

A Comparative Analysis of Minimally Invasive vs. Open Surgery: Patient Outcomes and Recovery in General Surgery

Ahmad Alshammari^{1*}, Ali Boabbas² and Amal Shaikhah³

¹Adan hospital, Kuwait

²Farwaniya hospital, Kuwait

³Faculty of Medicine, Al-Azhar University, Palestine

*Corresponding author:

Amal Shaikhah,
Al-Azhar University, Faculty of Medicine - Palestine

Received: 26 Sep 2024

Accepted: 29 Oct 2024

Published: 02 Nov 2024

J Short Name: AJSCCR

Copyright:

©2024 Amal Shaikhah, This is an open access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and build upon your work non-commercially.

Keywords:

Minimally invasive surgery; Open surgery; Laparoscopic surgery; Patient outcomes; Recovery times; General surgery; Surgical techniques; Complications; Rectus diastasis; Laparoscopic cholecystectomy; Surgical methods

Citation:

Amal Shaikhah. A Comparative Analysis of Minimally Invasive vs. Open Surgery: Patient Outcomes and Recovery in General Surgery. *Ame J Surg Clin Case Rep.* 2024; 8(3): 1-6

1. Abstract

This review article provides a comprehensive analysis of the comparative effectiveness of minimally invasive versus open surgical techniques in general surgery, with a focus on patient outcomes and recovery times. Open surgery, characterized by significant incisions, remains a conventional approach for various surgical procedures but is associated with prolonged recovery, increased postoperative discomfort, and higher rates of complications. In contrast, laparoscopic surgery has gained prominence due to its minimally invasive nature, resulting in reduced tissue trauma, shorter hospital stays, and enhanced aesthetic outcomes. This review synthesizes current literature to highlight the advantages and limitations of each technique, underscoring the importance of individualized surgical approaches based on patient-specific factors. The findings indicate that while laparoscopic surgery offers significant benefits, the choice of surgical method must be guided by clinical appropriateness and the surgeon's expertise. Future research directions are also discussed, emphasizing the need for larger datasets and prospective studies to refine surgical techniques and improve patient outcomes.

2. Background

Open surgery, also known as conventional surgery, involves significant incisions to reach underlying organs or tissues. This technique, traditionally acknowledged as the principal surgical method, is extensively used for several surgical interventions. In open surgery, the surgeon incises the skin and surrounding tissues to

a size enough for direct vision and intervention. This method allows surgeons to distinctly see and operate the specific organs or tissues, usually under general anesthesia [1]. Open surgery provides enhanced vision, allowing for accurate structural diagnosis and manipulation, which is especially advantageous in complicated situations involving many organs. This method's direct access enhances dexterity and control, allowing surgeons to do complex procedures like suturing and grafting [2]. Nevertheless, the significant incisions involved in open surgery may result in more tissue damage, extended healing durations, and an elevated risk of consequences, such as infection and scarring [3]. Patients having open surgery often have extended hospital stays relative to those who have minimally invasive treatments, with a likelihood of increased postoperative discomfort owing to the substantial stress imposed on tissues. Recovery following open surgery is sometimes prolonged, requiring many weeks or even months for patients to resume their typical activities [1]. Laparoscopic surgery, sometimes referred to as keyhole or minimally invasive surgery, utilizes specialized equipment and a narrow, tube-shaped camera (laparoscope) to perform surgical operations via tiny incisions. Generally, many incisions ranging from 0.5 to 1.5 millimeters are created in the abdominal wall. The belly is distended with carbon dioxide to provide a workspace and improve sight. The laparoscope is inserted via a single incision, enabling the surgeon to see interior organs and tissues on a video monitor while using supplementary specialist devices through the other wounds. This minimally invasive technique leads to less stress, blood loss,

discomfort, scarring, and infection risk, along with expedited healing periods. Minimized incisions result in less postoperative pain and shorter hospitalizations, enabling a swifter resumption to daily activities. The visual results of laparoscopic surgery are often improved owing to the little scarring from fewer incisions [4-6]. This review article rigorously examines the disparities in patient outcomes and recovery durations between minimally invasive and open surgical procedures in general surgery. Although minimally invasive surgery has been more favored for its advantages, such as less postoperative discomfort and expedited recovery times, open surgery continues to be a conventional method for several surgical interventions. This study consolidates existing material, emphasizing significant discoveries and clinical ramifications to provide a thorough review for healthcare practitioners.

