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Acetabulum fractures. Analysis of treatment results

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Treatment of patients with acetabulum fractures (AF) remains a big challenge for orthopaedists and traumatologists. Such fractures are known for their complications that lead to disability. Objective. To analyze the results of treatment of patients with AF and complications that arise depending on the of the injury mechanism and the method of treatment, to evaluate the effectiveness available methods of preventing the development of these complications. Methods. A retrospective study was done on the basis of 89 AF patients analysis (age 17–75 years, 22 women and 67 men) with different terms after the fracture. The majority of patients got primary care in other clinics. Diagnostic measures: clinical examination; X-ray examination of the pelvis, that under conditions of acute injuries were supplemented with CT scan; ultrasound of abdominal cavity, chest X-ray, brain MRI, electroneuromyography of the lower limbs. Results. Most AF occurred as a result of traffic accidents. The most common types are A1 and B1 according to the classification of AO/ASIF. The system of skeletal traction has been applied often at the stage of primary treatment. During surgical treatment the Kocher-Langenbeck approach and osteosynthesis was mainly used to stabilize the posterior wall and acetabulum column. The typical complications of AF are coxarthrosis, femoral head aseptic necrosis despite the chosen treatment tactics. Their clinical manifestation with the hip impaired function occurred within a year after the trauma. Defined complications led to the need for total hip replacement in 67 (75.3 %) cases out of 89. In 8 patients, total hip replacement was performed in the acute period of injury and it was possible to restore the joint function with better early functional results compared to the rest of the patients. Conclusions. Primary total hip replacement in the case of AF is an effective treatment measure that gives the possibility restore the function of the hip joint in the shortest time and prevent the development of typical complications.

Лікування пацієнтів із переломами кульшової западини (КЗ) залишається складним завданням для ортопедів-травматологів. Такі переломи відомі своїми небезпечними ускладненнями та наслідками, які призводять до інвалідизації. Мета. Проаналізувати результати лікування пацієнтів із переломами КЗ та ускладнення, які виникають залежно від характеру травми і способу лікування, оцінити ефективність наявних методів запобігання розвитку цих ускладнень. Методи. Ретроспективне дослідження здійснено на підставі аналізу історій хвороби 89 пацієнтів (вік 17–75 років, 22 жінки та 67 чоловіків) із переломами КЗ у різні терміни після травми. Первинне лікування більшість осіб одержала в інших установах. Діагностичні заходи: клінічне обстеження; оглядова рентгенографія таза, яку за умов гострої травми доповнювали КТ-обстеженням; за показаннями — УЗД черевної порожнини, рентгенографія грудної клітки, МРТ головного мозку, електронейроміографія кінцівок. Результати. Більшість переломів КЗ виникло внаслідок ДТП. Найпоширеніші типи — А1 і В1 за класифікацією АО/АСІФ. Систему скелетного витягнення застосовано частіше на етапі первинного лікування. Під час хірургічного втручання використано переважно доступ Кохера-Лангенбека й остеосинтез для стабілізації задньої стінки та колони КЗ. Незважаючи на обрану лікувальну тактику, виявлено типові для переломів КЗ ускладнення — коксартроз, асептичний некроз головки стегнової кістки. Їхня клінічна маніфестація з порушенням функції кульшового суглоба відбувалася протягом року після травми. Визначені ускладнення привели до необхідності ендопротезування в 67 (75,3 %) випадках із 89. У 8 пацієнтів проведено первинне ендопротезування в гострому періоді травми, що дозволило швидше відновити функцію суглоба з ліпшими функціональними результатами порівняно з рештою постраждалих. Висновки. Первинне ендопротезування в разі переломів КЗ є ефективним лікувальним заходом, який дає змогу відновити функцію кульшового суглоба в найкоротший термін і попередити розвиток типових ускладнень. Ключові слова. Переломи кульшової западини, остеосинтез, первинне ендопротезування, післятравматичний коксартроз.

