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Research Article

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Modification of fast-track surgery during partial nephrectomy

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Abstract. *The present study aimed to assess the efficacy of the multimodal fast-track surgery (FTS) program supplemented with the exclusion of renal thermal ischemia, urinary tract drainage, and postoperative wound management in patients undergoing partial nephrectomy for localized T1 RCC.*

Methods. *A total of 150 patients diagnosed with localized RCC in stage T1 N0 M0 were initially enrolled in this prospective randomized study, with 75 patients assigned to each study group. Patients undergoing perioperative management following the FTS program were randomly assigned to the main study group. The control group comprised patients receiving standard postoperative care. The study specifically involved patients with kidney neoplasms not exceeding 7 cm in the largest diameter based on computed tomography data. Tumor size, localization, and the volume of functioning parenchyma were considered in the assessment.*

Results. *Among the patients included, 24 cases (16%) underwent radical nephrectomy due to technical difficulties arising from tumor spread to the kidney hilum, rendering them ineligible for further analysis. Consequently, the clinical analysis focused on 126 patients. Within the main group, 64 cases (50.8%) of RCC underwent randomization, and the multimodal FTS program was applied during partial nephrectomy. The control group comprised 62 patients (49.2%).*

The median postoperative bed day in the main group was 1.5 days less compared to the control group, with values of 3.2 [2; 4] days versus 5 [4; 7] days, respectively ($p < 0.001$). Intraoperative complications occurred in 5 cases (4.0%) involving blood loss exceeding 1 liter (4 cases in the main group and 1 case in the control group). Transfusion of blood components occurred only once when the hemoglobin level dropped below 70 g/l.

In the early postoperative period, a total of 9 complications (7.1%) were observed with pyelonephritis lasting more than 3 days diagnosed in 4 cases (3.2%) and wound suppuration in 1 case (0.8%). Despite the absence of drainage in postoperative wounds within the main group, ultrasound examinations revealed small retroperitoneal hematomas (up to 100 ml) requiring drainage in 3% of cases.

Conclusions. *The multimodal FTS program for patients with localized RCC during partial nephrectomy, coupled with the exclusion of central thermal ischemia of the kidney, avoidance of retroperitoneal space drainage, and early patient activation, demonstrated a significant reduction in postoperative bed while maintaining a comparable level of perioperative complications.*

Key words: kidney cancer, fast-track surgery, program, partial nephrectomy.

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

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Модифікація «Fast-Track Surgery» під час резекції нирки

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Резюме. Метою цього дослідження було визначити ефективність мультимодальної програми Fast-Track Surgery (FTS) доповненої відмовою від теплової ішемії нирки, дренажу сечових шляхів та післяопераційної рани у хворих на локалізований НКР T1 при проведенні резекції нирки.

Методи. Загалом 150 хворих з локалізованим НКР в стадії T1 N0 M0 було залучено до цього проспективного рандомізованого дослідження, по 75 пацієнтів розподілено до кожної групи дослідження. Пацієнти, які проходили післяопераційне лікування за програмою FTS, були випадковим чином розподілені до основної групи дослідження. Контрольну групу склали пацієнти, які отримували стандартний післяопераційний догляд. У дослідженні брали участь пацієнти з новоутвореннями нирки, що не перевищували 7 см у найбільшому діаметрі за даними комп'ютерної томографії. При оцінці враховували розмір пухлини, її локалізацію та об'єм функціонуючої паренхіми.

Результати. Серед включених у дослідження пацієнтів 24 (16 %) проведено радикальну нефректомію через технічні складнощі внаслідок поширення пухлини на ворота нирки пацієнтам. Тому в подальший аналіз вони включені не були. Таким чином, клінічному аналізу загалом підлягало 126 хворих. В основну групу рандомізовано 64 (50,8 %) хворих на НКР, яким при проведенні резекції нирки застосовувалась мультимодальна програма FTS. До контрольної групи рандомізовано 62 (49,2 %) пацієнти зі стандартним післяопераційним доглядом.

Медіана післяопераційного ліжкодня в основній групі була на 1,5 дня меншою порівняно з контрольною групою зі значеннями 3,2 [2; 4] днів проти 5 [4; 7] днів відповідно ($p < 0,001$). Інтраопераційні ускладнення з крововтратою понад 1 л діагностовано в 5 (4,0%) випадках (4 випадки в основній групі та 1 випадок у контрольній). Переливання компонентів крові проводилось лише один раз при зниженні рівня гемоглобіну нижче 70 г/л.