3. Methodology

A thorough literature analysis was undertaken using many medical databases, including PubMed, Google Scholar, MEDLINE, and Embase. Search phrases like “open vs. laparoscopic surgery,” “endoscopy,” and “laparoscopic hysterectomy” were used. Only publications published in English were deemed eligible for inclusion, while editorials were rigorously removed. The literature review included articles from 2000 to the present., to explore the comparative effectiveness of minimally invasive and open surgical methods. The inclusion criteria for this evaluation included peer-reviewed publications published in the last decade, concentrating especially on general surgical procedures. The data extraction concentrated on patient outcomes, recovery durations, complications, and long-term results, which were then evaluated to get comparative insights. Laparoscopic surgery is often used for several treatments, including as hysterectomy, ovarian cyst excision, endometriosis management, and tubal ligation. Laparoscopic techniques are employed for various surgical procedures, including cholecystectomy, appendectomy, hernia repair, colorectal surgery, prostatectomy, nephrectomy, treatment of urinary tract disorders, and bariatric surgeries such as gastric bypass and sleeve gastrectomy. These surgical procedures need particular training and expertise from both doctors and their surgical teams. Due to the reduced tactile input in laparoscopic surgery compared to open surgery, doctors must rely more on visual signals and sophisticated instruments. Laparoscopic operations need specific instruments and equipment, which may not be universally accessible in all healthcare settings. Moreover, some patient attributes, such as obesity, significant scarring, or specific comorbidities, may complicate or diminish the feasibility of laparoscopic surgery for certain people [7-9].

4. General Surgery

General surgery is a surgical specialty that addresses a broad spectrum of illnesses and medical conditions through various surgical interventions. General surgeons receive comprehensive training

to perform an array of surgical procedures across multiple body systems, excluding specialized areas such as the brain, spine, and heart, which fall under distinct surgical specialties. This discussion provides an in-depth overview of general surgery, encompassing its scope, training requirements, common surgical procedures, and significant areas of practice [10-11]. The field of general surgery encompasses a diverse range of surgical techniques, enabling general surgeons to manage both elective and emergent surgical cases effectively. Typical procedures performed by general surgeons include abdominal surgeries, management of breast disorders, oncological surgeries, colorectal operations, orthopedic interventions, soft tissue procedures, abscess drainage, and treatment of conditions such as hemorrhoids and anal fissures. Additionally, general surgeons are crucial in the management of trauma patients, addressing injuries to the chest, abdomen, and other regions, as well as conducting interventions for vascular diseases [10,11].

5. Open Surgery

Open surgery, sometimes termed “traditional surgery” or “conventional surgery,” is creating a substantial incision in the body to access and conduct surgical procedures on underlying tissues or organs. This method offers the benefit of improved sight and direct access to the surgical site, especially in contrast to minimally invasive approaches that use tiny incisions and specialized devices. Before the treatment, patients get general anesthesia to guarantee a pain-free surgical experience [12]. The dimensions and positioning of the incision are dictated by the particular surgical intervention and the intended organs or tissues. This incision provides maximum sight of the surgical area, enabling precise manipulation and excision of diseased or damaged tissues. Surgeons use traditional surgical equipment, including scalpels, sutures, and other medical tools, to perform essential procedures, which may include tumor removal, wound management, or the restoration of damaged organs or tissues. Upon completion of the surgery, the incision site is carefully closed using sutures, staples, or surgical glue to provide adequate wound containment [13]. A notable benefit of open surgery is the unimpeded visibility it offers of the operative site, facilitating precise identification and manipulation of the relevant tissues. Open surgery is especially appropriate for intricate treatments involving numerous organs or systems, providing access to regions that may be difficult to reach by minimally invasive methods. Surgeons may directly palpate the tissues during these surgeries, offering significant tactile input. Although open surgery has been a common method for several years, the rising preference for less invasive methods has led to decreased exposure for general surgery residents to conventional surgical techniques [13].

