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Comparison between Creation of Pneumoperitoneum by Open Technique and Closed Technique

Amjad Gul, Zaki Hussain Salamat, Inshal Jawed, M. Najam Shabbir, Muhammad Umair, Zaffar Abbas

ABSTRACT:

Objectives: Compare closed (Veress needle) and open (trocar) techniques for pneumoperitoneum in laparoscopic procedures regarding access time, complication rates, and patient outcomes.

Study Design and Setting: 99 patients undergoing laparoscopic procedures were divided into two groups. Group A (closed technique with a veress needle) included 43 patients, and Group B (open technique using a trocar) included 56 patients. The main outcome was access time (minutes), and secondary outcomes included complications like gas leaks, organ injury, vascular injury, hematomas, and site infections. This design intended to compare the efficacy and safety of both techniques.

Methodology: Total of 99 patients were included: 43 in Group A (closed method) and 56 in Group B (open method). The primary outcome was access time, while secondary outcomes included complications such as gas leaks, organ injury, vascular injury, hematomas, and site infections. Statistical analysis was conducted to compare the two techniques.

Results: Access time was significantly longer in the open method group (7.88 ± 2.76 vs. 6.25 ± 2.55 min, p = 0.03). Open method was associated with a higher incidence of gas leaks (25% vs 7%, p = 0.029), vascular injury (16% vs 2%, p = 0.04), and site infections (25% vs 7%, p = 0.029). No significant difference was observed in organ injuries.

Conclusions: Closed method is more efficient and associated with fewer complications in low-risk cases. Open technique remains a viable alternative for patients with prior abdominal surgery or a higher risk of complications. Individualized patient assessment is essential for selecting optimal approach.

Keywords: Laparoscopy, Pneumoperitoneum, Prospective Complications, Trocar

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INTRODUCTION

Laparoscopic surgery would be impossible without the establishment of a pneumoperitoneum, which provides the necessary space for visualization of the abdominal cavity and the manipulation of instruments. Insufflation of gas, usually carbon dioxide (CO2), in a controlled manner, elevates the abdominal wall and genetically strains the peritoneal cavity, allowing access to internal structures. Pneumoperitoneum can be achieved with two main methods: the closed method performed traditionally with a veress needle and the open method done generally with a Hasson trocar. Though these techniques are a mainstay of laparoscopic effectiveness and safety, they each have pros and cons, which have been thoroughly investigated and discussed in the surgical literature.

A closed method is usually chosen due to its simplicity and speed. It consists of placing a Veress needle in the abdominal cavity and insufflating CO2 to obtain the necessary insufflation. This method is generally faster, which can be critical in time-critical scenarios. It has hazards, however. Not only does it cause harm to underlying structures, especially in patients with previous abdominal surgeries,[1] but it also increases future complications such as obesity and malformations. Surgery technique choice surgical forum

is one of the chief worries using this closed method.[2] This contrasts with the open method, which takes longer but is safer for patients with these risk factors. The operation starts with a small incision made in the abdominal wall, after which, under direct vision, the trocar is inserted. This approach is preferred, especially in high-risk patients, for closed technique complications such as bowel or vascular injury.[3]

The closed method is used for most laparoscopic surgery, but the open procedure remains superior in specific patient populations. For example, people with a history of abdominal surgery who make adhesions are in increased danger of damaging themselves during the closed system and so want an open approach.[4] Moreover, research has shown that in some high-risk groups, open surgery reduces complications as compared with the laparoscopic approach. These include obese patients (BMI = 35) or those who have had previous abdominal wall reconstruction surgery.[5]

The contention between the two strategies is primarily over the balance of quickness and risk of complication. However, two studies found that the closed method, despite its shorter time in surgery, actually led to more complications, including bowel perforation and injury to blood vessels.[6] On the other hand, while the open technique requires more time for each operation, it is safer in certain situations. Still, it has dangers. For instance, two may become infected at any wound site on your body; the positioning may bring on a hernia after the incision.[7] For this reason, the choice of methods is typically detective in nature: it depends on the surgeon's judgment, the medical histories of his patients, and peculiar developments that may occur in a given surgical case.

