Genij Ortopedii. 2023;29(2):137-147.

Original article

https://doi.org/10.18019/1028-4427-2023-29-2-137-147

Surgical outcomes of patients with acetabular fractures and quadrilateral plate involvement

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Abstract

Background Open reduction and internal fixation (ORIF) remain the standard method of treating acetabular fractures. Many authors report poor results in quadrilateral plate fractures of the acetabulum with the use of ORIF. **The objective** was to evaluate outcomes of quadrilateral plate fractures of the acetabulum. **Material and methods** Surgical outcomes of 55 patients with quadrilateral plate fractures of the acetabulum were retrospectively reviewed between 2009 and 2019. Early postoperative results were followed up in 55 patients. Surgical treatment was provided for 32 (58.2 %) control patients with acetabular fractures and 23 patients (41.8 %) with quadrilateral plate fractures of the acetabulum in the main group. Long-term results were explored in 45 patients aged 18 to 60 years with acetabular fractures (control group, n = 24) and in combination with quadrilateral plate involvement (main group, n = 21). **Results** Surgical interventions were performed by one team consisting of the same specialists. Surgical outcomes in both clinical groups were evaluated according to 11 criteria. **Discussion** The results of surgical treatment of acetabular fractures and quadrilateral plate involvement were associated with the negative impact of quadrilateral plate involvement on the duration and volume of blood loss, intraoperative and late complications and dynamics in the development of post-traumatic hip arthrosis. The results obtained were comparable with the data of the citation sources. **Conclusion** A comparative analysis of the outcomes suggested a negative impact of quadrilateral plate involvement on the results of surgical treatment and an objective necessity to rank quadrilateral plate fractures of the acetabulum as a risk factor for adverse outcomes with ORIF.

Keywords: quadrilateral plate fractures of the acetabulum, open reduction and internal fixation (ORIF), complications of ORIF

For citation: Donchenko S.V., Kolesnik A.I., Surikov V.V., Ivanov D.A., Tarasov E.P., Yarmamedov D.M., Solodilov I.M. Surgical outcomes of patients with acetabular fractures and quadrilateral plate involvement. *Genij Ortopedii*. 2023;29(2):1137-147. doi: 10.18019/1028-4427-2023-29-2-137-147

INTRODUCTION

Surgical outcomes of patients with acetabular fractures (AF) show that quadrilateral plate (QLP) involvement is common, in elderly patients, in particular, and the reduction and fixation is technically challenging [1, 2]. G.Y. Laflame et al. (2011) report that conventional plating with screws fails to provide sufficient stability with a high risk of adverse events, and more advanced plates are offered to avoid urgent primary arthroplasty (UPA) of the hip joint (HJ) [3]. QLP injuries are rarely reported in patients with acetabular fractures [4-8] with a brief description of the QLP anatomy [9, 10] and fixation methods for the fractures [3, 11-15]. Acetabular and QLP fractures can be optimized through Combined Hip Procedure (CHP) [16]. Original fixators are developed for acetabular and QLP fractures [9]. T.A. Ferguson et al. (2010) consider acetabular fractures as a prognostic factor for a poor outcome after open reduction and internal fixation (ORIF) [6]. S.P. Boelch et al. (2016) report that the use of ORIF in the repair of acetabular and QLP fractures results in hip arthrosis at 15 months [17]. The presence and nature of concomitant QLP fractures can significantly influence the surgical modality used for repair of acetabular fractures [11, 13, 18-21]. A combination of ORIF and urgent primary hip arthroplasty is considered for patients with acetabular and QLP fractures [8, 11, 18, 22, 23]. D.C. Mears and M. Shirahama (1998) reported preliminary use of wire cerclage to be followed by PA of the hip joint in patients with acetabular and QLP fractures [24]. Acetabular fractures in combination with QLP injuries present great difficulties in surgical treatment due to complexity of high-quality fracture repair and QLP fixation. Some authors report associations between poor results with ORIF used for repair of acetabular fractures and restoration of the QLP [17].

Classifications of R. Judet and E. Letournel, AOOTA are commonly used to characterize pelvic and

acetabular fractures [25-30]. B.A. Butler et al. (2019) report the fundamental significance and hidden potential of the R. Judet, J. Judet and E. Letournel classification in terms of modernization. The classification can be modified for acetabular fractures in the elderly [26]. Emile Letournel (1980), the founder of the classification indicates that it can be modified for acetabular fractures in the elderly [7]. We were unable to find a detailed description of the characteristics of QLP fractures in Russian and foreign studies.

The **purpose** of the study was to evaluate surgical outcomes of patients with acetabular and QLP fractures.

