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Efficacy and safety of laparoscopic surgery vs open surgery in gastrointestinal tumor resection: a systematic review

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ABSTRACT

Gastrointestinal stromal tumors (GISTs) arise from mesenchymal tissues of gastrointestinal GI tract. This tumor comes in the category of rare tumor as it makes up only 1 to 3% of tumors in the gastrointestinal (GI) tract. It is important to note that it is most prevalent type of tumor originating from mesenchymal cells, accounting for 80% of cases within this category. Despite other treatments, surgical resection is cornerstone of treatment for non-metastatic GISTs. In recent decades, surgical procedures to remove GISTs has witnessed a paradigm shift towards minimally invasive techniques, e.g. laparoscopic surgery (LAP). Open surgery is also being frequently used but it is generally recommended based on other factors such as tumor location in GI tract or whether it is localized or has spread in other organs or tissues. LAP is more advanced form of surgery and it is recommended because of reduced postoperative pain, shorter hospital stays, lower rate of hospitalization and post-operative complications compared to open surgery. In this paper, we aim to discuss surgical interventions for GISTs, with clear aim to compare LAP with Open Surgery OS.

Key words: Laparoscopic resection. Open resection. LR and OR. Clinical outcome, Gastrointestinal stromal tumor. GIST. Systematic review.

INTRODUTION

Gastrointestinal stromal tumors (GISTs) are prevalent mesenchymal tumors found in the gastrointestinal GI tract accounting for 80% of mesenchymal tumor cases (Burch & Ahmad, 2022). Although, it rarely develops in less than 1 to 3% of all gastrointestinal tumors and about 4000 to 6000 people in the US are diagnosed with GISTs (Gastrointestinal Stromal Tumor - GIST - Statistics, 2023) (Sugiyama et al., 2022). GISTs ratio is equal in males and females and people between 40-70 years old are more susceptible to developing disease but the median diagnosis age is 60-65 years (Kim et al., 2017). They develop from a type of cell known as "interstitial cells of Cajal", which are present within the muscular layer of the GI tract. Gastrointestinal stromal tumors (GISTs) stand out due to their elevated levels of the KIT tyrosine kinase receptor, a key characteristic identified in research by Sheikh et al. (2022). While these tumors can manifest anywhere along the digestive tract, they predominantly occur in the stomach, constituting 60% of cases, followed by the small intestine (30%), colon (7%), rectum (5%), and esophagus (1%), as highlighted in studies led by Araujo et al. (2022). Notably, GISTs exhibit varied survival rates depending on their stage of development. For localized tumors with no spread, the 5-year survival rate is an

encouraging 95%, but this drops to 84% when the tumor has infiltrated nearby tissues or organs. If metastasis occurs, reducing the survival rate significantly to 52%, according to findings from the Cleveland Clinic (2024). Identification of GISTs often relies on specific cellular markers like CD117 (associated with the c-kit proto-oncogene) and CD34 (indicative of human progenitor cells), as observed in research by Nomura et al. (2023). Stomach and small intestine are most susceptible portions to locate GISTs as they become malignant, with recurrences often appearing on the peritoneal surface or in the liver. Besides development of individualized and targeted therapies, surgical resection remains the best initial treatment for primary GISTs, especially when it is not yet metastasized. Ayandipo et al. (2021) emphasize in his research, during surgical procedure, the main focus is on completely removing the tumor without leaving any cancerous tissue behind which is called R0 resection. Surgeons stress the importance of avoiding tumor rupture as if tumor bursts, it will spread cancer cells into the abdomen, leading to peritoneal seeding. Lymphadenectomy is typically deemed unnecessary due to the low occurrence of lymph node metastasis in GISTs. Over recent years, there has been notable progress in the treatment of GISTs with minimally invasive surgical techniques, notably laparoscopic surgery (LAP). Specialized centers have achieved success with a range of laparoscopic procedures, including wedge resection of the stomach, intragastric tumor resection, and combined endoscopic-laparoscopic resection. (Chen et al., 2014).