Although several studies have compared the safety, effectiveness, and outcome of these open and closed pneumoperitoneum methods, the findings are divergent, which justifies further investigation.[3, 5] There were advantages to the open method as it required a smaller incision, was less invasive for high-risk patients and was overall safer.[8] However, heterogeneous patient selection and outcome measures limit direct comparisons. This research compares locked (Veress needle) and open (trocar) entry in a laparoscopic procedure based on fundamental quantitative indicators in the postoperative process (time access (min), complications, end results). These findings would help optimize patient management and surgical decision-making, contributing to the conduct of safer procedures. An academic session emphasized clinical decision-making, which is thus expected to be one outcome.

Recent studies emphasize that low-pressure pneumoperitoneum can accelerate postoperative recovery and lessen pain compared to standard pressures.[9] In addition, pulmonary recruitment maneuvers at the end of surgery reduce residual pneumoperitoneum and shoulder pain.[10] These findings can be used to emphasize the need to optimize pneumoperitoneum techniques to achieve maximal benefits from minimally invasive procedures.

METHODOLOGY

This study was performed in a tertiary care hospital with 99 patients undergoing laparoscopic surgeries from October 2024 to February 2025. The primary aim was to compare two commonly used methods for establishing pneumoperitoneum during laparoscopic surgery, closed technique (using Veress needle) and open technique (with trocar in another hand). Patients were randomly allocated to either group according to the method for creating pneumoperitoneum: Group A (Veress needle/closed technique) had 43 patients, and Group B (the open method) had 56 participants.

The study followed the principles of the Declaration of Helsinki.[12] All participants provided written informed consent and the study was approved by the hospital's Institutional Review Board (ERC/2024/SURG/III dated 21 October 2024), in accordance with standards of accepted medical ethics.

The sample size was calculated based on previous research outputs, which compared access time for open and closed methods for creating pneumoperitoneum.[1, 2] The undermentioned formula was used to compare two means:

$$n = \frac{[(\frac{Z\alpha}{2} + Z\beta)^2 * 2 * \alpha^2]}{d^2}$$

Where:

- $Z\alpha/2 = 1.96$ (for á = 0.05, two-tailed)
- $Z\beta = 0.84$ (for 80% power)
- $\sigma = 2.7$ (pooled standard deviation estimated from previous studies)
- $d = 1.63$ (expected difference in access time between groups)

This calculation resulted in a minimum sample size of 43 patients per group. Assuming a possible 15% dropout rate, we planned to enroll at least 99 patients (50 for each group) for this investigation.

The study included patients aged 18-70 years, planned for elective laparoscopic procedures such as cholecystectomy, appendectomy, or hernia who and gave formalized written consent for participation in the study. These criteria guaranteed that there were suitable candidates for laparoscopic procedures in which both pneumoperitoneum techniques could be conducted safely.[3, 4]

Patients were excluded from the study included those patients who have an absolute contraindication for pneumoperitoneum, such as, widespread abdominal adhesions, history of multiple abdominal surgeries at high complications, severe cardiovascular or respiratory disease contraindicating pneumoperitoneum.[5, 6] The above exclusion criteria were developed to reduce the risk of complications and provide an

opportunity for patient safety during the study.[11, 12]

Data was methodically collected. Age, sex, body mass index (BMI), and any comorbidities (e.g., prior surgery, diabetes, cardiovascular disease, etc.) were taken down from each patient. These are all important data for adjusting to differences in the basic situation of the groups.[2, 5] Regarding procedure time, time was noted in minutes for each of the two groups being studied, from the first incision until the target intra-abdominal pressure was achieved. One of the most important parameters for determining how efficient every technique is.[6] Complications were documented and categorized into several categories, including gas leaks, organ injuries, vascular injuries hematomas, and site infections. SPSS version 25 (IBM Corp) was used for data analysis, a statistical method for assessing access time and complications (primary outcomes).

