DOI: https://doi.org/10.17816/rmmar104695
Research Article

Innovative technology of total parietal peritonectomy for peritoneal carcinomatosis

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BACKGROUND: Peritonectomy is an integral part of cytoreductive surgery, accompanied by a fairly high incidence of postoperative complications and mortality. In this regard, the improvement and development of easy-to-perform, low-traumatic and safe methods of peritonectomy are topical in oncology.

AIM: Based on experimental studies to develop a technology of pneumodissection of the peritoneum using carbon dioxide insufflation and evaluate its effectiveness.

MATERIALS AND METHODS: The study was conducted on 10 non-embalmed corpses of deceased people whose cause of death is not related to tumors of the abdominal cavity and pelvic organs. The Karl STORZ Thermoflator 26432020-1 Insufflator (FSZ registration certificate 2011/09444, dated 12/21/2017), carbon dioxide cylinders with a volume of 20 liters, silicone lines 1.5 meters long, 1 cm in diameter; Seldinger puncture needle 18 G; flexible polypropylene bougie 16 G were used.

RESULTS: The conducted experimental study made it possible to develop and test a method of total parietal peritonectomy based on the technology of peritoneal pneumodissection using carbon dioxide insufflation. The analysis of the obtained results made it possible to define the concept of a new technology as a method of tissue separation based on the insufflation of carbon dioxide into the connective tissue layers of the retroperitoneal space for the purpose of safe dissection of anatomical structures.

CONCLUSIONS: Peritoneal pneumodissection using gas insufflation is a new and promising technology with a number of obvious advantages. First of all, they include ease of execution, low injury, high safety and, probably, ablasticity, which can potentially create conditions for the prevention of unintentional dissemination of tumor cells in the abdominal cavity. The data obtained as a result of the experimental study allow us to conclude that pneumodissection of the peritoneum using carbon dioxide insufflation is an effective method of performing total parietal peritonectomy and can be used in performing cytoreductive surgical interventions in patients with peritoneal carcinomatosis.

Keywords: cytoreductive surgery; diaphragmatic peritonectomy; gas insufflation; pelvic peritonectomy; peritoneal carcinomatosis; peritonectomy of the lateral walls of the abdomen; pneumodissection; total parietal peritonectomy.

To cite this article:
Prosvetov VA, Surov DA, Gaivoronsky IV, Nguyen VT Innovative technology of total parietal peritonectomy for peritoneal carcinomatosis. *Russian Military Medical Academy Reports*. 2022;41(2):143–149. DOI: https://doi.org/10.17816/rmmar104695

Received: 11.03.2022 **Accepted**: 25.04.2022 **Published**: 30.06.2022

DOI: https://doi.org/10.17816/rmmar104695
Научная статья

Инновационная технология тотальной париетальной перитонэктомии при карциноматозе брюшины

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Актуальность. Перитонэктомия является неотъемлемой частью циторедуктивной операции и сопровождается весьма высокой частотой развития послеоперационных осложнений и летальности. В связи с этим усовершенствование и разработка легковыполняемых, малотравматичных и безопасных способов перитонэктомии — одна из актуальных проблем в онкологии.

Цель исследования — на основании экспериментальных исследований разработать технологию пневмодиссекции брюшины с использованием инсуффляции диоксида углерода и оценить ее эффективность.

Материалы и методы. Исследование было проведено на 10 небальзамированных трупах умерших людей, причина смерти которых не связана с опухолями органов брюшной полости и малого таза. Были использованы инсуффлятор Karl STORZ Thermoflator 26432020-1 Insufflator (регистрационное удостоверение ФСЗ 2011/09444, от 21.12.2017); баллоны с диоксидом углерода объемом 20 л; силиконовые магистрали длинной 1,5 м, диаметром 1 см; пункционная игла Сельдингера 18 G; гибкий полипропиленовый буж 16 G.

Результаты. Проведенное экспериментальное исследование дало возможность разработать и апробировать способ тотальной париетальной перитонэктомии, основанный на технологии пневмодиссекции брюшины с использованием инсуффляции диоксида углерода. Анализ полученных результатов позволил определить понятие новой технологии как метода сепарирования тканей, основанного на инсуффляции диоксида углерода в соединительно-тканные слои забрюшинного пространства с целью безопасной диссекции анатомических структур.

