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Efficacy of combined general anesthesia with an epidural component in combined kidney and pancreas transplantation

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Abstract

Introduction. *Simultaneous kidney and pancreatic transplantation (SKPT) is the most effective surgical method for the treatment of patients suffering from type 1 diabetes mellitus complicated by stage 5 chronic kidney disease. Given the high traumatic nature and duration of this surgery, it is necessary to achieve an optimal depth of anesthesia, a sufficient level of anesthetizing with minimal negative pharmacological effects of drugs on grafts. This study aimed at investigating the efficacy of anesthetic management when using combined general anesthesia with or without an epidural component in SKPT.*

Objective. *To compare the efficacy of providing anesthesia when using combined general anesthesia with an epidural component and without an epidural component in SKPT recipients.*

Material and methods. *A retrospective study was performed with the prospective control of 85 recipients who underwent SKPT at the N.V. Sklifosovsky Research Institute for Emergency Medicine in the period from 01.01.2008 to 31.12.2024. There were 52 men (61%) and 33* *women (39%) among them, the median age was 35 (31;39) full years. The patients were divided into two groups: group I included patients who underwent surgery under general combined anesthesia with an epidural component of anesthetizing, group II included patients who underwent surgery under general combined anesthesia without an epidural component of anesthesia. Intraoperative hemodynamic parameters, acid-base state parameters and electrolytes at the main stages of surgery were analyzed; intraoperative consumption of basic anesthetic drugs, the frequency of extubation of patients in the operating room after surgery, the frequency of postoperative nausea and/or vomiting at the end of surgery were compared between the groups; recovery time was analyzed.*

Results. *In group I, there was a statistically significant decrease in the total amount of all major anesthetic drugs compared with group II ($p<0.001$). The rate of patient extubations in the operating room was 37.5%, making 72.2% in group I and being statistically significantly higher compared to 34.7% in group II ($p<0.001$). The total intraoperative volume of diuresis in patients of group I was 1.5 times higher than in group II, the difference being statistically significant (300 (175;500) ml versus 200 (100;300) ml, respectively) ($p=0.029$); the median time of intestinal motility recovery in the intensive care unit in group I was 22 (18;26) hours, which was 1.3 times shorter than 29 (26;34) hours in group II ($p<0.001$).*

Conclusion. *The use of the epidural component of anesthesia as part of general multicomponent anesthesia for SKPT can significantly reduce the amount anesthetic drugs to be administered. Intraoperative diuresis and the rate of operating room patient extubations after surgery increase statistically significantly, and the time of intestinal motility recovery in the early postoperative period is reduced.*

Keywords: simultaneous kidney and pancreas transplantation, epidural component of anesthesia, extubation rate, intestinal motility

Conflict of interests Authors declare no conflict of interest

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BMI, body mass index
BP, blood pressure
CI, confidence interval
CKD 5, stage 5 chronic kidney disease
CVP, central venous pressure
DM 1, type 1diabetes mellitus
HR, heart rate
MAP, mean arterial pressure
OR, odds ratio
PAG, pancreas allograft
PONV, postoperative nausea and/or vomiting
RAG, renal allograft
RRT, renal replacement therapy
SKPT, simultaneous kidney and pancreas transplantation

Introduction

Currently, diabetes mellitus (DM) and its complications present a global problem in the healthcare system throughout the world [1]. Simultaneous kidney and pancreas transplantation (SKPT) is the most effective surgical method to treat patients with type 1 diabetes mellitus (DM1) complicated by stage 5 chronic kidney disease (CKD 5) [2, 3]. Modern medicine has made a breakthrough in anesthesiology, which has undoubtedly contributed to the success of transplant operations and, in particular, SKPT. However, there remain the major problems associated with the extremely severe condition of recipients suffering from DM 1 and its complications [2–4]. Given the high traumatic nature and duration of this of surgery, it is necessary to achieve an optimal depth of anesthesia, reliable sympathetic and neurovegetative blockade, as well as a sufficient level of pain relief with the minimal negative pharmacological effects of drugs on the kidney graft [5, 6]. To minimize the pharmacological effects of general anesthesia and achieve an adequate pain relief in the immediate postoperative period some clinics and centers use regional anesthesia as one of the anesthetic management components of [7, 8]. Our own previous studies on this issue have also shown a positive effect of the regional component of anesthesia as part of general anesthesia on outcomes in SKPT [9]. However, in the literature there are conflicting opinions regarding the epidural component as part of general anesthesia in SKPT. Along with the high efficiency and safety of this technique, some studies have noted side effects of epidural anesthesia in transplant surgeries of long duration [10–12]. In general, the issue of the epidural component as part of general anesthesia requires a more in-depth analysis and further research in SKPT recipients.

