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THE ROLE OF MINIMALLY INVASIVE SURGERY IN THE TREATMENT OF ABDOMINAL DISEASES

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ABSTRACT

Introduction: Minimally invasive surgeries (MICs) have revolutionized medicine by allowing procedures with smaller incisions, reducing complications and recovery time. Laparoscopy and the introduction of robotic technology were important milestones, expanding surgical capabilities. Despite the advantages, CMI has high costs and some technical limitations. Objectives: To understand the role of minimally invasive surgery in the treatment of abdominal diseases Methodology: This is an integrative literature review, with a search for scientific articles in the Virtual Health Library, having as inclusion criteria articles with the theme that was related to the guiding question, articles with full text, in Portuguese and English and published in the last 10 years. Results and Discussion: We were able to observe the great advances in minimally invasive surgical techniques, highlighting laparoscopy for hepatic flexure hernia and mini-laparotomy for colon cancer, both promoting rapid recovery and fewer complications. There are also innovations in urological surgeries and treatment of acute pancreatitis, with techniques such as renal cryoablation guided by computed tomography (CT). For the treatment of pediatric empyema, video-assisted thoracoscopic debridement (VADT) is preferred for its good aesthetic results. In addition,

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emerging methods such as the single portal and NOTES promise less invasiveness and better aesthetic results. The findings emphasize the benefits of minimally invasive surgeries, despite the initial costs and the need for specialized training. Conclusion: The articles demonstrate that minimally invasive techniques offer significant benefits, such as fewer complications, faster recovery, and better aesthetic results. Although the initial costs are high due to the equipment and specialized training, these methods provide long-term savings by reducing hospital stay time and postoperative complications, resulting in improved efficiency and effectiveness in treatment.

Keywords: Abdomen. Abdominal. Benefits. Diseases. Minimally invasive surgical procedures.

INTRODUCTION

There are historical reports that the first instrument produced for minimally invasive procedures took place in 1806 when the German Phillipp Bozzini built the instrument.

Lichtleiter to visualize internal organs. He used an aluminum tube, lit by a wax candle, with mirrors to reflect images to visualize the genitourinary tract. In 1853, Antoine Jean Desormeaux, a French surgeon, first used Bozzini's Lichtleiter on a patient (Tan et al., 2011; Volpe, 2015).

Minimally invasive surgical techniques (MIC) are a revolution in medical practice, significantly changing the approach to surgical procedures (Gumbs et al., 2013; Fuchs & Breitenstein, 2014).

Laparoscopy was a milestone of this revolution, beginning in the twentieth century (Branco et al., 2014; Schwaitzberg et al., 2017).

Minimally invasive surgeries (MIS) are characterized by the use of small incisions, leading to less aggression to tissues, less transoperative blood loss, lower risk of infections, and less scarring, thus reducing postoperative pain and length of hospital stay, while promoting rapid recovery compared to conventional open-access surgical approaches (Varela et al., 2016; Feldman et al., 2018).

The main minimally invasive surgeries include: Laparoscopies, arthroscopies, endoscopic surgeries, and robotic surgeries (Lemke et al., 2017; Rassweiler et al., 2018).

With the introduction of robotic technology in the early 2000s, IMC entered a new era, which expanded the surgeon's capabilities with precision, control, and three-dimensional visualization (Herron & Marohn, 2008; Melfi et al., 2015).

IMCs are indicated for gynecological and urological procedures, laparoscopic cholecystectomy, and hernia reduction (Jemal et al., 2010; Carbonell et al., 2017).

The disadvantage of this technique includes its costs, in general, minimally invasive surgery tends to be more expensive than traditional open surgery, due to the use of specialized equipment and devices and the specialized surgical team, and an often longer surgical time. There are also some technical restrictions of IMT, such as very complex surgical procedures, anatomical limitations, such as excessive obesity, scars and adhesions, and limited access to certain areas of the body and requires an adaptation in the surgical technique (Schauer et al., 2014; Patel et al., 2018).