Key words. Acetabulum fractures, osteosynthesis, primary total hip replacement, posttraumatic coxarthrosis

Introduction

Fractures of the acetabulum have always been a complex, not fully resolved problem with which most orthopedic traumatologists have to work today. More often, fractures of the acetabulum are the result of high-energy trauma resulting from a road traffic accident, catatrauma, and are usually a component of polytrauma [1, 2]. Over the past 30 years, there has been a trend toward an increase in the number of low-energy, isolated fractures of the acetabulum secondary to systemic osteoporosis among the elderly [3].

Hip fractures are known for their consequences with impaired function of the hip joint, which, despite the entire arsenal of modern medical measures, lead to disability in 73–88 % of cases [4]. At the same time, the recently published findings of N. Ziran et al. [5] presented a series of observations involving 492 and 816 patients who underwent open reduction and metallo-osteosynthesis (MOS) of acetabular fragments. In the first group, 80 % outcomes were good and excellent (according to the modified scale of Merle d'Aubigne and Postel), in the second, twenty-year survival of the hip joint was established in 79 % of people, which proves the decisive influence of the quality and timeliness of repositioning on the clinical outcome of treatment. Such a discrepancy in results indicates the different effectiveness of approaches to the treatment of acetabular fractures.

Establishment of the ways to improve treatment outcomes in hip fractures requires a thorough analysis of the currently most common surgical techniques, taking into account possible consequences and complications.

Purpose: to analyze the results of treatment of patients with hip fractures and their complications, depending on the nature of the injury and the method of treatment, to evaluate the effectiveness of existing methods of preventing the development of these complications.

Material and methods

The materials of the study were reviewed at the meeting of the Bioethics Committee at the State Institution «Professor M. I. Sytenko Institute of Spine and Joint Pathology of the National Academy of Sci-

ences of Ukraine» and a positive decision was received (Protocol No. 197 of 28.10.2019).

A retrospective study was carried out on the basis of the analysis of the medical histories of 89 patients with hip fractures at different times after the injury, who were treated in the department of emergency traumatology and reconstructive surgery and orthopedic arthrology of the State Institution «Professor M. I. Sytenko Institute of Spine and Joint Pathology of the National Academy of Sciences of Ukraine». The age of the patients ranged from 17 to 75 years, there were 22 (24.7 %) women, 67 (75.3 %) men (Table 1). The majority of people received primary treatment in other institutions at different times after the injury.

Among the examined, the majority, 79 (88.7 %) persons, were injured as a result of a traffic accident, 9 (10.1 %) cases as a result of falling from a height, 1 (1.1 %) at work (crushed by a tractor). Patients with abnormal fractures of the acetabulum, occurring secondary to a sharp decrease in the density of bone tissue due to osteoporosis or tumor lesions, were excluded from the study.

All patients at the diagnostic stage after a clinical examination underwent a pelvic X-ray examination, which in case of acute injury was supplemented with a CT examination [6]. In concomitant injuries, abdominal ultrasound, chest x-ray, brain MRI, and limb electroneuromyography were performed according to indications. The most common injuries that accompanied hip fractures and could theoretically affect the final result of treatment were identified, namely: hip dislocation, pelvic ring damage, fractures/cartilage defects of the femoral head, closed chest or abdominal trauma, fractures of other parts of the skeleton, primary post-traumatic neuropathy of the sciatic nerve [7].

Fractures of the acetabulum were assessed according to the AO/ASIF classification, which is based on the concept of its two-column structure and takes into account the degree of damage to the articular surface [8].

Considering that the majority of patients were injured as a result of a road accident, the predominance of type A1 and B1 fractures in the overall structure was logical (Fig. 1).