6. Laparoscopic Surgery

Laparoscopy has significantly evolved in the medical field, profoundly altering the performance of several surgical operations. Despite its roots in the early 20th century, laparoscopy has seen

significant developments lately, leading to its broad acceptance in the medical world [2]. The notion of laparoscopy was originally inspired by cystoscopes, instruments intended for seeing the bladder, to investigate the abdominal cavity. In 1901, German surgeon Georg Kelling performed the first laparoscopic operation on a dog with a modified cystoscope; nonetheless, these initial efforts did not attract rapid interest or broad implementation. The first successful laparoscopy on a person was conducted in 1910 by Swedish surgeon Hans Christian Jacobaeus, who used a cystoscope for diagnostic examination of the abdominal cavity. Jacobaeus not only developed the name “laparoscopy” but also shared his discoveries with the medical world, so establishing the basis for this surgical method [14,15]. The invention of pneumoperitoneum, the inflation of the abdominal cavity with gas (originally carbon dioxide), marked a crucial milestone in laparoscopy, greatly enhancing visibility during surgeries. This method, along with progress in optical technology, yielded improved surgical results and greater image quality. The introduction of laparoscopic cholecystectomy in the late 1980s was a pivotal advancement that integrated laparoscopy into conventional surgical practice. In 1987, German surgeon Erich Mühe conducted the first laparoscopic cholecystectomy, demonstrating the capabilities of laparoscopic methods for significant surgical procedures and garnering international attention. The 1990s seen significant advancements in laparoscopic techniques and devices. The incorporation of high-resolution displays and video cameras improved vision, while articulated tools afforded surgeons more flexibility during procedures. In the wake of laparoscopic cholecystectomy’s success, several surgical specialties embraced laparoscopy, leading to the widespread implementation of treatments such as laparoscopic appendectomy, hernia repair, colorectal surgery, and gynecological interventions. The 2000s saw the emergence of robot-assisted laparoscopy, represented by systems such as the da Vinci surgical platform, which facilitated the execution of intricate operations with improved accuracy, dexterity, and low invasiveness. During this era, novel procedures such as natural orifice transluminal endoscopic surgery (NOTES) and single-incision laparoscopic surgery (SILS) emerged. SILS reduces visual scars by executing the whole surgery via a solitary tiny incision, while NOTES seeks to execute internal procedures without external incisions by entering the belly through natural orifices such as the mouth or anus. Laparoscopy is always advancing due to improvements in equipment, imaging technologies, and procedural methodologies. Currently, surgeons from several fields, including urology, gynecology, cancer, and bariatric surgery, frequently conduct a wide array of laparoscopic operations [16-18].

7. Laparoscopic Colorectal Surgery

Initially regarded as an experimental technique by a select group of pioneers in the early 1990s, laparoscopic surgery for colorectal conditions has now become a widely accepted practice worldwide.

This transition has occurred despite the fact that laparoscopic procedures often incur higher costs and longer operative times compared to traditional open colorectal surgeries. We are now entering a new era in minimally invasive colorectal surgery [19]. Recent studies have shown that laparoscopic surgery in patients with rectal cancer is associated with comparable rates of disease-free survival and overall survival, as well as similar locoregional recurrence rates and reduced intraoperative blood loss when compared to open surgical techniques. Evidence from large-scale, multicenter randomized trials has established the safety of laparoscopic colorectal surgery, demonstrating favorable short-term perioperative outcomes alongside long-term oncological efficacy [14,20-21].

8. Laparoscopic Cholecystectomy

Laparoscopic cholecystectomy is a minimally invasive technique for gallbladder removal, providing a less invasive option compared to conventional open gallbladder surgery. This method is often used in instances of gallstones, cholecystitis, or other gallbladder-related disorders. The treatment entails creating many tiny incisions in the belly, typically measuring between 0.5 and 1.5 millimeters, to allow the insertion of laparoscopic tools.

Conversely, open cholecystectomy involves the excision of the gallbladder via a more extensive abdominal incision. In an open cholecystectomy, the surgeon makes a significant incision, often ranging from 15 to 20 centimeters, in the upper right abdomen under the ribs. This procedure was the conventional strategy for gallbladder excision until the advent of laparoscopic methods.