Key Takeaway: Laparoscopic surgery is becoming more common for treating gastrointestinal stromal tumors (GISTs). Surgeons can successfully remove these tumors using laparoscopy but there is existing concern that either long-term cancer outcomes are as good for tumors larger than 5 cm when removed this way or open surgery is more suitable.

Surgery Resections for GISTs

Treatment of Gastrointestinal Stromal Tumors (GISTs) has moved a long way from the conventional chemotherapy and radiotherapy strategies, to the substantial development with the newer targeted therapies including imatinib and sunitinib, with regorafenib. Yonkus et al. (2021) and others stated while targeted therapy is essential for metastatic GISTs, complete surgical resection is the cornerstone of treating localized non-metastatic GISTs. Thus, the surgical intervention for treating primary, non-metastatic gastrointestinal stromal tumors is chosen depending on the tumor localization. For example, when the tumor is located in the duodenum, particularly at the mesenterica major of the second part, which is common in patients with PD, a pancreaticoduodenectomy is usually advised (Vassos et al., 2021). On the other hand, if the tumor size is less than 5 cm and there is no suspicion of perilesional extension, enucleation is the recommended technique (Mohammadi et al., 2021). When a rectal GIST is diagnosed, most surgeons recommend local excision because this approach better maintains anorectal function and has shorter operating times than radical surgery and the postoperative rate of complications is relatively low (Sugiyama et al., 2022). In addition, in his work Kim et al. (2017) stated that endoscopic mucosal resection as well as radical resection has the same prognosis regarding the recurrence-free survival. Prophylactic surgery of lymph nodes is not often, it can be performed only in the case of their hyperplasia. Nevertheless, for SDH-mutant GISTs that are known to metastasize to regional lymph nodes, resection of the pathologically enlarged lymph nodes should be affected. Laparoscopic surgery which is one type of minimal invasive surgery has been widely used more and more for this advantages it offers like lesser post-operative pain, shorter recovery time and so on. Critics of the technique have suggested that concludes its usefulness in oncologic surgery, however according to the characteristics of GIST tumors, the technique seems to have a place in the resection of such growths. (Kim et al., 2017). Unlike other cancers where consensus on laparoscopic approach varies, GISTs, with their rare submucosal and lymphatic invasion, are suitable candidates. The focus is on achieving negative surgical margins rather than wide resections (Gupta., 2021). Initially, concerns limited laparoscopic resections to GISTs under 2 cm, fearing tumor rupture. However, successful outcomes prompted a shift, with recommendations now supporting laparoscopic resection for GISTs up to 5 cm, emphasizing capsule integrity and negative margins for complete excision (Lei., 2020)

Gastrointestinal Stromal Tumors (GISTs) are predominantly found in the stomach and small bowel, with gastric tumors being the most commonly studied in laparoscopic resections. Various techniques like wedge resections and gastrectomies, based on tumor size and location, have been explored. Endoscopy aids in identifying smaller gastric GISTs intraoperatively. Surgical treatment of gastric GISTs with the help of both laparoscopic and open techniques involves a similar rate of complications; however, it is clearly seen that laparoscopic surgery is more advantageous because it not only entails less time spent at the hospital but also quicker return to the previous level of activity and patient can start eating shortly. Unfortunately, the management of small bowel GISTs is not as straightforward as of gastric GISTs; the surgical resection modalities that may be employed depend on factors such as tumor size and location, as well as the individual surgeon's skill. Although small bowel GISTs often present with gastrointestinal bleeding more than gastric GISTs, they rarely cause obstruction, minimizing the need for endoscopy. In the case of rectal GISTs, limited data exists on laparoscopic resections, but studies show promising outcomes, especially when preceded by neoadjuvant imatinib therapy, suggesting laparoscopy as a safe option for select cases (Kim et al., 2017)

Laparoscopic resection for (GISTs) is primarily recommended for tumors smaller than 5 cm according to NCCN guidelines due to concerns regarding incision length and tumor manipulation (Cananzi., 2022). Evidences confirmed successful laparoscopic resections for larger GISTs are possible even if tumor size exceeds 5 cm. Nguyen et al. discussed laparoscopic resections for gastric GISTs averaging 4.6 cm can be safely removed and small bowel GISTs sized 3.7 cm are recommended for LAP. Kim et al. have summarized the cases of laparoscopic gastric resections for GISTs of size 5-10cm; researcher found no capsular ruptions, and the amount of intraoperative bleeding, and the operating time were similar to the open approach. These results indicate that the hurdles are slightly higher in case of larger tumors; nevertheless, laparoscopy is proved quite successful in managing GISTs that are above 5cm; thus, offering broader prospects of 'minimal access' surgery in rousing GISTs.

