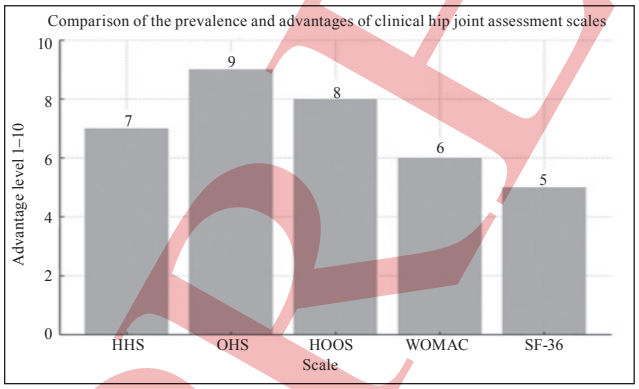

Fig. 2. Prevalence level of hip joint function assessment scales

pelvic ultrasound was performed, revealing free fluid in the abdominal cavity. Radiography of the pelvic bones was carried out, capturing both hip joints, revealing a fracture of the neck and head of the right femur, a comminuted fracture of the acetabulum, body, and wing of the right ilium with displacement of bone fragments (Figure 3, a). After stabilizing the patient's condition and performing PST of the wounds, a laparotomy was performed, along with suturing of the gunshot wounds to the small intestine, revision and drainage of the retroperitoneal hematoma on the right, and sanitation and drainage of the abdominal cavity. The fracture of the pelvic bones and proximal femur was stabilized using a rod EFD for the "pelvis-femur" according to the principles of damage control surgery.

After the surgery, the patient was placed in the anesthesiology, resuscitation, and intensive care unit (ARICU). A CT scan was then performed to clarify the nature of the pelvic bone fractures and the proximal right femur, with 3D modeling (Figure 3, b, c), and follow-up CT scans were performed three months later (Figure 4).

Seven months later, the patient's condition worsened. He presented with pain in the right hip joint and an increase in body temperature. During

microbiological examination using PCR, *Klebsiella pneumoniae, Candida krusei*, and *Acinetobacter baumannii* were identified. After further examination, the diagnosis of acute sepsis and septicemia (*Klebsiella pneumoniae, Candida krusei, Acinetobacter baumannii*) was confirmed.

Subsequent repeat surgical treatments were performed with the application of primary delayed sutures. During the treatment phases, no antibacterial cement spacer was installed. One year after the injury, the patient underwent total hip replacement of the right hip joint using a custom-made titanium acetabular implant. A follow-up CT of the pelvis was performed three months after the surgery, and the general appearance of the right hip joint area is shown in Figure 4, a, b.

Post-treatment status after THR. Post-traumatic neuropathy of the right tibial and common fibular nerves with significant paresis of the right foot. The patient was treated with lincomycin 600 mg twice daily intravenously, tazobactam 4.5 g in 100 ml of 0.9% sodium chloride solution, three times a day, transitioning to tigecycline 50 mg twice a day and voriconazole 200 mg twice a day for 21 days. The total duration of antibiotic therapy was 6 weeks. During the treatment, the patient's condition improved. The clinical outcome was assessed 33 months after the injury and 21 months after the final surgery using the HHS. The total score was 48 points, indicating a poor clinical result.

Clinical Case No. 2

A 45-year-old male patient sustained a combined gunshot wound to the proximal right femur and pelvic organs, resulting in a fracture of the acetabulum and penetrating injury to the upper ampullary part of the rectum, along with the presence of a foreign body (bullet) in the left gluteal area. The following procedures were performed: PST of the wounds, a damage control procedure with a Maidle sigmoidostomy and drainage of the perirectal tissue according to McWarter and fixation of the right hip joint and pelvic bones, which was achieved using a rod EFD "pelvis-femur".

The post-operative period was complicated by the development of phlegmon of the perirectal tissue. Microbiological examination revealed *Acinetobacter spp., Pseudomonas aeruginosa*, and the patient received colistin and tigecycline. After eradication of the infection, the sigmoidostomy was closed, and the rectal passage was restored.

31 months after the injury, the patient underwent THR. 6 months after the THR, according to the HHS, the patient achieved 80 points, indicating a good result.

