CASE REPORT

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Specific features of anesthetic management in simultaneous pancreas and kidney transplantation in a recipient with morbid obesity

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Abstract

Introduction. *Anesthetic management in simultaneous pancreas and kidney transplantation in recipients has some specific features. In addition to the presence of underlying pathology in the form of type 1 diabetes mellitus and secondary diabetic complications, pronounced comorbidities can often make some difficulties for an anesthesiologist.*

Aim. *We have reported a clinical case showing the specific features of anesthetic support for simultaneous pancreas and kidney transplantation in a recipient with morbid obesity.*

Clinical Case Report*. Specific features of the anesthetic management of a 42-year-old patient L. with morbid obesity (body mass index 43.3 kg/m²) and hypertension who underwent simultaneous pancreas and kidney transplantation have been described. A preoperative examination of this patient revealed predictors of difficult airways, so endoscopically assisted intubation was performed. The Trendelenburg position of the patient during surgical intervention due to an excess body weight led to* *the increased intrathoracic pressure intraoperatively. The pressure ventilation mode, the neutral position of the patient on the operating table, and the monitoring of ventilation efficiency made it possible to return the elevated intrathoracic pressure to normal. A preoperative examination by a cardiologist, timely diagnosis and treatment of hypertension at the stage of placing the patient on the waiting list made it possible to exclude adverse hemodynamic reactions at the main stages of the operation. The patient was extubated on surgery completion in the Operating Room. The pancreatic graft function and the kidney graft function were satisfactory.*

Conclusion. *Our approaches ensured the safety and efficacy of anesthesiological support and contributed to the successful implementation of simultaneous pancreas and kidney transplantation in the recipient having the concomitant pathology in the form of morbid obesity.*

Keywords: simultaneous pancreas and kidney transplantation, morbid obesity, anesthetic management, hypertension

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BP, blood pressure
i.v., intravenously
BMI, body mass index
ABS, acid -base state
CETA, combined endotracheal anesthesia
LV, left ventricle
ICU, Intensive Care Unit

PEEP, positive end expiratory pressure
Type 1 DM, type 1 diabetes mellitus
MPAP, mean pulmonary artery pressure
CO_2 et, exhaled CO_2 content
SPKT, combined pancreas and kidney transplantation
PG, pancreas graft
ESRD, end-stage chronic renal disease
USE, ultrasound examination
EF, ejection fraction
CVP, central venous pressure
RR, respiratory rate
HR, heart rate
ECG, electrocardiogram
EchoCG, echocardiography
Clt, compliance
FiO_2, fraction of inspired oxygen in the inhaled gas mixture
I:E, inhalation to exhalation ratio

Introduction

Combined pancreas and kidney transplantation (SPKT) is recognized worldwide as a surgical treatment option for patients suffering from type 1 diabetes mellitus (DM) complicated by end-stage chronic renal disease (ESRD) [1]. It allows one to stop or slow down the progression of secondary diabetic complications by achieving euglycemia amid true insulin resistance, achieving the best medical and social rehabilitation and, thereby, further improving the quality of life of these patients [2–5].

Unfortunately, the method has not received widespread clinical use due to a critical shortage of donor organs and a high level of post-transplant surgical complications [6]. In addition, the initially severe condition of recipients due to severe diabetes mellitus, secondary diabetic complications, and severe concomitant pathology place increased demands on anesthesia during this operation [7, 8].

Recipient age is not an absolute contraindication, but data on outcomes in older recipients are scarce [9]. However, studies have shown that recipients over 40 years of age who require SPKT are 4 times more likely to suffer from cardiovascular diseases, while the risk of perioperative cardiovascular complications in such patients may exceed 10% [9, 10].

Over the past decade, the prevalence of obesity among patients with type 1 DM and ESRD has been steadily increasing, as in the general population [7, 11]. Obesity may influence the results of surgical intervention of for SPKT [12, 13]. This is confirmed by the data obtained by Bedat et al. who showed that overweight and obesity were independent predictors of early pancreas allograft loss and early patient death (less than 90 days), and obesity was associated with poorer long-term pancreas allograft survival [14]. However, some studies have shown similar patient and graft survival in obese patients compared with patients with normal body mass index (BMI) [15]. Thus, although obesity may affect surgical outcomes, it is not considered an absolute contraindication for performing SPKT [13–15].