The objective was to compare the efficacy of anesthetic management using combined general anesthesia with and without an epidural component in SKPT recipients.

Material and methods

A retrospective comparative analysis with prospective control of the anesthetic management efficacy when using combined general anesthesia with and without an epidural component was performed in 85 SKPT recipients operated on in the period from January 1, 2008, to December 31, 2024 in the Kidney and Pancreas Transplantation Department of the N.V. Sklifosovsky Research Institute for Emergency Medicine. Preliminary approval was obtained from the local ethic Committee on Biomedical Ethics of the N.V. Sklifosovsky Research Institute for

Emergency Medicine to conduct the study (extract from Protocol No. 7-24 dated September 3, 2024).

The inclusion criteria for the study were the following:

– patients suffering from type 1 diabetes complicated by CKD 5 as a result of diabetic nephropathy, who have been placed on the waiting list for SKPT surgery;

– Patient age from 18 to 50 years;

– Informed consent signed by the patient to participate in the study.

The criteria for exclusion from the study were as follows:

– isolated kidney transplantation;

– patient's refusal to participate in the study.

Depending on the anesthetic support method, all recipients were allocated into two groups. Group I included the patients operated on under general combined anesthesia with an epidural component of intraoperative pain relief. Group II included the patients who underwent surgery under general combined anesthesia without an epidural component of pain relief. The epidural component as part of general anesthesia was not used in patients due to patient refusal of the technique, the presence of one or more contraindications, hemodialysis less than at 6 hours before surgery, intake of antiplatelet agents or anticoagulants, technical failures during an attempt at puncture and (or) catheterization of the epidural space.

Demographic and clinicopathological characteristics of recipients included age, gender, body mass index (BMI), type and length of renal replacement therapy (RRT), duration of diabetes history, and the presence of concomitant cardiac pathology. All patients had an initially severe condition due to the presence of type 1 diabetes in the decompensation stage in combination with CKD 5, and were evaluated as belonging to the third class by the Physical Status Classification system of the American Association of Anesthesiologists.

A 0.75% ropivacaine solution was used as an epidural anesthetic. Epidural space catheterization was performed at the level of Th8–Th9 in patient's lateral decubitus position before induction anesthesia in the Operating Room. There were no complications with epidural space puncture. The schemes of induction anesthesia, relaxation, and maintenance anesthesia were similar in both groups. Induction of general anesthesia was performed by intravenous administration of midazolam (0.05–0.1 mg/kg), propofol (1.5 mg/kg), fentanyl (3 mcg/kg) and cisatracurium (0.15 mg/kg), maintenance anesthesia was performed using an inhalation agent (isoflurane, sevoflurane or desflurane) in an oxygen-air mixture with a target minimum alveolar concentration of 0.7–1.0 with fractional administration of fentanyl, cisatracurium, and propofol, depending on the surgery stage and the time factor. Maintenance of airway patency in both groups was performed by standard orotracheal intubation. All patients were on mechanical ventilation (Drager Primus) in Volume Control mode using minimal or low flow of fresh gas (0.5–2 L/min). After ventilation and hemodynamic parameters had been stabilized, 0.375% ropivacaine solution was administered into the epidural space to patients of group I (the officinal preparation of a 0.75% solution of the local anesthetic ropivacaine that was diluted in 0.9% sodium chloride solution in a 1:1 ratio). Ropivacaine was administered through a drug dispenser. The dosage of ropivacaine was selected individually with respect to the intraoperative hemodynamic parameters, to create a sympathetic and analgesic segmental blockade at the level where the iliac vessels and a section of the small intestine, necessary for creating anastomoses with transplanted organs, were located. The total dose of ropivacaine did not exceed the maximum acceptable dose.

All patients received dopamine infusions via a perfusion pump. A 4% dopamine solution was used at a dose of 200 mg, diluted in 50 ml of physiological sodium chloride solution.

The rate of dopamine administration depended on hemodynamic parameters, i.e. to maintain the systolic blood pressure (BP) at least 100 mm Hg, and mean arterial pressure (MAP) of at least 70 mm Hg. During reperfusion of the renal allograft and pancreatic allograft, the blood pressure was maintained at a level of at least 140/90 mmHg, the mean arterial pressure at a level of at least 90 mmHg. The rate of dopamine administration averaged 2-9 mcg/kg/min.

The surgery consisted of the following intraoperative stages: beginning of surgical intervention(I); RAG reperfusion (II); PAG reperfusion (III); forming the interintestinal anastomosis (IV); surgery completion (v).

