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The Use of Minimally Invasive Surgery in the Treatment of Crohn's Disease: A Systematic Review of Evidence

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ABSTRACT

Minimally invasive surgery (MIS) is a groundbreaking approach for treating Crohn's disease (CD), affecting approximately 100-300 per 100,000 people. In 2015, an estimated 3.1 million people were diagnosed with Inflammatory Bowel Disease (IBD). Our research aims to consolidate previous evidence on MIS techniques, including laparoscopic techniques and robotic-assisted surgery, and compare them to traditional surgical techniques in managing CD. The practical benefits of MIS are evident in comparative studies, which consistently show that laparoscopic approaches result in shorter hospital stays and faster recovery than open surgery. MIS also demonstrates significant long-term benefits, particularly in reducing the mortality rate. Even pediatric CD patients have shown improved outcomes with laparoscopic-assisted surgery, experiencing fewer postoperative complications and better recovery. MIS applications include Laparoscopic ileocolic resections, a key MIS technique, offer comparable outcomes to other therapies like open ileocolic resection but with the added advantages of lower costs and long-term disease control. This cost-effectiveness of MIS techniques is a significant advantage. Techniques like intracorporeal anastomosis and trans colonic specimen removal have further improved postoperative recovery and cosmesis. Strictureplasty is another MIS technique, is particularly beneficial for CD patients with strictures due to its ability to preserve intestinal length and function. Lastly, laparoscopic robotic-assisted surgery is a game-changer, offering a significant reduction in postoperative pain and faster recovery compared to manual surgeries.

KEYWORDS: Surgery, laparoscopic surgery, complex, laparoscopy, robotic surgery, transanal surgery, complications

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INTRODUCTION

First introduced in the 20th century, minimally invasive surgery (MIS) has revolutionized surgical procedures compared to conventional open surgery. Under MIS procedures, smaller incisions lead to less pain, shorter hospital stays, quicker recovery times, and ideal cosmetic results with fewer scars. It also minimizes the chance of hernias and bowel obstructions that arise from open surgery[1]. After it's Instrumentalization in gallbladder surgery, MIS has progressed to treating various types of abdominal surgeries more effectively. It has proven its effectiveness for complicated diseases such as colonic diverticulitis, colon cancer, and rectal cancer. Crohn's Disease (CD) is an inflammatory bowel disease that afflict any part of the

digestive system but is mostly affect small intestine and colon portion. CD is prevalent in young adults of the years between 15 and 35, and according to the Crohn's & Colitis Foundation, Crohn's disease is growing rapidly and has affected about 780,000 Americans[2]. Advancements in surgery and its awareness have significantly improved treatment outcomes reducing reoccurrence and prevalence rate, however, approximately two-thirds to three-quarters of individuals with Crohn's disease are estimated to undergo one or more surgical procedures in their lifetime, with around 30% experience flare-up within three years post-surgery and 80% within 20 years [2] which need attention and more research to develop advance and novel ways to effectively control long-term post-surgical outcomes.

Symptoms of Crohn's disease may include intestinal pain, weight loss, diarrhoea, fatigue, cramping and malnutrition. Generally Crohn's disease is mixed up with ulcerative colitis. Primary age range that gets affected by Crohn's disease is fifteen to thirty-five, which is twice more often in children than ulcerative colitis [2]. Doctor's think that cause of Crohn's disease could stem from an autoimmune response, where the immune system mistakenly targets healthy cells within the body. Specialists speculate that bacteria residing in the digestive tract might inadvertently prompt this immune system reaction. Its inflammatory response results in the manifestation of Crohn's disease symptoms. Factors like family history, smoking, and environment might exacerbate disease. Intense symptoms depend on Crohn's type, which can target any section of the Gastrointestinal GI tract. Diagnosis includes multiple tests, including blood and stool tests, endoscopies, and imaging tests like CT scan or MRI which can help to elaborate whole disease conditions. Although it is not curable, the therapy targets the reduction of inflammation and symptom management through medications, immune suppressors and, in some cases, surgery. The dietary modification serves one purpose: limiting certain foods and maintaining a good nutritional balance. Crohn's disease significantly influences whole patient's life quality since it requires a multidisciplinary approach for proper management[2].

