SURGICAL TACTICS FOR COMBINED INJURIES OF THE RETROPERITONEAL REGION IN CHILDREN

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Abstract. *The aim of the study was to evaluate the types of surgical interventions, their results, and the feasibility of their use in combined retroperitoneal injuries in children. A total of 64 clinical cases were analyzed using a combination of instrumental diagnostic methods and differentiated surgical approaches. Surgical interventions were performed in 22 patients (34.3%). The most common operation was lumbotomy with suturing of the renal rupture (21.9%). The use of organ-preserving technologies allowed preserving renal function in 82.5% of children. The developed algorithm for selecting a surgery reduced the incidence of complications and improved functional outcomes. An individualized approach based on modern imaging techniques and injury severity assessment optimizes surgical tactics in this category of patients.*

Key words: *Children, polytrauma, retroperitoneal region, kidney injury, organ-preserving surgery, lumbotomy, surgical tactics.*

Relevance. Combined retroperitoneal injuries in children are a significant component of polytrauma and are accompanied by multiple internal organ damage, increasing the risk of life-threatening injury to patients [1, 2]. The kidneys are most frequently affected, followed, to a lesser extent, by the adrenal glands, pancreas, and retroperitoneal tissue [3, 4]. Such injuries present a particular challenge for pediatric surgery, as the anatomical and physiological characteristics of the organs and the high elasticity of the tissues in children may obscure the severity of the injury at the initial stage of examination [5].

Optimizing surgical tactics for these injuries remains a pressing issue, as late diagnosis and untimely surgical intervention can lead to the development of postoperative complications, organ loss, chronic dysfunction, and a decrease in the child's quality of life [6, 7]. The use of modern imaging techniques, such as ultrasound and multislice computed tomography (MSCT), allows for a more accurate assessment of the extent of damage and the selection of the optimal treatment [8].

The aim of this work is a comprehensive analysis of the surgical interventions used and their clinical effectiveness, as well as the development and substantiation of an algorithm for selecting an operation for retroperitoneal injuries in children [9, 10].

The aim of the study was to evaluate the types of surgical interventions, their outcomes, and the feasibility of their use in the treatment of combined retroperitoneal injuries in children.

Material and Methods. The study included 64 children with combined retroperitoneal injuries. Clinical data, ultrasound, CT, and laboratory findings were assessed, as well as injury severity assessment using international scales.

Intervention methods. The study included 64 children aged 1 to 16 years, treated for combined retroperitoneal injuries in specialized pediatric surgery departments. All patients were admitted to the hospital as emergency patients after blunt or combined abdominal trauma involving damage to the kidneys, adrenal glands, retroperitoneal tissue, and major vascular structures (Table 1).

Table 1.

Characteristics of the study population, n = 64

Gender: boys/girls	
41 (64.1%) / 23 (35.9%)	41 (64.1%) / 23 (35.9%)
Age range	
–16 years old	
Basic mechanisms of injury	

Road accidents – 45.3%;	fall from height – 32.8%;
household injury – 17.2%;	sports injuries – 4.7%
Damage structure	
Kidney injury – 71.8%;	adrenal gland – 14.0%;
vessels – 6.2%;	retroperitoneal hematoma – 53.1%
Hemodynamic instability on admission	
28.1%	
Combined injuries (chest, pelvis, spine)	
56.2%	

Clinical assessment included grading the patient's condition using a severity scale, monitoring hemodynamic parameters, analyzing the estimated volume of blood loss, and dynamically assessing urinary tract function. Modern imaging techniques were used for primary and follow-up diagnostics: ultrasound of the abdominal and retroperitoneal organs served as a screening method, computed tomography with contrast served as the primary tool for determining the extent of damage to the kidneys and retroperitoneal structures, radiography was performed if bone damage was suspected, and angiography was performed in cases of suspected vascular disorders. Laboratory examination included a complete blood count, biochemical parameters (creatinine, urea), urinalysis for hematuria, and hemostatic assessment using a coagulogram.

Table 2.

Inclusion and exclusion criteria for patients in the study

Inclusion criteria	Confirmed retroperitoneal trauma (based on ultrasound, CT, or intraoperative revision). Patients must be under 18 years of age. Post-blunt, penetrating, or combined trauma. Indications for conservative or surgical treatment.
Exclusion criteria	Lack of imaging data. Isolated abdominal organ injuries without retroperitoneal involvement. Severe comorbidities that distort the results (cancer, chronic renal failure, etc.).

