

GASLESS LAPAROSCOPIC NEPHRECTOMY IN PATIENTS WITH AUTOSOMAL DOMINANT POLYCYSTIC KIDNEY DISEASE

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Introduction. Autosomal dominant polycystic kidney disease (PKD) is one of the most common hereditary diseases leading to the development of end-stage renal failure. According to modern concepts, nephrectomy of polycystic-altered kidneys in such patients is performed in the event of complications, as well as in order to prepare for kidney transplantation. The creation of intense carboxyperitoneum leads to carbon dioxide reabsorption and the development of hypercapnia and respiratory acidosis in the patient. Taking into account the age of patients and the high incidence of cardiovascular and valvular pathology in patients with PKD, this fact becomes significant and can lead to the development of severe complications. The solution to this problem, in our opinion, is to perform laparoscopic nephrectomy under low-pressure carboxyperitoneum (LPC). **Materials and methods.** In the period from 2013 to 2018, 55 monolateral laparoscopic nephrectomies were performed in 36 patients with PKD. The study identified 2 groups of patients. The study group included 8 patients who were diagnosed at the preoperative stage with cardiovascular disease performed LPC (12 operations). The second group was represented by 28 patients who were operated laparoscopically with the creation of intense carboxyperitoneum (41 operations). Workspace when LPC was created with the help of laparolift – mechanical device for lifting the abdominal wall on the abdominal cavity. **Results.** The mean duration of surgery in the groups was 126 ± 18 and 114 ± 11 minutes, respectively ($p < 0.05$). Intraoperative blood loss was significantly different: in the comparison group – 225 ± 45 ml, in the study group – 440 ± 76 ml ($p < 0.05$). Mean blood pCO₂ and pH levels in the study group were 38.2 ± 2.7 mm Hg and 7.371 ± 0.021 , the comparison group – 44.4 ± 3.8 mm Hg and 7.231 ± 0.035 ($p < 0.05$). Among the patients who underwent LPC, there was one fatal outcome. The frequency of postoperative complications was 16.6% (2) in the study group and 12.2% (5) in the comparison group. **Summary.** Laparoscopic nephrectomy in conditions of low pressure carboxyperitoneum allows to completely avoid the development of hypercapnia and respiratory acidosis in the patient, to prevent severe cardiovascular complications despite the high risk of their development among patients with PKD.

Keywords: laparoscopic nephrectomy; polycystic kidney disease.

ЛАПАРОСКОПИЧЕСКАЯ НЕФРЭКТОМИЯ В УСЛОВИЯХ КАРБОКСИПЕРИТОНЕУМА НИЗКОГО ДАВЛЕНИЯ У ПАЦИЕНТОВ С АУТОСОМНО-ДОМИНАНТНЫМ ПОЛИКИСТОЗОМ ПОЧЕК

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⊗ **Введение.** Аутосомно-доминантный поликистоз почек (АДПП) — одно из самых распространенных наследственных заболеваний, ведущих к развитию терминальной почечной недостаточности. По современным представлениям, нефрэктомия поликистозно измененных почек таким пациентам выполняют при возникновении осложнений, а также с целью подготовки к трансплантации почки. Создание напряженного карбоксиперитонеума приводит к резорбции углекислого газа и развитию у пациента гиперкапнии и респираторного ацидоза, что с учетом возраста больных, а также высокой частоты встречаемости сердечно-сосудистой и клапанной патологии у пациентов с АДПП может приводить к развитию тяжелых осложнений. Решением этой проблемы является выполнение лапароскопической нефрэктомии в условиях карбоксиперитонеума низкого давления (ЛНД). **Материалы и методы.** В период с 2013 по 2018 г. в клинике выполнено 55 моностеральных лапароскопических нефрэктомий 36 пациентам с АДПП. В ходе исследования выделено две группы больных. В исследуемую группу вошли 8 пациентов, которым в связи с диагностированной на дооперационном этапе сердечно-сосудистой патологией выполняли ЛНД (12 операций). Вторая группа была представлена 28 больными, которые были прооперированы лапароскопически с созданием напряженного карбоксиперитонеума (41 операция). Рабочее пространство при ЛНД создавали с помощью лапаролифта — механического устройства для подъема брюшной стенки над органами брюшной полости. **Результаты.** Средняя длительность операции в группах составили соответственно 126 ± 18 и 114 ± 11 минут ($p < 0,05$). Значимо отличался объем интраоперационной кровопотери: в группе сравнения — 225 ± 45 мл, в исследуемой группе — 440 ± 76 мл ($p < 0,05$). Средний уровень pCO_2 и pH крови в исследуемой группе составил $38,2 \pm 2,7$ мм рт. ст. и $7,371 \pm 0,021$, в группе сравнения — $44,4 \pm 3,8$ мм рт. ст. и $7,231 \pm 0,035$ ($p < 0,05$). Среди больных, которым была выполнена ЛНД, имел место один летальный исход. Частота послеоперационных осложнений в исследуемой группе оказалась равна 16,6 % (2), в группе сравнения — 12,2 % (5). **Выводы.** Лапароскопическая нефрэктомия в условиях карбоксиперитонеума низкого давления позволяет избежать развития у пациента гиперкапнии и респираторного ацидоза и предотвратить тяжелые сердечно-сосудистые осложнения, несмотря на высокий риск их развития среди больных с АДПП.