MATERIAL AND METHODS

Design of the study. A monocenter cohort retrospective study of surgical outcomes of patients with acetabular and acetabular fractures combined with QLP injuries was performed. Inclusion criteria included age from 18 to 70 years and older, closed displaced acetabular fractures including those with quadrilateral plate injuries, the time between injury and surgical intervention of less than 3 weeks, the patient's consent to participate in a strict observation protocol and rehabilitation. Exclusion criteria included conservative treatment, chronic infection in the acute stage, severe comorbid pathology, polyvalent intolerance to antibiotics, open and pathological acetabular fractures, patients who refused surgery and refused to participate in a strict protocol of observation and rehabilitation. The study complied with the ethical standards of the local committee of the medical institution and 1975 Declaration of Helsinki, and the requirements of the Declaration of Helsinki as revised in 2013.

Early postoperative results were evaluated in all 55 patients. The main group included 23 (41.8 %) patients with acetabular fractures in combination with QLP injuries, the control group consisted of 32 (58.2 %) patients with acetabular fractures (Table 1). Long-term results were explored in 45 patients aged 18 to 60 years who sustained acetabular fractures in combination with QLP injuries (main group, n = 21) and acetabular fractures (control group, n = 24). The patients of both groups sustained high-energy injury during traffic accidents and falls from a height.

The operations were performed by leading specialists with more than 20 years of experience in the treatment of acetabular fractures. Acetabular fractures were classified in both groups according to R. Judet and E. Letournel. The algorithm of surgical treatment of the acetabular and QLP fractures included the use of a 3D image intensifier. The principle of the "iatrogenic zone" was used for fixation of QLP fractrures with screws being placed in the QLP through the front acetabular wall.

Statistical processing of the results was performed by calculating the arithmetic mean (M), standard deviation (δ), standard error of the arithmetic mean (m). The Mann-Whitney U-test was used to determine the statistically significant differences between groups using parameters of descriptive statistics (arithmetic mean, median, mode) and significant deviations from the Gaussian distribution curve. The significance level was used as the standard level for biomedical research with a probability of 95% ($p \leq 0.05$).

Clinical example of surgical treatment of a patient of the main group

A 36-year-old patient M. was treated at the S.P. Botkin hospital, the Moscow Health Department for closed displaced fracture of both columns of the left acetabulum and displaced QLP fracture, closed displaced fracture of pubic and ischial bones, closed fracture of the lateral mass of the sacrum on the left, comminuted displaced fracture of the wing of the left iliac bone, closed comminuted displaced transtrochanteric fracture of the left femur (the diagnosis is presented in a shortened version) (Fig. 1).

Table 1

Distribution of patients by sex and age

Description		Early postoperative results				Long-term outcomes			
		Main group		Control group		Main group		Control group	
		abs.	%	abs.	%	abs.	%	abs.	%
Males		13	56.5	18	56.2	11	52.4	13	54.2
Females		10	43.5	14	43.8	10	47.6	11	45.8
Age, years	18-30	7	30.4	5	15.6	3	14.3	7	29.2
	31-50	14	60.9	17	53.1	16	76.2	15	62.5
	51-60	2	8.7	6	18.8	2	9.5	2	8.3
	61-70			3	9.4				
	71 and over			1	3.1				
Total		23	100	32	100	21	100	24	100