Since its introduction, minimally invasive surgery (MIS) has evolved from basic laparoscopic procedures, which used to have only a 10-mm standard resolution camera with 12-mm ports, evolving to complex 3D-HD laparoscopy, enabling treatment of challenging cases like fistulizing Crohn's disease and refractory chronic ulcerative colitis, particularly in patients unresponsive to traditional medical therapies[1]. Laparoscopic bowel resection involves the usage of small cuts and specialized instruments alongside a camera that enters through the trocars to visualise and withdraw the affected portions of the intestine. Modern laparoscopic instruments such as graspers, dissectors, and energy devices such as harmonic scalpels or electrocautery for meticulous tissue dissection and hemostasis are major advancements[3]. With flexible endoscopes, inflatable balloons may be used endoscopically for the dilation of intestinal strictures or narrowing, and this procedure is called endoscopic balloon dilation [4]. The fluoroscopy or endoscopic visualization guides the procedure, and the balloon is inflated to the desired width to permit luminal patency improvement. Balloon-assisted Strictureplasty or stent-assisted Strictureplasty are employed in endoscopic Strictureplasty as specialized tools to help widen the structured segments of the intestine. These tools provide a tight incision and closure of strictures. Bowel length and function are preserved with this technology advancement. Robotic-assisted surgery incorporates robotic arms with high-definition cameras and advanced instrumentation. The surgeon manipulates these elements from the control console. This system may provide 3D visualization, dexterity enhancement, and tremor filtering, allowing for better dissection, suturing and tissue manipulation inside the abdomen that are limited by size. These achievements attained in the field of tools and tactics have transformed the way of managing Crohn's disease by providing more secure and efficient surgical options featuring reduced morbidity and better patient outcomes [5].

Rationale

In Crohn's Disease (CD), surgery is sometimes necessary for CD patients, and traditionally, these procedures involve open surgery, which demands surgeons to make large incisions. Since minimally invasive surgery (MIS) is introduced in the medical field, it has replaced conventional operations. Preliminary studies suggest MIS may offer advantages over open surgery for CD, including reduced complications, faster recovery, and improved cosmetic results. Smaller incisions result in less noticeable scarring with and reduced blood loss. However, a systematic review is needed to consolidate and critically evaluate the evidence, providing a solid foundation for clinical decision-making.

Conventional Laparoscopic Surgery for Crohn's Disease

The development of laparoscopic surgery and its use was started for the treatment of CD in 1993, has undergone this technology explosion. When its use was started in the past, physicians used to make 5 cm incisions, and physicians made multiple 5-12 mm laparoscopic ports, and some professional tools were used [6,7]. It yields many improvements for open surgery with quicker recovery, fewer complications, decreased hospital stays, and better cosmetic results. It has been found that laparoscopic surgery is safe and sufficient for noncomplicated as well as complicated Crohn's disease. Although the minimally invasive surgery has reduced surgical burdens of physicians but there persist conditions such as very bad adhesion, fistulas, or inflammation add difficulty to the operation. For a novice surgeon, the operate-first cases and restrictive cases (for example, recto-vaginal fistula) constitute the most reasonable and safe choice. A certain percentage of situations will need to be translated using professional skills into open surgery [7].

Single Incision Laparoscopic Surgery (SILS)

Single-incision laparoscopic Surgery (SILS) is a specialized form of laparoscopy where surgeons consolidate all ports into one incision, typically paraumbilical or transumbilical. This means this approach allows the entire procedure to occur through a single entry point, facilitating specimen extraction. In a study comparing 174 patients undergoing ileocolonic resection, SILS and traditional laparoscopy showed similar conversion rates (10.3% vs. 12%) and postoperative complication rates. SILS patients experienced shorter hospital stays (5 days vs. seven days for laparoscopy and nine days for open surgery) and may require less opioid analgesia, indicating potential benefits over standard laparoscopy. Despite higher conversion rates to open surgery, SILS feasibility in complex Crohn's disease cases underscores its safety and potential advantages, albeit with a steeper learning curve and technical challenges than traditional laparoscopy.

Hand-assisted laparoscopic surgery (HALS)

The hand-assisted laparoscopic approach merges the advantages of minimally invasive surgery with tactile feedback and manual assistance, enhancing anatomical visibility and bowel access while performing surgery. Surgeons utilize laparoscopic instruments with one hand while inserting the other through a Gelport device into the abdomen. Nakajima et al. studied 38 consecutive patients undergoing subtotal or complete colectomy, revealing significantly shorter operation duration with HALS (251 min) than with laparoscopic surgery (330 min). Though postoperative complications did not significantly differ, HALS popularity has decreased with broader laparoscopic adoption and improved surgical proficiency. However, HALS may expedite procedures for intricate cases like fistulizing disease and extensive Crohn's colitis while preserving minimally invasive benefits [8, 9, 10].