Morbid obesity is an excessive deposition of fat mass with BMI of at least 40 or 35 kg/m^2 in the presence of serious complications associated with obesity [16]. The incidence of morbid obesity is increasing among patients with type 1 DM and currently reaches 36% [17]. It is known that the administration of anesthesia in patients with morbid obesity has certain peculiarities [11, 18]. Most of these patients have difficulty with maintaining the airway. Therefore, they need more detailed preoperative diagnostic measures to identify predictors of difficult airways and prepare for anesthesia [18, 19]. Obesity affects the development of hypertension with damage to target organs, mainly blood vessels and the heart [20, 21]. This leads to ventricular hypertrophy, the development of pulmonary hypertension and an increased incidence of cardiac complications [21, 22]. Morbid obesity also causes the respiratory system dysfunction, in particular, restrictive disorders caused in most cases by a decrease in the effective volume of the lungs [19, 21]. A specific feature of the SPKT operation is the position of the table with the head end lowered downwards by 15°–20°, which technically improves the surgical access and facilitates some surgical manipulations [23, 24]. However, these intraoperative aspects pose an additional anesthetic challenge in patients with high BMI due to the development of increased intrathoracic pressure [19, 25]. In addition to the fact that SPKT is a non-routine multi-hour operation, and most recipients, due to the characteristics of the underlying disease, have a normal or reduced BMI, a successful anesthesia in a patient with concomitant comorbidity in the form of morbid obesity served as the reason for describing this clinical case.

Objective. To demonstrate a clinical case showing the specific features of anesthesia during combined pancreas and kidney transplantation in a recipient with concomitant pathology in the form of morbid obesity.

Clinical Case Report

Patient L., 42 years old, had the height of 168 cm, weight of 122 kg (BMI 43.3 kg/m^2) with the diagnosis of Type 1 diabetes mellitus of severe course, subcompensation, diabetic nephropathy, chronic kidney disease stage 4, ESRD (predialysis stage), morbid obesity, stage III hypertension, grade 3, risk 4 (very high).

From the patient medical history it was known that Type 1 DM was diagnosed in 1979. After the diagnosis had been made, an insulin replacement therapy was immediately started. By the time of the operation, the need for exogenous insulin reached 40 units per day. Since

2001, the episodes of arterial hypertension have periodically occurred with blood pressure rising to 170/110 mm Hg. In the same year, proteinuria was first identified and the initial stage of chronic renal failure was diagnosed. Despite conservative treatment, diabetic nephropathy progressed, and a conservatively curable stage of chronic renal failure (stage 4 chronic kidney disease) was diagnosed. Indications were determined for starting renal replacement therapy, predialysis SPKT. In terms of examinations for the placement on the waiting list, the patient was consulted by a cardiologist, and a permanent three-component regimen of antihypertensive therapy was prescribed, including enalapril 5 mg twice daily; Nifecard 30 mg once daily; moxonidine 0.2 mg twice a day. The patient also took atorvastastin 10 mg once a day. In terms of additional examination, an electrocardiogram (ECG) was performed that showed heart rate (HR) of 84 beats per minute, sinus rhythm, diffuse changes in the myocardium, as well as echocardiography (EchoCG) that showed the ejection fraction (EF) of the left ventricle (LV) 65%; global and segmental myocardial functions were not impaired, pulmonary artery pressure was 28–30 mm Hg.

After all the necessary tests, consultations with specialists, and the absence of absolute contraindications, the patient was put on the waiting list for SPKT. The total period on the waiting list was 2 years and 5 months. During that period, the patient was examined annually by a cardiologist, and the efficacy of antihypertensive therapy was monitored, as well as control ECG and EchoCG investigations (without significant dynamics). While taking the medications, a target blood pressure (BP) of 140/80 mmHg was achieved.

As soon as histocompatible grafts were found, he was hospitalized to the N.V. Sklifosovsky Research Institute for Emergency Medicine on an emergency basis in order to perform SPKT.