Regarding Access Time two independent cohorts have been studied for comparative analysis of pneumoperitoneum time between the two groups (guided vs blind pneumoperitoneum) using an independent Student's t-test. The means of the two independent groups can be compared for normally distributed data using the t-test. Levene's test for equality of variances was used to check that the variances fulfilled the assumptions of the t-test.[9] Moreover, the incidence of complications was compared between two groups using Fisher's Exact test, which is suitable in the presence of small sample sizes and categorical data. This test provides a correct calculation technique for the significance of complication rates when closed versus open surgery methods are being debated.[4, 11] All tests were done two-tailed for significance at $p < 0.05$. Multivariate analysis well as there - also was with adjustments for possible confounders, including BMI and previous abdominal surgery history.[1, 3]

RESULTS:

Both cohorts were comparable in demographic variables, including age, gender distribution, and BMI category (Table 1). The mean age of patients in Group A (closed method) was 36 ± 13.78 years, while for Group B (open method), it was 33.5 ± 12.23 years, with no significant age difference between the two groups. The comparable age distribution indicates that age-related factors were unlikely to have impacted surgical outcomes. Furthermore, the two groups were well-matched for BMI and gender, reducing the risk of confounding from these variables in our results. This demographic matching suggests that confounding factors such as age, gender, and BMI were adequately normalized, underlying that the differences in surgical outcomes could be isolated using the different pneumoperitoneum methods.Complication rates were reported in the two groups (Table 3). The difference between closed and open-tech cigarettes in the occurrence of these complications is significant.

The incidence of gas leaks was 1.5 times larger in Group B (open-open method) than in Group A (closed-closed method), with 14 patients having gas leaks versus three patients in Group A, $p = 0.029$. This aligns with countless reports on the conventional (open) method getting air leaks more readily than the closed method closed by a programmed needle. One explanation is that it is necessary to pass the trocar entranceway, which may harm wires around the balloon or not close corners of a pneumoperitoneal apparatus adequately.[8, 9] On the other hand, because a Veress needle is used in the closed scar-free puncture method, complications arising from peritoneal access are fewer than for the open method.

More vascular injuries were observed in Group B (open method) than in Group A. Nine (16%) of the Group B patients had vascular injuries in particular, whereas there was only one case of a patient (2%) in Group A who experienced vascular injury ($p = 0.04$). At the start of open-method abdominal surgery, the trocar penetration can result in trauma to large blood vessels in the abdominal wall, and the incidence of vascular injuries has been reported as frequent.[5] By comparison, a low frequency of vascular injuries has been associated with the closed method: The Veress needle technique is often done under controlled conditions that reduce the chance of injuring large blood vessels.[7]

Patients in Group B (open method) had a significantly higher rate of site infection (14 patients, 25%) than in Group A (closed method; 3, 7%) ($p = 0.029$). This observation aligns with the available literature, which shows that the open method is subjected to post-operative infections due to its greater invasiveness, with more extensive incisions and greater exposure to external contaminants, such as trocars placed into the abdomen.[1] In addition, although site infections were found in both groups, the higher prevalence in Group B reflects the need for strict aseptic techniques in laparoscopic procedures, especially in open pneumoperitoneum patients.[9]

No significant difference was observed in statistics between the two groups regarding complication rate (Table 3). Organ injury was found in two patients (5 %) of Group A and four patients (7 %) of Group B. Hematomas were found in one patient (2 %) of Group A and two patients (4 %) of Group B. Although these complications were rare in both groups, their similar incidences rule out pneumoperitoneum technique as a significant cause of these postoperative occurrences.[3,11]