Всього в ранньому післяопераційному періоді спостерігалось 9 ускладнень (7,1%): пієлонефрит тривалістю понад 3 дні діагностовано у 4 (3,2%) пацієнтів та нагноєння рани у 1 (0,8%) хворого. Незважаючи на відсутність дренажу в післяопераційних ранах основної групи, при ультразвуковому дослідженні в 3% випадків виявлені невеликі заочеревинні гематоми (до 100 мл), які потребують дренажування.

Висновки. Мультимодальна програма FTS у хворих на локалізований НКР при проведенні резекції нирки доповнюється відмовою від центральної теплової ішемії нирки, відмовою від дренажу заочеревинного простору та ранньою активізацією хворих, що дозволяє знизити післяопераційний ліжко-день при аналогічному рівні периопераційних ускладнень.

Ключові слова: рак нирки, fast-track surgery, програма, резекція нирки.

Introduction. In 2005, based on fast-track surgery (FTS), the European Society for Clinical Nutrition and Metabolism formulated a unified scheme of Enhanced Recovery After Surgery (ERAS). The most studied use of these protocols in colorectal, thoracic and cardiac surgery [1-2], which has proven its effectiveness for patients, increasing the comfort of recovery, and for the health care system, thanks to the use of cost-effective methods that allow reducing the length of stay of patients in a hospital and reduce the costs of their treatment.

In urology, ERAS protocols are most widely used in the context of radical cystectomy [3-5]. Therefore, the use of this approach made it possible to reduce the

length of the patient's stay in the hospital. Another important component is the reduction of the number of potential complications, which affects the preservation of the quality of life and the final functional result of the treatment.

The use of ERAS protocols, in the context of nephrectomy in patients with renal cell carcinoma (RCC), made it possible to shorten the stay of patients in the hospital and facilitate the course of the postoperative period [6]. However, given the likelihood of developing postoperative complications, partial nephrectomy is a more complex surgical intervention. However, the results of randomized trials devoted to the use of FTS in the organ-preserving treatment of renal carcinoma have not yet been presented [7].

Partial nephrectomy with a tumor in 54% is complicated by acute damage to its parenchyma [8, 9]. Symptoms of acute kidney damage – temperature, pain syndrome, increase in creatinine, etc. complicate the postoperative period and increase the postoperative bed day. One of the causes of acute kidney damage dur-

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ing its resection is central thermal ischemia [10]. The mechanisms of parenchymal damage are complex and include reperfusion-related oxidative stress, nitric oxide deficiency, and immune cell activation, which together lead to epithelial dysfunction [11, 12].

Application of the ERAS protocol and modification of perioperative methods – refusal of central heat ischemia of the kidney, nephron-preserving sutures of the kidney, lack of drainage of the postoperative wound and urinary tract, etc., may have an impact on the prevention of acute kidney injury and the course of the postoperative stay in the hospital of patients with RCC subject to organ preservation treatment.

The present study aimed to assess the efficacy of the multimodal FTS program supplemented with the exclusion of renal thermal ischemia, urinary tract drainage, and postoperative wound management in patients undergoing partial nephrectomy for localized T1 RCC.

Patients and Methods. This prospective randomized study initially included 150 patients with T1 N0 M0 kidney neoplasm who were scheduled to undergo partial nephrectomy. The study was conducted as a part of the Institute project “Determine ways to reduce the disability of patients with localized kidney cancer based on the development and optimization of innovative methods of diagnosis, neoadjuvant targeted therapy and surgical treatment” (State Registration Number 0118U003727) between January 2020 and July 2021. The study protocol obtained official approval from the local Ethics Committee at the Institute (protocol number: 163.23.06.2020, issued on June 23, 2020). Throughout the study, the research team consistently followed ethical principles and legal regulations governing biomedical research, ensuring strict adherence to the guidelines outlined in the Helsinki Declaration. Written informed consent was obtained from all patients included in the study.