Carbon dioxide gas is insufflated into the abdominal cavity to provide a working area for the surgery, enhancing vision and dexterity of surgical equipment. A laparoscope, a thin camera, is introduced via a tiny incision, accompanied by supplementary laparoscopic instruments, including a light source. The camera conveys high-definition photos of the surgical site to a video display, offering the surgeon a magnified perspective to direct their efforts. Additional specialized laparoscopic equipment are inserted via the remaining incisions to assist in cutting, suturing, and manipulating tissues [16,19,20-21]. The gallbladder is carefully separated from its connections to the liver and bile duct before to extraction. During the surgery, doctors observe for any hemorrhaging and guarantee that adjacent tissues stay intact. Upon the removal of the gallbladder, the wounds are either sutured or sealed with surgical glue. The low scarring resulting from minor incisions is often attractive to patients from an aesthetic viewpoint [19]. Patients having laparoscopic surgery often enjoy less postoperative pain and a faster recovery duration compared to those undergoing standard open cholecystectomy. Laparoscopic cholecystectomy is often conducted on an outpatient basis. The choice to do laparoscopic cholecystectomy depends on the patient’s medical history and general condition, necessitating meticulous evaluation by surgeons to

ascertain the most suitable surgical method [20]. Laparoscopic cholecystectomy is the preferred method for gallbladder removal owing to its least invasive characteristics; nevertheless, open cholecystectomy is a viable alternative in some situations when laparoscopic surgery may be impractical or unsafe. The principal difference between these two surgical techniques is their level of invasiveness; laparoscopic surgery is linked to a reduced risk of postoperative complications, such as infections, and facilitates a quicker return to normal activities for patients, frequently leading to shorter hospitalizations [19,22-23].

9. Rectus Diastasis Surgery

The choice between open and laparoscopic surgery for rectus diastasis is determined by several aspects, such as the severity of the diastasis, the patient's general health, the surgeon's proficiency, and the preferences of the patient. Laparoscopic rectus diastasis surgery is an emerging procedure, and information on its long-term effects remains scarce. Nevertheless, current research demonstrates that this method is both secure and effective in mitigating discomfort and improving the cosmetic quality of the abdomen [16]. When a patient is considered appropriate for minimally invasive procedures due to the severity of their diastasis, laparoscopic surgery is often the chosen choice. Conversely, in instances of severe diastasis or when the patient exhibits certain clinical characteristics that limit laparoscopic access or elevate surgical risk, open surgical techniques are more often used [14,15]. In open surgery, the divided abdominal muscles are accessible and reconnected via a single, bigger abdominal incision. The incision is often executed in the midline, granting the surgeon clear view and access to the rectus abdominis muscles for repair. Laparoscopic surgery, by contrast, entails many tiny incisions through which the whole operation is performed. A laparoscope and other specialized devices are inserted into these incisions, enabling the surgeon to see the surgery site and assist in the closure of the rectus diastasis [18].

10. Laparoscopic Hysterectomy

A hysterectomy is conducted for many benign medical disorders and may be executed using two main techniques: open surgery via an abdominal incision and laparoscopic surgery. Research literature suggests that open abdominal hysterectomy, requiring longer incisions, leads to increased tissue stress and an extended recovery duration. Conversely, patients receiving laparoscopic hysterectomy benefit from shortened recovery periods owing to the smaller incisions, less blood loss, and reduced tissue trauma linked to the treatment. The first successful laparoscopic hysterectomy was documented in 1989, with the authors emphasizing the advantages of this method, such as a reduced recovery duration. Laparoscopic hysterectomy is advised in some circumstances to reduce morbidity and improve recovery rates [20].

11. Laparoscopic Hernia Repair

Hernia repair may be executed using both open and laparoscopic methodologies. Meta-analyses have shown that the recurrence rates for both surgical techniques are essentially same, with similar durations of operation and hospitalization. While several studies indicate elevated recurrence rates after laparoscopic operations relative to open surgery, the prevailing consensus from many meta-analyses indicates that the recurrence rates for both techniques are essentially comparable. Moreover, research comparing the results of laparoscopic and robotic surgical techniques in hernia repair enhances the existing knowledge on this subject [16,20-21].

12. Laparoscopic Appendectomy

Laparoscopic appendectomy has emerged as the preferred approach for managing acute appendicitis, largely due to its advantages over open surgery. This preference is attributed to several factors, including a reduced number of incisions, shorter hospitalization durations, and a decreased requirement for analgesics. An umbrella review encompassing ten meta-analyses reported a 48-70% reduction in surgical site infections (Relative Risk: 0.56 [95% CI: 0.47-0.67]) associated with laparoscopic procedures; however, there was a noted increase in the risk of intra-abdominal abscess formation (Relative Risk: 1.20 [95% CI: 0.88-1.63]) compared to open surgeries. Furthermore, systematic reviews and meta-analyses have investigated laparoscopic versus open surgery for acute appendicitis in pregnant women, reinforcing the preference for laparoscopic techniques. These studies concluded that there was no significant association between the surgical method employed and the risk of preterm delivery during pregnancy. Overall, laparoscopic appendectomy is associated with minimal morbidity, shorter hospital stays, lower infection rates, reduced readmissions, and higher success rates [23].