Summary of Key Findings: In conclusion, our results showed that our access time is significantly shorter in the closed method (Veress needle) pneumoperitoneum than in the open method (trocar) in laparoscopic surgery. The closed approach also had significantly fewer gas leaks and vascular injuries. However, the open approach had a higher rate of site infections. These results offer important information regarding the safety and efficacy of both of these techniques and may

influence clinical decision-making, especially within populations of patients at increased risk for complications, including prior abdominal surgery or obesity.[6]

DISCUSSION:

Based on previous research, the closed method of creating a pneumoperitoneum was shown to shorten the times needed for access points, which reduced anesthesia duration, shortened the overall time of operation and improved recovery as well.[3, 6] This method also encountered fewer complications, such as gas leaks and vascular injury, which are critical points for patient security. Gas leaks can affect vision and movement, while vascular injuries cause severe bleeding and require additional medical care.[2, 15] The closed method is undoubtedly less of an ordeal than the open approach. Previous research showed that this method produces a pneumoperitoneum more efficiently and safely.[8, 9]

Despite these benefits, this study does recognize the constraint of the closed technique. It may be more favorable to use the open method in specific clinical contexts, given the decrease in the incidence of organ injury in the closed group. Patients who have had previous abdominal surgeries, adhesions, or other anatomical changes, for example, are at increased risk of injury using the closed approach, especially if they have either dense scar tissue or altered anatomy that may challenge appropriately directing the Veress needle.[5, 16] For these high-risk cases, although access time and complication rate were longer than usual, the open method could be a safer alternative, which directly observed the abdominal cavity and reduced the risk of inadvertent injury.[3, 17] For example, populations such as patients who have had multiple laparotomies and patients with a history of peritoneal disease may be better suited to the open method since this can allow for safer trocar placement and a reduced risk of bowel or vascular injury.[2, 13]

However, the higher site infection rate among the open group should also be interpreted cautiously. The open technique may have a more invasive effect: larger incisions and the abdominal cavity are much more exposed to external contamination.[10, 18] When the surgical field is more exposed, the risk of picking up the infection is higher because this can enable the entry of bacteria into the operative field. Although the closed method is less harmful and probably has fewer infections, the infection risk does not depend only on the method of pneumoperitonization. While the biofilm's nature affects infection severity, aseptic technique, prophylactic antibiotics, and patient factors (immune status and comorbidities) are critical to infection outcome.[19]

Results from this study are similar to previous studies regarding the trade-off between the closed and open methods. Agarwal et al. (2023) emphasized the time efficacy of the closed technique but also suggested that the open approach may be safer in high-risk patients, particularly those with a history of prior abdominal operations.[2] The closed method is generally faster and associated with fewer complications. However, the open method may be safer in specific patient populations. These studies propose that the technique of choice should be patient-specific and tailored to the patient's history and risk factors.[2] The open versus closed method debate continues, and although the scale appears to lean toward the closed method with faster time to intervention and decreased complications, the open method proves to be a powerful device in the specific clinical setting, particularly in patients at greater risk for intra-abdominal injury or who lack a safe, closed approach for some other reason.[6, 21]

The results of our study have important clinical consequences for the practice of laparoscopic surgery. The difference in

Table 01**:** Demographic variables of the patients in each group.

Variables		**Group A: Veress Needle (N=43)**		**Group B: Open Method (N= 56)**	
		Mean ± SD	**Count (%)**	**Mean ± SD**	**Count (%)**
Age (years)		36 ± 13.78	-	33.5 ± 12.23	-
Gender	Female	-	16 (35)	-	30 (65)
	Male	-	27 (51)	-	26 (49)
Body Mass Index	Greater than 25	-	17 (39)	-	27 (61)
	Less than 25	-	26 (47)	-	29 (53)

Table 02: Time for the creation of pneumoperitoneum in each group.