Surgical intervention methods included the choice of tactics depending on the extent of organ damage and the child's hemodynamic status. Organ-preserving surgeries included suturing renal parenchymal ruptures, resection of damaged areas without nephrectomy, hemostasis using suture and coagulation technologies, and drainage of the retroperitoneal space to prevent purulent-inflammatory complications. In cases of severe and irreversible damage, radical interventions were performed, such as nephrectomy when more than 75% of the parenchyma was destroyed or the kidney was completely crushed, removal of non-viable tissue, and reconstruction of vascular structures in case of their traumatic rupture. Various surgical approaches were used to access the organs: lumbotomy as the most common method, ensuring a complete revision of the kidney; midline laparotomy - when retroperitoneal trauma is combined with damage to the abdominal organs; as well as minimally invasive approaches used for limited retroperitoneal hematomas.

The developed algorithm for selecting a surgical approach was based on three key parameters: injury grade, hemodynamic stability, and imaging data. Assessment of the injury grade according to the AAST classification guided treatment: for grades I–III injuries, preference was given to organ-preserving methods, while for grades IV–V injuries, the decision on the need for radical intervention was made on an individual basis based on CT data and the patient's overall condition. Hemodynamic stability was the most important criterion: stable patients underwent extensive diagnostics with the option of conservative or gentle surgical treatment, while unstable children were subject to emergency surgery. Imaging data, including assessment of hematoma volume, signs of active bleeding, the degree of parenchymal destruction, and the condition of the urinary tract, played a significant role. The use of this algorithm standardized the decision-making process and increased the proportion of organ-preserving surgical interventions.

Statistical data processing was performed using standard methods of variation statistics. Normality of distribution was assessed using the Shapiro–Wilk test. Quantitative indicators were described as M ± SD or Me [Q1; Q3], and categorical indicators were expressed as n (%).

The Student t-test or Mann–Whitney U-test were used to compare groups; for multiple comparisons, ANOVA or the Kruskal–Wallis test were used. Categorical variables were analyzed using Pearson's χ^2 test or Fisher's exact test. Correlations were assessed using Pearson's or Spearman's $\chi 2$ test. Differences were considered statistically significant at $p < 0.05$. Data were processed using SPSS 26.0, Statistica 10.0, and Microsoft Excel 2019.

Results. This section presents the main study data, reflecting the frequency of surgical and conservative treatments for children with retroperitoneal injuries, the surgical pattern, the effectiveness of the proposed approach, and the incidence of complications. Analysis of these data allows us to evaluate the clinical feasibility of various approaches, their impact on preserving renal function, and the rationalization of surgical strategies.

Table 3

Structure of surgical interventions in children with retroperitoneal injuries

Type of operation	**Number of patients (%)**	**Characteristics of the intervention**
Lumbotomy with suturing of the kidney rupture	21.9%	The main organ-preserving method for parenchymal ruptures
Retroperitoneal space drainage	9.3%	Used for local hematomas and infections
Organ-preserving reconstructive surgeries	12.5%	Resection and restoration of kidney structure without nephrectomy
Radical interventions (nephrectomy)	3.1%	It was performed in case of total destruction of the kidney
Total number of surgical interventions	**34.3% (22 patients)**	—

Table 3 demonstrates the pattern of surgical interventions in children with retroperitoneal injuries. In the study group, surgical treatment was required in 22 patients (34.3%). Lumbotomy with suturing of the renal rupture was the most

common procedure—21.9% of cases—which is the primary organ-preserving method for parenchymal injuries. Retroperitoneal drainage was used in 9.3% of cases, primarily for local hematomas or infections. Organ-preserving reconstructive surgeries, including resection and restoration of the renal structure without nephrectomy, were performed in 12.5% of cases. Radical interventions, such as nephrectomy, were performed only in cases of total kidney destruction and accounted for 3.1% of all surgeries. Thus, the presented table clearly reflects the distribution of surgical intervention types and their nature depending on the severity of the injury.

Table 4.

The effectiveness of surgical tactics for retroperitoneal injuries in children

Indicator	Result	Comment
Preservation of renal function after organ-preserving interventions	82.5%	High efficiency of organ-preserving methods
Avoiding unnecessary surgeries for minimal and moderate damage using an algorithm	65.7%	The algorithm allowed us to rationalize tactics and reduce the trauma of treatment.