The primary endpoints in the study were the following: intraoperative hemodynamic parameters, including central venous pressure (CVP), mean arterial pressure (MAP), and heart rate (HR) at the stages of surgery; comparison of acid-base balance and blood electrolyte levels at these stages of surgery; comparison of intraoperative consumption of anesthetic drugs: fentanyl , propofol and cisatracurium at the end of surgery; comparison of patient extubation rates in the operating room on surgery completion, as well as the frequency of development of postoperative nausea and(or) vomiting (PONV) at the end of surgery between the two groups.

Secondary endpoints were: 1) the time of gastrointestinal motility recovery determined by auscultation and/or passage of intestinal gases in the Intensive Care Unit; 2) the patient length of hospital stay.

Recipients with in-hospital deaths were excluded from the study of the length of hospital stay.

Intraoperative data of patients from both groups were analyzed, including data on surgery duration, blood loss volume, the intravenous fluid therapy volume, vasopressor administration rates, and diuresis by the end of surgery.

Induction immunosuppressive therapy was performed using mono- or polyclonal antibodies. Basic immunosuppressive therapy included calcineurin inhibitors (tacrolimus or cyclosporine), mycophenolic acid preparations, and glucocorticosteroids. There were no differ statistically significantly differences between the groups in the main components of the immunosuppressive therapy regimens ($p>0.05$).

Quantitative parameters were assessed for normal distribution using the Shapiro–Wilk test. The quantitative indicators with normal distribution were described using arithmetic means and standard deviations. In the absence of normal distribution, the quantitative data were described using the medians and the lower and upper quartiles (Me (Q_1;Q_3)). Categorical data were described using absolute values and percentages. The comparison of two groups for a quantitative parameter with a normal distribution, assuming equal variances, was performed using the Student's t test. The comparison of percentages in the analysis of four-field contingency tables was performed using Fisher's exact test (for expected event values less than 10) and Pearson's χ^2 (for expected event values greater than 10). To assess the significance of the odds ratio, the 95% confidence interval limits were calculated. Differences were considered statistically significant at $p<0.05$. Microsoft Office graphic editors v. 16.16.27, SPSS v. 27.0 and StatTech v. 2.8.8 were used to create diagrams and graphs.

Results

The main demographic and clinical-pathological characteristics of the two groups were compared and presented in Table 1.

Table 1. Demographic and clinical pathology characteristics of recipients under anesthesia of different types

Parameter	Group I (n=36)	Group II (n=49)	p
Age, full years Me (Q_1;Q_3)	36 (30.5;38.5)	34 (31;39)	0.982*
Gender: Men, (n) (%) Women, (n) (%)	16(44.4%) 20 (55.6%)	17(34.7%) 32 (65.3%)	0.362**
BMI, kg/m^2 Me (Q_1;Q_3)	21.38 (20.1;22.66)	20.55 (19.19; 22.4)	0.204*
History of diabetes, full years Me (Q_1;Q_3)	25 (20;29.5)	24 (20;28.5)	0.853*
Period on RRT, full years Me (Q_1;Q_3)	2 (1;4)	2.5 (1;4)	0.584*
Associated cardiac pathology:			
Hypertension, n (%)	14 (38.9%)	14 (28.6%)	0.317**
Ischemic heart disease, n (%)	14 (39%)	11 (22.5%)	0.100**

Notes: The differences are statistically significant at $p<0.05$; *Mann–Whitney U test; **Pearson χ^2

As can be seen from Table 1, the main baseline characteristics of recipients were similar in both groups; no statistically significant differences were obtained for any of the parameters.

Table 2 presents intraoperative hemodynamic parameters: CVP, MAP and HR at the beginning of surgery, at the moment of RAG and PAG reperfusion, at the moment of the intestinal anastomosis completion, and at the end of surgery.

Table 2. Intraoperative hemodynamic parameters under anesthesia of different types

Parameter	Group I (n=36)	Group II (n=49)	p
CVP, mmHg			
Start of surgery Me (Q_1;Q_3)	8 (5;9)	8 (6;9)	0, 833
RAG reperfusion Me (Q_1;Q_3)	9 (7;10)	8 (6;9)	0,290
PAG reperfusion Me (Q_1;Q_3)	8 (6.5;10)	7 (6; 9)	0.100
Intestinal anastomosis Me (Q_1;Q_3)	8 (7;10)	7 (7;10)	0.341
End of surgery Me (Q_1;Q_3)	7 (6;9)	7 (6;8)	0.949
MAP, mmHg			
Start of surgery Me (Q_1;Q_3)	106 (88;113)	113 (105;120)	0.016*
RAG reperfusion Me (Q_1;Q_3)	98 (91;103)	97 (89;103)	0.366
PAG reperfusion Me (Q_1;Q_3)	96 (92;102)	95 (91;100)	0.337
Intestinal anastomosis Me (Q_1;Q_3)	94 (89;99)	94 (89;98)	0,890
End of surgery Me (Q_1;Q_3)	103 (90;116)	94 (84;110)	0.105
Heart rate, bpm			
Start of surgery Me (Q_1;Q_3)	72 (66;80)	72 (66;82)	0.947
RAG reperfusion Me (Q_1;Q_3)	72 (63.5;82)	73 (66;82)	0.643
PAG reperfusion Me (Q_1;Q_3)	74 (69;85)	74 (68;88)	0.549
Intestinal anastomosis Me (Q_1;Q_3)	80.5 (68.5;90.5)	88 (75;91)	0.078
End of surgery Me (Q_1;Q_3)	84 (74;97)	88 (81;95)	0.449