Upon admission, an ECG was performed: heart rate was 88 per minute, with sinus rhythm, signs of LV hypertrophy; at EchoCG, no zones of hypokinesis and akinesis were identified, LV contractility was preserved, F was 60%, mean pulmonary artery pressure (MPAP) was- 25 mm Hg., chest X-ray showed the lung fields without fresh focal and infiltrative shadows, with pneumosclerosis.

At the time of admission for surgery, the patient maintained his own diuresis in a volume of up to 1500 ml/day.

When examined by an anesthesiologist, attention was drawn to morbid obesity (BMI 43.3 kg/m^2), as well as to the present predictors of difficult airways: the distance between the incisors when opening the mouth was less than 4 cm, the Mallampati Scoring Class III, the thyromental distance was less than 6 cm, the temporomandibular joint stiffness. The El-Ganzouri risk index scored 9. Indications for intubation of a conscious patient using bronchoscopy have been determined. General anesthesia in combination with an epidural component was used throughout the entire surgical procedure.

Intraoperative antibiotic prophylaxis was performed by a single dosage of ceftriaxone 1000 mg intravenously (i.v.) 20 minutes before the skin incision, and vancomycin 500 mg i.v. over an hour.

In the operating room under local anesthesia with 2.0 ml of 2% Sol. Lidocaini, the puncture and catheterization of the epidural space at the Th7–Th8 level were performed in accordance with the required technique. The epidural catheter was inserted at 3.5 cm cranially. A test dose of 3.0 ml (60 mg) of 2% lidocaine solution was administered. There were no signs of spinal block. Considering the duration of the intended intervention, concomitant cardiac pathology and obesity, the patient underwent installation of an arterial catheter for invasive blood pressure measurement. Local anesthesia of the oropharynx was performed with a spray containing a 10% lidocaine solution. Next, the patient underwent preoxygenation through a face mask for 5 minutes. For the purpose of sedation, an intravenous bolus injection of midazolam was made. Under the bronchoscope control, the orotracheal intubation procedure was performed with a 9.0 endotracheal tube on the first attempt. During the manipulation, an enlarged epiglottis was visualized. After successful intubation through the bronchoscope, anesthesia was induced with the following drugs administered intravenously: propofol 2 mg/kg, fentanyl 0.005 mg/kg, cisatracurium 0.15 mg/kg. Anesthesia was maintained throughout the operation with the inhalational anesthetic of sevoflurane with a target minimum alveolar concentration of 0.8–1.0 (1.0–2.7 vol.%), as well as the administration of fentanyl 0.003 mg/kg/h and cisatracurium 0.2% at a dose of 0.05 mg/kg depending on the surgery stage, time factor and hemodynamic presentation. When calculating the drug consumption, the patient's ideal body weight was used. The patient was ventilated using a Drager Primus anesthesia breathing circuit. Initially, the ventilation mode by volume was chosen with the following parameters: tidal volume of 8 ml/kg in terms of ideal body weight, respiratory rate (RR) of 10 per minute, inhalation to exhalation ratio (I:E) was 1:2, positive end expiratory pressure (PEEP) was 4 cm of H_2O; the fraction of inspired oxygen in the inhaled gas mixture (FiO_2) was 50%. The effectiveness of ventilation was determined by pulse oximetry, expiratory capnometry data (CO_2 et), blood gas composition, and by auscultation. With these ventilation parameters, the mean airway pressure was at the level of 14 cm H_2O, the peak inspiratory pressure was 21–25 cm H_2O with compliance (Clt) of 85–95 ml/cm H_2O. However, when placing the patient in the Trendelenburg position with an elevation of 20° at the foot end of the operating table, the negative dynamics appeared in the form of an increased peak pressure to 38–40 cm H_2O, a decreased compliance to

35–40 ml/cm H_2O. The patient was switched to pressure ventilation mode with the following parameters: the inspiratory pressure of 28 cm H_2O, respiratory rate of 14 per minute, I:E being 1:2, PEEP of 5 cm H_2O. Given the patient's difficulty ventilating, the operating table was returned to its original neutral position. Positive dynamics were noted in the form of an increase in compliance up to 90 ml/cm H_2O. Subsequently, until the surgery completion, the ventilation mode and parameters remained unchanged.