Patients chosen for this type of minimally invasive surgical technique must meet the clinical criteria of a good state of general health, have this type of indication for the surgical procedure, size and location of the surgery must be appropriate to the technique and also

the anatomical position of the site to receive the procedure (Brunt et al., 2015; Holihan et al., 2016).

In addition, this study aimed to understand the role of minimally invasive surgery in the treatment of abdominal diseases and to explain the concept of minimally invasive surgery.

METHODOLOGY

This is an integrative literature review study, which allows the researcher a better understanding and analysis of the scientific content based on the exploration of research, where it was possible to synthesize certain subjects and support the researcher about the elaboration of new questions and analyses (Mendes, Silveira and Galvão, 2019; Torraco, 2016).

For the present study, the development criteria were used, respecting the stages of elaboration of the integrative literature review research. This research method allows the synthesis of multiple published studies and enables general conclusions regarding a particular area of study (Souza, Silva, and Carvalho, 2020; Whittemore, 2005).

Integrative literature review is a method that aims to reduce results obtained in research on a theme or issue, in a systematic, orderly, and comprehensive manner. It is called integrative, because it provides broader information on a topic, constituting a set of knowledge. The researcher can perform an integrative review with various purposes, directing to the definition of concepts, review of theories, or methodological analysis of a particular topic. To carry out the integrative review, it is necessary to go through six distinct stages (Ercole, Melo, and Alcoforado, 2014; Toronto and Remington, 2020).

It is important to emphasize that the steps of the integrative literature review must be followed, namely:

First Stage: ELABORATION OF THE GUIDING QUESTION - What is the role of minimally invasive surgery in the treatment of abdominal diseases?

Second Stage: LITERATURE SEARCH: In this stage, we selected which would be the keywords in the DECs (Health Science Descriptors). The words were: Abdomen, Abdominals; Benefits; Diseases; and Minimally invasive surgical procedures.

After selecting the keywords, we determined the inclusion criteria for the search for articles, namely: a theme that was related to the guiding question, articles with full text, in Portuguese and English, published in the last 10 years.

Third Stage: DATA COLLECTION - In this stage, we cross-reference the keywords to collect the articles that will be integrative for our literature review. On the BIREME website, we cross the following keywords:

Minimally Invasive Surgical Procedures vs Diseases vs Abdominals, Minimally Invasive Surgical Procedures vs Benefit vs Abdomen, Minimally Invasive Surgical Procedures vs Disease vs Abdomen.

We can observe the number of articles found, selected, and excluded after crossing the keywords, as shown in the table below:

Chart *1* - Cross-Referencing of Keywords

Cross-referencing of keywords	**Articles Found**	Selected Articles	Excluded Articles
Minimally invasive surgical procedures x Diseases x Abdominals	27	6	21
Minimally invasive surgical procedures x Benefit x Abdomen	23	4	19
Minimally invasive surgical procedures x Disease x Abdomen	31	9	21

Source: Authors, 2025.

Fourth Stage: – CRITICAL EVALUATION OF THE SELECTED ARTICLES: After crossing the keywords, we obtained a quantity of 81 articles. We carried out a thorough evaluation of them to compose our integrative review. After reading the abstracts, we selected those that were coherent with the theme of the guiding question and met the selection criteria, thus, in the end, we obtained 19 articles to compose this work.

Fifth Stage: INTERPRETATION OF RESULTS: According to the selected articles, to interpret the results, we extracted the following data: author, year, objective, results, and theme of approach, as shown in the table below:

Table 2 - Data Extracted from the Reviewed Studies

AUTHOR AND YEAR OF PUBLICATION	STUDY NAME	GOAL	SURVEY RESULTS	THEME OF THE APPROACH

ABE, N. et al (2009).	Endoscopic single-port cholecystectomy: a bridge between laparoscopic and transluminal endoscopic surgery.	To evaluate the technical feasibility of SPEC (endoscopic single-port cholecystectomy).	Complete excision of the gallbladder was performed easily and safely in all cases, SPEC is simpler, easier, and safer than NOTES cholecystectomy (transluminal endoscopic surgery with natural orifice).	Approach to the SPEC technique (single-port endoscopic cholecystectomy).
AHMED, K. et al (2011)	The role of laparoscopic single-incision surgery in abdominal and pelvic surgery: a systematic review.	To determine the role of laparoscopic single-incision surgery (SILS) in abdominal and pelvic operations.	Potential benefits of SILS include superior cosmesis and possibly shorter operative time, lower costs, and shorter time to complete physical recovery.	Laparoscopic single-incision surgery.
AL-ZAHIR, A. et al (2019).	Boerhaave Syndrome: Delayed Management Using Over-the-Scope Clip.	To analyze the treatment of Boerhaave Syndrome with endoscopic intervention in the form of over-the-scope clip application (OTSC)	Delayed presentation of Boerhaave syndrome can be safely treated using an over-the-scope clip. This endoscopic method speeds recovery and shortens the length of hospital stay.	Endoscopic intervention in the form of over-the-scope (OTSC) clip application.
BELYANSKY, I. et al (2018)	The trend towards complex minimally invasive abdominal wall reconstruction: is it worth it?	To identify the impact of laparoscopy and robotics on the AWR (abdominal wall reconstruction) program.	The transition to performing abdominal wall reconstruction in cases that were previously performed through an open approach decreased the total length of stay and translated into significant total cost savings.	Minimally invasive abdominal wall reconstruction.
COLLINS, W. J. et al (2023)	Minimally invasive surgery for genitourinary trauma: an outcome-based analysis across the country.	To compare the results of the open surgical approach and laparoscopy in trauma patients with isolated bladder and ureter injury.	Mortality was lower in the open-label group compared to the laparoscopy group and the length of hospital stay for survivors alone was higher in the open-label group.	Laparoscopic surgical repair.
GALAZKA, P.; REDLOCH, K.; KROCZEK, K.; STYCZYNSKI, J. (2020)	Minimally invasive surgery for congenital abdominal cystic lesions in newborns and infants.	To evaluate the results of the diagnosis and treatment of ACL (Abdominal Cystic Lesions).	With the management strategy based on ultrasound and laboratory data, a laparoscopic-assisted minimal access approach resulted in minimal risk of complications and complete recovery in all patients, leading to the exclusion of oncological risk.	Conservative technique, laparoscopic technique, and laparotomy combined with laparoscopy.

GITE, V. A. et al (2021)	Minimally Invasive Techniques as a First-Line Approach in the Treatment of Emphysematous Pyelonephritis - Single-center experience.	Evaluate the various minimally invasive techniques sequentially (step by step) in renal unit rescue.	Minimally invasive decompressive surgical techniques have excellent results in preserving renal function in the management of PE (Emphysematous Pyelonephritis).	Minimally invasive techniques in the treatment of Emphysematous Pyelonephritis (PE).
GIULIANI, A. et al (2015)	Total abdominal approach to posterosuperior segments (7, 8) in laparoscopic liver surgery: a multicenter experience.	Analysis of laparoscopic resection of liver tumors located in the posterosuperior segments of the liver with a total abdominal approach.	The technique is feasible and safe, with short-term results similar to other laparoscopic liver resections.	Total abdominal approach in laparoscopic liver surgery.
HUANG, D. et al (2022)	From step-up to step-jump: a groundbreaking intervention for infected necrotizing pancreatitis	To compare the safety and efficacy of a new four-step approach and the conventional approach in the management of IPN.	Fewer patients in the four-step group required emergency surgery when compared to the conventional group, and the four-step approach had a significantly lower incidence of organ failure compared to the other group.	Four-step approach to the management of IPN.
ISHIDA, H. (2011)	Impact of previous abdominal surgery on curative resection of colon cancer via mini-laparotomy.	To evaluate the impact of prior abdominal surgery on curative colon cancer resection using a mini-laparotomy approach.	Prior abdominal surgery may require an extension of the mini-laparotomy incision but does not appear to contraindicate a mini-laparotomy approach for curative colectomy.	Minilaparotomy approach.
KALAITZIS, C. et al (2012)	Minimally invasive treatment options in pregnant women with ovarian vein syndrome.	Describe the treatment modalities of symptomatic ovarian vein syndrome in pregnancy.	After insertion of the DJ stents, the respective colic crises in percutaneous nephrostomy regressed immediately and the febrile pyelonephritis in a few days.	Minimally invasive treatment in pregnant women.
KNIGHT, J. K.; MARSHALL, M. B.; (2016)	Minimally Invasive Treatment of Recurrent Lymphangioma Complex of the Chest and Abdomen.	To report the minimally invasive management of a complex recurrence of lymphangioma involving bilateral chest, mediastinum, and abdomen.	The report suggests that the use of minimally invasive combination techniques, including laparoscopy, thoracoscopy, percutaneous drainage, and sclerosis, maybe the ideal strategy to deal with these complex situations.	Minimally invasive combined techniques.