Table 1

Distribution of patients by gender and age

Age group (years)	15–24		25–54		55–64		65 and more		Total	
	m	f	m	f	m	f	m	f	m	f
Number	7	—	46	18	14	4	2	—	67	22

Table 2

Distribution of the main types of concomitant injuries in different types of fractures

Type of fracture according to AO/ASIF	Concomitant damage						
	Dislocation of the femoral head	Pelvic ring fracture	Fracture/cartilage defect of the femoral head	Thoraco-abdominal injury	TBI	Skeletal trauma	Neuropathy of the sciatic nerve
A1	43	—	9	3	2	5	3
A1.2	3	—	1	—	—	—	—
A2	2	—	—	—	—	—	1
B1.2	9	1	—	—	—	—	—
B1.2b	15	1	7	—	2	1	3
B2.2 b	3	—	—	—	—	1	1
B2.3c	1	—	—	1	—	1	1
B3.2	—	—	—	—	—	—	—
B3.3	—	—	—	—	—	—	—
C	1	2	—	1	—	1	—

The main methods of treatment were as follows: skeletal extraction, open repositioning of fragments of the acetabulum and osteosynthesis with various types of fixators, closed or open removal of dislocation of the femoral head with subsequent plaster fixation, total hip arthroplasty (THA). To evaluate the effectiveness of a certain technique, complications that occurred at different times after the treatment of hip fractures were taken into account, and approaches to their elimination were analyzed. The functional state of the affected hip joint was analyzed according to the rating scale of Merle d'Aubigne and Postel (considering such parameters as pain, range of motion and ability to move) in points from 1 to 6: 1 is the worst result, 6 is the excellent one. The average indicator was calculated [9].

Results and their discussion

The study showed that the average age of patients was 42.3 years, the absolute majority of 46 (51.68 %) were men of working age from 25 to 54 years,

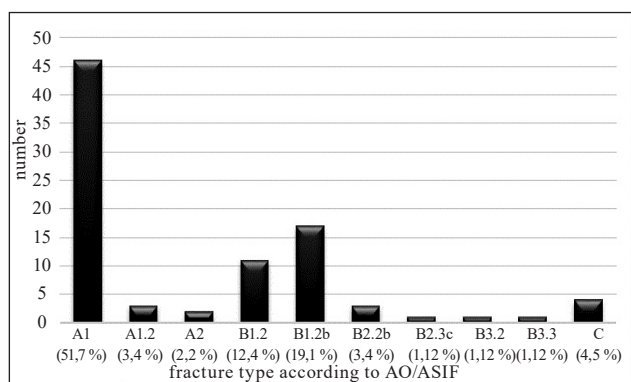


Fig. 1. Diagram of the distribution of patients by type of hip fracture according to the AO/ASIF classification

which emphasizes the socio-economic significance of the problem. The mechanisms of injury were predominated by traffic accidents — 79 (88.7 %), which is absolutely typical for the fast pace of life in most megacities. Taking into account the predominance of this mechanism of injury, dividing the patients by the type of fracture of the acetabulum, the absolute predominance of fractures of type A (57.3 %) and B (38.2 %) was shown, occurring under the action of the impulse transmitted indirectly (through the femur and its head). Such fractures are typical for drivers and passengers in the front car seat, mostly spread to the back wall or column of the acetabulum, and can also be transverse in orientation, usually accompanied by a posterior or central dislocation of the femoral head. Fractures of the acetabulum, as a result of high-energy trauma, are accompanied by concomitant injuries that affect the choice of tactics, determine the stages of treatment and determine the final result. In total, femoral head dislocation was found in 77 (86.5 %) cases, pelvic ring fractures in 4 (4.5 %), femoral head cartilage fractures or defects in 17 (19.01 %), thoraco-abdominal trauma in 6 (5.6 %), traumatic brain injury (TBI) with varying degrees of residual neurological deficit in 4 (4.5 %), multiple skeletal injuries in 9 (10.1 %), post-traumatic neuropathy of the sciatic nerve in 9 (10.1 %) (Table 2).