After stabilizing the patient’s condition, the ultrasound-guided puncture and catheterization of the internal jugular vein on the right was performed with technical difficulties caused by anatomical features due to impaired neck extension and head rotation, as well as a short neck due to the morbid obesity, with installation of a 12Fr catheter to a depth of 13 cm. Twenty minutes before the skin incision, 0.375 % bupivacaine infusion into the epidural catheter was started at an initial rate of 6 ml/h (20 mg/h) with hemodynamic parameters being stable. Further, during the surgery, the rate of bupivacaine administration varied from 3 to 10 ml/h (9-30 mg/h) depending on the certain hemodynamic parameters and clinical presentation, as well as the surgery stages, to create sympathetic and analgesic segmental blockade. For the assessment and monitoring of the patient’s condition parameters, we defined six intraoperative stages: (I) endoscopic orotracheal intubation in consciousness and induction anesthesia; (II) surgery initiation; (III) renal reperfusion; (IV) pancreas reperfusion; (V) making of interintestinal anastomosis; (VI) surgery completion.

At each stage, the parameters of the acid-base state, hematocrit, hemoglobin and glucose levels were determined.

The total surgery duration was 760 minutes. The intraoperative volume of blood loss was 500 ml. The hemoglobin level did not decrease below 90 g/L, while the hematocrit was in the range of 32.3–27.9%. The fluid therapy volume was 3100 ml. The fluid therapy was performed with monitoring the central venous pressure (CVP). It contained crystalloids based on balanced crystalloid solutions, and 5% sodium bicarbonate solution (1.5 ml/kg of body weight) for reperfusion. The rate of diuresis was maintained at a level of at least 100 ml/h and by the end of surgery it made 1500 ml. The patient's body temperature was monitored throughout the entire surgery.

The patient was hemodynamically stable at all stages of surgery, the blood pressure was in the range of 120–155/70–90 mm Hg (mean 87–122 mm Hg), the heart rate was 66–87 beats per minute; CVP varied from 4 to 13 cm H_2O.

Considering that the patient had severe decompensated Type 1 DM and hyperglycemia before surgery (glycemia level before admission to the operating room was 14.6 mmol/L), immediately after placement of the central venous catheter, the insulin infusion was started through an insulin infusion pump at an initial rate of 10 U/h. Subsequently, the infusion rate varied within 6–10 U/h with mandatory glycemic control at least once an hour and was completely stopped after reperfusion of the pancreas graft, with the glycemia stabilized at a level of 6–8 mmol/L.

On surgery completion, after restoring a good muscle tone and clear consciousness, the patient was extubated in the operating room and transferred to the Intensive Care Unit (ICU) for further treatment.

In the ICU, a delayed renal graft function was observed, which required three sessions of prolonged veno-venous hemodiafiltration with the water excretory function having been restored by the 6th day of the postoperative period, and the nitrogen excretory function by the 8th day. From the first day, an immediate pancreas graft function (PGF) was noted with euglycemia amid true insulin independence without exogenous insulin administration. At the end of surgical treatment after SPKT, the patient was successfully discharged from the hospital.

At the time of writing this clinical case report, the patient has been monitored on an outpatient basis for more than 1 year with stable functioning renal graft and PG, with preserved water and nitrogen excretory functions, and in a state of euglycemia without exogenous insulin administration.

Results and discussion

Obesity is a steadily growing disease among the global population in general and among diabetics in particular [26]. Besides worsening the prognosis of the underlying disease, obesity causes progression of comorbidities [27]. Studies have shown that obesity can affect the outcomes of surgical intervention for SPKT [12–14]. The position of the patient on the operating table matters. As can be seen from the clinical example, the Trendelenburg position, often used by surgeons for SPKT, is a provoking factor in the development of hypoventilation and hypoxemia in a number of recipients [19]. In particular, in recipients with overweight and obesity, this body position leads to the development of increased intrapulmonary pressure. This condition, if untimely detected in recipients with decompensated diabetes and the presence of concomitant cardiac pathology, leads to homeostasis impairment with unfavorable outcomes [25–27]. Table 1 shows that the lowest levels of blood oxygen, saturation, capnometry, and compliance were recorded at the first two stages of surgery. This was mainly caused by poor ventilation when the operating table was tilted between surgery stages I and II, respectively.