KRESO, A. et al (2020)	New techniques for the treatment of portal system hemorrhage in acute pancreatitis.	To analyze two cases of portal venous bleeding in patients undergoing treatment for infected pancreatic necrosis with a staggered approach, as well as to analyze different techniques that can be used to successfully control venous bleeding.	Both patients recovered well, with no residual bleeding or additional procedures.	Techniques to be used to control venous bleeding in necrotizing pancreatitis.
MAGI, J. et al (2017)	Minimal abdominal incisions.	To demonstrate the feasibility and usefulness of minimal incision laparotomies based on the literature and exemplifying with a case.	Laparotomy techniques with minimal incisions should be considered a valid and viable option in the treatment of surgical conditions.	Laparotomy technique.
MEIER, A. H.; HESS, C. B.; CILLEY, R. E. (2010).	Complications and treatment failures of video-assisted thoracoscopic debridement for pediatric empyema.	To review institutional experience for factors that predict treatment failure or complications of video-assisted thoracoscopic debridement.	The technique provided effective treatment for pediatric empyema, the complications were mostly minor, occurring more frequently in older patients and those with lower admission hematocrit.	Video-assisted thoracoscopic debridement.
MILLER, H. et al (2021)	Adjuvant hysterectomy after primary chemoradiation for stage IB2 and IIA2 cervical cancer: a retrospective comparison of complications for open versus minimally invasive surgery.	To compare complications and recurrences between minimally invasive and open adjuvant hysterectomy for early-stage cervical cancer.	Adjuvant hysterectomy after chemoradiation for bulky early-stage cervical cancer has been shown to decrease the rate of local relapse.	Minimally invasive adjuvant hysterectomy.
PHILLIPS, S. H.; HILL, S. K.; LIPSCOMB; L. D.; AFRICA, J.B. (2017)	Changing the approach: minimally invasive kidney transplantation in obese patients through the anterior rectus sheath.	To retrospectively analyze wound problems in obese kidney transplant patients, as well as post-transplant outcomes, including graft and patient survival, hypothesizing improvement over the standard approach.	For obese patients, the anterior rectus sheath approach proved to be an effective option that reduced wound complications and operative time.	Minimally invasive approach to the anterior rectus sheath: technique

SELVAGGIO, O. et al (2020)	Minimally invasive approaches in the treatment of small renal masses: CT-guided renal cryoablation in the elderly.	The objective of surgery is to achieve oncological efficacy with the lowest rate of complications.	Percutaneous cryoablation of small renal masses in the elderly population is an effective and safe technique. The procedure is easy to perform, has a low complication rate, and is well tolerated by elderly patients.	Percutaneous cryoablation of small renal masses.
YES, K. K. ; FOSTER, A. (2019)	Hernia of hepatic flexure through Winslow's foramen and review of the literature describing the minimally invasive technique.	Learn the main techniques in the use of laparoscopy in the management of future cases.	The minimally invasive approach is a safe and viable alternative that should be considered as it would lead to improved patient recovery and outcomes.	Laparoscopy technique.