Заключение. Пневодиссекция брюшины с использованием инсуффляции газа является новой и перспективной технологией, обладающей целым рядом очевидных достоинств. В первую очередь к ним относятся простота выполнения, низкая травматичность, высокая безопасность и, вероятно, абластичность, которая может потенциально создавать условия для профилактики непреднамеренной диссеминации опухолевых клеток по брюшной полости. Полученные в результате экспериментального исследования данные позволяют заключить, что пневмодиссекция брюшины с использованием инсуффляции диоксида углерода является эффективным методом выполнения тотальной париетальной перитонэктомии и может быть использована при выполнении циторедуктивных оперативных вмешательств у больных карциноматозом брюшины.

Ключевые слова: диафрагмальная перитонэктомия; инсуффляция газа; канцероматоз брюшины; перитонэктомия боковых стенок живота; пневмодиссекция; тазовая перитонэктомия; тотальная париетальная перитонэктомия; циторедуктивная хирургия.

Как цитировать:
Просветов В.А., Суров Д.А., Гайворонский И.В., Нгуен В.Т. Инновационная технология тотальной париетальной перитонэктомии при карциноматозе брюшины // Известия Российской Военно-медицинской академии. 2022. Т. 41. № 2. С. 143–149. DOI: https://doi.org/10.17816/rmmar104695

Рукопись получена: 11.03.2022 **Рукопись одобрена:** 25.04.2022 **Опубликована:** 30.06.2022

BACKGROUND

Cytoreductive surgical interventions play a key role in the complex treatment of patients with peritoneal carcinomatosis of various etiologies [1, 2]. These include various combinations of resections, extended lymphodissection, and peritonectomy. The technical complexity, duration, and traumatic nature of cytoreductive surgeries naturally cause not only a high incidence of postoperative complications and lethality but also significant risks of iatrogenic damage to vital anatomical structures [3–6]. This type of surgery mainly aims to eliminate peritoneal carcinomatosis, remove primary and metastatic tumor foci as much as possible, and create favorable conditions for effective systemic antitumor therapy [7–10].

The study aimed to develop the technology of pneumodissection of the peritoneum using carbon dioxide insufflation based on experimental studies and evaluate its efficiency.

MATERIALS AND METHODS

The study was conducted with the permission of the Independent Ethical Committee of the S.M. Kirov Military Medical Academy on 10 unembalmed cadavers whose cause of death was unrelated to tumors of the abdominal cavity and pelvic organs. Karl STORZ Thermoflator 26432020-1 Insufflator (registration certificate 2011/09444, dated 21.12.2017); 20 L carbon dioxide cylinders; 1.5 m long, 1 cm diameter silicone lines; 18 G Seldinger puncture needle; and 16 G flexible polypropylene bougie were used.

RESULTS

The experimental study allowed the development and validation of total parietal peritonectomy based on the pneumodissection of the peritoneum using carbon dioxide insufflation. The results allowed us to define the concept of the new technology as a method of tissue separation based on carbon dioxide insufflation into the connective tissue layers of the retroperitoneal space to safely dissect anatomical structures. In the literature, a clinical case of carbon dioxide insufflation use in the course of cytoreductive surgical intervention was reported; however, it lacks a detailed description of the operative technique and topographic and anatomical justification, which, undoubtedly, any surgical intervention should be based on [11].

Taking into account the topographic and anatomical features of the parietal peritoneum, it is reasonable to distinguish three main types of peritonectomy using pneumodissection technology (Fig. 1):

1. Peritonectomy of the lateral abdominal walls
2. Pelvic peritonectomy
3. Diaphragmatic peritonectomy

To perform pneumodissection, an 18 G Seldinger puncture needle must be used, which is inserted under the parietal peritoneum at an angle of 10°–30° and at the end of which is placed in the subperitoneal vascular-free fascial layer. Gas insufflation creates an air cushion, and after the formation, the needle was changed to a flexible bougie that serves as a 16 G manipulation catheter (Fig. 2). The bougie is advanced with fan-like progressive movements in the required direction in the presence of continuous gas supply by the insufflator, ensuring pneumodissection of the peritoneum. During the procedure, constant visual control of movements in the dissection plane is necessary to prevent iatrogenic damage to vital anatomical structures.