Patients who were subject to perioperative management of patients according to the program of rapid postoperative recovery of FTS were randomized into the main group of the study. The control group included patients who underwent standard postoperative management of patients. The study included only patients with kidney neoplasms whose size did not exceed 7 cm in the largest diameter according to computer tomography data. Along with the size of the tumor, its localization and the volume of the functioning parenchyma were determined.

Randomization of patients was carried out by the method of random numbers in the randomization center of the National Cancer Institute.

Criteria for including patients in the study:

- patients with clinically diagnosed neoplasms of one of the kidneys (T1 N0 M0);
- central placement of a kidney tumor with a diameter of up to 4 cm;
- peripheral or polar location of the kidney tumor, more than 50% of the preserved functioning kidney parenchyma;

- age from 18 to 80 years;
- patients with a satisfactory general condition (ECOG 0 – 1).
- absence of absolute contraindications to surgical intervention;
- written consent of patients to participate in the study;
- consent to follow the recommendations of perioperative management of patients according to the protocols of rapid postoperative rehabilitation of FTS patients.

Criteria for excluding patients from the study:

- concomitant diseases, the presence of which can significantly affect the results of the study (uncontrolled arterial hypertension, paroxysmal tachy- or bradysystolic atrial fibrillation, heart failure of the III degree, CRF, liver failure, diabetes mellitus type I in the stage of decompensation, acute violation of cerebral blood circulation in the period up to 6 months, myocardial infarction within 6 months, angina pectoris III-IV functional class, etc.);
- leukopenia $< 1.5 \times 10^9/l$; neutropenia $< 1.0 \times 10^9/l$; thrombocytopenia $< 100 \times 10^9/l$;
- previous systemic therapy for RCC;
- acute infectious diseases;
- acute ulcer of the stomach or duodenum;
- nonspecific ulcerative colitis or Crohn's disease;
- surgical interventions that were performed 1 month before inclusion in the study;
- presence of a tumor in another location;
- known or suspected metastases of any location;
- mental disorders;
- participation in any other clinical trial in the last 30 days before inclusion.

Criteria for dropping patients from the study:

- for each specific patient, the conditions for termination of participation in the study are:
- performance of radical nephrectomy;
- non-compliance with the treatment regime;
- refusal of the patient to participate in the study.

The study design is shown in Fig. 1.

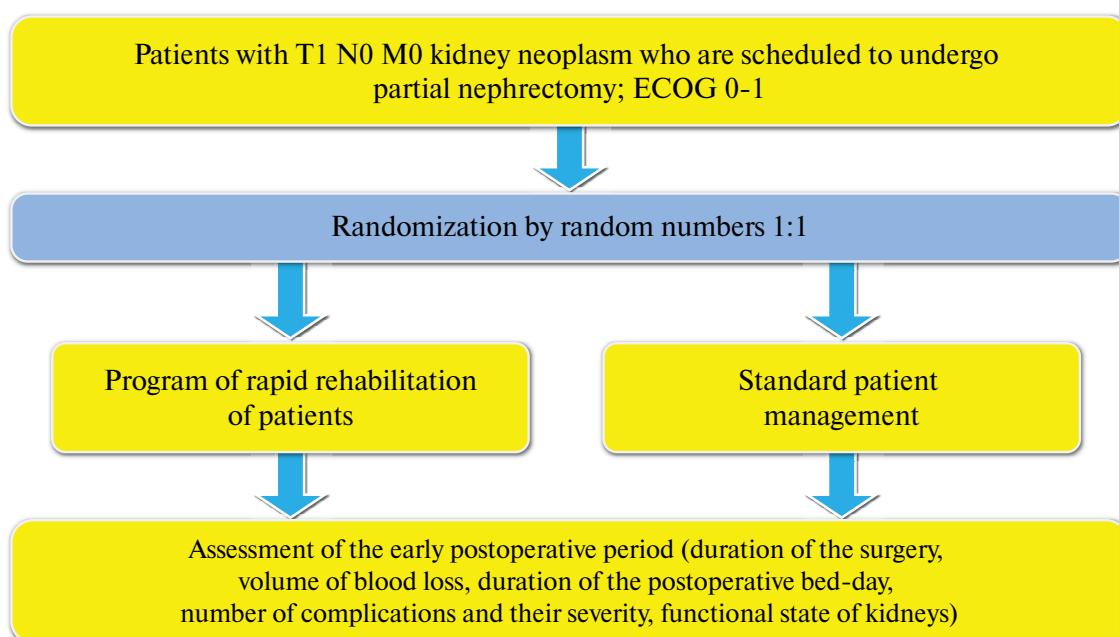


Fig. 1. The study design.