Transanal surgery

Transanal surgery, which is frequently transanal total mesorectal excision (TaTME), has developed into a remarkable way of treating various rectal problems which may involve Crohn's disease (CD). Acting CD on rectal stenosis or extended perianal diseases might require proctectomy. Transanal colon surgery consists of cutting around the perianal area using the intersphincteric space and then inserting a transanal port into the wound through the perineum so that dissection can be enhanced from down above. The first step is to open the posterior plane to expose the working space; second, resect the rectum posteriorly and laterally; and third, carry anterior dissection. The remarkable advantage of this transanal surgery is that it does not need anatomic resection. Alternatively, a safer way to achieve this may be through rectal epigraphy, minimizing the likelihood of pelvic nerve injuries and internal iliac vessel injuries.

Furthermore, the transanal route also provides proper visualization of the lower pelvis especially in severely scarred, fibrotic, and narrow pelvis, commonly observed in CD patients. Transanal surgery require small incisions that lead to shorter hospital stays, reduced postoperative pain, and faster recovery. As opposed to conventional oncologic resections, transanal surgery in the case of Crohn's disease enables the conservation of essential organs, reducing the incidence of functional defects such as incontinence or sexual failure. The transanal path provides excellent visualization of the pelvic floor, consequently allowing precise dissection and preservation of the tissue, even in anatomic situations that might present challenges. Through carrying out resection, as long as there is minimum damage to surrounding tissues, the transanal surgery lowers the risk of adverse outcomes such as pelvic nerve injury or vascular damage. Patients recovering post-resectional to treat Crohn's disease via transanal surgery often report improvements in the quality of life through reduction of symptoms and speedier recovery[11, 12].

Robotic-assisted laparoscopic minimally invasive surgery for IBD

Robot-assisted surgery has recently become perfect alternative of traditional laparoscopic surgical procedures in treating Crohn's disease (CD). This state-of-the-art technology offers multiple benefits, which make it an ideal choice for tackling the consequences of such an inflammatory bowel disease, and the recent advances in this field are adding to its capacity in this respect. The major advantages of robot-assisted surgeries in CD are the greater precision and the dexterity they give to surgeons. The robotic device provides a multi-dimensional, high-definition view of the surgical space with 3D perception, thus making it easy for the surgeon to perform precise dissections and manipulation of the tissues. This is particularly appropriate in CD surgical operations as inflammation and scarring can distort anatomical landmarks and increase the possibility of adjacent structures suffering accidental damage. Also, more recent robotic equipment uses haptic feedback, which adds a sense of touch to surgeons and assists them in improving precision and reducing the possibility of inadvertent damage [13, 14].

Similarly, advanced imaging is increasingly encompassing robotic surgery to guide complex procedures. Preoperative MRI or CT scans can be integrated into the robotic system's visualization, superimposing important anatomical information onto the operative field image. In robotic Crohn's disease surgery, AI is assists surgeons by integrating preoperative imaging data for augmented reality visualization, enhancing navigation and precision during the procedure. Augmented reality facilitates surgical navigation and permits prior marking of a resection line to reduce the need for intestinal manipulation during the intraoperative period. Robotic surgery has enabled the application of fluorescent imaging with indocyanine green (ICG). With this method, an ICG dye is injected to identify the parts of the inflamed tissue that stand out from the healthy tissue. It helps in determining the amount of resection and assessing the possibility of anastomoses (connections between bowel segments), thereby preventing postoperative problems like leaks or complications. The minimally invasive nature of

robot surgery and its accuracy in movements, as well as visualization capabilities, mean some operational trauma is eliminated. It is one benefit for CD patients. This could enable faster recovery, less postoperative pain, and a lower complication chance.

Additionally, increased visualization can allow for identification and skipping of the inflamed or fistulized bowel segs, which may keep the resection to a minimum, thus preserving bowel length. While robotic surgery has a promising future for CD patients, for fairness, let us quickly review its drawbacks. Nowadays, the technology could be expensive, so the training curve for surgeons to adapt to new modes of operation is quite substantial. Nevertheless, technological advances and surgeons' hands-on training will guarantee more accessibility and affordability to robotic surgery with time[15].