*Differences are statistically significant at $p<0.05$

Given the data in Table 2, we can conclude that the MAP values differed statistically significantly only at the first stage, namely at the beginning of surgery, which can be explained by the baseline state of the patients rather than by the function of the epidural component of anesthesia. At this stage of comparison, the effect of the epidural component had not yet reached the required analgesic and sympathetic level. The HR and CVP values at all stages of monitoring did not differ between the groups statistically significantly, however, the HR values at the stages of interintestinal anastomosis and at the end of surgery in the first group were lower compared to those in the second group, which can be explained by the analgesic and sympathetic effect of the epidural component as part of general combined anesthesia.

The assessments of electrolyte parameters and acid-base balance data are presented in Table 3.

Table 3. Acid-base status parameters and electrolyte blood level during anesthesia of different types

Parameter	Group I (n=36)	Group II (n=49)	p
pH			
Start of surgery Me (Q_1;Q_3)	7,339 (7,325;7,366)	7,359(7,336;7,411)	0.157
RAG reperfusion Me (Q_1;Q_3)	7,325 (7,306;7,351)	7,335 (7,311;7,351)	0.487
PAG reperfusion Me (Q_1;Q_3)	7,336 (7,333;7,393)	7,353 (7,334;7,390)	0.918
Intestinal anastomosis Me (Q_1;Q_3)	7,374 (7,344;7,411)	7,385 (7,344;7,417)	0.961
End of surgery Me (Q_1;Q_3)	7,382 (7,339;7,436)	7,382 (7,327;7,436)	0.792
Lactate, mmol/L			
Start of surgery Me (Q_1;Q_3)	0.9 (0.8;1,6)	0.9 (0.7;1.6)	0.580
RAG reperfusion Me (Q_1;Q_3)	1.6 (1.2;2.1)	1.4 (1.2;2.0)	0.445
PAG reperfusion Me (Q_1;Q_3)	1.1 (1.0; 1.6)	1.2 (1.0;1.5)	0.775
Intestinal anastomosis Me (Q_1;Q_3)	1.1 (0.9;1.3)	1.3 (1.0;1.5)	0.035*
End of surgery Me (Q_1;Q_3)	1.25 (1.1;1.7)	1.5 (1.1;1.7)	0.497
Glucose, mmol/L			
Start of surgery Me (Q_1;Q_3)	10.5 (8.45;13.7)	10.6 (8.4;14.0)	0.862
RAG reperfusion Me (Q_1;Q_3)	9.35 (7.55;11.0)	11.1 (8.9;13.4)	0.008*
PAG reperfusion Me (Q_1;Q_3)	7.35 (5.0;8.9)	7.6 (6.3;10.1)	0.203
Intestinal anastomosis Me (Q_1;Q_3)	7.4 (5.85;8.95)	8.2 (6.5;9.9)	0.150
End of surgery Me (Q_1;Q_3)	7.25 (6.05;9.35)	7.3 (6.6;9.7)	0.644
K^+			
Start of surgery Me (Q_1;Q_3)	4.2 (3.7;5.3)	4.3 (3.8;5.3)	0.721
RAG reperfusion Me (Q_1;Q_3)	4.0 (3.6;4.75)	4.0 (3.5;4.7)	0.812
PAG reperfusion Me (Q_1;Q_3)	3.7 (3.6;4.0)	3.8 (3.6;4.2)	0.473

Intestinal anastomosis Me (Q_1;Q_3)	3.85 (3.55;4.1)	3.9 (3.7;4.1)	0.489
End of surgery Me (Q_1;Q_3)	3.9 (3.75;4.0)	4.0 (3.7;4.3)	0.366
Cl^-			
Start of surgery Me (Q_1;Q_3)	105 (101;107)	106 (101;107)	0.774
RAG reperfusion Me (Q_1;Q_3)	107.5 (104;109)	106 (104;108)	0.088
PAG reperfusion Me (Q_1 ;Q_3)	105 (102.5;109)	106 (102;109)	0.774
Intestinal anastomosis Me (Q_1;Q_3)	104 (101;110)	104 (101;107)	0.975
End of surgery Me (Q_1;Q_3)	104 (101.5;108)	105 (101;107)	0.950
NSO_3^-			
Start of surgery Me (Q_1;Q_3)	22.7 (21.5;23.9)	22.7 (20.9;23.9)	0.583
RAG reperfusion Me (Q_1;Q_3)	22.3 (21.7;23.7)	22.5 (21.9;22.8)	0.982
PAG reperfusion Me (Q_1;Q_3)	22.1 (21;24.3)	22.1 (20.7;23.8)	0.583
Intestinal anastomosis Me (Q_1;Q_3)	23.7 (22.4;25)	24.1 (22.4;24.9)	0.954
End of surgery Me (Q_1;Q_3)	25.4 (22.85;26.15)	24.6 (22.9;25.6)	0.714