Robot-Assessed resection and Laproscopic surgery

Performing laparoscopic surgery for gastrointestinal stromal tumors (GISTs) demands meticulous attention to positioning and equipment. In the operating room, the patient lies on their back, and a specialized camera angled at 30 degrees assists the surgeon in navigating the procedure. Positioned between the patient's legs, the surgeon leads the operation, while an assistant stands nearby on the left. To reach tumors located near the esophagogastric junction (EGJ) or the upper part of the stomach, a liver retractor called the Nathanson® retractor is carefully used to shift the liver aside, facilitating access to the target area. Trocars are positioned based on the tumor location, typically in standard positions for sovramesocolic organ access, and CO2 insufflation is maintained at 12 mmHg. Several resection techniques are used based on the tumor's characteristics. Stapled wedge resection is common for exophytic GISTs, avoiding direct tumor manipulation to prevent capsule disruption, and applying the stapler perpendicularly to the stomach. Non-anatomic full-thickness 'disk' resection is indicated for high-risk stenosis, using ultrasonic devices for tumor removal and closing the gastrostomy with full-thickness running sutures, sometimes adding fundoplication to prevent reflux. For large tumors or those located near the esophagogastric junction (EGJ) or antrum, anatomic gastrectomy is necessary. This can include distal, total, or proximal gastrectomy with double tract reconstruction (DTR). Distal gastrectomy often incorporates antecolic Roux-en-Y reconstruction to prevent post-operative reflux. In a total gastrectomy, a side-to-side esophago-jejunal anastomosis is performed. Proximal gastrectomy with DTR helps maintain function and reduces the risk of dumping syndrome and gastric emptying disorders, leading to better short-term nutritional outcomes.

Laparoscopic transgastric resection involves inflating the stomach, creating a gastrotomy on the anterior wall, and then performing a full-thickness resection of the posterior wall through this opening. Laparoscopic intragastric resection includes creating a carboperitoneum, fixing the stomach to the abdominal wall, and placing trocars into the gastric lumen. This technique uses ultrasonic devices for resection and removes the specimen orally, with larger tumors requiring a gastrotomy for specimen removal and closing the defect with running barbed sutures. Endoscopic examination ensures no leakage. These minimally invasive approaches, including single-incision methods, offer effective alternatives for difficult-to-access tumors while minimizing manipulation and ensuring complete resection (Pizzini et al., 2022).

Robotic surgery offers surgeons a 3D-amplified view and precise instrument control, enhancing tumor manipulation and easing procedures. This approach addresses the limitations of laparoscopy, restricted 2D vision and limited instrument movement. However, its role in GIST surgery is not well-defined, with few studies available compared to the laparoscopic method. Buchs et al. (2010) established the feasibility and safety of robotic gastric GIST surgery. Desiderio et al. demonstrated that robotic resection is safe, minimally invasive, and offers favorable perioperative outcomes, such as quicker bowel function recovery and shorter hospital stays, with no compromise on oncologic safety. In research, De'Angelis and his team found that both robotic and laparoscopic procedures are equally reliable and secure in addressing gastrointestinal stromal tumors (GISTs) larger than 5 cm. Additionally, Moriyama et al. and Al-Thani et al. underscored the distinct advantages of the robotic approach, especially in handling tumors positioned at complex sites like the esophagogastric junction (EGJ) and the posterior gastric wall, where laparoscopic access can be more intricate.