Methodology

SEARCH STRATEGY

A thorough literature review was conducted using PubMed and Web of Science databases to explore the topic of minimally invasive surgery (MIS) for Crohn's disease (CD). The search criteria encompassed terms like "Crohn's disease," "inflammatory bowel diseases," "surgery," "laparoscopy," "laparoscopic surgery," "robotic surgery," and others related to CD complications and recurrence. Each retrieved study underwent meticulous evaluation, focusing on relevance to specific aspects of MIS in CD. The findings were extensively analyzed and discussed to provide comprehensive insights.

Mesh Terms: (Mesh "Crohn's Disease" OR Mesh "Inflammatory Bowel Diseases") AND (Mesh "Surgery" OR "laparoscopy" OR "laparoscopic surgery" OR "robotic surgery" OR "transanal surgery") AND (Mesh "Complications" OR "complications, surgical" OR "complications, postoperative" OR "recurrence" OR "fistula" OR "stricture")

Inclusion/Exclusion Criteria

We decided to include those studies that discuss laparoscopic (standard, single-incision), hand-assisted, transanal, and robotic surgery. While including this, we focused on strictures, fistulas, and recurrence risks related to surgical choices. We searched for papers that discuss MIS and compared it to open surgeries for IBD or Crohn's disease, and compared with a hospital stay, recovery times, complications (infections, leaks, re-operations), long-term disease recurrence, quality of life measures, and comparison between techniques were noted. In your analysis of minimally invasive surgery (MIS) for Crohn's Disease, we included patient-reported outcomes, cost-effectiveness, surgeon and patient factors. We included papers published on authentic databases and peer-reviewed published between 2000 and 2024 so that we can make our paper comprehensive, addressing MIS evolution with time. Only English papers were selected.