Clinical Case No. 3

A 34-year-old male patient was hospitalized with a gunshot wound to the left hip joint, resulting in

Table 2

Comparative analysis of hip joint function assessment scales

Шкала	Оцінювання/ класифікація	Суб'єк-ть/об'єк-сть	К-ть балів/ запитань	Основне застосування	Переваги	Недоліки
Harris Hip Score (HHS)	Pain, function (walking, stairs, footwear), range of motion, deformity	Combination: doctor + patient	100 points	Clinical examination, joint replacement, injuries	Objective parameters, classic and well-known scale	Less sensitive to patient's subjective feelings, has a "ceiling" in results
Oxford Hip Score (OHS)	Pain and function in daily life	Patient (self-completion)	12 questions (0–48 points)	Quality of life after joint replacement	Simple, convenient, validated	Subjective, without clinical objective component
WOMAC	Pain, function, stiffness	Patient	24 questions	Osteoarthritis, clinical studies	Well adapted for osteoarthritis	Not specific only to the hip joint
HOOS	Pain, symptoms, function, sport/recreation, quality of life	Patient	40 questions	Extended version of WOMAC for the hip joint	Broader domain coverage	Longer questionnaire, more complex to use
SF-36	Quality of life (8 domains, including physical and mental health)	Patient	36 questions	Overall health assessment	Comprehensive assessment, multidisciplinary	Not specific to the hip joint

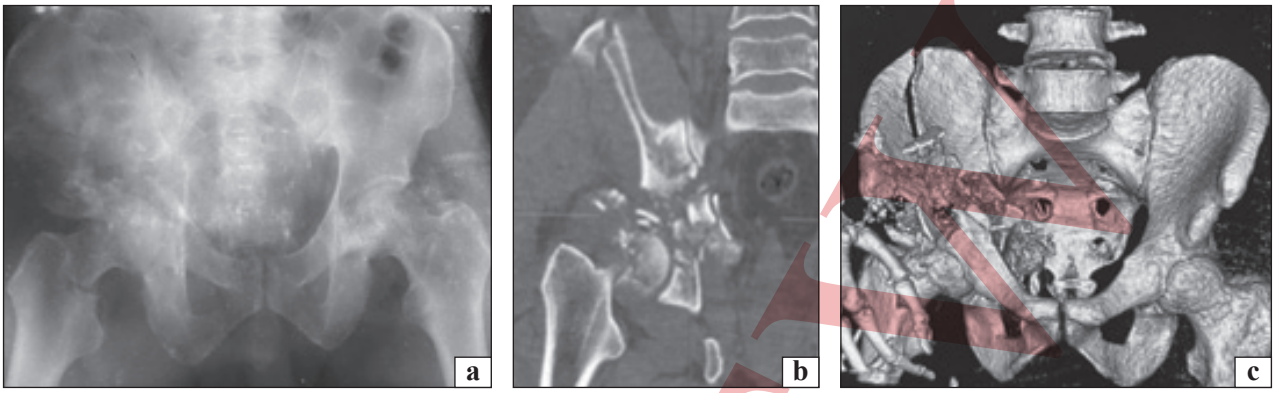

Fig. 3. Photographs of the patient (clinical case No. 1): a — X-ray of the pelvic bones, b and c — CT of the pelvic bones with modeling, comminuted fracture of the neck and head of the right femur, comminuted fracture of the right acetabulum, body and wing of the right iliac bone with displacement of bone fragments and formation of a bone defect

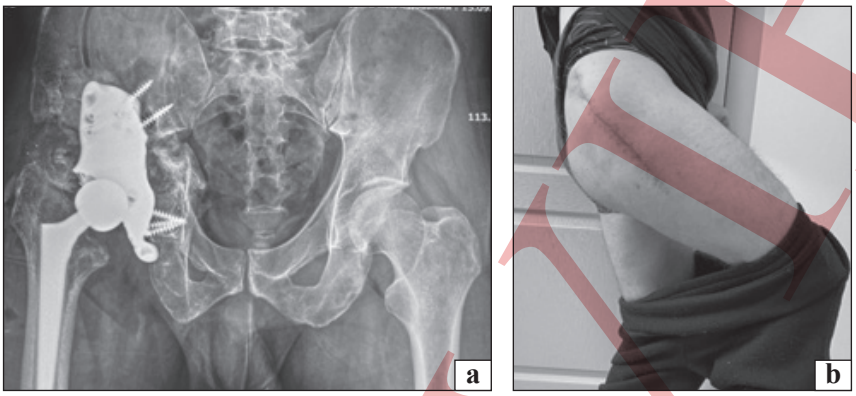

Fig. 4. Photographs of the X-ray image and the right hip joint of the patient (clinical case No. 1): a — control CT of the pelvic bones with hip joints 3 months after surgery, hip joint endoprosthesis and titanium acetabular; b — general view of the proximal femur after surgery with active flexion in the hip joint.

a fracture of the femoral head and neck and a comminuted fracture of the acetabulum floor with displacement, along with damage to the sciatic nerve.