It should be noted that femoral head injuries, the impact of which on the development of secondary changes in the hip joint is difficult to overestimate, were mostly identified in the group of patients with fractures of type A1 and B1.2b among them, the frequency of hip dislocations was the highest. Femoral head injuries are often diagnosed during intraoperative findings, when changing the intervention plan

is technically impossible. In our opinion, dislocation of the femur should be considered as a predictor of possible damage to the head, the condition of which should be given special attention even at the stage of diagnosis. In particular, out of 77 patients with dislocations of the femur secondary to hip fracture, aseptic necrosis of the femoral head did not develop in only 8 (10.4%) cases [6, 10, 11].

During the analysis of the treatment methods that were applied, attention was focused on those aimed directly at the fracture of the acetabulum and carried out from the first days after the injury (Table 3).

The method of skeletal extraction was preferred more often, both independently and as part of staged treatment (reposition of fragments, reduction of dislocation of the femur, maintenance of the achieved reposition and congruence of the joint before further surgical intervention). The subgroup «others» included 2 patients who had to undergo open removal of hip dislocation in the course of treatment with the help of a permanent skeletal traction system. The average duration of permanent skeletal stretching on its own was 42 days, 21 days before another treatment. Studying each case in detail, we were convinced that the expediency of using various medical measures after skeletal extraction is mostly justified by its failure, unacceptable displacement of fragments, or recurrence of hip dislocation. This may indicate an incorrect assessment of the severity of the injury and an overestimation of the universality and effectiveness of this method.

Open reposition of fragments of the acetabulum with MOS was performed for type A and B fractures both initially and after skeletal extraction. It comprised fixing a fragment of the back edge or column of the acetabulum with plates and screws. Most often, it involved Kocher-Langenbeck posterior access, which did not make it possible to carry out anatomical reposition of fragments, especially in cases of delayed surgical interventions after trauma. The analysis of postoperative X-rays and the development of coxarthrosis in the early period after surgery clearly confirmed this. A less common intervention (2 cases) was fixation of the anterior column of the acetabulum with a plate and ceramodesis of the sacroiliac junction through anterior approaches. For the most part, the quality of repositioning and the reliability

of fixation, especially in the areas of the medial wall of the acetabulum, the quadrilateral surface, and the anterior column, left much to be desired. This situation, in our opinion, indicated a lack of experience among surgeons in the use of anterior intrapelvic approaches to the acetabulum (Stoppa, iliac-inguinal) and a lack of specific pelvic instrumentation for effective repositioning maneuvers.

In 8 cases, due to the nature of the damage to the acetabulum, its successful reconstruction and satisfactory function of the hip joint were impossible, and primary TEX was required. On average, the observation period before endoprosthetic repair was 17 days. Such a period is necessary for monitoring and treatment of accompanying injuries, however, some time was spent on remote consultations and organization of transfer to Professor M. I. Sytenko Institute, where endoprosthetic repair was performed. During the entire stay in other medical institutions, the patients underwent constant skeletal traction, which most likely had the character of a disciplinary measure and did not significantly affect the treatment tactics. In one case, the patient came to the institute immediately after the injury, and skeletal traction was not applied to him before endoprosthetic repair.

A clinical example

A 36-year-old patient Kh. was injured in a traffic accident (collision of cars, a driver). He was hospitalized by an emergency medical team 2 hours after the injury with pain in the left hip joint, impaired function.

An X-ray of the thoracic organs and skull in two projections, a survey X-ray of the pelvis (Fig. 2, a), and an ultrasound of the abdominal cavity were performed. To clarify the nature of the damage to the left acetabulum, a CT scan of the pelvis was performed (Fig. 2, b). The diagnosis was as follows: fragmentary fracture of the left acetabulum with a transverse component and transition to the body of the iliac bone 62 B3.2 according to the AO/ASIF classification. The fracture had a multifragmentary nature, a significant zone of fragmentation of the medial wall; the transverse component of the fracture was located in the loading zone, a fracture of the body of the iliac bone with a violation of the integrity of the anterior column (Fig. 2). The prospects of restoring the congruence of the acetabulum with its stable fixation were