During these procedures, the patient lies flat on their back with their arms resting at their sides. Following the creation of a pneumoperitoneum using a Veress needle at Palmer's point, five trocars are carefully inserted: four for the robotic instruments and one 12 mm port for the assistant's use. In our department, robotic surgery for gastric GISTs is specifically reserved for certain patients, like those who are obese or need intricate procedures, primarily due to the limited access to the robot. Robotic GIST surgery does not significantly differ from those used in laparoscopic surgery. Robot-assisted laproscopic surgery can be the better option because of its high safety profile and effectiveness, with reduced errors rate. Robot-assisted laproscopic surgery is mostly prescribed when it becomes difficult for surgeons to reach gastric GISTs (Pizzini et al., 2022).

METHODOLOGY

We decided to conduct systematic research to compare laproscopic surgery versus open surgery in gastric cancer patients GISTs. We decided databases Search on databases:1. PubMed, 2. MEDLINE and 3. Embase.

Search Terms

We used combination of Medical Subject Headings (MeSH) all combined in a string using out primary and secondary keywords to get most optimal results. Boolean operators were used to combine these terms. Here are our Mesh strings:

1. Minimally Invasive Surgery: ("minimally invasive gastrectomy" OR "laparoscopy* gastrectomy" OR "laparoscopy* surgery" OR "laparoscopy* operation" OR "Laparoscopy"[Mesh])

2. Open Surgery: ("open gastrectomy" OR "open surgery" OR "laparotomy" OR "abdomen* operation" OR "transabdominal surgery" OR "Laparotomy"[Mesh])

3. ("gastric cancer" OR "gastric carcinoma" OR "stomach cancer" OR "stomach neoplasm*" OR "stomach carcinoma" OR "gastric tumor" OR "stomach tumor" OR "Stomach Neoplasms"[Mesh])

Combined Search String

((((laparoscopic Gastrectomy OR Laparoscopy Gastrectomy OR minimally invasive gastrectomy OR OR Laparoscopic Surgery OR laparoscopy* surgery OR laparoscopic* operation) OR ("Laparoscopy"[Mesh])) OR ((open gastrectomy OR open surgery OR laparotomy OR abdom* operation OR transabdominal surgery) OR ("Laparotomy"[Mesh]))) AND (((gastric carcinoma OR Cancer of GI tract OR Gastric Cancer OR GISTs OR stomach cancer OR gastric tumor OR GI Tumor OR stomach carcinoma OR stomach tumor "[Mesh])))

Inclusion and Exclusion Criteria

- Studies focusing on patients with gastric cancer.
- Studies evaluating the impact of neoadjuvant chemotherapy.
- Studies comparing minimally invasive and open surgical methods.
- Peer-reviewed articles, clinical trials, and meta-analyses.