During the standard management of patients (control group), they were not informed about rehabilitation measures in the perioperative period. They were given a cleansing enema 2 times (in the evening and the morning before the surgery), after 12 hours they stopped taking solid food and after 6 hours they stopped drinking liquids. 30 minutes before the surgery, premedication was carried out with a solution: 2 ml of Trimeperidine 2%, 1 ml of Diphenhydramine 1%, and 0.5 ml of Atropine 1%.

Partial nephrectomy was performed by open access under combined anesthesia. Patients remained in the intensive care unit under bed rest conditions

for 16-18 hours after the surgery. At this time, they did not receive solid food, and the oral liquid intake was 200-300 ml. The volume of infusion therapy with crystalloid solutions in the first 2 days was on average 1000 ml. Analgesia was performed with the opioid analgesic tramadol 0.5% (2 ml) on demand up to 3-4 times a day, with subsequent transition to injectable non-steroidal anti-inflammatory drugs. Activation within the ward 24 hours after surgery was carried out using a postoperative bandage.

Measures of the rapid recovery program after partial nephrectomy with a tumor in the experimental group are presented in Table 1.

Table 1

Program of rapid rehabilitation of FTS patients with partial nephrectomy

Measure	Actions
Preoperative measures	
Hospitalization	Explanation of the content of FTS, expected results, possible situations, and solutions to reduce the patient's anxiety.
Preoperative nutrition	Preoperative nutrition is stopped 6 hours before the surgery, liquid consumption up to 2 hours before the surgery; intravenous administration of 500 ml of 10% glucose solution with insulin or appointment of 250 ml of 5% glucose orally 2-3 hours before surgery; appointment of antibacterial therapy before surgery
Bowel preparation	Appointment of protein-carbohydrate electrolyte mixtures the day before the intervention; do not prescribe mechanical bowel preparation or antibiotics the day before the intervention The use of drugs Bisacodyl and duphalac to clean the intestines
Intraoperative measures	
Anesthesia	General anesthesia + permanent epidural anesthesia; the minimum possible use of Morphine
Temperature protection	Increasing the temperature in the room to 22-26°C; increase the temperature before transfusion or blood transfusion; cover areas of the patient where the intervention is not performed; heat the electric sheet under the patient to 40-45°C

Continuation of Table 1

Measure	Actions
Postoperative measures	
Surgical measures	Minimal surgical subcostal access (including laparoscopic)
	Avoidance of central renal ischemia during partial nephrectomy
	Use of nephron-preserving sutures
	Refusal to drain the postoperative wound
	Refusal to drain the urinary tract, including urethral catheter, stents
Food	If there is no nausea, vomiting or a bloated stomach, it is possible to drink a little plain water after fully waking up; at the first signs of intestinal activity, you can use a decoction of rice and, provided there is no discomfort, after 24-48 hours, a small amount of liquid and semi-liquid diet food can take place; gradual introduction of regular food; chewing gum to prevent bloating
Postoperative analgesia	Use of a pump with an analgesic with the possibility of regulation to relieve pain; oral use of anti-inflammatory non-steroidal drugs to reduce pain; an attempt to reduce the use of opioids as much as possible.
Transfusions	Controlled infusion therapy; an attempt to reduce the volume of transfusions; use of transfusions through peripheral vessels
Drainage and urethral catheter	Removal of wound drainage after 6-8 hours, or surgical treatment without drainage of the surgical wound.
Activation	Encourage patients to go to bed as early as possible; getting out of bed within 12 hours after the intervention and walking already on the first day after the surgery, with a decrease in staying in bed every day
Anti-edematous, anti-inflammatory therapy	use of anti-inflammatory, anti-edematous agents in the perioperative and postoperative period (Dexamethasone, Infulgan, Furosemide)
Ultrasound control	Ultrasound control of the area of the operated kidney and organs of the abdominal cavity – control of intestinal peristalsis.