* Differences are statistically significant at $p<0.05$

Statistically significant differences between groups I and II were noted in the glycemia levels at the stage of restoring blood flow in the transplanted kidney, 9.35 (7.55;11.0) mmol/L and 11.1 (8.9;13.4) mmol/L, respectively (p=0.008). At these stages, the epidural component of anesthesia reaches the required depth and effect. The remaining compared parameters did not show statistically significant differences, their differences between the groups were insignificant. Electrolyte parameters in both groups were within the acceptable values, which might indicate the adequacy of the fluid therapy volume and composition in patients of both groups.

Figures 1, 2 and 3 clearly show the consumption of anesthetic drugs: fentanyl, propofol, and cisatracurium at the end of surgery in two groups.

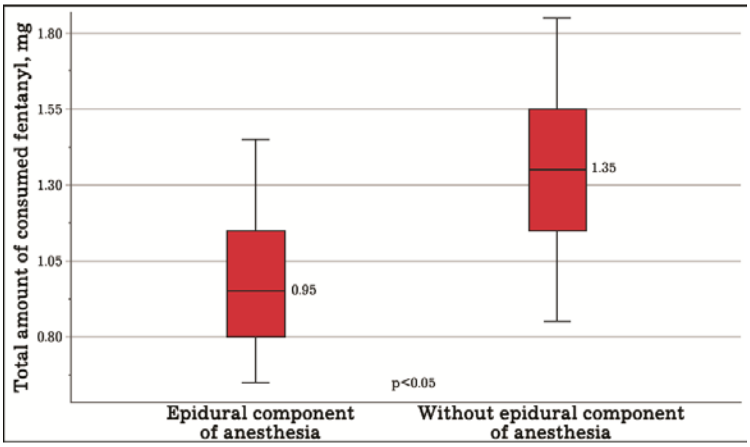

Fig. 1. Intraoperative consumption of fentanyl for different anesthesia types

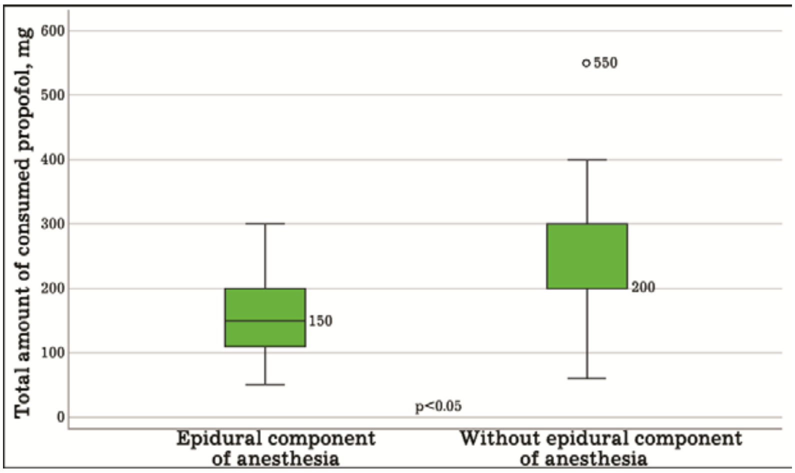

Fig. 2. Intraoperative consumption of propofol for different anesthesia types

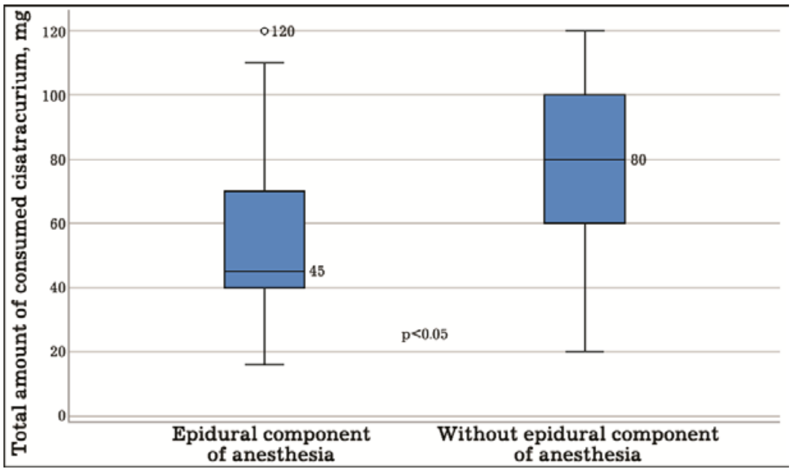

Fig. 3. Intraoperative consumption of cisatracurium for different anesthesia types