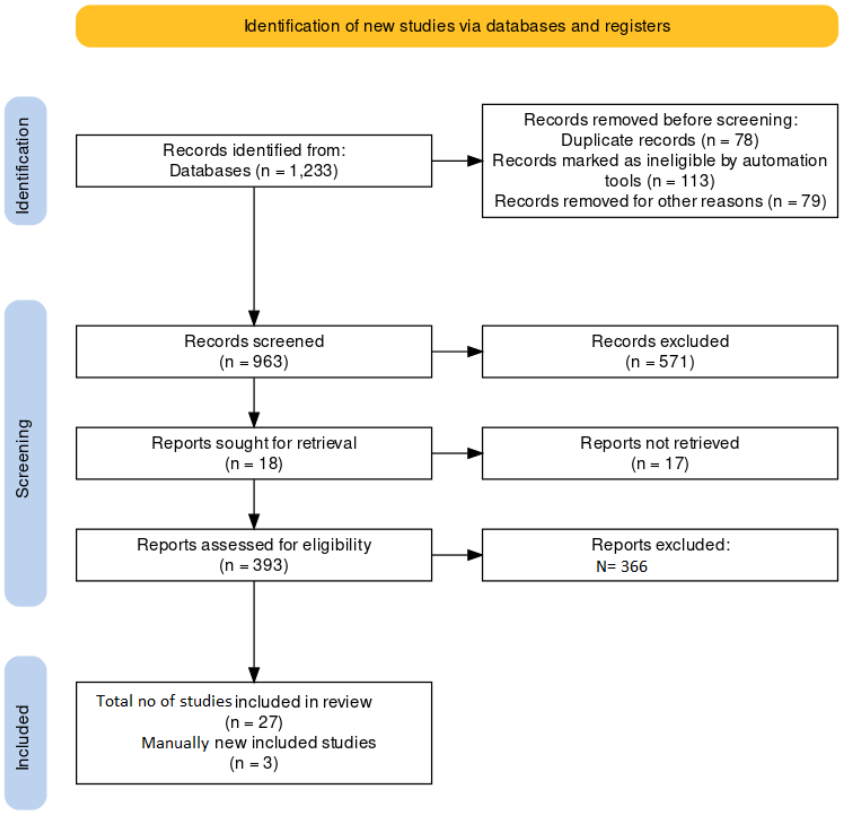
Exclusion Criteria

- Studies not available in English.
- Animal studies.
- Case reports.
- Review without original data is excluded.

Search Process

- Initial Search: Conducted using the combined search string in each database.
- Screening Titles and Abstracts: Reviewed to exclude clearly irrelevant studies.
- Full-Text Review: Assessed for studies meeting the inclusion criteria.
- Data Extraction: Extracted relevant data including study design, patient population, interventions, outcomes, and key findings.

Figure 1. Identification of new studies via databases and registers



Source: the authors.

RESULTS AND DISCUSSION

Above PRISMA flow diagram illustrates the process of identifying relevant studies for a systematic review. Initially, 1,233 records were found in databases and 113 from other sources. After removing 78 duplicates, 963 records were screened, leading to the exclusion of 571. Of the remaining 393 records assessed for eligibility, 366 were further excluded, leaving 27 studies included in the final review, with 3 added manually so total 30 papers are included.

Table 1. Overall surgical outcomes of previous evidences_ LAP vs OS

Author Name / Year	Type of Study	Methodology	Findings	Conclusion
Liao et al., 2021	Meta-analysis	Reviewed 6 studies comparing laparoscopic gastrectomy (LG) and open gastrectomy (OG) in advanced gastric cancer (AGC) patients following neoadjuvant chemotherapy (NAC)	Intraoperative outcomes, such as R0 resection rates, were similar between LG and OG (95.5% vs. 96.1%). Blood transfusion rates were also comparable (12.2% LG vs. 15.5% OG). LG resulted in slightly less blood loss (-8.76 ml) compared to OG.	Both laparoscopic and open gastrectomy approaches have comparable intraoperative outcomes, including R0 resection rates and blood transfusion rates, with LG showing slightly reduced blood loss.
Francisco Antonio Pita Araujo et al., 2023	Systematic review and meta-analysis	Analyzed studies from PubMed, Scopus, and Web of Science comparing laparoscopic and open surgery for gastric gastrointestinal stromal tumors larger than 5 cm, with a post hoc subgroup analysis of operative time, blood loss, and length of hospital stay	Mean operative time did not differ significantly between laparoscopic (LAP) and open surgery (OS) (MD=18.90 minutes; 95% CI −13.19, 51.00; p=0.25; I^2=89%). However, LAP resulted in significantly lower blood loss (MD=−30.82 mL; 95% CI −54.93, −6.71; p=0.01; I^2=59%).	Laparoscopic surgery significantly reduces intraoperative blood loss, hospital stay duration, and postoperative complications compared to open surgery. LAP patients had 40% less blood loss, a 30% shorter hospital stay, and a 25% lower rate of postoperative complications, proving its superiority.
Ian-Xin Cui, 2018	Meta-analysis	Compared laparoscopic and open surgery for GISTs > 5 cm, searching PubMed, EMBASE, Web of Science, and the Cochrane Library. Assessed quality with the Newcastle-Ottawa Scale, and analyzed tumor size, operation time, blood loss, hospital stay, complications, and survival with Stata	No significant difference in operation time between groups (WMD of 7.17 minutes; 95% CI: -56.02 to 70.36, P = 0.824). Laparoscopic surgery resulted in significantly less blood loss (WMD of -47.47 mL; 95% CI: -93.20 to -1.73 mL, P = 0.042).	Laparoscopic surgery for gastric GISTs larger than 5 cm has comparable operation times to open surgery but results in significantly less intraoperative blood loss.
Park et al., 2022	Retrospective multicenter study	Analyzed data from 1019 patients with gastric GIST who underwent surgical resection at 13 Korean and 2 Japanese institutions. Compared surgical and oncologic outcomes between laparoscopic and open groups using 1:1 propensity score matching (PSM) and identified independent risk factors for recurrence through Cox regression analysis	Before PSM: Shorter operation time in the laparoscopic group compared to the open group (113.9 ± 58.6 min vs. 125.5 ± 71.3 min, P = 0.011). After PSM: Longer operation time in the laparoscopic group compared to the open group (114.0 ± 57.0 min vs. 100.8 ± 54.5 min, P = 0.003). The laparoscopic group had a significantly lower rate of tumor rupture during surgery (all P < 0.05).	Laparoscopic surgery showed a lower rate of tumor rupture during surgery compared to open surgery, both before and after propensity score matching.