The surgery was performed under endotracheal anesthesia with the use of epidural anesthesia. The technical performance of partial nephrectomy was carried out from a laparoscopic approach or from an anterolateral, transabdominal incision, the length of which did not exceed 10 cm. The integrity of the kidney after its partial nephrectomy was restored with the help of a double-row suture: internal – -medullary, continuous and external – -corticomedullary, and nodal sutures. Nephrectomy was a criterion for dropping a patient from the study. To reduce the likelihood of acute kidney damage and the development of corresponding symptoms, partial nephrectomy was performed without the use of central thermal ischemia.

The effectiveness of the treatment was evaluated by the number and complexity of intra- and postoperative complications that occurred, according to the Clavien-Dindo classification, the duration of the surgery, the level of pain manifestations on the 3rd day after the surgery, the speed of recovery of intestinal peristalsis and the duration of the postoperative bed day.

Statistical analysis utilized the Statistics 10 Software, considering the data distribution. For data with

a normal distribution, mean values (M), standard deviations (SD), and 95% confidence intervals (CI) were computed, with comparisons conducted using the Student's t-test. In instances of non-normally distributed data, descriptions included the median (Me) and interquartile range (Q25-Q75), and comparisons were made using the non-parametric Mann-Whitney U-test. Fisher's exact test (χ^2) was employed to evaluate differences in frequencies between groups.

Results. A total of 150 patients with localized RCC in stage T1 N0 M0 were randomized into the study (75 patients in each study group). All patients met the inclusion and exclusion criteria, however, in 24 (16%) cases, radical nephrectomy was performed due to technical difficulties due to the spread of the tumor to the hilum of the kidney. Therefore, they were not included in further analysis. Thus, a total of 126 patients were subject to clinical analysis.

In the main group, 64 (50.8%) cases of RCC were randomized and the multimodal FTS program was used during partial nephrectomy. Sixty-two (49.2%) patients were randomized to the control group. Comparative data are presented in Table 2.

Table 2

Comparative assessment of the initial data in the studied groups

Indicator		Statistical units	Main group n = 64 (%)	Control group n = 62 (%)	Statistical assessment
Age, years		M±SD (95% CI)	55,8 ± 11,2 (53 – 58,6)	53,8 ± 14 (50,3 – 57,4)	t-test; p = 0,38
Gender:	male	n (%)	28 (43,8)	37 (59,7)	x ² =3,2 p= 0,08
	female	n (%)	36 (56,3)	25 (40,3)	
T	1a	n (%)	28 (43,8)	34 (54,8)	x ² = 1,55; p = 0,21
	1b	n (%)	36 (56,3)	28 (45,2)	
Size of kidney tumor, mm		M±SD (95% CI)	41,2 ± 18,9 (36,5 – 45,9)	39,9 ± 15,1 (36,1 – 43,8)	t-test; p = 0,67
Total glomerular filtration, ml/min		M±SD (95% CI)	89,9 ± 25,2 (79,3-101,8)	91,2 ± 24,9 (81,1-99,6)	Mann-Whitney U test; p = 0,92
ECOG		Me [25 %; 75 %]	0 [0, 1]	0 [0, 0]	Mann-Whitney U test; p=0,59
Body mass index		M±SD (95% CI)	28,6 ± 5,9 (27,2-30,2)	27,8 ± 4,8 (26,6-29)	t-test; p = 0,36
Hemoglobin		M±SD (95% CI)	140 ± 16 (136-144)	139 ± 14 (135-143)	t-test; p = 0,72
Blood creatinine, μmol/l		Me [25 %; 75 %]	81 [71,5; 100,5]	84 [74; 95]	Mann-Whitney U test; p = 0,87
Chronic kidney disease (CKD)		n (%)	4 (6,3)	2 (4,8)	x ² = 0,64; p = 0,42
Associated pathology		n (%)	53 (82,8)	46 (74,2)	x ² = 1,4; p = 0,24
RENAL score, points (Me [25 %; 75 %]) [13]		M±SD (95% CI)	6,3 ± 2,5 (5,7 – 7)	6,8 ± 2,4 (6,2 – 74)	t-test; p = 0,28
Volume of functioning parenchyma, %		Me [25 %; 75 %]	93 [81,5; 96]	90 [83,6; 95]	Mann-Whitney U test; p = 0,23

As can be seen from Table 2, no statistical difference was found in the comparison groups before treatment in patients with localized RCC, according to the main clinical characteristics.