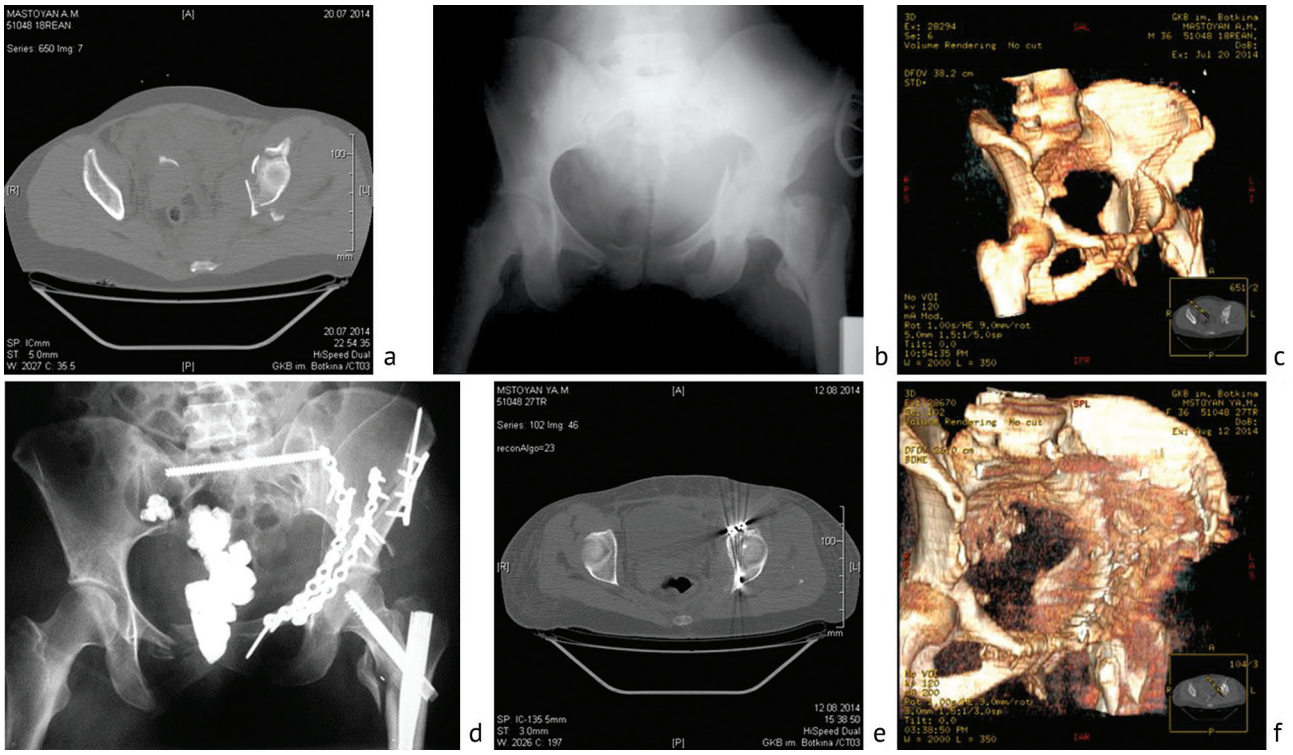

Fig. 1 Clinical instance: (*a*) CT scan of the injury in the anterior and posterior projections showing displaced fracture of both columns on the left, displaced fracture of the QLP; displaced fracture of both pubic and ischial bones on the right, a fracture of the lateral mass of the sacrum on the left; comminuted displaced fracture of the left iliac wing; (*b*) radiograph of the pelvis, displaced fracture of the QLP; (*c*) 3D reconstruction of fractured anterior column, a fracture of the QLP with transition to the anterior column and pubic bone; (*d*) AP and lateral view after ORIF of both columns and the iliac wing with reconstruction plates, fixation of the broken proximal femur with PFN and of the sacrum with a long cannulated screw; (*e*) axial CT scan of the pelvis after ORIF with fixation of both columns with reconstruction plates; (*f*) 3D reconstruction of the pelvis after ORIF of both columns using reconstruction plates

RESULTS

Surgical outcomes in both clinical groups were evaluated according to the following criteria:

- intraoperative complications of performing surgical accesses to the acetabulum and QLP;
- clinical and radiographic evaluation of the results (the quality of open reposition) according to the J.M. Matta criterion;
- surgical timing;
- duration of in-patient stay;
- intraoperative blood loss;
- late postoperative complications;
- dynamics of development of PTA stage 1-2;
- dynamics of development of PTA stage 2-3;
- functional results were evaluated with the d'Aubigne and Postel scales modified by J. Charnley (D'A-P) and according to W.H. Harris (HHS);
- repeated operations, THA;
- disability.

Analysis of Short-term Complications of Surgical Approaches to the Acetabulum and QLP

A combination of the Kocher-Langenbeck and ilioinguinal approaches was commonly used in both groups. A combination of Stoppa and Kocher-Langenbeck approaches, and a combination of Stoppa and ilioinguinal approaches were used with the same frequency. The table does not show the Kocher-Langenbeck access due to the absence of complications. There were 18 (78.3%) complications diagnosed in the main group, and 22 (68.8%) among controls (Table 2).

Clinical and radiographic evaluation of surgical outcomes

All patients were examined using five standard radiographs and CT scan of the pelvis. The average displacement of QLP fragments was 2.5 ± 11 mm (range, 2.5 to 65 mm). The reduction quality scores was different in the groups. There were more excellent and satisfactory results in the control group with more poor results noted in the main group (Table 3).

Analysis of surgical timing and intraoperative blood loss with surgical approaches used

Six types of surgical approaches were used in both clinical groups, presented in the corresponding clinical groups (Fig. 2 and 3).