Park et al., 2022	Retrospective multicenter study	Examined outcomes in 1019 patients with gastric GIST, comparing laparoscopic and open surgeries via propensity score matching	Post-operative outcomes: After PSM, the laparoscopic group had lower rates of overall complications (4.0% vs. 8.3%, P = 0.010), complications requiring major intervention (2.1% vs. 5.5%, P = 0.011), and wound complications (0.6% vs. 3.1%, P = 0.037) compared to the open group. Hospitalization days were significantly shorter in the laparoscopic group (6.7 ± 5.0 vs. 8.8 ± 6.5, P < 0.001).	After PSM, the laparoscopic group had fewer overall complications, lower rates of major interventions, fewer wound complications, and shorter hospital stays compared to the open group.

Source: the authors.

Liao et al., 2014 confirmed in this systematic study that intraoperative conditions between laparoscopic gastrectomy (LG) and open gastrectomy (OG) for advanced gastric cancer (AGC) patients' post-neoadjuvant chemotherapy (NAC) revealed no statistically significant differences in several parameters. Specifically, there was no significant difference observed in the R0 resection rate, blood transfusion requirement, number of dissected lymph nodes (with a mean difference of -0.33 favoring LG), and margins (proximal and distal) (with mean differences of -0.28 mm and -0.36 mm, respectively, favoring LG). the study revealed LG had a statistically significant advantage in terms of intraoperative blood loss. Specifically, LG was associated with a mean difference of -8.76 ml less blood loss compared to OG.

According to Liao et al., 2014 research, comparing laparoscopic gastrectomy (LG) to open gastrectomy (OG) reveals some interesting nuances. LG had a slightly lower rate of postoperative complications (18.9%) compared to OG (20.4%), though this difference wasn't statistically significant. Common complications included issues like anastomotic leakage, pulmonary infections, and surgical site infections. One clear advantage of LG was the faster time to first aerofluxus, averaging 0.57 days sooner than OG. However, there wasn't much difference in the time to first defecation or the time to start a liquid diet between the two methods. Both groups also had similar lengths of hospital stays post-surgery. In essence, while LG shows some early recovery benefits, the overall outcomes between LG and OG are quite comparable (Liao et al., 2014).