A mandatory parameter of the nephrometric assessment of localized RCC was the determination of the volume of functioning kidney parenchyma, as a parameter included in the NCIU nephrometry and is an important indicator of the choice of the patient's treatment method (partial nephrectomy or radical nephrectomy).

As mentioned above, the effectiveness of the FTS strategy was evaluated based on the level of perioperative complications, the length of stay in the hospital, the intensity of pain on the 3rd day after surgery, and the level of repeated hospitalizations up to 30 days after surgery. Taking into account the refusal to perform thermal ischemia during partial nephrectomy in the FTS group, which could affect a number of parameters, the duration of the surgery and the level of intraoperative blood loss were taken into account separately. The results are presented in Table 3.

Table 3

Comparative characteristics of treatment results in groups

Indicator	Main group, n = 64	Control group, n = 62	Integrity
Volume of blood loss, ml Me [25%, 75%]	300 [250, 400]	275 [200, 300]	Mann-Whitney U test; p < 0,05
Surgery duration, min Me [25%, 75%]	77,5 [60, 100]	90 [70, 100]	Mann-Whitney U test; p = 0,29

Continuation of Table 3			
Indicator	Main group, n = 64	Control group, n = 62	Integrity
Restoration of intestinal peristalsis, h Me [25%, 75%]	7 [5, 10]	12 [8, 15]	Mann-Whitney U test; $p < 0,001$
Pain assessment, VAS, points Me [25%, 75%] [14]	2 [2; 3]	3 [2, 3]	Mann-Whitney; $p = 0,09$
Postoperative bed day, Me [25%, 75%]	3,2 [2, 4]	5 [4, 7]	Mann-Whitney U test; $p < 0,001$

As can be seen from Table 3, there was no significant difference in the duration of the surgery and the level of pain manifestations on the 3rd day after the surgery in patients according to the visual analog scale (VAS) [14], between the comparison groups. However, a slightly significant increase in the volume of intraoperative blood loss was noted in the main group. The detected difference in the level of intraoperative blood loss can primarily be due to the refusal to perform central thermal ischemia in the group of patients where the multimodal FTS approach was used.

Factors that can affect the possible development of complications during organ-preserving surgical interventions on the kidneys are the size of the tumor, its localization, and its relation to the main renal structures (vascular pedicle and cavity system). According to the literature, the level of complications during organ-preserving surgical interventions for kidney tumors does not exceed 10% [15].

Another important parameter affecting the speed of rehabilitation of patients was the rate of restoration of peristalsis in the early postoperative period. The measures applied in the multimodal FTS approach made it possible to restore intestinal peristalsis twice as early in patients of the main group, the median of which was only Me [25%, 75%] 7 [5; 10] hours against 12 [8; 15] hours in the control group (Mann-Whitney U test; $p < 0.001$), where standard approaches to patient management were used.

The main goal of the multimodal FTS approach during partial nephrectomy is the rapid rehabilitation of patients and, thanks to this, the reduction of the patient's stay in the hospital. Thus, in the main group of patients, the median postoperative bed day was reliably 1.5 days less and was (Me [25%, 75%]) 3.2 [2; 4] days

against 5 [4; 7] days in the control group (Mann-Whitney U test; $p < 0.001$).

Taking into account the inclusion in the study of patients with localized RCC only in stage T1, intraoperative complications occurred in 5 (4.0%) cases of blood loss of more than 1 liter (4 (6.3%) cases of the main group and 1 (1.6%) case of the control group). It should be noted that the transfusion of blood components (erythrocyte mass and plasma) was carried out only in 1 case when the blood hemoglobin level dropped below 70 g/l.

In total, 9 (7.1%) complications occurred in the early postoperative period. In percentage terms, these levels are lower than the reference literature data on the issue. A small number of complications are associated with effective surgical techniques, the use of new hemostatic agents, modern antibacterial drugs, and early activation of patients.

Complications of a purulent-septic nature were most common: pyelonephritis with hyperthermia for more than 3 days was diagnosed in only 4 (3.2%) cases (3 cases in the control group and 1 in the main group), and suppuration of the postoperative wound in only 1 (0.8 %) of the case of the control group.