Table 1. Values of some homeostasis parameters at the main stages of surgery

Stage of surgery	PaO_2 – mm Hg	PvO_2 mm Hg	SvO_2 %	SpO_2 %	CO_2 et	Clt mL/cm H_2O
I	145	47.5	71.1	95	40	6 4
II	122	38.5	61.5	92	50	52
III	1 92	50.5	77.3	99	34	81
IV	190	52.5	75.9	99	32	90
V	202	50.6	77.1	98	29	88
VI	188	42.6	74.2	99	30	83

Subsequently, at the remaining stages, positive dynamics were observed with stable parameters of gas composition, saturation, capnometry, and compliance in connection with the selected parameters and ventilation mode, returning the operating table to the “zero position”.

As can be seen from Table. 2, the acid-base status parameters and the blood level of electrolytes were within normal range at each stage of surgery, as well as in the first two stages, which was probably caused by a good compensatory reaction of the body at the time of unsatisfactory ventilation.

Table 2. Values of acid-base status and electrolyte levels in blood at the main stages of surgery

Parameter	Stage of surgery					
	I	II	III	IV	V	VI
pH	7.29	7.30	7.31	7.33	7.34	7.38
PvO_2	47.5	38.5	50.5	52.5	50.6	42.6
Lac, mmol/l	0.5	1.1	1.4	1.2	1.1	1.2
Na^+, mmol/l	134	135	136	138	139	139
Cl^-, mmol/l	113	112	113	114	113	111
K^+, mmol/l	4.5	4.2	3.7	3.4	3.7	3.9
BE, mmol/l	-3.3	-4.5	-2.6	-4.6	-3.8	-1.7
HCO_3^-, mmol/l	20.9	20.5	21.7	20.4	21.1	22.6

"Stiff joint" syndrome, which occurs in up to 50% of patients with type 1 DM, along with a higher incidence of obesity, increases the likelihood of difficult airway, which should be carefully assessed [18, 28]. Preoperative examination of the patient to identify predictors of difficult airways helps to promptly attract specialists with endoscopic equipment and to plan intubation tactics with minimal complications for the patient [28].

This category of patients is characterized by the presence of arterial hypertension, dyslipidemia, atherosclerosis and calcification of the coronary arteries, which certainly affects the surgery outcome [22].

Recipients should not discontinue antihypertensive or antianginal therapy on the eve of surgery; moreover, it is recommended to administer the previously selected drugs as part of premedication [22, 23]. These recommendations were followed in our clinical case.

Table 3. Hemodynamic parameters of the patient at the main stages of surgery

Stage of surgery	BP, syst./diast. (mean) mm Hg	Heart rate, per minute	CVP, cm H_2O
I	135/75 (95)	66	4
II	120/70 (87)	70	9
III	125/80 (95)	68	12
IV	129/89 (109)	74	10
V	140/60 (87)	73	13
VI	155/90 (122)	87	12

The data in Table 3 indicate that the patient remained hemodynamically stable during all stages of surgery, with the exception of the last one, which is probably explained by the patient's reaction to awakening and withdrawal of the inhaled anesthesia agent.

Intraoperatively, the patient required no inotropic or vasopressor support due to stable hemodynamic parameters at the main stages of surgery.

The importance of maintaining the patient's normothermia is undoubted. Body temperature during the operation remained at 36.0°.

Equally important is the optimal tactics of fluid therapy. Creation of adequate intravascular volume before reperfusion prevents the development of early graft dysfunction [24, 29]. This is especially important in kidney transplantation, since a denervated kidney graft can aggravate already altered autoregulatory mechanisms [30]. Moreover, even a slight decrease in a mean blood pressure below 70 mm Hg leads to a decrease in renal perfusion [23, 30]. From Table 2 of our clinical case report it is clearly seen that at all stages of surgery without an exception, the level of mean blood pressure was at a sufficient level for adequate reperfusion of the renal graft and PG.