Table 2

Complications at a short term

Complications	Main group (n = 23)							Control group (n = 32)						
	Acetabular approaches					Total		Approaches to acetabulum and QLP					Total	
	II	CL-II	St-KL	St-II	Stoppa	abs.	%	II	CL-II	St-KL	St-II	Stoppa	abs.	%
Partial damage to the obturator nerve		1				1	5.6		1				1	4.5
Damage to the branch of the external iliac vein	3					3	16.7		1		1		2	9.1
V/s screw location	1	1				2	11.1	1			1		2	9.1
Inadequate reduction	1	2	1	-	1	5	27.8		2	1		1	4	18.2
Decentration of the femoral head		1		1	1	3	16.7	1	2	1	1	1	6	27.3
Inadequate adaptation of the implant	1	1	1			3	16.7	1	1	2	1		5	22.7
Leaving a fragment in the joint			1			1	5.6		1	1			2	9.1
Total	6	6	3	1	1	18	78.3	4	8	5	4	1	22	68.8

Types of accesses and the combinations: KL, Kocher-Langenbeck; II, ilioinguinal approach; CL-II, Kocher-Langenbeck and ilio-inguinal; St-KL, Stoppa and Kocher-Langenbeck; St-II, Stoppa and ilio-inguinal

Table 3

Clinical and radiological results of assessing the reduction quality using the J.M. Matta scale at a short term

Groups of patients	Оценка (по степени смещения)					
	excellent / good (0-1 mm)		fair (2-3 mm)		poor (> 3 mm)	
	abs.	%	abs.	%	abs.	%
Main group (n = 23)	3	13.0	12	52.2	8	34.8
Control group (n = 32)	4	12.5	18	56.2	10	31.3

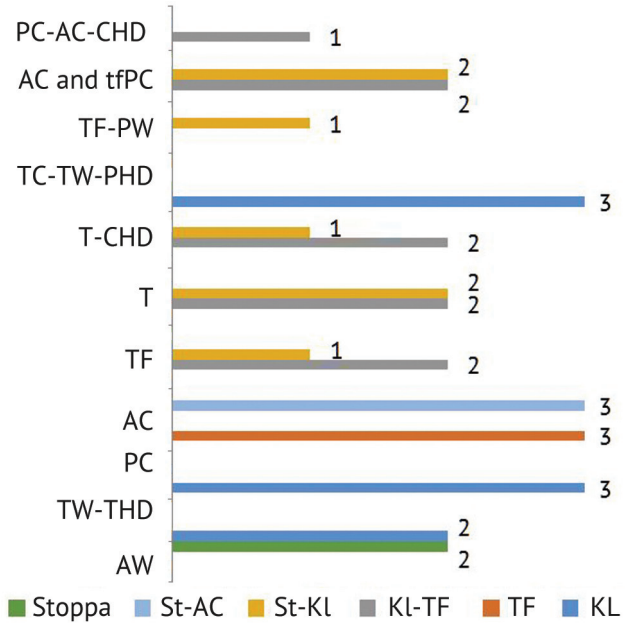

Fig. 2 Distribution of patients in the control group. Abbreviations: AW, anterior wall; PW and PFD, posterior wall and posterior femur dislocation; PW, posterior wall; PC, posterior column; T-CHD, T-shaped fracture and central hip dislocation; PC PW PHD, posterior column-posterior wall and posterior hip dislocation; AC-STFPC, anterior column + semi-transverse fracture of the posterior column. Types of accesses and the combinations: KL, Kocher-Langenbeck; II, ilio-inguinal; CL and II, Kocher-Langenbeck and ilio-inguinal; St-KL, Stoppa and Kocher-Langenbeck; St-II, Stoppa and ilio-inguinal

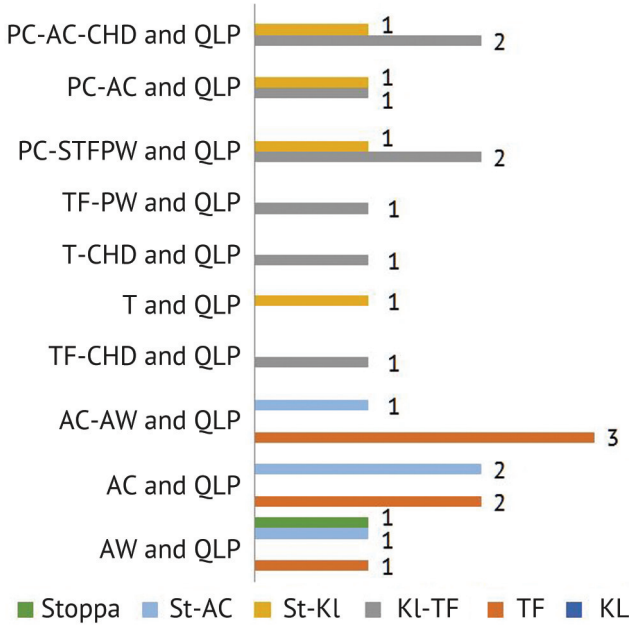

Fig. 3 Distribution of patients in the control group. Abbreviations: AW, anterior wall; PW, posterior wall; PC, posterior column; AC, anterior column and QLP; TF, transverse fracture and QLP; TF-CHD, transverse fracture + central hip dislocation; T, T-shaped fracture and QLP; T-CHD, T-shaped fracture and central hip dislocation; PC-PW, posterior column and posterior wall; TF-PW, transverse fracture and posterior wall; AW-STFPW, anterior column + semi-transverse fracture of the posterior wall; PC-AC, both columns fractured; PC-AC and CHD, both columns fractured and central hip dislocation. Types of accesses and the combinations: KL, Kocher-Langenbeck; II, ilio-inguinal; CL and II, Kocher-Langenbeck and ilio-inguinal; St-KL, Stoppa and Kocher-Langenbeck; St-II, Stoppa and ilio-inguinal