Source: Authors, 2025.

Sixth Stage: ELABORATION OF THE RESULTS AND DISCUSSION: After in-depth reading of the articles and according to the themes of approaches, we synthesized the results found.

RESULTS AND DISCUSSION

Sim & Foster (2019) explain that hepatic flexure hernia through Winslow's foramen is considered rare and difficult to diagnose. One technique that has been pointed out as promising and preferred to treat this hernia is laparoscopy. Cases reported by these same authors show that it is effective and has advantages over traditional laparotomy, causing fewer complications and ensuring a faster recovery. However, it needs specialized training.

When it comes to colon cancer, mini-laparotomy is becoming an attractive and less invasive option, especially in cases where the patient has already faced other abdominal surgeries. With smaller cuts, this technique not only reduces surgical trauma but also speeds up recovery, without losing effectiveness in the fight against cancer. In addition, reconstructing the abdominal wall in a minimally invasive way brings economic benefits and ensures a faster recovery, even if, at first, these advanced techniques cost a little more. (ISHIDA, H., 2011)

The diagnosis of Boerhaave syndrome is usually late, causing a high mortality rate, and endoscopic intervention in the form of over-the-scope clip application (OTSC) has shown promising results and is gaining popularity in the treatment of esophageal perforations. This endoscopic method speeds up recovery, reduces the length of hospital stay, and brings safety to the treatment. (AL-ZAHIR et al., 2019)

Minimal incision laparotomy is considered a minimally invasive procedure that requires only the surgeon's skill, not requiring investments to add technology and new equipment. Compared to traditional laparotomies, they cause less surgical trauma entail less hospital costs, and become an alternative to videolaparotomy. (MAGI et al., 2017)

Miller (2021) highlights adjuvant hysterectomy after primary chemoradiation and highlights that minimally invasive approaches are effective. Compared to traditional techniques, despite moving a little further away from general surgery, they offer clear advantages in terms of recovery and lower morbidity.

For the posterosuperior segments of the liver, laparoscopy is technically feasible and beneficial. It causes less trauma and ensures a faster recovery. However, operative exposure and bleeding control are challenges that require advanced skills and good equipment. (GIULIANI, A. et al, 2015)

Even with greater technical requirements, the minimally invasive surgery (MIS) approach has become a trend in ventral hernia (VHR) repairs, demonstrating a decrease in the rate of wound morbidities and shorter hospital stay when compared to open abdominal wall reconstruction, an open invasive technique. The costs of the operating room are higher using the minimally invasive technique due to the equipment used, but the savings in hospitalization and hospital stay costs are significant. (BELYANSKY, I. et al 2018)

Collins et al. (2023), compared results of open and laparoscopic surgical techniques for traumatic bladder and ureter injuries, although uncommon in trauma, are associated with increased morbidity and mortality, and in the analysis, open surgical repair was associated with lower mortality, suggesting that laparoscopic surgical repair may not have an advantage over open surgical repair for bladder and urethral injuries resulting from trauma.

Selvaggio (2020) brings an approach to urological surgeries and addresses innovative techniques, such as CT-guided renal cryoablation and the minimally invasive approach in kidney transplants for obese patients. These techniques have been shown to reduce complications and recovery time.

Treating portal system hemorrhage in cases of acute pancreatitis with minimally invasive techniques is effective. These techniques decrease the morbidity associated with open surgery. The use of these approaches is expanding to more complex conditions, showing versatility and efficiency. (KRESO, A. et al, 2020)

The treatment of infected necrotizing pancreatitis (IBP), with the emergence of minimally invasive techniques, was also influenced and adapted. Given the creation of the technique known as "step-up", which combines percutaneous drainage and endoscopic debridement. This approach is as effective as open surgery, which, in addition to mitigating

complications, decreases the need for more aggressive surgical interventions. However, there are cases, usually the most serious, in which immediate open surgical interventions are required, especially when the initial drainage is not successful. Therefore, the choice of treatment should be individualized and carefully adapted to the clinical and morphological characteristics of pancreatic necrosis in each patient. (HUANG et al., 2021)