13. Open vs. Laparoscopic Surgery

Open surgery has been a standard practice for many years, and most surgeons are well-versed in this technique. One of the primary advantages of open surgery is the direct visualization it offers; surgeons benefit from an unobstructed view of the surgical site, which can be particularly advantageous in cases involving complex anatomical structures. However, the significant drawback of open surgery is the large incision required, which, while providing visibility, leads to increased tissue trauma, prolonged hospital stays, and a slower recovery process. In contrast, laparoscopic surgery presents several benefits, including its minimally invasive nature, which results in less tissue damage, shorter hospital stays, and the potential for faster recovery [25].

14. Limitations

Notable constraints of laparoscopic surgery include the need for technical proficiency, since this method demands comprehensive

training and the use of modern, intricate devices. In contrast to open surgery, which affords superior tactile feedback, laparoscopic methods primarily depend on visual cues, resulting in less sensory input throughout the operation. The use of laparoscopic procedures may be limited for some people owing to medical issues, making it less broadly accessible. Conversely, open surgery may be conducted in resource-constrained environments while attaining similar clinical results. In circumstances when laparoscopic surgery is considered risky or impractical—such as in instances of significant inflammation, substantial scarring, hemorrhagic complications, or other aggravating factors—open surgery may be the favored alternative. Both open and laparoscopic surgical procedures include distinct benefits and drawbacks, and the assessment of which method is superior is extremely customized; what may be ideal for one patient may not be applicable to another.

15. Conclusion

Determining a conclusive victor in the comparison between open surgery and laparoscopic surgery about which technique is best is challenging. The selection of an appropriate technique is contingent upon the patient's health and specific circumstances prior to surgery. Each strategy has distinct advantages and disadvantages. A comprehensive evaluation of the patient's medical history, clinical appropriateness, and the proficiency of the surgical team is essential to ascertain the most effective surgical method for maximizing patient safety and outcomes. Laparoscopic techniques have been refined for some surgical operations, using minimally invasive procedures that decrease hospital stays, postoperative problems, expenses, and recovery durations. For future research, this study serves as a foundation for exploring more complex models and larger datasets. The integration of additional variables, potentially from other cancer types or broader demographic data, could further refine the predictive models. Moreover, the study highlights the potential of machine learning in transforming cancer prognosis and treatment strategies, suggesting avenues for further exploration in predictive analytics.

16. Limitations and Future Directions

Despite its contributions, this study has limitations that warrant consideration. The exclusion of patients with incomplete data records, while necessary for maintaining data quality, might introduce bias, potentially excluding patients with specific characteristics. Future studies could explore methods to handle incomplete data without excluding cases, perhaps by developing more sophisticated imputation techniques. Furthermore, the reliance on retrospective data from existing datasets limits the ability to capture real-time changes in treatment protocols or patient outcomes. Prospective studies, or real-time data collection methods, could be implemented to address this limitation, providing a more dynamic view of cancer treatment and its outcomes. In conclusion, this study exemplifies the integration of statistical and machine

learning methods in analyzing complex health data, offering valuable insights into cancer outcomes. The findings underscore the potential of these approaches in enhancing predictive accuracy and personalizing cancer treatment, setting a precedent for future research in this field.