Access time (minutes)	*Group A: Closed method (N = 43)*	*Group B: Open method (N = 56)*	*P value**
1–5	*24*	*15*	-
6–10	*15*	*39*	-
>10	*4*	*2*	-
Mean access time	*6.25 ± 2.55*	*7.88 ± 2.76*	*0.03*

*Values are significant when p-value <0.05

access time detected in closed (6.25 ± 2.55 min) compared to open (7.88 ± 2.76 min) methods has an important efficiency advantage that could manifest in decreased anesthesia exposure and enhanced operating room throughput. The findings are consistent with Madhok et al. (2022), who underscored that even small gains in time in high-volume surgical centers significantly boost resource utilization.[6] Our findings for the closed method group (7% vs. 25%, p = 0.029) with greatly decreased gas leak rates are consistent with observations by Naqvi et al (2024), who reported that with stable pneumoperitoneum, operative field visualization is improved and surgical precision optimized.[8] The significant difference in vascular injury rates (2% for closed method versus 16% for open method, p=0.04) is particularly striking. It compares to the work of Martínez-Hoed et al. (2021), who found similar advantages in the closed technique.[3] Our site infection findings' clinical significance (7% closed vs. 25% open, p=0.029) is evident from the Garteiz-Martínez et al (2021) study identifying entry technique as a contributing factor to postoperative infection risk.[10] Although our research reinforces the closed approach in routine cases, it also recognizes the ongoing significance of the open technique in certain high-risk situations, especially for abdominal surgery or adhesions, as pointed out by Agarwal et al. (2023).[2] This highlights the need for individualist techniques, such as choosing a specific patient risk profile rather than using a particular protocol for everyone, in favor of a personalized surgical approach, as described by Patel et al. (2022).[5]

Finally, this study adds novelty to the ongoing debate to determine the best approach for establishing pneumoperitoneum during laparoscopic surgery. Although access time and complication rates are considerably improved with the closed method, especially for low-risk patients, the open method is still relevant for high-risk patients. For instance, additional research should assess and narrow down the parameters and define the basis for selecting the technique as per each patient.[9, 22]

Various limitations of our study should be taken into account in the interpretation of its results. Naqvi et al. (2016) noted the inherent limits of a single-center design, which might not apply to other health systems with dissimilar levels of surgical expertise and experience in minimally invasive surgeries.[8] Although sufficiently large to detect differences in primary outcomes and common complications, our sample size was likely small for rare but major adverse events, as the same limitation was noted by Liu et al. (2024) in other comparative studies.[11] Despite our best attempts at standardization, the operators' variability and effects on outcomes may be a confounding factor identified in comparisons of surgical technique by Luketina et al. (2021).[12] Focusing as we do on immediate and short-term outcomes, our study may miss late complications like trocar site hernias or adhesion-related problems that Jimenez-Santana et al. (2024) considered important when considering a comprehensive surgical outcome.[22] Lack of standardized patient-reported outcomes, including postoperative pain scores and satisfaction assessment is another limitation since such indicators are an important source of complementary data.[9] Even after attempts at randomization, subtle selection biases might have affected technique choice in some cases, especially where a patient had challenging anatomical features – one of the methodological challenges highlighted by Kim et al. 2021 in comparative surgical studies.[1] Future research should attempt to overcome these limitations in larger, multicenter randomized controlled trials with long-term follow-up and comprehensive outcome evaluations reported by Delia et al. (2021) in their review of surgical research methodology.[21]

CONCLUSION:

The closed technique (C) is traditionally performed using a Veress needle. It provides significantly shorter access time than the open technique (Op), thus decreasing anesthesia and surgical time. Our results show that the closed technique offers much shorter access time than the open technique (6.25 ± 2.55 min versus 7.88 ± 2.76 min), hence reduced anesthesia time and total operation time.

Further, the closed method was linked to lower complication rates, especially the gas leaks (7% as compared to 25%), vascular injuries (2% as compared to 16%), and site infections (7% as compared to 25%). The declined incidence of complications implies that the closed technique is more efficient and less dangerous for patients who have not undergone abdominal surgery, contributing to tissue integrity maintenance and faster recovery.