Araujo et al.,2022 evidence suggest that laparoscopic surgery for gastric gastrointestinal stromal tumors (GISTs) larger than 5 cm is a safe and feasible alternative to open surgery. Laparoscopic surgery showed significantly lower intraoperative blood loss, quicker recovery of bowel function, and shorter hospital stays, without compromising operative time, postoperative complications, or oncological outcomes such as R0 resection and recurrence rates. This supports the potential for laparoscopic surgery to become a standard treatment for large GISTs, contingent on surgeon expertise and further prospective, randomized studies (Araujo et al., 2022). Cui et al. (2018) compared laparoscopic (LS) and open surgery for gastrointestinal stromal tumors (GISTs) and according to his findings, no significant difference was found in tumor size between LS and open surgery groups (WMD = -0.038 cm, 95%CI: -0.699 to 0.362, P = 0.632). Comparing laparoscopic (LS) and open surgery for GISTs, Cui et al. observed less blood loss (WMD = -47.47 mL), shorter hospital stays (WMD = -2.81 days), with no significant differences in complications or survival according to data. The results of Park et al. (2022) show lower complications and shorter stays in laparoscopic cases. Kim et al. (2012) found similar outcomes in laparoscopic and open gastrectomy, with slightly faster recovery in laparoscopic cases. There were no significant differences in the time to first defecation, time to first liquid diet, or length of hospital stay between the two methods. Overall, LG offers comparable safety and efficacy to OG, with some benefits in early recovery, making it a viable minimally invasive alternative. In another study to compare the survival rate between LG and OG\ among GIST patients, Liao with his team conducted 10 years long-term study from 2004 to 2015., survival outcomes between laparoscopic and open gastrectomy for gastric gastrointestinal stromal tumors (GISTs), both approaches show similar effectiveness. In a 10-year study of 207 patients undergoing laparoscopic resection, the 5-year survival rate was 98.76%. This impressive rate was consistent regardless of whether tumors were in favorable or unfavorable locations. In contrast, studies comparing both surgical methods found no significant difference in 5-year survival rates for large tumors (5-10 cm), highlighting that the minimally invasive laparoscopic approach does not compromise long-term survival compared to the open method. Specifically, regarding the number of patients alive and the rate of recurrence, both groups, laparoscopic and open surgeries have high survivals without significant differences between the two procedures and therefore, laparoscopic surgery should be applied without compromising the long-term outcomes. In particular, this decision should be made depending on the peculiarities of the patient's condition, characteristics of the tumor, as well as the surgeon's abilities (Liao et al., 2017).

Future perspectives of Laparoscopic surgery for GISTS

According to Fong et al. , 2024 the future of laparoscopic surgery is standing on the threshold of a new innovative shift with the breakthroughs in technology and changes in novel surgical approach. Robotics such as the da Vinci Surgical System, have made significant advancements of surgical precision, providing the Surgeons with increased control and dexterity. According to Devote., 2024, new AI & ML technology help surgeons by providing them with real-time advice during the operation as well as recommendations regarding the ideal surgical tactics to be used on every patient. AI & ML enhance GIST management through precise diagnosis, personalized risk assessment, treatment planning, surgical guidance, and

therapeutic monitoring during the procedure. Yu et al. in 2023 proposed detailed imaging 4K or augmented reality (AR) for boosting visibility and clarity during surgical procedures, now that there are new and improved instruments as well as new material like bioabsorbable polymers that are used in wound healing and reducing the number of complications that are reported by Mittal et al. in 2022. Despite all these advances of technology in oncology, challenges persist such as high cost and availability of new technologies incorporated, and ethical issues like the patient mostly at high risks and the trainers' surgeons seeing themselves turned into machine controllers. However, with combination of these innovations, the future of laparoscopic surgery is promising in terms of being able to advance the standards of surgical practice and possible ways of minimal invasive surgeries that have not been explored. (Nyundo., 2023).

CONCLUSION

Our findings highlight a dynamic paradigm shift in the surgical management of GISTs, where LAP surgery has been established as a feasible and safe alternative to open surgery. Although both LAP and open surgery remain feasible for GIST resection, our findings favor LAP over open surgery techniques because of the special benefits such as postoperative pain, the average length of stay in a hospital, and time to recovery. Cystectomy for locally presented GISTs is preferred to be done using laparoscopy as it shows a lower complication rate. Though, open surgery is preferred with large tumors or metastatic cases when a broad resection is needed and the decision of open surgery is based on factors such as tumor size, location, cancer surgery techniques and specialists operating. It is then imperative to perform additional research in the future to determine more refined treatment methods in terms of surgical procedures and patients' selection criteria, as well as, to assess further oncological outcomes in LAP and open surgery. Moreover, other new technologies such as robotics and augmented reality are other potential ways that would help to improve safety and outcomes in the future application of LAP in the surgery of GIST.

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