Based on the results presented in Fig. 1–3, we can conclude that the epidural component used as part of general multicomponent anesthesia contributes to a significant statistically significant reduction in the consumption of the used drugs: fentanyl by 30.7%, propofol by 25%, and cisatracurium by 43.8% when compared to their consumption during general anesthesia without an epidural component.

In the study, the frequency of extubations in the operating room and the PONV incidence in the operating room were analyzed and compared between the patients of two groups at the end of surgery (Table 4).

Table 4. The extubation rate and postoperative nausea and/or vomiting incidence in the operating room in general anesthesia with an epidural component

Event	Group I (n=36)		Group II (n=49)		p	OR [95% CI]
	Abs.	%	Abs.	%		
Extubations in the operating room	26	72.2	17	34.7	0.001*	4.89 [1.92–12.49]
PONV	4	11.1	14	28.6	0.063**	0.31 [0.09–1.05]

Notes: CI, confidence interval; OR, odds ratio; * Pearson χ^2; ** Fisher's exact test

According to the obtained data presented in Table 4, the frequency of extubations in the operating room was statistically significantly higher in group I compared to group II (p<0.001). The odds of being extubated in the operating room in patients of group I were 4.89 times higher than in patients of group II (95% CI [1.92–12.49]). There was a moderate Cramer correlation (V=0.371) between this event in the operating room and group I (patients with an epidural component of intraoperative analgesia).

When comparing the PONV incidence between groups I and II, no statistically significant differences were seen.

Figure 4 shows a comparison of the rates of extubation and PONV in the operating room in groups I and II.

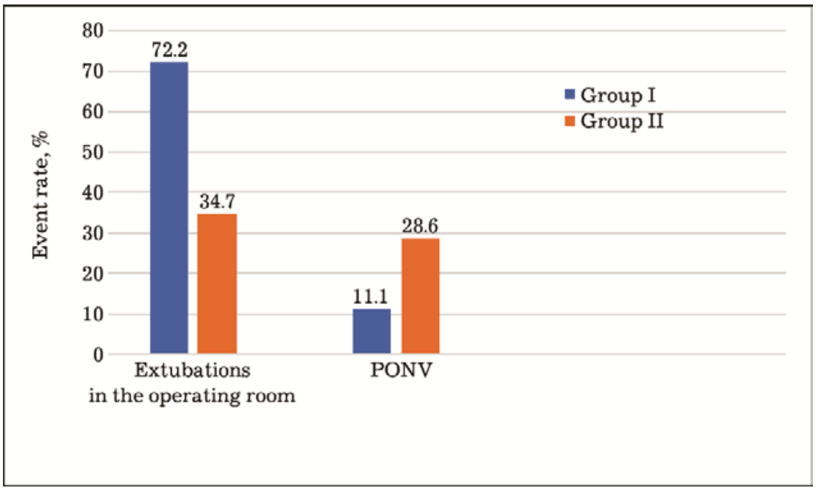

Fig. 4. Comparison of the extubation rates and postoperative nausea and/or vomiting in the operating room under different anesthesia types

As can be seen from Fig. 4, in group II the PONV incidence was 17.5% more frequent compared to patients in group I, although these differences did not reach statistical significance.

Intraoperative data of recipients of both groups and their statistical significance are presented in Table 5.

Table 5. General intraoperative data for different types of anesthesia

Parameter	Group I (n=36)	Group II (n=49)	p
Surgery duration, minutes Me (Q1;Q3)	530 (490;602)	530 (445;610)	0.689
Blood loss volume, mL Me (Q1;Q3)	350 (250;500)	300 (200;450)	0.203
Total infusion volume, mL Me (Q1;Q3)	3500 (3000;4100)	3440 (2500;4290)	0.447
Diuresis, mL Me (Q1;Q3)	300 (175; 500)	200 (100;300)	0.029*
Dopamine infusion rate, mcg/kg/min Me (Q1;Q3)	3(2; 4.5)	4(2;5)	0.259

* Differences are statistically significant at p<0.05

It follows from Table 5 that diuresis in Group 1 was statistically significantly higher than in Group II (300 (175;500) ml and 200 (100;300) ml, respectively) (p=0.029). a delayed RAG function was seen in 5 cases (13.9%) in the group with the epidural analgesia component, and in 9 cases (18.4%) in the group without the epidural component. There were no statistically significant differences in the number of patients with delayed RAG function between the groups (p=0.769). The remaining intraoperative parameters did not differ statistically significantly between the two groups.