Table 3

Distribution of patients by treatment method

MOS	THA	Skeletal extension	Open dislocation reduction, plaster fixation	Closed dislocation reduction, plaster fixation	Drug therapy	Other
36	8	37	2	1	1	4

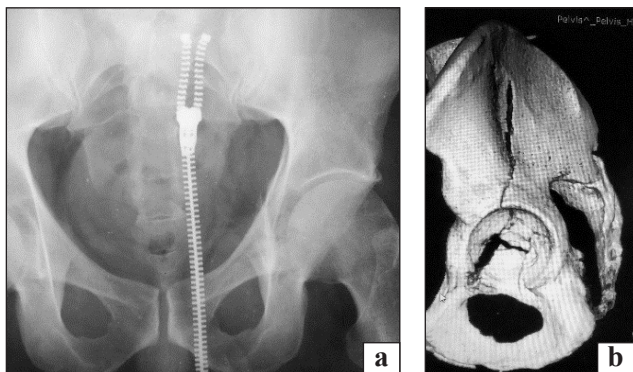


Fig. 2. A 36-year-old patient Kh., fragmentary fracture of the left acetabulum with a transverse component and transition to the body of the iliac bone 62 B3.2 according to AO/ASIF: a) radiogram; b) CT scan of the pelvis (3D reconstruction)



Fig. 3. X-ray of the left hip joint of a 36-year-old patient Kh. after surgery



Fig. 4. A 36-year-old patient Kh., functional result 4 weeks after osteosynthesis and endoprosthetic repair

considered doubtful. Taking into account the serious nature of the injury, the inevitable rapid development of secondary degenerative changes in the joint, the patient's desire to restore its full function as soon as possible, a decision was made to perform THA. Seven days after the injury, the patient underwent cementless THA of the left hip joint, bone autoplasty of the medial wall of the acetabulum with autografts from the femoral head, stabilization of the anterior column of the acetabulum, the body of the iliac bone with plates (Fig. 3).

Standard antibiotic prophylaxis, anticoagulant and analgesic therapy were used in the postoperative period. The patient was upright on the second day after the operation, on the fourth day he started walking with the help of a walker. On the seventh day, due to local limited muscle necrosis in the area of the postoperative wound, its revision and necrectomy were performed. Restorative rehabilitation therapy was carried out without changes to the general plan of measures. The postoperative wound healed, the function of walking without additional support was restored 4 weeks after endoprosthetic repair (Fig. 4).

This tactic of treating hip fractures required employment of endoprostheses of the cementless type

of fixation. When choosing the acetabular component of the endoprosthesis, preference was given to cups with a trabecular coating structure to form a stronger union with the bone in a smaller contact area.

Primary press-fit fixation of the endoprosthesis cup was supplemented with polyaxial fixation with screws through holes in the latter. In optimal planning of the trajectory of the screws, in our opinion, the cup of the endoprosthesis performs the function of a hemispherical fixing plate, which is extremely appropriate for certain types of fractures. In some cases, to achieve the necessary stability and increase the area of contact with the bone during fixation of the cup, additional stabilization of the acetabulum fragments with plates and screws was performed. In the presence of defects of the medial wall of the acetabulum, autoosseous replacement was performed. Autografts were obtained from the femoral head. Rehabilitation and restorative treatment was carried out in the same way as after a standard primary arthroplasty, with minor changes depending on the type of fracture and features of fixation of the acetabular component.

We analyzed the complications that occurred in the early and late periods after the treatment. At the time of the analysis, only 6 (6.7 %) cases did

not have complications that disturbed the function of the hip joint and reduced the quality of life of the patients. These were type A1 and B1 fractures in young people who were successfully treated with MOS plates as soon as possible after the injury.

In the remaining cases, at various times after the injury and treatment, certain complications were observed (Table 4).