References

- Smiley KE, Wuraola F, Mojibola BO, Aderounmu A. An outcomes-focused analysis of laparoscopic and open surgery in a Nigerian hospital. *JLS*. 2023; 27: 2022.
- Spaner SJ, Warnock GL. A brief history of endoscopy, laparoscopy, and laparoscopic surgery. *Journal of Laparoendoscopic & Advanced Surgical Techniques*. 1997; 7(6): 369-373.
- Caroff DA, Chan C, Kleinman K. Association of open approach vs laparoscopic approach with risk of surgical site infection after colon surgery. *JAMA Network Open*. 2019; 2: e1913570.
- Twaij A, Pucher PH, Sodergren MH, Gall T. Laparoscopic vs open approach to resection of hepatocellular carcinoma in patients with known cirrhosis: systematic review and meta-analysis. *World Journal of Gastroenterology*. 2014; 20(25): 8274-8281.
- Biondi A, Grosso G, Mistretta A. Laparoscopic vs. open approach for colorectal cancer: evolution over time of minimal invasive surgery. *BMC Surgery*. 2013; 13: S12.
- Wormser C, Runge JJ. Advances in laparoscopic surgery. *Veterinary Clinics of North America: Small Animal Practice*. 2016; 46(1): 63-84.
- Liu F, Huang C, Xu Z. Morbidity and mortality of laparoscopic vs open total gastrectomy for clinical stage I gastric cancer: the CLASS02 multicenter randomized clinical trial. *JAMA Oncology*. 2020; 6(11): 1590-1597.
- Antoniou SA, Antoniou GA, Franzen J, Bollmann S. A comprehensive review of telementoring applications in laparoscopic general surgery. *Surgical Endoscopy*. 2012; 26(8): 2111-2116.
- Vitale SG, Alonso Pacheco L, Haimovich S. Pain management for in-office hysteroscopy: A practical decalogue for the operator. *Journal of Gynecology Obstetrics and Human Reproduction*. 2021; 50: 101976.
- Bass BL. Fundamental changes in general surgery residency training. *American Surgeon*. 2007; 73(2): 109-113.
- Diaz JJr, Cullinane DC, Dutton WD. The management of the open abdomen in trauma and emergency general surgery: part 1-damage control. *Journal of Trauma*. 2010; 68(6): 1425-1438.
- Bielser D, Gross MH. Open surgery simulation. *Studies in Health Technology and Informatics*. 2022; 85: 57-63.
- Bingmer K, Ofshteyn A, Stein SL. Decline of open surgical experience for general surgery residents. *Surgical Endoscopy*. 2020; 34(2): 967-972.
- Blackmore AE, Wong MT. Evolution of laparoscopy in colorectal surgery: an evidence-based review. *World Journal of Gastroenterology*. 2014; 20(17): 4926-4933.

15. Georgiou AN, Rassweiler J, Herrmann TR. Evolution and simplified terminology of natural orifice transluminal endoscopic surgery (NOTES), laparoendoscopic single-site surgery (LESS), and mini-laparoscopy (ML). *World Journal of Urology*. 2021; 30(5): 573-580.
16. Cuscheri A, Dubois F, Mouiel J. The European experience with laparoscopic cholecystectomy. *American Journal of Surgery*. 1991; 161(4): 385-387.
17. Teixeira J. One hundred years of evolution in surgery: from asepsis to artificial intelligence. *Surgery Clinics of North America*. 2020; 100(0): 0.
18. Birindelli A, Podda M, Segalini E. Is the minimally invasive trauma surgeon the next (r)evolution of trauma surgery? Indications and outcomes of diagnostic and therapeutic trauma laparoscopy in a level 1 trauma center. *Updates in Surgery*. 2020; 72(2): 503-512.
19. Johansson M, Thune A, Nelvin L, Stiernstam M, Westman B. Randomized clinical trial of open versus laparoscopic cholecystectomy in the treatment of acute cholecystitis. *British Journal of Surgery*. 2005; 92(1): 44-49.
20. Bonjer HJ, Deijen CL, Abis GA. A randomized trial of laparoscopic versus open surgery for rectal cancer. *New England Journal of Medicine*. 2015; 372(2): 1324-1332.
21. Laparoscopic surgery versus open surgery for colon cancer: short-term outcomes of a randomized trial. *Lancet Oncology*. 2005; 6(6): 477-484.
22. Coccolini F, Catena F, Pisano M. Open versus laparoscopic cholecystectomy in acute cholecystitis: systematic review and meta-analysis. *International Journal of Surgery*. 2015; 18: 196-204.
23. Lombardo S, Rosenberg JS, Kim J. Cost and outcomes of open versus laparoscopic cholecystectomy in Mongolia. *Journal of Surgical Research*. 2018; 229: 186-191.
24. Mommers EH, Ponten JE, Al Omar AK. The general surgeon's perspective of rectus diastasis: A systematic review of treatment options. *Surgical Endoscopy*. 2017; 31(10): 4934-4949.
25. ElHawary H, Chartier C, Alam P. Open versus laparoscopic surgical management of rectus diastasis: systematic review and pooled analysis of complications and recurrence rates. *World Journal of Surgery*. 2022; 46(6): 1878-1885.