Advanced approaches (ilio-inguinal) or their combinations (combination of Kocher-Langenbeck and ilio-inguinal approaches) were commonly used in the main clinical group with longer surgical intervention and greater blood loss. The average surgical timing was 3.2 hours in the main group and 2.9 hours in the control group, which was 30 minutes less (9.2%). The average blood loss was 1308 ± 700 ml in the main group and 1083 ± 650 ml in the control group (Fig. 4 and 5).

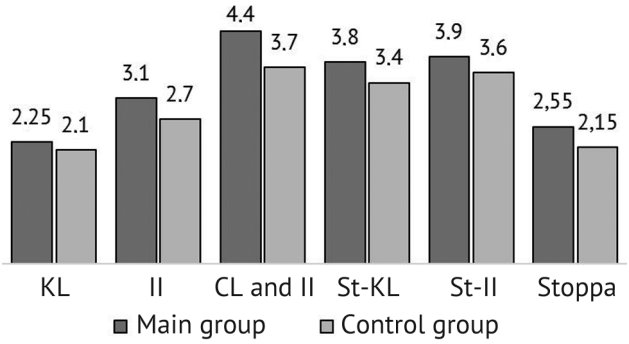

Fig. 4 Surgical timing in the groups, hours. Abbreviations: KL, Kocher-Langenbeck; II, ilio-inguinal; CL and II, Kocher-Langenbeck and ilio-inguinal; St-KL, Stoppa and Kocher-Langenbeck; St-II, Stoppa and ilio-inguinal

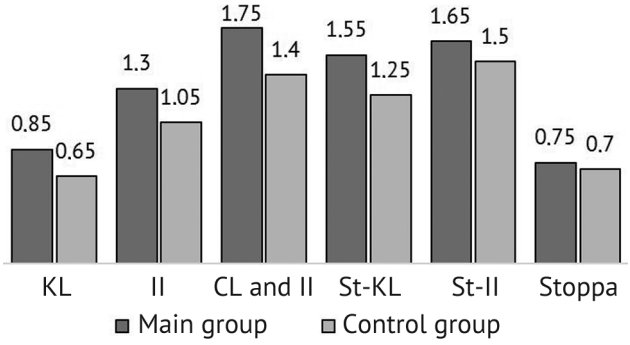

Fig. 5 Blood loss in the groups, litre. Abbreviations: KL, Kocher-Langenbeck; II, ilio-inguinal; CL and II, Kocher-Langenbeck and ilio-inguinal; St-KL, Stoppa and Kocher-Langenbeck; St-II, Stoppa and ilio-inguinal

Complications at a long term

Post-traumatic arthrosis (PTA) of the HJ was common and was diagnosed in 16 (66.7%) controls and in 100% of cases in the main group. PTA grade 1-2 was detected at 3 months of surgery during the first follow-up visit. Combined hip joint contracture was revealed in 4 control (12.9 %) or 5.1% of all complications, in 6 cases (12.8 %) of the main group or 7.7 % of all complications. Other complications were noted in 1-2 cases of both groups. Two types of complications noted in the main group and were not observed among controls included osteolysis of intermediate acetabular fragments (n = 2; 4.2 %) and non-united QLP (n = 3 cases; 6.3 %). There were 30 complications (38.5 %) diagnosed in the control group, and 48 (61.5 %) complications detected in the main group (Fig. 6). The incidence of PTA of HJ radiological grades 1-2 and 2-3 was reviewed by years of observation (Table 4).