The «restriction of movements» group included patients with the specified complication due to pain or muscle dysfunction. Ankylosis of the joint together with para-articular, heterotopic ossification was classified as «other». The «violation of congruence» group comprised cases of subluxations, fusion of bone fragments with unacceptable displacement, migration of metal structures with secondary displacement secondary to violation of the consolidation process. The obtained results confirm the postulate of E. Letournel (1964): timely surgical treatment with anatomical reposition and stable fixation significantly increases the survival of the joint [12]. The high rate of complications in the group of patients who underwent osteosynthesis makes us doubt the quality of its performance.

A hip joint destroyed by trauma inevitably undergoes secondary degenerative-dystrophic changes, mostly during the first year after the injury. At the current stage of the development of orthopedics, only THA allows the patient to return to the pain-free realization of the function of support and walking. In our observation, 62 (69.9 %) cases of acetabular fractures out of 89 resulted in THA due to critical destruction of the joint with complete loss of the ability to articulate and the development of secondary degenerative-dystrophic changes [13]. A two-stage approach to the restoration of joint function was partially implemented, namely: in the first stage, treat-

ment measures were aimed at consolidating the fracture and preserving natural bone tissue to create favorable conditions for endoprosthetic repair, and in the second stage, a total replacement of the hip joint was performed. The time interval from the moment of the injury to the clinical manifestation of complications that led to THA varied from 2 weeks to 30 years (34 weeks on average with a median of 6 months). Accordingly, the terms of endoprosthetic surgery also differed from 1 month up to 48 years after the injury (75 weeks on average, median 2 years) (Fig. 5).

Based on the analysis, it was determined that most of the complications and the need to perform THA occurred during the first year after the injury, often before full verticalization and restoration of bearing capacity. With the aim of restoring the function of the hip joint, the treatment of a patient with a hip fracture can be considered complete only after arthroplasty. Thus, the treatment process is prolonged for about 1.5 years, which has obvious negative socio-economic consequences. The lack of adequate joint function during this time leads to degenerative-dystrophic changes in the muscles and the capsule-ligament complex of the hip joint, which subsequently significantly worsens the functional result after endoprosthesis. Based on these considerations, in 8 cases primary THA was performed during the acute period of the injury, which made it possible to restore the function of the joint and the working capacity of the patients within the periods not exceeding 3 months after an injury.

Treatment outcomes were evaluated using the rating scale of M. D'Aubigne and M. Postel [9] (Table 5).

Analyzing the current functional treatment outcomes, all patients were conditionally divided into groups taking into account the performed THA due to complications in 62 (69.9 %) cases out of 89.

Table 4

Distribution of the most common complications depending on the method of treatment

Complication	Method of treatment							Total (n = 89)
	MOS (n = 36)	Skeletal extension (n = 37)	THA (n = 8)	Open dislocation reduction, plaster fixation (n = 2)	Closed dislocation reduction, plaster fixation (n = 1)	Drug therapy (n = 1)	Other (n = 4)	
Pain	28 (77 %)	35 (94 %)	2 (25 %)	1 (50 %)	1 (100 %)	1 (100 %)	4 (100 %)	72 (80.1 %)
Movement restrictions	14 (39 %)	18 (49 %)	1 (12,5 %)	1 (50 %)	1 (100 %)	1 (100 %)	3 (75 %)	39 (43.8 %)
Aseptic necrosis	27 (75 %)	33 (89 %)	—	1 (50 %)	1 (100 %)	1 (100 %)	4 (100 %)	67 (75.2 %)
Coxarthrosis	16 (44 %)	18 (49 %)	—	1 (50 %)	1 (100 %)	1 (100 %)	4 (100 %)	41 (46.1 %)
Violation of congruence	12 (33 %)	17 (46 %)	—	—	—	—	1 (25 %)	30 (33.7 %)
Other	8 (22 %)	12 (32 %)	—	—	—	—	4 (100 %)	24 (27 %)

Table 5

The average score according to M. D'Aubigne and M. Postel scale depending on the treatment