⊗ **Ключевые слова:** лапароскопическая нефрэктомия; поликистоз почек.

INTRODUCTION

Autosomal dominant polycystic kidney disease (ADPKD) is a hereditary disease characterized by the replacement of the renal parenchyma with multiple cysts of different sizes [1]. The size and weight of polycystic kidneys can reach up to 40 cm and 8 kg, respectively. Terminal renal failure develops in most patients with ADPKD by the age of 60 years. Renal transplantation is a method of choice in such patients. Transplantation without removal of the native kidney and subsequent immunosuppressive therapy are associated with a high risk of infectious complications because of the high prevalence of cyst infection [2, 3]. Thus, the majority of patients with ADPKD need to undergo nephrectomy before registering in the transplant waiting list. Laparoscopic nephrectomy is the surgery of choice for these patients [4].

High-pressure carbon dioxide pneumoperitoneum laparoscopic nephrectomy is contraindicated in patients with cardiovascular comorbidity. This is particularly true in patients with ADPKD with the incidence of cardiovascular comorbidity in the settings of renal replacement therapy and main disease of up to 50%.

With the advancement in laparoscopic technology, there is an increasing interest in laparoscopy with low-pressure carbon dioxide pneumoperitoneum with lapa-

rolifts and endlifts for traction of the abdominal wall and creation of a working space [5].

There are several laparolifts and endlifts with various designs for laparoscopic surgery. These techniques are used in almost all surgical areas [6–10].

MATERIAL AND METHODS

This study was based on a prospective treatment analysis in 36 patients with ADPKD who underwent laparoscopic nephrectomy in 2013–2018. Two-step bilateral nephrectomy was performed in 19 (52.8%) patients and monolateral nephrectomy in 17 (47.2%). A total of 55 surgical interventions were performed. Eight (22.2%) patients underwent surgery under low-pressure carbon dioxide pneumoperitoneum (12 surgeries). The indications for the surgery were registration in the transplant waiting list and complications of ADPKD, such as pyelonephritis, infection and rupture of cysts, and gross hematuria.

Low-pressure carbon dioxide pneumoperitoneum laparoscopic nephrectomy was performed as follows. The patient was placed in the lateral decubitus position with three-quarter rotation. The abdominal wall was lifted using a clamp. Using the Veress needle, insufflation with carbon dioxide under a pressure of 6–8 mm Hg was performed. Such pressure in combination with abdominal wall lifting using a clamp is suffi-