Table 4 reflects the effectiveness of surgical approaches for retroperitoneal injuries in children. According to the presented data, the use of organ-preserving interventions preserved renal function in 82.5% of patients, demonstrating the high clinical efficacy of these methods. Furthermore, the use of the developed algorithm for selecting surgical approaches for minimal and moderate injuries helped avoid unnecessary surgeries in 65.7% of cases, confirming the rationalization of the treatment process and the reduction in invasiveness of the interventions. Thus, the table demonstrates that an individualized approach, taking into account the extent of injury and imaging data, ensures optimal functional outcomes and reduces the number of unnecessary surgeries.

Table 5.

Complications in children after surgical treatment of retroperitoneal injuries

Type of complication	Frequency (%)	Comment
Early complications	9.3%	Includes postoperative bleeding, wound infection, etc.
Late functional disorders	6.2%	Moderate decline in renal function during long-term observation

Table 5 demonstrates the incidence of complications in children following surgical treatment of retroperitoneal injuries. Early complications were observed in 9.3% of patients and included postoperative bleeding, wound infection, and other complications typical of the recovery period. Late functional impairment, manifested by a moderate decline in renal function during long-term follow-up, occurred in 6.2% of children. These data demonstrate that the use of a differentiated approach and algorithms for selecting tactics can minimize both early and late complications after surgery.

Table 6.

Summary results of surgical treatment of children with retroperitoneal injuries

Meaning	Comment
Number of patients requiring surgical intervention	
22 (34.3%)	Of the 64 subjects studied
Organ-preserving interventions	
12.5%	Allowed to preserve kidney function in 82.5% of children
Radical interventions (nephrectomy)	
3.1%	They were used only in cases of irreversible organ damage.
Lumbotomy with suturing of the kidney rupture	
21.9%	The most common access method
Retroperitoneal space drainage	
9.3%	Used for hematomas or after vascular damage

Avoiding unnecessary surgeries for minimal/moderate damage	
65.7%	Application of the algorithm for selecting tactics
Early complications	
9.3%	Postoperative bleeding, infection, etc.
Late functional disorders	
6.2%	Moderate decrease in renal function

Table 6 presents the summary results of surgical treatment of children with retroperitoneal injuries. Of the 64 patients studied, 22 (34.3%) required surgical intervention.

Lumbotomy with renal rupture suturing was the most common procedure, used in 21.9% of cases, ensuring optimal access for organ-preserving surgeries. Organ-preserving interventions accounted for 12.5% of cases and preserved renal function in 82.5% of children, while radical interventions (nephrectomy) were performed only in cases of irreversible organ damage (3.1%). Retroperitoneal drainage was performed in 9.3% of cases for local hematomas or vascular damage. The use of a strategy selection algorithm allowed us to avoid unnecessary surgeries for minimal and moderate injuries in 65.7% of cases. Early complications, including postoperative bleeding and infection, occurred in 9.3% of patients, and late functional impairment (moderate decline in renal function) occurred in 6.2%.

The data in the summary table demonstrate the effectiveness of a differentiated approach to the choice of surgical tactics and minimizing the trauma of treatment.

Discussion. The study results highlight the importance of a personalized approach to retroperitoneal injuries in children. The use of modern imaging techniques, primarily multislice computed tomography (MSCT), allows for a reliable assessment of the location and extent of injuries, the volume of retroperitoneal hematomas, and the condition of the renal parenchyma. This, in turn, reduces the risk of unnecessary surgical interventions and improves treatment safety.

Organ-preserving surgeries are the preferred treatment for most injuries, as children have a high capacity for regeneration, and kidney loss at an early age can

lead to long-term functional impairment and the development of chronic renal failure. In this study, organ-preserving interventions preserved renal function in the majority of patients, confirming their clinical effectiveness.

Lumbotomy remains the most popular approach due to its ability to fully explore the kidney and retroperitoneal space with minimal damage to other anatomical structures. Furthermore, the use of a developed algorithm for selecting surgical tactics has facilitated standardization of decision-making, a reduction in the number of unnecessary surgeries, increased accuracy of indications, and, consequently, improved functional outcomes in children with retroperitoneal injuries.

Thus, the combination of modern imaging techniques, organ-preserving interventions, and an algorithmic approach allows for the optimization of treatment, minimization of trauma, and an increased likelihood of preserving the function of vital organs.

Conclusions. Surgical interventions are required in approximately one-third of children with concomitant retroperitoneal injuries. The most common procedure is lumbotomy with suturing of renal lesions. An organ-preserving approach has proven effective, preserving renal function in 82.5% of patients. The proposed algorithm for surgical selection reduces the number of unnecessary interventions, decreases the incidence of complications, and improves clinical outcomes. Individualized treatment based on modern imaging techniques should become the standard of care for this patient population.

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