Method of treatment	THA after surgical treatment	THA after conservative treatment	Surgical treatment	Conservative treatment	Primary THA
Number	34	28	16	3	8
Average score	4.27	4.61	3.60	2.70	5.00

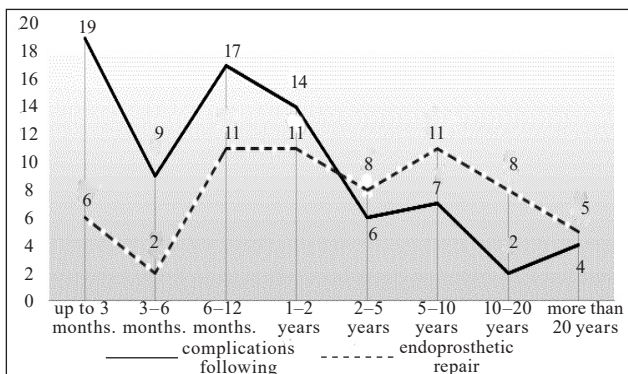


Fig. 5. Distribution diagram of the number of complications and endoprosthetic operations over time

Attention was drawn to a somewhat better result in the group of patients who were treated conservatively (taking into account skeletal extension) with fracture and underwent endoprosthesis due to complications, compared to those who underwent surgical interventions before THA. This can be explained by technical difficulties during endoprosthetic repair of a previously operated joint and certain functional disorders in dystrophically changed para-articular tissues and muscles of the hip joint. Obviously, today endoprosthetic repair is an indispensable tool in the arsenal of treatment measures in the case of fractures of the acetabulum. Of course, this intervention involves a complex of specific complications, which certainly occurred among the analyzed cases and affected the final result. The analysis of such complications requires separate attention. Insufficient results of organ-sparing tactics indicate the need to master modern methods of osteosynthesis with proper technical support and their differentiated application along with the implementation of current trends in functional therapy.

Conclusions

Today, hip fractures mostly occur as a result of traffic accidents, with the incidence prevailing among men of working age, which indicates the socio-economic significance of their effective treatment.

The most common fractures are type A1 and B1.2b according to the AO/ASIF classification. Fractures are quite often accompanied by concomitant injuries, which affects the stage and timing of treatment (thoraco-abdominal injuries) or the outcome of treat-

ment (dislocations, fractures of the femoral head, sciatic nerve damage, TBI with persistent neurological deficit). The study showed that aseptic necrosis of the femoral head occurred more often among patients with hip dislocation than in an isolated acetabular fracture.

CT imaging traditionally ranks high in diagnosis, providing an optimal assess to the configuration of the fracture and a possibility to plan the treatment.

Among the applied methods of treatment in our observation, skeletal traction was most frequently used as an independent treatment measure.

Osteosynthesis was mainly performed using the Kocher-Langenbeck approach, the use of which makes it impossible to provide anatomic reposition and fixation of fragments in certain types of fractures, which partially explains the large number of complications after MOS, namely: aseptic necrosis of the femoral head, coxarthrosis, subluxations, non-union or false union of the fracture.

The clinical manifestation of complications occurs in the first year after the injury. In the study, complications had to be managed by endoprosthetic surgery in 67 (75.3 %) of 89 cases and in 62 (69.7 %) patients. Refusal from THA in 5 cases was related to socio-economic factors or the presence of medical contraindications. In 8 cases, primary THA was performed in the acute period of the injury, which allowed to restore the function of the joint within the period not exceeding 3 months after the accident. The best functional results were recorded among these patients.