However, since it operates longer and has higher complication rates, the open approach is a useful alternative to specific patient groups. For patients who have had abdominal surgeries, adhesions, obesity, or abdominal wall disorders, the open method will provide direct vision that may avoid potential organ injuries. The direct visual access offered by the open technique may be life-saving for high-risk cases in which blind needle insertion may be a problem.

The individualized patient understanding and evaluation used in the selection of the optimal approach of pneumoperitoneum highlights the study. Despite the closed method's superiority for everyday low-risk cases, the open method remains relevant to patients with complex surgical histories and anatomical predicaments.

Further validation of these findings would be possible with future studies with large multi-center studies, varying patient populations, and long-term follow-up. Further, exploring patient-specific risk factors can also result in a more specific set of recommendations on the choice of technique, which can contribute to greater effectiveness in the surgical process and improved safety in laparoscopic procedures.

LIMITATIONS

Being a single tertiary care hospital study may limit the generalizability of these findings. Pump-related complications also may be underreported because the sample size may not have had enough statistical power to detect differences in less common complications. The findings of this study may be confirmed by future studies with larger cohorts and multi-center data.[3, 1]

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REFERENCES:

1. Kim W-J, Lim T-W, Park P-J, Choi S-B, Kim W-B. Safety and feasibility of pure laparoscopic extended cholecystectomy: comparison with the open technique in a propensity analysis at a single center. Surgical Endoscopy. 2021:1-7. https://doi.org/10.1007/s00464-020-08112-3
2. Agarwal PK, Golmei J, Goyal R, Maurya AP. Comparison between closed and open methods for creating pneumoperitoneum in laparoscopic cholecystectomy. Cureus. 2023;15(3). DOI: 10.7759/cureus.35991
3. Martínez-Hoed J, Bonafe-Diana S, Bueno-Lledó J. A systematic review of the use of progressive preoperative pneumoperitoneum since its inception. Hernia. 2021:1-16. https://doi.org/10.1007/s10029-020-02247-x
4. Bada-Bosch I, Escolino M, De Agustín JC, Esposito C. Pediatric inguinal hernia repair, laparoscopic versus open approach: a systematic review and meta-analysis of the last 10-year evidence. Journal of Laparoendoscopic & Advanced Surgical Techniques. 2022;32(5):583-94. https://doi. org/10.1089/lap.2021.0690
5. Patel K, Shergill S, Vadivelu N, Rajput K. Analgesia for gynecologic oncologic surgeries: a narrative review. Current Pain and Headache Reports. 2022;26(1):1-13. https://doi.org/10.1007/s11916-022-00998-z
6. Madhok B, Nanayakkara K, Mahawar K. Safety considerations in laparoscopic surgery: a narrative review. World journal of gastrointestinal endoscopy. 2022;14(1):1. doi:10.4253/wjge.v14.i1.1
7. Ietto G, Amico F, Pettinato G, Iori V, Carcano G. Laparoscopy in emergency: why not? Advantages of laparoscopy in major emergency: a review. Life. 2021;11(9):917. https://doi.org/10.3390/life11090917
8. Naqvi AZ, Balasubaramaniam V, Raza W, Rai L, Whiteley GS. Systematic review on techniques for the creation of pneumoperitoneum in laparoscopic surgeries. Asian Journal of Medical Sciences. 2024;15(5):253-9. DOI: 10.3126/ajms.v15i5.62482