The timing of intestinal motility recovery in the early postoperative period was analyzed in both groups. The median time of intestinal motility recovery determined by auscultation and/or passage of intestinal gases in the Intensive Care Unit was 32 (28;36) hours in group I, which was statistically significantly lower compared to group II, where this parameter was equal to 39 (36;44) hours ($p<0.001$). The medians of the intestinal motility recovery timing in patients compared between groups I and II are clearly presented in Fig. 5.

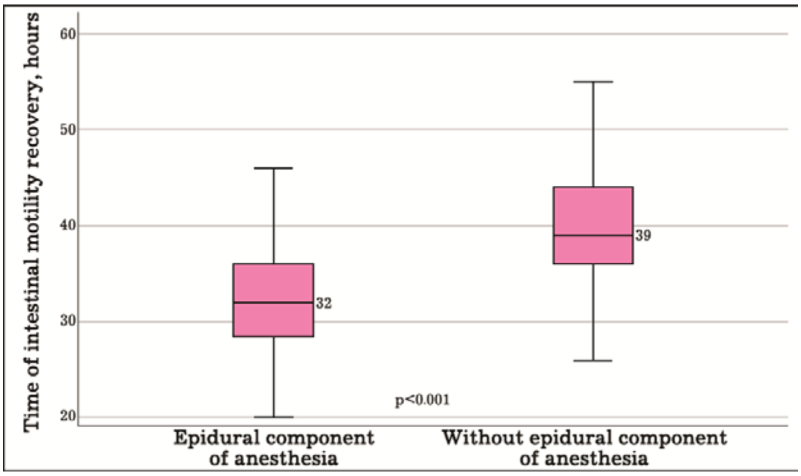

Fig. 5. Timing of intestinal motility recovery after simultaneous kidney and pancreas transplantation

Among patients in group I, there were 4 in-hospital fatal outcomes (11.1%), the minimum period before fatal outcome was 3 days, and the maximum was 27 days. In group II, there were 5 patients with hospital fatal outcome (10.2%). The minimum period before fatal outcome in this group was 4 days, the maximum was 77 days. There was no statistically significant difference in hospital fatal outcomes between groups I and II ($p=1.000$).

The conducted analysis of patients' hospital stay did not reveal statistically significant differences between the compared groups (p=0.395). However, the median hospital stay of recipients from group I was 35 (26;58) days, while it was 38.5 (28;68) days in group II, which is clearly demonstrated in Fig. 6.

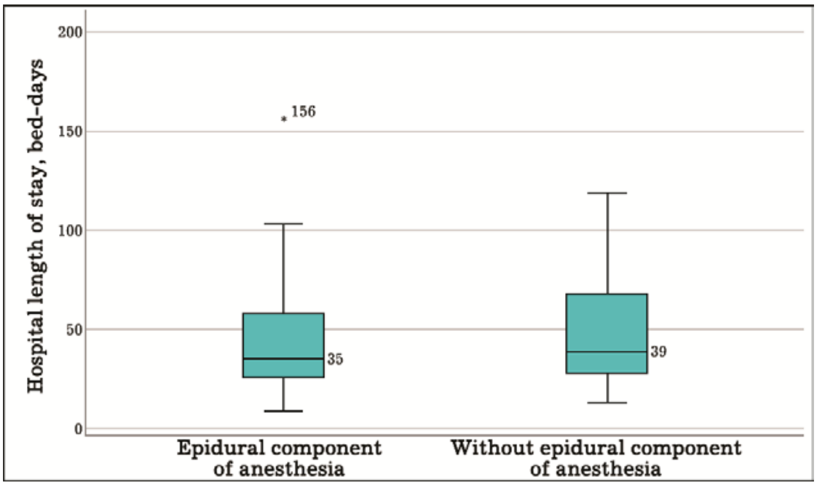

Fig. 6. Hospital length of stay for recipients with intraoperative anesthesia of different types