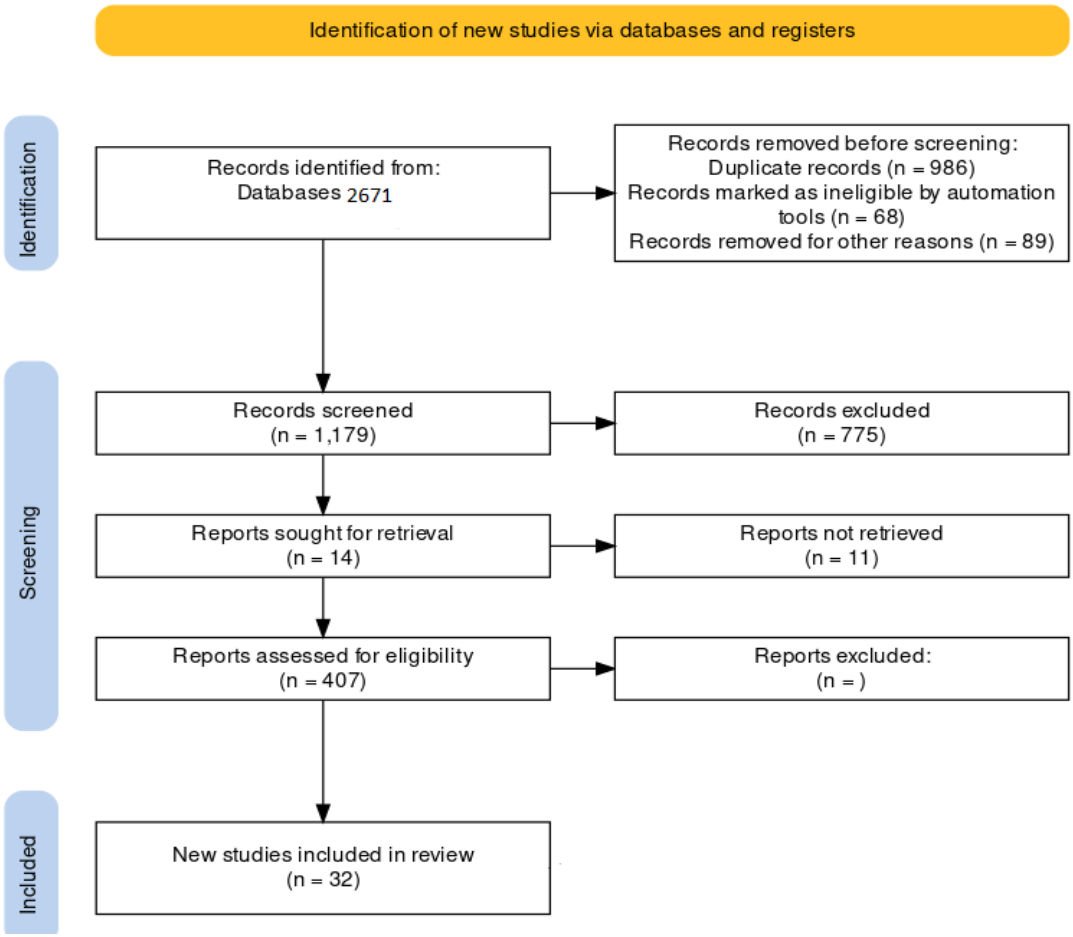

Figure 1. Prisma-Flow Chart

RESULTS

Is a chart depicting the process for choosing studies for a systematic review. The search yielded 2,671 records from databases (databases) and registers. Of the 1,179 qualified and nonduplicated records, 1,179 remained. After reading titles and abstracts, 775 were excluded. Fourteen of the subsequent studies were kept for retrieval and 11 excluded from 14. The number of reports reviewing the criteria for eligibility was 407; and after careful selection 32 were selected in the end for inclusion.

Refined Theme	Author(s)	Year	Methods/ Characteristics.	Findings
Recurrence Rates after MIS vs. Open Surgery for Crohn's Disease [16].	Martin Hoffmann, Dina Siebrasse, Erik Schlöricke, Ralf Bouchard, Tobias Keck, Claudia Benecke	2017	Retrospective analysis compared laparoscopic and open surgery outcomes in 113 Crohn's disease patients (2000-2010). Follow-up: median nine years for open, six years for laparoscopic. Data from the database included demographics, surgeries, and outcomes. Statistical tests: chi-square, Fisher's, Mann–Whitney U. Controlled for age, urgency, and resection year; limitations included uncontrolled factors like comorbidities.	Hospital stays: Laparoscopic (median=8 days) vs. open (median=11 days) ($p<0.0001$). No significant differences in mortality, complications, recurrence rates, or re-admissions. Long-term mortality was higher in the open surgery group ($p=0.005$).
Analysis of laparoscopic versus Cochrane surgery [17].	H Hasegawa M Watanabe, H Nishibori, K Okabayashi, T Hibi, M Kitajima	2003	Examined 61 laparoscopic operations in 52 patients with ileal or ileocolonic Crohn's disease, conducted between January 1994 and May 2002.	Out of the 61 cases undergoing laparoscopic surgery for Crohn's disease, 16 procedures were conducted for recurrence at the anastomotic site. The median time to reoperation was 46 months. There was no significant difference in the incidence of enteric fistula or conversion rate between patients who underwent laparoscopic surgery for recurrence and those who had primary procedures.
Crohn's disease (CD) surgery and potential impact on recurrence rates [18].	Kristo, Stift, Bergmann, Riss	2015	After retrospective analysis and discussion of surgical trends and medical therapies, 24 patients were randomly assigned to either infliximab or placebo. Endoscopic recurrence after one year	Minimally invasive surgery (MIS) for Crohn's disease (CD) reduces surgical recurrence rates (8.6% post-MIS). Laparoscopic approaches offer short-term benefits, including decreased infections and shorter hospital stays. Specific anastomotic configurations, like wide-lumen stapled side-to-side anastomosis, may decrease postoperative complications. However, further research must confirm long-term effectiveness in preventing disease recurrence.
Postoperative complications of laparoscopic surgery in pediatric Crohn's disease [19].	V. Dotlacil, T. Lerchova, and others	2023	Retrospective analysis of pediatric CD patients (≤ 19 years) undergoing ileocecal resection at a single tertiary centre, comparing open and laparoscopic-assisted surgery outcomes.	Laparoscopic-assisted surgery in pediatric CD patients did not increase 30-day postoperative complications. It showed reduced hospital stay, earlier oral intake, and decreased need for catheterization and epidural analgesia. Statistical analysis revealed no significant difference in complication rates between surgical approaches.