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

References

1. Epidemiology of pelvic and acetabular fractures in France / E. Melhem, G. Riouallon, K. Habboubi [et al.] // *Orthopaedics & Traumatology, Surgery & Research.* — 2020. — Vol. 106 (5). — P. 831–839. — DOI: 10.1016/j.otsr.2019.11.019.
2. Outcomes of total hip arthroplasty after acetabular open reduction and internal fixation in the elderly-acute vs delayed total hip arthroplasty / G. M. Nicol, E. B. Sanders, P. R. Kim [et al.] // *The Journal of Arthroplasty.* — 2021. — Vol. 36 (2). — P. 605–611. — DOI: 10.1016/j.arth.2020.08.022.
3. Acetabular fractures in elderly patients: a comparative study of low-energy versus high-energy injuries / J. W. Kim, B. Herbert, J. Hao [et al.] // *International Orthopaedics.* — 2015. — Vol. 39. — P. 1175–1179. — DOI: 10.1007/s00264-015-2711-0.

4. Zhigun A. I. Consequences of acetabulum fractures: prediction, diagnostics, treatment (clinico-experimental research) [Naslidky perelomiv kul'shovoyi zapadyny: prohnozuvannya, diahnozyka, likuvannya (kliniko-eksperymentalne doslidzhen-nya)]: Tesis ... doctor of medical sciences / A. I. Zhigun. — Kharkiv, 2010. — 307 p. (in Russian)
5. Ziran N. Outcomes after surgical treatment of acetabular fractures: a review / N. Ziran, G. Soles, J. M. Matta // *Patient Safety in Surgery*. — 2019. — Vol. 13. — Article ID: 16. — DOI: 10.1186/s13037-019-0196-2.
6. Femoral head subchondral impaction on CT: what does it mean in patients with acetabular fracture? / P. A. Poletti, M. Sahin, R. Peter [et al.] // *Skeletal Radiology*. — 2019. — Vol. 48 (6). — P. 939–948. — DOI: 10.1007/s00256-018-3100-8.
7. Iatrogenic nerve injury in acetabular fracture surgery: a comparison of monitored and unmonitored procedures / G. J. Haidukewych, J. Scaduto, D. Herscovici [et al.] // *Journal of Orthopaedic Trauma*. — 2002. — Vol. 16 (5). — P. 297–301. — DOI: 10.1097/00005131-200205000-00002.
8. Fractures of the pelvis and acetabulum: Principles methods of management / M. Tile, D. L. Helfet, J. F. Kellam, M. Vrahas. — 4th edition. — Thieme: AO Foundation, 2015. — 978 p.
9. Evaluation of the reliability of the modified Merle d'Aubigné and Postel Method / Fernanda Kazue Ugino, Carolina Moraes Righetti, Débora Pinheiro Lédio Alves [et al.] // *Acta Ortopédica Brasileira*. — 2012. — Vol. 20 (4). — P. 213–217. — DOI: 10.1590/S1413-78522012000400004.
10. Size and location of posterior wall fragment on CT can predict hip instability in a cadaveric model / T. Apivatthakakul, J. L. Kerner, S. Luangsod [et al.] // *Injury*. — 2021. — Vol. 52 (8). — P. 2104–2110. — DOI: 10.1016/j.injury.2021.03.041.
11. Contributions of the capsule and labrum to hip mechanics in the context of hip microinstability / A. M. Johannsen, L. Ejnisman, A. W. Behn [et al.] // *Orthopaedic journal of sports medicine*. — 2019. — Vol. 7 (12). — Article ID: 2325967119890846. — DOI: 10.1177/2325967119890846.
12. Judet R. Fractures of the acetabulum: classification and surgical approaches for open reduction. Preliminary report / R. Judet, J. Judet, E. Letournel // *The Journal of Bone and Joint Surgery. American volume*. — 1964. — Vol. 46. — P. 1615–1646. — DOI: 10.2106/00004623-196446080-00001.
13. Functional outcomes of elderly patients with nonoperatively treated acetabular fractures that meet operative criteria / S. P. Ryan, T. T. Manson, M. F. Sciadini [et al.] // *Journal of Orthopaedic Trauma*. — 2017. — Vol. 31 (12). — P. 644–649. — DOI: 10.1097/BOT.0000000000000990.

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ACETABULUM FRACTURES. ANALYSIS OF TREATMENT RESULTS

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