Gite et al. (2021), conducted a study with 18 patients, where 83.3% of these patients with various comorbidities, and about 44.4% had obstructions in the urinary system with indications of nephrectomy. For these patients, the minimally invasive approach emerged as a solution. Techniques such as DJ stent insertion ultrasonography and fluoroscopy-guided procedures have proven not only effective but essential for treatment. Interestingly, only a small fraction, 7.7%, of the most severe cases required nephrectomy. According to the aforementioned author, previous studies highlighted the need for immediate surgical interventions when antibiotics and minimally invasive procedures failed. The present study emphasizes the relevance of these less invasive techniques as the first line of approach, thus avoiding nephrectomies and the subsequent dependence on renal replacement therapy.

In pregnant patients with ovarian vein syndrome, resources should be minimally invasive to mitigate any risks to the gestational process. According to Kalaitzis et al. (2011), ovarian vein syndrome in pregnancy can cause intense cramps and, in some cases, be complicated by febrile pyelonephritis. In these cases, the insertion of a DJ stent or percutaneous nephrostomy under ultrasound guidance are safe and effective procedure, providing immediate relief of symptoms.

For Ahmed et al. (2010), technological advances in laparoscopy, articulated instruments, and multi-lumen ports have made single-incision laparoscopic surgery (SILS) possible for procedures in general, gynecological and urological surgeries. The clinical benefits and cost-benefit evidence, such as better aesthetics, reduced hospital stay, and a brief return to work, require high qualification of surgeons, with extensive experience in conventional laparoscopy surgery.

In the case of pediatric empyema, VADT (video-assisted thoracoscopic debridement) offers fewer complications and a better aesthetic recovery. However, choosing between VADT and open thoracotomy depends on the stage of the disease and the patient's condition. The minimally invasive approach is preferred in less advanced cases. (MEIER, A. H.; HESS, C. B.; CILLEY, R. E., 2010).

For obese patients undergoing kidney transplantation with a change in approach through the anterior rectus sheath, it reduced wound complications, and increased graft

survival and operative time, being an effective option to reduce complications. (PHILLIPS et al., 2017)

Knight et al. (2016) suggest using combined techniques in complex situations, such as lymphangioma, although traditional thoracotomy and pleurectomy methods are ways to ensure complete resection and eliminate the risk of recurrence, the selective use of minimally invasive approaches allow ideal management with reduced pain and shorter recovery time, while achieving complete resection and reducing the risk of recurrence.

According to Gałązka et al. (2020), a single-center experience in the management of congenital abdominal cystic lesions (ACLL) should be based on the application of abdominal ultrasound along with a laparoscopic approach. For neonates there is no standard approach to treat congenital abdominal cystic lesions, this minimally invasive approach is safe and effective in the preliminary diagnosis and differentiation of congenital abdominal cystic lesions.

Single-port and NOTES (Natural Orifice Transluminal Endoscopic Surgery) techniques are at the forefront of minimally invasive surgery, promising less invasiveness and better aesthetic results. Single-port endoscopic cholecystectomy, still in the experimental phase, has significant potential. (ABE, N. et al, 2009)

CONCLUSION

The articles show a clear trend and benefit of minimally invasive techniques in various areas of surgery. Technological developments and improvements in techniques are continually reducing complications, improving recovery times, and often offering better aesthetic results. These approaches are increasingly applicable and preferred, although the need for specialized training and good equipment remains crucial for success.

We can analyze that the costs of minimally invasive surgery are high due to the equipment, specialty, and medical training involved. However, these investments end up generating savings in the long run, as they minimize the length of hospital stay and reduce postoperative complications. Despite the high initial cost, the efficiency and effectiveness of minimally invasive surgical treatment contribute to lower overall expenses, improving patient outcomes and optimizing available resources.

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