To achieve optimal exposure of the operating field, revision of the abdominal cavity organs and preparation of the necessary equipment are performed after a midline laparotomy and installation of retractors.

Pneumodissection of the peritoneum of the lateral abdominal walls should be started after puncturing the preperitoneal space in the peritoneal region at a distance of 1–2 cm from the edge of the laparotomy incision. Gas insufflation is initiated in cranial and caudal directions and the direction of the lateral abdominal canals. Fan-like progressive movements of the manipulation bougie and dynamic visual control of its location in the dissection plane ensure the safety of the procedure.

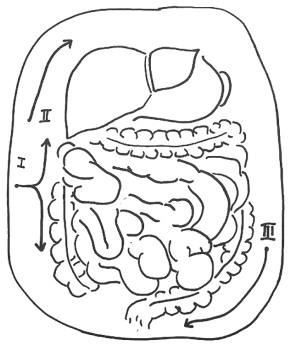

Fig. 1. General scheme of the pneumodissection of the parietal peritoneum: I, peritonectomy of the lateral abdominal walls; II, diaphragmatic dissection; III, pelvic peritonectomy

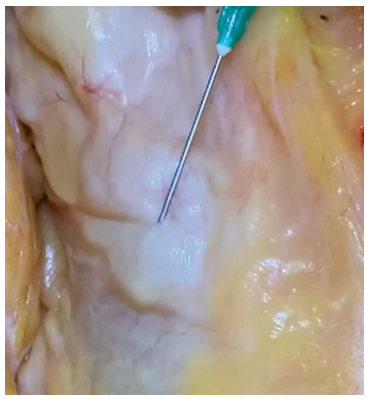

Fig. 2. CO_2 distribution in the subperitoneal space during insufflation

DOI: https://doi.org/10.17816/rmmar104695

Fig. 3. Pneumodissection of the peritoneum of the lateral abdominal walls

The cranial border of pneumodissection is the lower bundles of the rib part of the diaphragm; caudal border, iliac fossa; and dorsal border, conditional Told line (Fig. 3).

Pelvic peritonectomy should be understood as the removal of the parietal peritoneum located within the anatomical boundaries of the pelvic cavity. Topographic and anatomical features of the pelvic peritoneum, different planes of its course, and variety of visceral and neurovascular structures make it necessary to perform pneumodissection of the pelvic peritoneum from different accesses. As shown in the results of literature analysis and topographic and anatomical studies, distinguishing three key directions of pneumodissection at pelvic peritonectomy, namely, lateral, anterior, and posterior, is reasonable (Fig. 4).

Pneumodissection of the pelvic peritoneum in the lateral direction should be started after puncturing the peritoneum in the iliac fossa at the level of the anterior superior iliac spine. The bougie should be advanced parallel to the internal iliac vessels in the direction of the pelvic diaphragm. Owing to the well-developed subperitoneal tissue, the peritoneum was dissected without serious technical difficulties. As a result, performing safe mobilization of ureters, external and internal iliac, and gonadal vessels is possible. The caudal border of pneumodissection in the lateral direction in women is the cervix and in men the seminal vesicles. During pneumodissection in this area, the direction of catheter advancement in the dissection plane must be controlled.