After PST of the wound, the left hip joint was stabilized with a rod EFD "pelvis-femur" according to the damage control principles. After wound healing, the EFD was removed, and the left hip joint was fixed with a circular hip brace. Because of the infection risk, THR was postponed initially, but the procedure was performed 23 months after the injury.

27 months after the injury, the patient still had sciatic neuropathy and contracture of the left knee, significantly impairing the support function of the lower limb. 6 months after the THR, the patient had 36 points on the HHS, indicating a poor treatment outcome.

Clinical Case No. 4

A 47-year-old patient with a combined gunshot shrapnel penetrating injury to the abdomen and contusion of the extraperitoneal portion of the sigmoid colon, fracture of the left ilium and acetabulum with the presence of a foreign body (metallic shrapnel) in the left sacroiliac joint. The following procedures were performed: PST of the wounds, laparocentesis with subsequent myoplasty of the left lateral abdominal wall according to the damage control principle. Nine months after the injury, THR was performed. According to the HHS, 24 months after the THR, the patient received 84 points, indicating a good treatment outcome.

Clinical Case No. 5

A 46-year-old male soldier sustained a combined gunshot shrapnel injury to the pelvis with a gunshot fracture of the femoral head and upper third of the right femur, a fracture of the right ilium with rectal injury, formation of a retroperitoneal hematoma on the right side, and fecal peritonitis. An urgent laparotomy was performed, including obturative resection of the colon, rectal repair, tamponade of the abdominal cavity, and fixation of the hip joint and pelvic bones with a rod EFD "pelvis-femur" according to the damage control principle. The patient was later transferred to medical institutions in western Ukraine. Three weeks later, the EFD was removed. Four months later, an antibacterial cement spacer was installed due to the development of an infection in the hip joint (*Pseudomonas aeruginosa, Klebsiella*). Due to prolonged bed rest (10 months), the patient developed pressure sores in the sacral area. Reconstruction was performed only in 2 years — restoring

the connection between the sigmoid and rectum with the formation of an ileostomy. Final reconstruction of the small intestine is planned. During the surgical interventions, the patient developed adhesion disease and, due to prolonged bed rest and inadequate rehabilitation, developed an extensor contracture of the knee joint. Two years after the injury, the patient received 32 points on the Harris Hip Score (HHS), indicating a poor treatment outcome. THR was not performed.

Clinical Case No. 6

A 30-year-old male patient with a combined gunshot shrapnel injury to the pelvis and extremities, with a comminuted fracture of the pubic and ischial bones, a dislocation of the femoral head, massive bone and soft tissue defects, traumatic amputation of the penis, left scrotal injury, and damage to both testicles. The following procedures were performed: PST of the left inguinal and gluteal wounds, resection of the hanging part of the penis, bilateral orchiectomy, placement of an epi-cystostomy; fixation of the upper third of the femur fragments using a rod EFD "pelvis-femur" according to the damage control principle. Nine months after the injury, the patient underwent THR. The patient continued to have urinary issues due to chronic prostatitis, along with the absence of part of the penis and testicles. According to the HHS, 7 months after the THR, the patient received 34 points, indicating a poor treatment outcome.

Clinical Case No. 7

A 37-year-old male soldier was hospitalized with a combined gunshot wound to the pelvis and extremities, with a complete rupture of the pendulous part of the urethra, comminuted fracture of the acetabulum, ischial and pubic bones on the right side, and marginal fracture of the femoral head along with the presence of a foreign body. The following procedures were performed: PST of the wounds, laparotomy, cystostomy, bladder revision, suturing of the wound in the pendulous part of the urethra on the catheter, epi-cystostomy with drainage of the paravesical space and pelvis, fixation of the pelvic bone fragments and the right femoral head with a rod EFD "pelvis-femur" according to the damage control principle. Later, the patient developed chronic post-traumatic osteomyelitis of the femoral head, complicated by phlegmon of the right hip joint and perineum. Three months after the injury, drainage of the phlegmon in the right hip joint and perineum was performed. After revision of the hip joint area, debridement, and placement of an antibacterial cement spacer with gentamicin and vancomycin, the patient developed complications in the right hip joint area (*Klebsiella pneumoniae and Staphylococcus epidermidis*). Only after removal of the spacer, repeated surgical treatments, and administration of a combination of linezolid 600 mg and co-trimoxazole (Biseptol 480 mg) for 6 weeks, the infectious process was controlled. According to the HHS, 12 months after the injury, the patient received 38 points, which indicates a poor treatment outcome. THR was not performed.