Considering the lack of drainage in the postoperative wound when using the program of rapid rehabilitation of patients with FTS in the main group of patients, we performed a routine ultrasound examination. In 3 (%) cases of the main group, the presence of small (up to 100 ml) retroperitoneal hematomas, which required their drainage, was diagnosed during an ultrasound on the 2nd day after the surgery.

Complications that occurred during surgery and in the early postoperative period in the comparison groups were summarized and classified according to Clavien-Dindo [16] (Table 4).

Table 4

Intra- and postoperative complications according to Clavien-Dindo in comparison groups

Complications by Clavien-Dindo	Main group n = 64 (%)	Control group, n = 62 (%)	Total, n = 126 (%)
I	0	1 (1,6)	1 (0,8)
II	5 (7,8)	4 (6,5)	9 (7,1)
III	3 (4,7)	0	3 (2,4)
Total, n (%)	8 (12,5)	5 (8,1)	13 (10,3)
Integrity	$\chi^2 = 0,67; p = 0,41$		

As can be seen from Table 3, complications that occurred during and after surgical treatment occurred in both study groups with the same frequency ($\chi^2 = 0.67$; $p = 0.41$). In one case, suppuration of a postoperative wound did not require additional appointments and was classified as complications of I grade. 5 (4%) cases (4 main and 1 control group) of transfusion of blood components with intraoperative blood loss of more than 1000 ml and 4 (3.2%) cases (1 main and 3 control groups) were classified as complications of II grade according to Clavien-Dindo exacerbation of pyelonephritis, which required additional anti-inflammatory, anti-edematous and antibacterial therapy. 3 (2.4%) cases of retroperitoneal hematomas that required drainage under ultrasound control in the main group were classified as complications of III grade. Complications of IV and V grades according to the Clavien-Dindo classification were not noted in our study, which is primarily due to the high efficiency of the developed techniques of partial nephrectomy [16].

Discussion. Major surgical procedures cause profound physiological responses and frequent complications, including pain, nausea, bowel, cardiac, and pulmonary dysfunction. These complications can lead to an increase in the length of stay of patients in the hospital, an increase in the number and complexity of postoperative complications, and even a fatal outcome [17].

The principles of (FTS) are used to optimize all stages of the treatment process including preparation for surgical intervention, the entire intraoperative period, and the postoperative stage, and also guarantee the safe discharge of the patient from the hospital [18].

Postoperative organ dysfunction and complications are primarily associated with concomitant diseases, therefore preoperative assessment allows to determine risks and opportunities to stabilize the state of concomitant diseases optimize organ functions before surgery, and increase the level of physical activity [19, 20].

The preoperative assessment also provides an opportunity for patient training. In the FTS program, patients receive information about possible conditions in the postoperative period, methods of pain relief, a program of mobilization, rehabilitation, and discharge from the hospital. It is extremely necessary to inform the patient about the time of stay in the intensive care unit, the planned time of transfer to the ward, the start of activity, and nutrition. Having a plan for their rehabilitation in advance, patients are subconsciously prepared for a positive course of the postoperative period. The information provided can reduce anxiety, the frequency of analgesia, and the length of hospital stay [21].

The main goal of the multimodal FTS approach during partial nephrectomy is the rapid rehabilitation of patients and, thanks to this, the reduction of the patient's stay in the hospital. Thus, in the main group of patients, the median postoperative bed day was reliably 1.5 days less and was (Me [25%, 75%]) 3.5 [3; 4] days against 5 [4; 7] days in the control group (Mann-Whitney U test; $p < 0.001$).

The main problem of partial nephrectomy without ischemia is the unpredictable and poorly controlled volume of blood loss. The volume of blood loss in patients with non-ischemic partial nephrectomy was significantly higher than with total thermal ischemia, the indicator increases with increasing complexity of the surgical intervention.

The formation of pain syndrome in the early postoperative period, as a rule, has a nociceptive nature and is primarily due to the volume of surgical trauma. The pain syndrome is more pronounced with a more traumatic open surgical approach. The use of minimally invasive methods reduces the inflammatory component of the stress response but does not affect neuroendocrine and metabolic reactions. However, minimally invasive surgery is generally associated with less pain and shorter hospital stays compared to open methods. This difference is most pronounced when open surgery requires a long vertical incision. Pain and pulmonary dysfunction are reduced when transverse or oblique incisions are used instead of vertical, presumably due to a reduction in the number of injured tissues and nerve endings. Minimally invasive surgical interventions have shown their superiority over open interventions in kidney surgery [22].