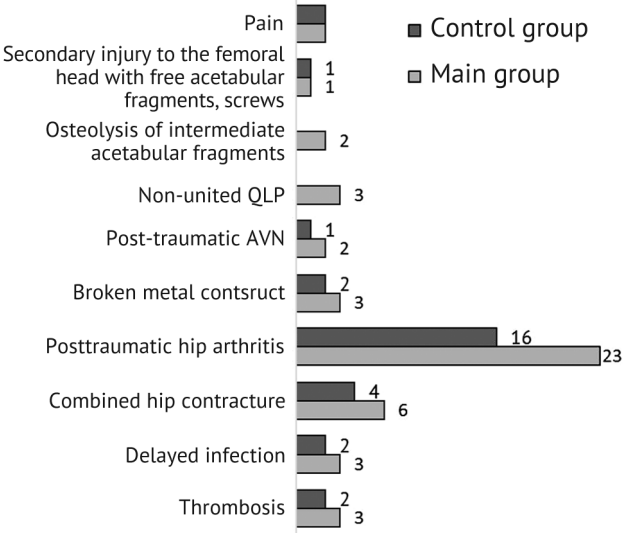

Fig. 6 Complications at a long term

PTA of the hip was diagnosed during the first year after ORIF in both groups, at 3 and 5 years in the control group and throughout the entire follow-up period in the main group being more common at 2, 3, 5 and 7 years. PTA of the hip grades 2-3 were diagnosed in 14 (66.7 %) cases of the main group and in 11 (45.8%) controls at 7 years. In both clinical observation groups. There was a gradual increase in the number of patients with PTA of the hip grades 2-3.

Table 4

Occurrence of post-traumatic hip arthritis during the observation period

PTA of the hip	Study group	Number of patients											
		Follow-up period (years)										Total	
		1		2		3		5		7			
		abs.	%	abs.	%	abs.	%	abs.	%	abs.	%	abs.	%
PTA of the hip grade 1-2	Main (n = 21)	2	9.5	4	19.0	4	19.0	6	28.7	5	23.8	21	100
	Control (n = 24)	1	6.3	3	18.8	4	25.0	5	31.2	3	18.7	16	66.7
	*p	0.21		0.25		1.0		0.69		0.7			
PTA of the hip grade 2-3	Main (n = 21)			2	14.3	3	21.4	5	35.7	4	28.6	14	66.7
	Control (n = 24)			1	9.1	2	18.1	4	36.4	4	36.4	11	45.8
	*p	0.18	0.4	0.6	0.8	1.0							

*p, statistically significant differences between the groups.

In-patient period

There were no statistically significant differences in in-patient stay in both clinical groups due to a small sample of patients and good postoperative rehabilitation in both groups.

Fracture consolidation timing

Consolidation of fractures occurred 4 weeks earlier in the control group as compared to the main group (Table 5).

Table 5

Fracture consolidation in the groups

Groups	Healing timing (days)		
	beginning	end	mean timing
Main (n = 21)	185	295	255 ± 31,4
Control (n = 24)	169	257	227 ± 28,5

($p < 0.001$).

Functional surgical outcomes assessed with the d'Aubigne and Postel scale modified by J. Charnley (D'A-P) and W.H. Harris (HHS)

There was a direct correlation between radiological and clinical results of ORIF. D'A-P and HHS scores were comparable. No excellent results were found in the main and control groups. Poor D'A-P scores (< 12) were observed in 14 (66.7%) cases in the main group and 17 (70.8%) in the control group, HHS score < 70 were noted in 14 and 2 cases, respectively. The number of satisfactory results did not differ significantly. Walking with crutches period was longer by 2-3 weeks in the main group (Table 6).

Re-operations, THR

14 (66.7 %) cases required THR in the main clinical group (n = 21) at 7 years of ORIF (Fig. 7).

THR was required in 11 (45.8%) controls, THR was required for one patients of the main group during the first 12 months of ORIF. The number of THR performed for the year of observation noted in the table for each clinical group was almost the same. 3 to 5 THRs were performed for each year of observation in both clinical groups.

Disability

11 (52.4%) patients of the main clinical group became disabled at 7 years of ORIF with the majority of patients (8-72.7 %) having diability group 3. Disability was noted in 14 control cases (58.3%), of which 10 (74.1 %) having group 3.

Table 6

Functional outcomes of acetabular and QLP fractures

Description		Study groups							
		main (n = 21)				control (n = 24)			
		excellent	good	fair	poor	excellent	good	fair	poor
D'A-P, score		18	17-16	15-12	< 12	18	17-16	15-12	< 12
Number of patients	abs.		1	6	14		3	4	17
	%		4.8	28.6	66.7		12,5	16,7	70,8
HHS, score		100-90	89-80	79-70	< 70	100-90	89-80	79-70	< 70
Number of patients	abs.		1	6	14		3	4	2
	%		48	28.6	66.7		12,5	16,7	70,8
Starting gradual weight-bearing (weeks)		1-2 (use of crutches)				1-2 (use of crutches)			
Starting full weight-bearing (weeks)		15-16 (use of crutches first, then use of cane)				12-15 (use of crutches first, then use of cane)			
THR to follow		14 (66.7 %) from 6 months to 7 years				11 (45.8 %) from 6 months to 7 years			