cient for satisfactory visualization of the peritoneum in the area of the needle and insertion of ports. A 10-mm port was inserted in the standard position. A 10-mm 30°-viewing laparoscope was used. Under direct vision, one needle was inserted in the lateral abdomen in the most convenient position in the longitudinal direction, considering the anatomical location of the polycystic kidney (the needle in the iliac region was inserted 2–3 cm medial to the anterior axillary line and 2 cm above the anterior superior iliac spine, longitudinally along the same line, and penetrating 4–5 cm below the costal arch). Thereafter, the needle was fixed to the rigid arc of the laparolift. Using a thread bar through the knee of the operating lamp, traction of the abdominal wall was performed, and the working space was created. The abdomen was desufflated. The subsequent steps of the surgery were performed under low-pressure carbon dioxide pneumoperitoneum. Minimal (1–3 mm Hg) insufflation of carbon dioxide was found to prevent vacuum formation in the abdominal cavity. Furthermore,

ports for nephrectomy were inserted, and the main step of the surgery was performed. The triangular shape of the working space with the highest point in the projection of the renal hilum allowed sufficient visualization and freedom to move the instruments. Laparolift insertion in the most convenient position, considering the anatomical location of the polycystic kidney, simplified the operating technique and improved visualization. The typical configuration of the laparolift is shown in Fig. 1.

According to the method of laparoscopic nephrectomy, patients were categorized into two groups. The study group comprised eight patients who underwent low-pressure carbon dioxide pneumoperitoneum laparoscopic monolateral nephrectomy (12 surgeries). The control group included 28 patients who underwent high-pressure carbon dioxide pneumoperitoneum (10–12 mm Hg) laparoscopic nephrectomy (41 surgeries). No significant difference was observed between the two groups with respect to the main parameters (Table 1).

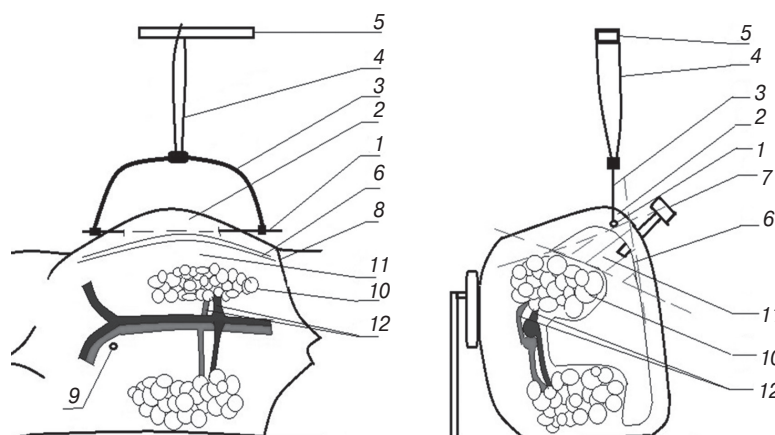


Fig. 1. Laparoscopy in terms of low pressure carboxyperitoneum, the arrangement of laparolift: 1 – laparolift needle; 2 – abdominal wall; 3 – laparolift arcuate bracket; 4 – filament traction; 5 – operating lamp knee; 6 – abdomen; 7 – endoport to install the laparoscope; 8 – costal margin; 9 – navel; 10 – polycystic-changed kidney; 11 – workspace; 12 – kidney leg

Рис. 1. Схема расположения лапаролифта при лапароскопии в условиях карбоксиперитонеума низкого давления: 1 – спица лапаролифта; 2 – брюшная стенка; 3 – дугообразная скоба лапаролифта; 4 – нитевая тяга; 5 – колено операционной лампы; 6 – брюшина; 7 – эндопорт для установки лапароскопа; 8 – реберная дуга; 9 – пупок; 10 – поликистозно измененная почка; 11 – рабочее пространство; 12 – почечная ножка

Table 1

The main characteristics of the patient groups

Таблица 1

Основные характеристики групп пациентов

Parameters	Study group, n = 8	Control group, n = 28	p
Men	5 (62.5 %)	13 (46.4 %)	> 0.05
Women	3 (37.5 %)	15 (53.6 %)	
Age. years	56.4 ± 7.8	51.9 ± 8.3	> 0.05
Dialysis. months	48.5 ± 30.5	47.1 ± 33.4	> 0.05
Maximum size of the kidney. mm	204 ± 35	217 ± 49	> 0.05
Preparing for the transplant waiting list	6 (75 %)	20 (71.4 %)	> 0.05
Complications of ADPKD	2 (25 %)	8 (28.6 %)	

Note. ADPKD. autosomal dominant polycystic kidney disease.