In our example, the patient had pre-dialysis ESRD with his own preserved diuresis at the time of surgery. In patients on hemodialysis, if the latter was performed on the day of surgery immediately before surgical intervention, it is recommended to take into account the status of the lost volume, with its replacement by the time of reperfusion [8, 31]. A number of publications note the advisability of using balanced crystalloid solutions, since their use does not result in the development of hyperchloremic acidosis, on the one hand, or a significant increase in the blood plasma level of potassium, on the other. It is also recommended to refrain from using dextran-based colloidal media as primary infusion solutions [32, 33].

Table 4 shows the dosages of the main anesthetic drugs. Based on these data, we can conclude that the epidural component of anesthesia allows the use of lower doses of narcotic analgesics, muscle relaxants, and inhalational anesthetics to achieve a sufficient antinociceptive and anesthetic effect, which influences beneficially on the renal graft and PG functions, and also allows for early extubation of the patient on surgery completion. This is confirmed by data from literature sources [34–36].

Table 4. Consumption of anesthetic drugs at the main stages of surgery

Stage of surgery	Bupivacaine dose (mg/h)	Fentanyl dose (μg/kg/h)	Sevoflurane dose (MAC)	Cisatracurium besylate dose (mg/kg/h)
I	0	4.1	0	0.17
II	6	3.7	0.8	0.05
III	7	1.6	1.0	0.04
IV	8	1.6	1.1	0.03
V	5	1.6	1.0	0.03
VI	3	0.9	0.1	0

Insulin infusion was undertaken from the first stage of surgery until the moment of pancreas reperfusion against the glycemia stabilization at a level of 6–8 mmol/L (figure).

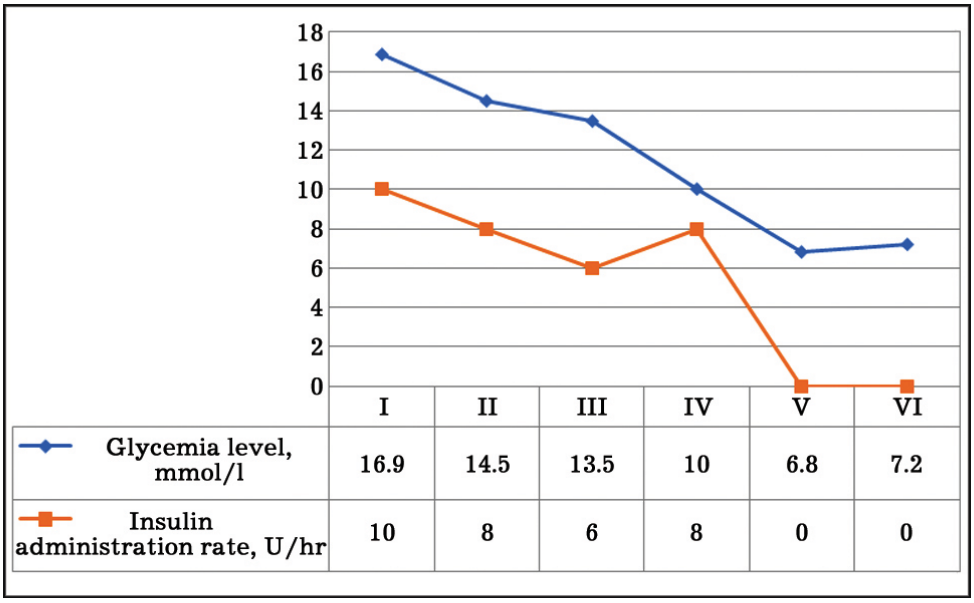

Figure. Glycemia level and the rate of insulin administration at the main stages of surgery

Stable glycemic levels after reperfusion indicate successful PG function. From this moment onwards, the patient showed true insulin independence without exogenous insulin administration.

Conclusion

The authors would like to emphasize that the Case Report described exclusively anesthetic aspects and features of intraoperative management during combined pancreas and kidney transplantation in a recipient with morbid obesity.

The approaches we used made it possible to ensure the safety and efficacy of anesthesia and contributed to the successful implementation of a combined pancreas and kidney transplantation in a recipient with concomitant pathology in the form of morbid obesity.

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