9. Moro ET, Pinto PC, Neto AJ, Hilkner AL, Salvador LF, da Silva BR, et al. Quality of recovery in patients under low-or standard-pressure pneumoperitoneum. A randomised controlled trial. Acta Anaesthesiologica Scandinavica. 2021;65(9):1240-7. https://doi.org/10.1111/aas.13938
10. Garteiz-Martínez D, Rodríguez-Ayala E, Weber-Sánchez A, Bravo-Torreblanca C, Carbó-Romano R. Pulmonary recruitment can reduce residual pneumoperitoneum and shoulder pain in conventional laparoscopic procedures: results of a randomized controlled trial. Surgical Endoscopy. 2021;35:4143-52. https://doi.org/10.1007/s00464-020-07881-1
11. Liu S, Chi J, Cao H, Zhou X, Ma Q, Yang Y, et al. Massive subcutaneous emphysema and bilateral tension pneumothorax following laparoscopic inguinal hernia repair under general anesthesia: A case report. Heliyon. 2024;10(16). DOI:10.1016/j.heliyon.2024.e36005
12. Luketina R, Luketina TL, Antoniou SA, Köhler G, Könneker S, Manzenreiter L, et al. Prospective randomized controlled trial on comparison of standard CO 2 pressure pneumoperitoneum insufflator versus AirSeal®. Surgical endoscopy. 2021;35:3670-8. https://doi.org/10.1007/s00464-020-07846-4
13. Farda W, Tani MK, Manning RG, Fahmi MS, Barai N. Laparoscopic cholecystectomy: review of 1430 cases in cure international hospital, kabul, Afghanistan. BMC surgery. 2021;21:1-8. https://doi.org/10.1186/s12893-021-01342-9
14. Liang H, Ganji N, Alganabi M, Zhu H. Evidence-based advances in minimally invasive surgery in infants with congenital gastrointestinal anomalies: a narrative review. Translational Pediatrics. 2024;13(5):791. doi:10.21037/tp-23-611
15. Mohamed Ea, Ibrahim Ab, Mashal Ah. Clip Application Versus Harmonic Scalpel in Sealing and Division of the Appendicular Stump during Laparoscopic Appendectomy in Children. The Medical Journal of Cairo University. 2024;91(12):1289-300. DOI:10.21608/mjcu.2024.342718
16. Huang T. Purpose: As depression in patients with pelvic inflammatory diseases (PID) has. Women in Obstetrics and Gynecology. 2023;16648714:247. DOI:10.3389/fmed. 2022.926351
17. Morozov K, Morozova O, Severgina L, Marchuk T, Morozov D. Scientific Publications Experimental Surgery. 2021. DOI:https://dx.doi.org/10.18484/2305-0047.2021.2.137
18. Joelson AM, Shen B. Salvage Endoscopy in the Management of Acute Lower Gastrointestinal Endoscopy-Associated Complications. Corrective Endoscopy and Surgery in Inflammatory Bowel and Colorectal Diseases-E-Book: Advanced Management of Complications. 2024:165. https://doi.org/10.1016/B978-0-323-83439-1.00011-1
19. Di Carlo A, Gunder M, Doria C. Surgical Management of Pancreatic Adenocarcinoma. Hepato-Pancreato-Biliary Malignancies: Diagnosis and Treatment in the 21st Century: Springer; 2022. p. 557-68. https://doi.org/10.1007/978-3-030-41683-6_52
20. Rim CM, Verghese ST, Kane TD. Minimally Invasive Versus Open Surgical Approaches in Children: Pros/Cons. Anesthetic Management in Pediatric General Surgery: Evolving and Current Concepts. 2021:129-39. https://doi.org/10.1007/978-3-030-72551-8_8

21. Delia C-G, Hübner M, Mohammad A, Aditi B, Wim C, Olivier G, et al. Primary and metastatic peritoneal surface malignancies (Primer). Nature Reviews: Disease Primers. 2021;7(1). DOI:10.1038/s41572-021-00326-6

22. Jimenez-Santana JD, Díaz-Cambronero O, Schultz MJ, Mazzinari G. Current Concepts in Intraoperative Ventilation during Anesthesia for Laparoscopic and Robot–Assisted Surgery–a Narrative Review. Current Anesthesiology Reports. 2024;14(4):534-50. https://doi.org/10.1007/s40140-024-00648-7

23. Anita Kottapalli B, Megha Gangadhar B, Ven Kottapalli M. A Novel Treatment Approach to Treatment-Resistant, Recurrent Clostridioides difficile. 2022. DOI:10.1159/000527854