Statistical analysis showed that among 7 patients with an average age of 41.1 years, THR was performed in 5/7 (71 %). The average time to THR was approximately 17.0 months. Infectious complications were found in 4 out of 7 (57 %). The most common pathogens were *Klebsiella pneumoniae* (3), *Pseudomonas aeruginosa* (2); other pathogens included *Acinetobacter / A. baumannii, Staphylococcus epidermidis*, and *Candida krusei*. The average HHS for all patients was 50.3, for those with infections it was 49.5, and for those without infections it was 51.3. Based on the data, it was revealed that the high percentage of infections (57 %) and the dominance of Gram-negative flora (*Klebsiella, Pseudomonas, Acinetobacter*) requires a change in the treatment strategy, including early microbiological diagnostics, aggressive wound debridement, and targeted antibiotic therapy. Due to contamination (fecal, urogenital, or foreign bodies such as bullets, shrapnel) and massive defects, in some cases, delayed reconstruction or THR with a staged approach is advisable, which corresponds to current recommendations for post-traumatic and contaminated cases.

According to the literature, in the case of established infection or suspected sterility, a two-stage strategy (removal with intensive debridement using an antibacterial cement spacer, followed by reconstruction or THR after infection eradication) shows better results in controlling infection in several studies.

In all 4 patients studied, the presence of Gram-negative pathogens was found. In two of them, antibiotic spacers were used. Despite the use of antibiotic spacers, complete eradication of the infection was not achieved, and therefore THR was postponed due to the persistence of the microflora.

Given the high percentage of unsatisfactory treatment outcomes, there was a need to form a preliminary treatment algorithm for gunshot combined injuries of the hip joint based on our own research and the data from literature sources [17–21].

I. Initial measures (acute period):

1. ABC (resuscitation), hemostasis, shock control — damage control principles. Embolization or vascular reconstruction in pelvic hemorrhage;

2. Rapid multidisciplinary assessment (traumatologist, abdominal surgeon, urologist, infectious disease specialist);

3. Early and documented microbiological diagnosis, initiation of antibiotic therapy considering the risk of Gram-negative multi-resistant bacteria in combat injuries.

II. Surgical tactics in the acute period:

1. Radical surgical treatment, necrectomy, removal of foreign bodies;

2. Control of contamination sources (small and large intestine, rectum, urethra/urogenital tract);

3. Primary stabilization of the pelvis (external fixation according to damage control orthopedics);

4. Use of antibacterial spacers or VAC therapy for soft tissue and bone defects.

III. Planning of reconstruction or THR:

1. In the absence of infection and with stable soft tissues — delayed THR (after ≥ 6 months);

2. In the presence of infection or high risk — two-stage approach (sanitation, antibiotic spacer → THR);

3. In case of Gram-negative flora (Klebsiella, Pseudomonas, Acinetobacter) and multi-resistant flora, mandatory consultation with an infectious disease specialist and immunologist with the use of reserve antibiotics based on sensitivity, considering the potential presence of biofilm on implants.

IV. Orthopedic technical recommendations for THR after gunshot injury to the hip joint:

1. Preparedness for large bone defects: use modules for restoring acetabular defects (anti-protrusion rings, structural autografts/allografts, and in case of a large defect — additive technologies);

2. In case of neurological damage (sciatic nerve) — realistic expectations regarding function; consider special prostheses/limiting devices to reduce dislocations in conditions of weak muscles;

3. Planning for implantation with the involvement of a rehabilitation specialist — individual recovery program.

V. Postoperative control:

1. Regular clinical and laboratory monitoring: C-reactive protein, ESR, procalcitonin;

2. Aspiration if infection is suspected and mandatory microbiological testing;

3. Targeted antibiotic therapy based on culture results with mandatory consultation with an infectious disease specialist and immunologist;

4. Individual rehabilitation program.

Discussion

Gunshot combined injuries of the pelvis and hip joint are severe polystructural trauma, and the treatment outcome depends on timely, consistent, and adequate medical assistance at all levels; the degree of damage to the internal organs of the abdominal cavity and pelvic region, especially the small and large intestines; and the nature of the fracture of the bone structures involved in the formation of the hip joint.

Patients with pelvic bone fractures and hemodynamic instability present a complex challenge for the trauma team, as acute bone fragments resulting from pelvic ring injuries can tear surrounding soft tissues and cause severe bleeding. The most common sources of bleeding are the fracture surfaces and the retroperitoneal venous plexus; less frequently, damage occurs to the sciatic artery [22].

The group at risk also includes the hollow visceral organs of the abdominal cavity and pelvis, as well as the LV nerve root and lumbar plexus.