When performing pneumodissection of the pelvic peritoneum in the posterior direction, the peritoneum is punctured at a distance of 15–20 mm from the aortic bifurcation in the caudal direction. The manipulation catheter is advanced along the common iliac vessels, connecting the posterior and lateral directions of pneumodissection. If interventions on the pelvic organs are

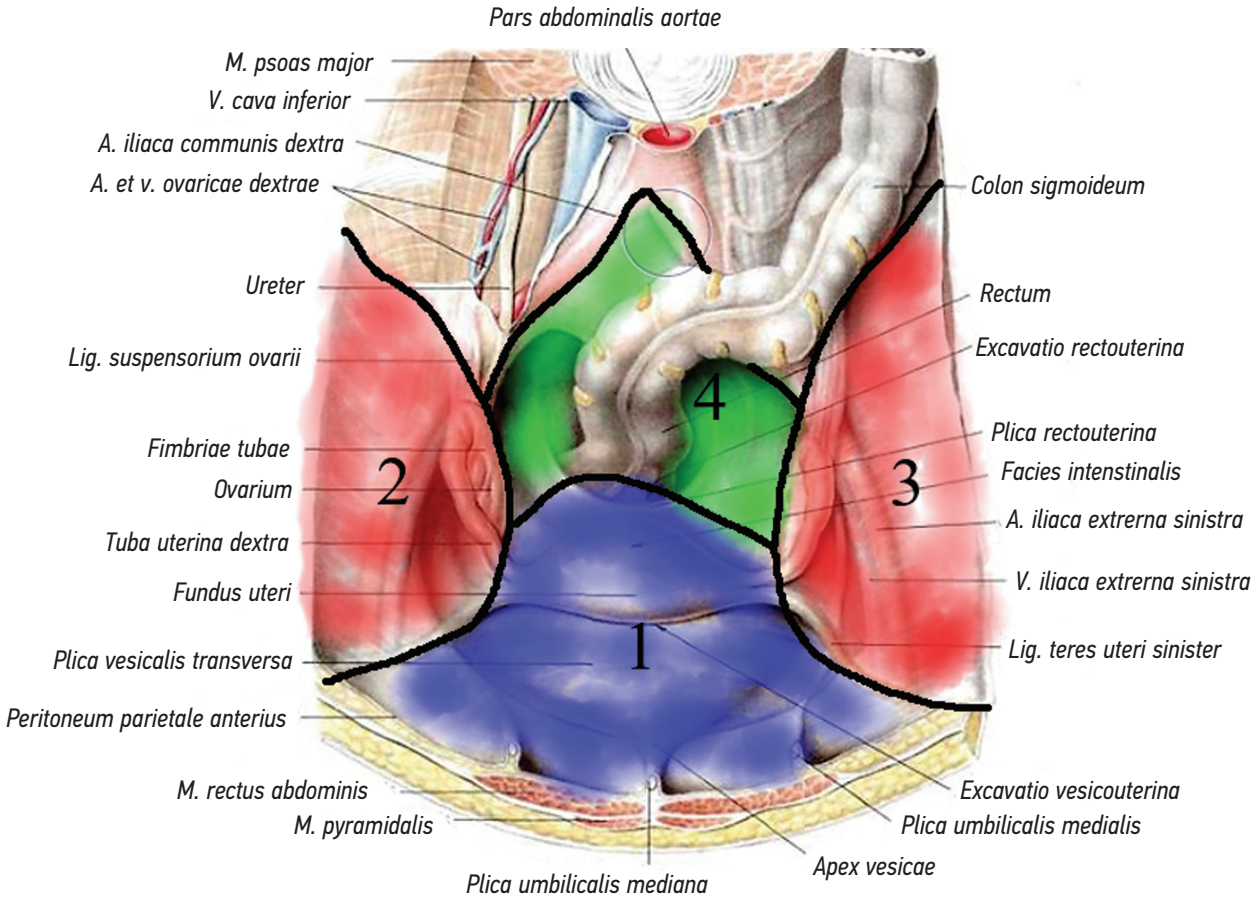

Fig. 4. Gas insufflation directions during pelvic peritonectomy. Area 1 indicates gas diffusion from the anterior access; 2 and 3, direction of gas diffusion from the lateral access; 4, direction of dissection from the posterior access

DOI: https://doi.org/10.17816/rmmar104695

necessary, the advancement of the manipulation bougie along the sacrum in the direction of the pelvic diaphragm mobilizes the posterior and partially posterolateral surfaces of the mesorectum.