Discussion

In our earlier study, which assessed the effectiveness of using epidural anesthesia as part of general multicomponent anesthesia, we demonstrated that the use of this technique reduced the consumption of opioids, hypnotics, and muscle relaxants during surgery, which, on the one hand, undoubtedly reduced the drug load on the transplanted organs and, and on the other hand, facilitated a patient extubation in the operating room at the end of the surgery and earlier ambulation in the postoperative period [9]. Earlier international studies emphasized the efficacy and safety of epidural anesthesia in isolated kidney transplantation with proper preoperative preparation of recipients. Hemodialysis on the day of surgery and unstable initial hemodynamic parameters of recipients preclude the use of epidural anesthesia [13]. However, there are other points of view based on the studies conducted. Thus, in their studies B.L. Philips et al. do not recommend the use of an epidural component because of the development of hypotension during surgery and the risk of developing spinal cord ischemia [10]. In their study, Y.L. Yeap et al. emphasize the importance of a multimodal approach to perioperative pain relief in pancreas transplants due to its higher efficiency and reduced use of opioids. In this regard, the authors emphasize the greater efficiency of the transverse abdominis muscle block compared to epidural analgesia [14]. Researchers are wary of epidural analgesia due to possible complications during puncture and an epidural catheter placement in terms of hypocoagulation, especially during RRT and systemic heparinization immediately before surgery [11, 14]. At the same time, interfascial blockade of the transverse abdominis muscle under ultrasound guidance is not always effective, does not have a pronounced vegetative effect, and requires additional special skills [11, 12]. Meanwhile, the use of epidural analgesia improves pancreatic perfusion and reduces the severity of postoperative pancreatitis [15]. N. Hadimioğlu et al. have also showed that the combination of epidural and general anesthesia attenuates stress responses to surgery, reducing inflammatory markers and insulin resistance. The same researchers have demonstrated a relationship between the use of the epidural component as part of general anesthesia and a reduction in hospital length of stay [7].

The results of our studies, both previous [9] and current, have shown more convincingly that the use of an epidural component as part of general multicomponent anesthesia for SKPT has obvious advantages and, following certain criteria, namely excluding hemodialysis on the day of surgery and indicating normal hemostasis parameters, the technique is safe.

The use of an epidural component of anesthesia as part of general multicomponent anesthesia for SKPT provides additional antinociceptive protection, allowing a statistically significant reduction in the use of anesthetic drugs without affecting intraoperative hemodynamic parameters. In our study, in the group of patients with an epidural component of anesthesia, the total volume of intraoperative diuresis statistically significantly increases, probably due to a pronounced sympathetic effect in the area of iliac vessels and improved perfusion of the renal allograft. It is worth noting that this occurs in terms of stable hemodynamic parameters, in particular, the mean arterial pressure at the stage of renal transplant reperfusion. The combination of an epidural component as part of general anesthesia and a mean arterial pressure of at least 90 mm Hg during reperfusion of the renal graft provided better diuresis parameters at the end of surgery compared to the group of patients without an epidural component. Similar results are presented in the studies by E. S. Hirata et al., where total diuresis after kidney transplantation was observed to be higher in the group of patients who received a combination of epidural and general anesthesia in the absence of episodes of intraoperative hypotension [16]. In another study, R. Sucher et al. emphasize the importance of intraoperative MAP exceeding 91 mm Hg at the stages of RAG and PAG reperfusion with the subsequent positive effect on the early and long-term results of surgery [17]. In our similar study, early results were examined in groups of patients with MAP lower than 90 mm Hg and with MAP over 90 mm Hg during reperfusion of the kidney allograft, where we obtained the results similar to those of foreign colleagues [18]. Thus, maintaining MAP at least 90 mm Hg during RAG and PAG reperfusion provides better results in SKPT, and in combination with the epidural component of anesthesia, it favorably influenced the total intraoperative diuresis, providing better perfusion of the renal allograft.

In the group of patients with an epidural component of anesthesia, a statistically significantly higher rate of tracheal extubation in the operating room at the end of surgery and a more rapid intestinal motility recovery in the early postoperative period were noted compared to group II.

Median hospital length of stay for recipients made 35 (26;58) days in group I, and 38.5 (28;68) days in group II. These differences were statistically insignificant ($p=0.395$), however, the tendency to reduce the hospital length of stay in the patients of the group with an epidural intraoperative component of analgesia indicated a favorable effect of the latter. At the same time, one should remember that there are other independent factors that also affect the overall hospital length of stay in patients after SKPT.

Conclusions

1. The use of an epidural component as part of general multicomponent anesthesia allows for a 37.5% more frequent extubation of patients in the operating room at the end of surgery ($p<0.001$), as well as a 1.3-fold reduction in the time required to restore intestinal motility in recipients ($p<0.001$).
2. The epidural component of anesthesia as part of general multicomponent anesthesia has a positive effect on the initial function of the nephrograft, statistically significantly increasing intraoperative diuresis by 1.5 times ($p=0.029$).
3. The use of an epidural component as part of general multicomponent anesthesia helps to reduce the consumption of fentanyl by 1.45 times ($p<0.001$), cisatracurium by 1.78 times ($p<0.001$), and propofol by 1.33 times ($p<0.001$) compared to their consumption during general anesthesia without an epidural component.

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