Pelvic bone fractures are often associated with other life-threatening injuries. The mortality rates among the civilian population range from 6 % to 35 %, with higher rates associated with open fractures [7, 23, 24].

High-velocity gunshot wounds (> 2000 ft/s) are characterized by more destructive effects on the musculoskeletal system, requiring more aggressive surgical intervention strategies, similar to open fractures resulting from blunt trauma [25–28].

Although hip and pelvic joint injuries are rare, their diagnosis and treatment remain complex, particularly in cases of blind combined injuries, where the entry wound is located not over the damaged joint but in another anatomical region [10].

The most challenging to treat are transabdominal gunshot wounds to the hip joint and pelvis, as they are accompanied by contamination (soiling) of these areas with bowel contents. This requires urgent surgical intervention for vascular, visceral, and urogenital injuries after achieving hemodynamic stability [11, 29–31].

There is a consensus in the literature regarding the removal of intra-articular bullets, which are in contact with synovial fluid, to avoid mechanical joint destruction, lead arthropathy, plumbism (systemic lead toxicity), and infection [20].

Bullets and metal fragments located within the bone without contact with synovial fluid do not require removal, but the risk of infection in this category of gunshot wounds is higher compared to gunshot fractures of the limbs [32–34].

In gunshot wounds to the abdomen, buttocks, or thighs, there should be a high suspicion of a transpelvic trajectory. It is important to note that the bullet's

path can be nonlinear with unpredictable trajectories due to its instability, ricochets, and fragments [20, 35].

P.H. Navsaria et al. defined the indications for laparotomy as: peritoneal signs, hemodynamic instability, rectal bleeding, or the inability to perform a reliable clinical examination. They suggested routine CT scans only for macroscopic hematuria. The percentage of non-operative treatment for transpelvic injuries was 26.4 %, with a minimum of 24 hours of careful monitoring. The frequency of therapeutic laparotomies in their study was 97.7 % [16].

According to foreign sources, the main recommendations for gunshot transpelvic injuries of the hip joint should include mandatory repeated intra- and postoperative sampling for microbial cultures and sensitivity testing, early removal of foreign fragments (if possible), and radical wound sanitation. Molecular methods (mNGS) can be helpful in cases of negative cultures or polymicrobial infections. Empirical therapy based on local resistance data should be conducted. In military cases, it is necessary to account for the high frequency of multidrug-resistant gram-negative strains [6, 32, 39, 40–43].

Such injuries are associated with a high percentage of unsatisfactory treatment outcomes due to the development of infectious complications, lack of adequate surgical intervention, and, given the deep location of the hip joint, the development of contractures in adjacent joints due to the absence of timely and appropriate rehabilitation. Other complications may include adhesive disease, formation of bowel and bladder fistulas in case of damage to these organs, pressure ulcers, and deep vein thrombosis of the lower extremities due to prolonged bed rest and lack of preventive measures, as well as cosmetic and functional changes in the genital organs.

The use of damage control surgery in patients with gunshot wounds to the hip joint should be strictly individualized, as the high risk of infectious complications does not allow for a predictable good outcome. Emphasis should be placed on wound sanitation, controlled stabilization, a staged approach, and delayed reconstruction.

This category of patients should be treated in multidisciplinary healthcare institutions of the Ministry of Defense and the Ministry of Health of Ukraine, where all diagnostic and therapeutic equipment is available, and surgeons with a high level of expertise and experience in treating severe combined combat trauma are present. These institutions should also ensure timely medical and social rehabilitation.

Conclusions

Combined gunshot wounds of the hip joint with concomitant damage to the internal organs of the abdominal cavity and pelvic region are complex both diagnostically and therapeutically, characterized by a high risk of complications and significant deterioration in the quality of life in the future.

Based on statistical analysis, it was established that, among 7 patients with an average age of 41.1 years, damage control surgery was performed in 5 out of 7 (71 %). The average time to damage control surgery was 17 months. Infectious complications were observed in 5% of the patients, with *Klebsiella pneumoniae* and *Pseudomonas aeruginosa* being the predominant contaminants.

The implementation of damage control surgery in this category of patients requires an extremely cautious approach. The obtained results indicate the need for further clinical studies to determine the optimal criteria for indications for damage control surgery after combat-related injuries of the hip joint.

Conflict of Interest. The authors declare no conflict of interest.

Prospects for Further Research. It can be expected that the use of the proposed preliminary treatment algorithm for gunshot combined injuries of the hip joint could potentially reduce the incidence of infectious complications, but this needs to be confirmed by further clinical studies.

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FEATURES OF SURGICAL TREATMENT OF COMBINED GUNSHOT WOUNDS OF THE HIP JOINT

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