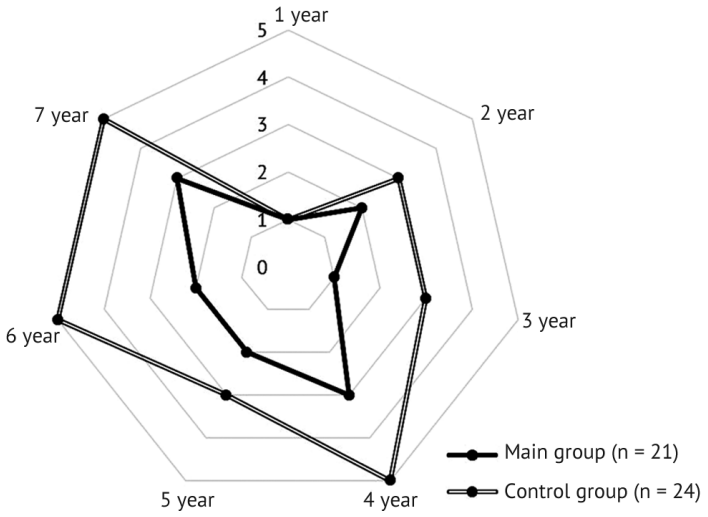

Fig. 7 Dynamics in the performance of THA in the groups

DISCUSSION

Six types of surgical approaches were used in both clinical groups. The higher rate of complications was observed in the control group with use of Kocher-Langenbeck and ilioinguinal access (n = 8; 36.4 %). A smaller number of complications were detected with use of a combination of Stoppa and Kocher-Langenbeck approaches (n = 5; 22.7 %) and the same rate of adverse events noted with Stoppa access and a combination of Stoppa and ilioinguinal approaches (n = 4; 18.2 %)., A higher rate of complications was observed in the main group (n = 6; 33.3 %) with use of the ilio-inguinal approach and the combination of the Kocher-Langenbeck and ilio-inguinal approaches. A smaller number of complications were detected with use of a combination of Stoppa and Kocher-Langenbeck approaches (n = 3; 16.7 %). Intraoperative complications in the control group correlated with data on the most [7, 17, 31-33] and least frequent complications [7, 32, 34-37] in quantitative and qualitative terms.

The analysis of our own results on the use of surgical approaches is consistent with the data published and which indicates to the combination of the ilioinguinal approach and Kocher-Langenbeck taking longer hours. Less time was required to complete the Stoppa and Kocher-Langenbeck approaches. The papers report a direct dependence of blood loss on the surgical timing confirming the fact that the blood loss and surgical timing depend on the use of specific approaches as a standalone procedure or their combination [14, 28, 38-40]. The results on the use of surgical approaches in both clinical groups showed the negative effect of acetabular fractures on the duration and volume of blood loss confirming the objective need to classify acetabular fractures as risk factors for adverse outcomes with ORIF used for acetabular and QLP fractures [17].

A higher rate of complications in the main group can be explained by the complexity of QLP fractures due to acetabular injury and displaced columns, the extent of QLP displacement, the presence of two or more fragments and smaller QLP fragments, difficult QLP reduction that was seen in each specific case. QLP reduction was also difficult due to the presence of defects, marginal defects of the acetabular columns. Inadequate adaptation of the plate relative to the anatomical surface of the fixed acetabular segment, decentration of the femoral head were cause by similar factors. Injury to the branches of the external iliac vein, partial damage to the obturator nerve were associated with technical difficulties performing accesses and ORIF.

A smaller number of excellent / good observations (n = 7; 12.7 %), a large number of satisfactory (n = 30; 54.5 %) and poor (n = 18; 32.7 %) outcomes were primarily associated with complex acetabular fractures (in addition to difficulties with the reduction of columns and acetabular fragments), the extent of bone displacement, the presence of two or more fragments and smaller fragments. The difficulty of reduction could be explained by difficulty of detecting some QLP fractures, which were not visualized radiologically and created objective difficulties in the reduction of acetabulum and QLP. A poor outcome of a fracture of the acetabulum and QLP resulting in severe osteoarthritis at 15 months of ORIF and an indication to THR reported by S.P. Boelch et al. (2016) could suggest the necessity of a classification for fractures of the acetabulum and QLP [17]. Many authors consider THR as a good option for acetabular fracture in combination with QLP injury [11, 13, 18-21]. The unfavorable effect of QLP fractures on the outcomes of surgical treatment is confirmed by the complications diagnosed in the main group including post-traumatic arthritis of the hip joint. Long-term complications including PTA of the hip joint and AVN were common for acetabular fractures, additional tissue trauma during ORIF. The incidence of PTA in hip joint ranges from 3.0 to 53.2 % [32, 36, 41-43]. The incidence of AVN varies from 0.7 to 27.7 % with maximum rates (11.8-27.7 %) seen with a combination of two approaches [7, 32, 43, 44]. The dynamics in the need for THR reported primarily in the main clinical group could be explained by the combination of acetabular and QLP fractures and by the technical difficulties with ORIF and the adverse effect of QLP fractures on long-term outcomes with ORIF. M. Hanschen et al. (2017) reported 25 % of older people with acetabular fractures repaired with ORIF requiring delayed THR [45]. The analysis performed correlated with the data of other authors [35, 46, 47]. There is also a high (30 to 66.7 %) rate of disabled individuals who had sustained acetabular fractures [35, 47, 48]. T.A. Ferguson et al. (2010) reported the incidence of radiological characteristics of acetabular fractures available for analysis in 173 (73.6 %) of 235 patients aged 60 years and older who were identified as predicting an unfavorable outcome after ORIF [6]. The authors identified 61 CLJ fractures (35.3 %) in comparison with our data (41.8 %). The majority of QLP fractures were combined with injury to the anterior column 40/32 which amounted to 80.0%. There was a rare combination with broken anterior column. Surgical outcomes of acetabular fractures indicated to common acetabular fractures,