RESULTS

The average duration of the surgery in the study and control groups was 126 ± 18 and 114 ± 11 min, respectively ($p > 0.05$). Intraoperative blood loss was significantly more in the low-pressure carbon dioxide peritoneum group (440 ± 76 ml vs. 225 ± 45 ml, $p < 0.05$). The incidence of intraoperative vasopressor support was 33.3% (4 cases) in the study group and 19.5% (8 cases) in the standard laparoscopic technique group. The average pCO_2 level and blood pH were 38.2 ± 2.7 mm Hg and 7.371 ± 0.021 , respectively, in the study group compared with 44.4 ± 3.8 mm Hg and 7.231 ± 0.035 , respectively, in the control group ($p < 0.05$). In the low-pressure carbon dioxide peritoneum group, one patient died on postoperative day 4 due to the mesenteric thrombosis. The time of mobilization, duration of hospital stay, and postoperative complications are presented in Table 2.

DISCUSSION

Cardiovascular comorbidity limits the use of high-pressure carbon dioxide pneumoperitoneum. Increased gas pressure in the abdominal cavity necessary for the preservation of the working space during laparoscopic surgery is associated with several negative effects:

1. Compression of the large venous vessels with increased venous pressure and impaired circulation.
2. Restriction of the diaphragm mobility, which necessitates the supply of a larger respiratory volume to maintain adequate lung ventilation and correct hypoxia.
3. Direct adsorption of carbon dioxide by tissues, leading to metabolic and respiratory disorders caused

by hypercapnia (increased blood carbon dioxide partial pressure).

4. Reduction in cardiac output due to increased peripheral resistance and compression of the chest organs.
5. Specific complications of carbon dioxide pneumoperitoneum (pneumothorax, subcutaneous emphysema, pneumomediastinum, and gas embolism).

In our opinion low-pressure carbon dioxide pneumoperitoneum is the solution to the problem of creating a high-pressure pneumoperitoneum. The results of using this technology are consistent with those for standard high-pressure carbon dioxide pneumoperitoneum laparoscopic technique, regardless of the initial patient status. The complication rates after low-pressure carbon dioxide pneumoperitoneum were slightly higher compared with those in the control group, but cardiovascular complications were not included in the analysis. Lethal mesenteric thrombosis developed in only one patient with severe sepsis, advanced atherosclerosis, and malignant neoplasm in the polycystic kidney.

CONCLUSION

Low-pressure carbon dioxide pneumoperitoneum laparoscopic nephrectomy prevents hypercapnia, respiratory acidosis, and severe cardiovascular complications, although the risk of their development in patients with ADPKD is low. Because of the laparolift, it is possible to obtain the advantages of minimally invasive laparoscopic techniques and eliminate the disadvantages of high-pressure carbon dioxide pneumoperitoneum.

Table 2

The surgical treatment results of patients with PKD

Таблица 2

Результаты оперативного лечения больных с аутосомно-доминантным поликистозом почек

Parameters	Study group, $n = 12$	Control group, $n = 41$	p
Average duration of surgery, min	126 ± 18	114 ± 11	> 0.05
Duration of stay in the intensive care unit, days	1–2 (1.6 ± 0.5)	1–2 (1.4 ± 0.33)	> 0.05
Time of patient mobilization, days	2–3 (2.85 ± 0.39)	2–3 (2.63 ± 0.23)	> 0.05
Duration of hospital stay, days	8–9 (8.6 ± 1.3)	7–8 (7.7 ± 0.5)	> 0.05
Surgical complications	16.6 % (2)	12.2 % (5)	> 0.05
• Mesenteric thrombosis	1 (8.3 %)	–	> 0.05
• Wound infection	1 (8.3 %)	2 (4.8 %)	
• Bleeding, hematoma	–	2 (4.8 %)	
• Arteriovenous fistula thrombosis	–	1 (2.4 %)	
Mortality rate	8.3 % (1)	–	> 0.05

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