Anterior pneumodissection of the pelvic peritoneum should be started from a point on the posterior surface of the rectus abdominis 2 cm above the bosom articulation and continued toward the pelvic diaphragm. The caudal boundary of peritoneal mobilization in women is the vesicouterine recess and in men the vesico-rectal recess (Fig. 5).

Diaphragmatic peritonectomy is the most technically difficult stage of cytoreductive intervention because of the morphofunctional features of the diaphragm, its variant anatomy, close topographic and anatomic relationship of the liver and large blood vessels, and high risks of diaphragm perforation with inevitable tumor dissemination into the pleural cavity. These circumstances largely determine the need to develop low-traumatic methods of peritonectomy, which, in our opinion, should include pneumodissection technology.

Three key directions of pneumodissection of the diaphragmatic peritoneum are as follows: from the side of the rib, the sternal part of the diaphragm, and from the area of the hepatorenal recess (Fig. 6).

The dissection of the peritoneum of the rib part of the diaphragm should be started from the points of fixation of its lower bundles. The manipulation bundle is advanced along the plane of the diaphragm in the cranial direction.

Fan-shaped progressive movements of the manipulation bougie and visual control of its location in the plane of pneumodissection ensure the safety of the procedure. The border of dissection is the right triangular ligament of the liver on the right and gastroesophageal ligament on the left. Pneumodissection of the diaphragmatic peritoneum from the sternal side should be started from the projection of the apex of the sternal triangle, 10–15 mm from the edge of the laparotomy incision. The dissection is performed in the cranial direction, and its border is the left venous ligament of the liver. Pneumodissection of the diaphragmatic peritoneum from the area of the hepatorenal pocket should be performed 2 cm lateral to the outer edge of the right kidney projection.

The catheter is advanced in the cranial direction, with the right triangular ligament of the liver being the border of pneumodissection (Fig. 7).

Thus, consistent performance of the above-described stages of pneumodissection allows the total mobilization of the parietal peritoneum during peritonectomy.

Fig. 5. Pneumodissection of the pelvic peritoneum

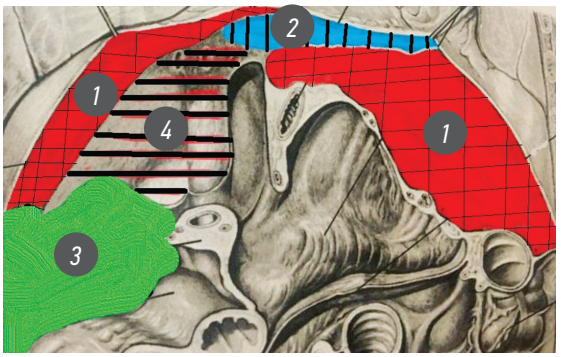

Fig. 6. Main directions of gas spreading when performing diaphragmatic peritonectomy. Area *1* indicates the direction of pneumodissection in the area of the rib part of the diaphragm; *2*, the direction in the area of the sternal part of the diaphragm; *3*, the direction in the area of the hepatorenal recess; *4*, gas spreading in the *area nuda*

Fig. 7. Pneumodissection of the parietal peritoneum of the left diaphragmatic dome

CONCLUSIONS

Pneumodissection of the peritoneum using gas insufflation is a new and promising technique with several advantages: ease of performance, low trauma, high safety, and probably ablative, which can potentially create conditions for the prevention of inadvertent dissemination of tumor cells through the abdominal cavity.

Experimental data allow us to conclude that pneumodissection of the peritoneum using carbon dioxide insufflation is an effective method of performing total parietal peritonectomy; however, further studies are needed to evaluate the effectiveness of this technology and its possible introduction into cytoreductive surgical interventions in patients with peritoneal carcinomatosis.

DOI: https://doi.org/10.17816/rmmar104695

ADDITIONAL INFORMATION

Funding. The study had no external funding.

Conflict of interest. The authors declare that there are no obvious and potential conflicts of interest related to the publication of this article.

Ethical review. The study was approved by the local ethical committee of the S.M. Kirov Military Medical Academy, Ministry of Defense of Russia (Protocol No. 256 from 23.11.2021).

Authors' contribution. All authors contributed substantially to the study and article, read and approved the final version before publication.

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