in elderly patients, in particular, and the fixation of the fractures is technically challenging. G.Y. Laflame et al. (2011) reported the use of a conventional plating being unable to provide sufficient stability with a high risk of poor results, with the need for better plate design to avoid THR [3].

Based on the surgical outcomes of acetabular fractures and acetabular fractures combined with QLP injury, we undertook to systematize and classify acetabular fractures to objectify their impact on the results of surgical treatment. Analysis of radiographs and CT scans identifying differences in QLP fractures was carried out by leading orthopedic traumatologists with more than 20 years of experience in the treatment of acetabular fractures and radiologists, leading experts in the field of CT examination of acetabular fractures and 3D reconstructions of CT images. We identified 6 groups of different signs of QLP fractures. The systematization of QLP fractures, as the basis for the classification, is being developed by Prof. Dr. med. A.I. Kolesnik and Associate Professor S.V. Donchenko, Ph.D. with the participation of trauma and orthopedic surgeons V.V. Surikova, D.A. Ivanova, Ph.D. I.M. Solodilova, E.P. Tarasova.

Systematization of QLP fractures

1. By localization:

1.1 unilateral;

1.2 bilateral.

2. By fracture line:

2.1 transcerse;

2.2 oblique;

2.3 oblique and transverse;

2.4 vertical.

3. With transition to other acetabular areas:

3.1 to the anterior column;

3.2 to the posterior column;

3.3 to the anterior and posterior column;

3.4 to the weight-bearing surface;

3.5 to the iliac body and the wing;

3.6 to the pubic bone.

4. By number of fragments:

4.1 monofragmental;

4.2 bi-fragmental;

4.3 polyfragmental;

4.4 fractures with small / and intermediate, extra- and intra-articular fragments (they may be not seen on preoperative radiographs and CT scans and in the fracture site during surgery and can be diagnosed on radiographs and CT scans postoperatively)

5. Extent of displacement:

5.1 no significant displacement;

5.2 displaced;

5.3 displaced and femoral head being partially protruded to the pelvis (central subluxation);

5.4 significant displacement of the quadrolateral plate into the pelvis with complete protrusion of the femoral head (central dislocation).

6. Combined injury:

6.1 injury to the QLP cartilage;

6.2 depression of the weight-bearing acetabular portion;

6.3 fracture (depression) of the subchondral bone of the superomedial and sciatic acetabulum;

6.4 posterior acetabulum;

6.5 acetabular body and the wing;

6.6 sacrum;

6.7 posterior column;

6.8 pubic bone;

6.9 ischium;

6.10 injury to pubic bone;

6.11 injury to CPS;

6.12 injured cartilage of the femoral head;

6.13 marginal fracture (subchondral zone) of the femoral head;

6.14 depressed fracture of the femoral head (subchondral zone of the inferior posterior quadrant).

CONCLUSION

Based on the analysis of intraoperative complications in the clinical groups and the personal surgical experience with acetabular fractures including those with broken QLP, we suggest that the QLP fracture classification we are developing can provide a specific approach to determining the severity of acetabular fractures, a most optimal decision on the surgical technology for acetabular fractures, identifying a pattern of QLP injury which is commonly combined with injury to critical acetabular structures including the supporting components of the impaired weight-bearing portion, the anteromedial region, the subchondral weight-bearing portion and the ischium. Preoperative detection of the injuries allows for a full restoration of QLP and the supporting acetabular structures using the most optimal surgical treatment individually for each case with reasonable indications for ORIF or urgent primary THR.

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The article was submitted 17.11.2022; approved after reviewing 29.12.2022; accepted for publication 20.02.2023.

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Conflict of interest. *The authors declare the absence of obvious and potential conflicts of interest related to the publication of this article.*

Financing. *Absent.*

Ethical expertise. *The study was approved by the local ethics committee of the State Budgetary Institution of Healthcare of the city of Moscow "City Clinical Hospital named after S.P. Botkin" DZM. Minutes No. 5 dated 12.07.2022*

Informed consent. *The patients gave voluntary written informed consent*