Depending on the type of surgical intervention, namely, central ischemia of the kidney leads to its acute damage, which is aggravated by the formation of a zone of local ischemia of the parenchyma due to the application of hemostatic sutures at the edge of the partial nephrectomy. Ischemia of the parenchyma is one of the pathogenetic mechanisms of pain in the early postoperative period. This study showed that patients who underwent partial nephrectomy without ischemia had less pain. The proposed double-row suture of the kidney provides effective restoration of its integrity and does not require drainage of the pelvic system. Using this suture, we did not observe the occurrence of urinary fistulas.

The technique of anesthesia should be aimed at rapid recovery of the patient with minimal use of opioids. For this reason, short-acting anesthetics and pain-relieving agents are ideal. In major abdominal surgery, serious attention should be paid to the use of epidural anesthesia, which has a number of significant advantages, compared to intravenous anesthesia, and consists of better functional capacity of the patient after laparotomy, reduces mobilization time, provides better static and dynamic pain control, reduces postoperative pulmonary complications and also has a positive effect on the recovery of intestinal motility after surgery [22].

Good analgesia is important for postoperative activity and the resumption of normal activities. The main thing in FTS is the use of multimodal or balanced analgesia, the main principle of which is to obtain an analgesic effect from various forms of pain control with minimal side effects, in particular, opioids. Attention should be paid to the combination of local and regional anesthesia. Using this approach eliminates the need for

opioids, which minimizes side effects (sedation, nausea, intestinal paresis, and urinary retention) that interfere with early activation and enteral feeding. In most cases, the epidural catheter is removed after 48 to 72 hours. After removal of the epidural catheter, the patient regularly takes non-steroidal anti-inflammatory drugs and paracetamol. Severe pain after 72 hours should cause suspicion of an intra-abdominal complication [23].

Oral nutrition is traditionally limited in the postoperative period, but recent trends in colorectal surgery favor earlier initiation of liquid formulas in the early postoperative period. Patients start using mixtures already on the first day after surgery. Oral nutrition is preferred over parenteral nutrition [20]. A strategy to reduce the duration of intestinal paresis includes the use of minimally invasive surgical methods to reduce the stress response and minimize bowel processing, as well as avoiding the routine use of a nasogastric tube [22]. Also, one of the elements that accelerates the restoration of normal peristalsis is chewing gum, which is proven in two randomized studies in patients after radical cystectomy.

The success of the multimodal approach of rapid repair surgery is also achieved by minimizing the use of drains after surgery. The described techniques related to colorectal surgery prove that reducing the number of drains and removing the urethral catheter on the first postoperative day has a positive effect on treatment results compared to classical drainage techniques [20].

The results of the randomized study presented in our work indicate the promising application of the multimodal FTS program in patients with localized RCC during partial nephrectomy compared with standard surgical treatment, which allows for reliably reduced postoperative bed day ($p < 0.0005$) with a similar level of postoperative complications and pain intensity.

Successful implementation of the FTS program requires the interdisciplinary cooperation of anesthesiologists, surgeons, nurses, and physical therapists. The role of the surgeon includes the appropriate choice of treatment method, type and size of the incision, minimizing the use of drains, ensuring quick removal of the catheter, starting feeding, and early activation of the patient. The role of the anesthesiologist includes the use of anesthesia with a rapid recovery of the patient's condition, optimal fluid balance, and a balanced analgesia regimen that includes epidural anesthesia.

Conclusion. The multimodal FTS program for patients undergoing partial nephrectomy for localized RCC is enhanced by the decision to avoid central thermal ischemia of the kidney, reject retroperitoneal space drainage, and initiate early patient activation. This approach enables a reduction in the postoperative hospital stay to 3.5 days while maintaining a comparable level of perioperative complications.

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

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Authors contribution.

O.A. Voylenko: Data analysis, writing the manuscript;

M.V. Pikul, S.L. Semko, A.V. Tymoshenko, O.A. Kononenko, and Iu.V. Vitruk, B.O. Hrechko, D.O. Koshel: Data curation and processing;

O.E. Stakhovskiy: Data analysis, writing the manuscript;

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