Five-year survival and complication rate[20].	Roberto Bergamaschi 1, Patrick Pessaux, Jean-Pierre Arnaud	2003	A comparative study contrasted 39 laparoscopic ileocolic resection patients with 53 open-surgery patients. Criteria included small-bowel obstruction and recurrence, analyzed via Fisher's exact test and others.	Open and laparoscopic ileocolic resection patients were comparable in demographics, complications (9.4% vs. 10.2%), and recurrence rates (29.1% vs. 27.7%). Laparoscopic patients had longer operation times but shorter hospital stays. Small-bowel obstruction rates were significantly lower in laparoscopic patients (11.1% vs. 35.4%) at five years.
MIS for Fistulizing Crohn's Disease [21].	Masahiko Watanabe, Hirotoshi Hasegawa, Seiichiro Yamamoto, Toshifumi Hibi, Masaki Kitajima	2002	Laparoscopic surgery in 20 Crohn's disease patients with fistulas.	Median oral intake starts: 1 day post-op, discharge: 8 days. Complication rate: 16%. Recurrent disease treated laparoscopically with success. Laparoscopic treatment for Crohn's with fistulas is feasible. Low complication rates; recurrent disease can be successfully treated laparoscopically.
Comparative Outcomes: Robotic-Assisted vs. Laparoscopic Surgery for Crohn's Disease [22].	Shafqat Zaman et al.	2024	Eleven non-randomized studies (n = 5566 patients) comparing robotic (n = 365) and laparoscopic (n = 5201) colorectal resections in IBD patients were included.	Robotic platforms showed significantly lower postoperative complication rates than laparoscopic surgery (p = 0.03). Laparoscopic surgery had shorter operative times (p = 0.00001) and similar conversion rates, specific complications, and mortality. Robotic sub-total colectomy had shorter hospital stays (p = 0.03).

DISCUSSION

The research findings pooled across many studies of surgical options for CD give an idea of the procedures' effectiveness and results. Martin Hoffmann et al. (2017) compared the outcome of laparoscopic with that of open surgery in CD patients for a median follow-up of 9 years and six years, respectively [16]. The results imply that laparoscopic surgery is linked to an average hospital stay of lower magnitude than open surgery, with insignificant variations in mortality, complications, recurrence rates, and re-admissions. It is emphasized that long-term mortality is higher among the open surgery group, suggesting an advantage of the laparoscopic approach for long-term results. The study by Kristo, Stift, Bergmann, and Riss (2015) also accentuates the positive sides of the MIS for CD, consisting of the reduced rate of surgical recurrence. The benefits of using the laparoscopic approach, such as reduced incidences of infections and shorter hospital stays, reflect the results of Hoffmann et al. [18]. The work of Hasegawa, Watanabe, Nishibori, Okabayashi, Hibi, and Kitajima (2003) unveils the prospects of laparoscopic procedures in case of recurrence [17]. The lack of noticeable differences in complication rates between older and recurrent laparoscopic treatments shows that laparoscopic treatment continues to be an option even with disease recurrence.

The work of Dotlacil, Lerchova, and other researchers sheds more light on the safety and possible benefits of an approach using minimally invasive surgery in paediatric CD patients [19]. In children, too, reduced postoperative complications, shorter hospital stays, and improved recovery points make a more suitable way even for laparoscopic procedures[19]. However, the longitudinal study by Bergamaschi, Pessaux, and Arnaud (2003) reveals the medium-term outcomes of laparoscopic as well the open ileocolic resection, showing adverse effects and recurrence comparable between the two interventions. After five years, the increasing absence of small-bowel obstruction in laparoscopic patients also testifies to the possible beneficial effects of laparoscopic surgery in the long run by decreasing the long-term complication rates [20]. Research by Shafqat Zaman et al. (2025) discussed the comparison between robotic and laparoscopic surgery techniques in the context of CD and has catered to the emergent trend in surgical techniques. Despite having significantly lower overall post-operative complication rates, according to robotic platforms, laparoscopic surgeries still have advantages like fewer procedure times [22]. Hence, it is clear that the area requires more research to determine the best surgical techniques used in CD along with different factors that need consideration, like patient outcomes, healthcare resource utilization and long-term effectiveness.

The laparoscopic colon resections using the approach have been observed to challenge the surgeon due to the wider, often thickened mesentery and accessibility of penetrating conditions like fistulae and abscesses. Even though these new robotics techniques have restricted the scope, at the same time, they have provided ample opportunities for complicated colonic resections in Crohn's disease (CD) [23]. In a study by Umanskiy et al., the laparoscopic colectomy was compared

to the open one. The findings revealed that the laparoscopic approach contributed to less blood loss, faster bowel function recovery and short hospital stays. One more study involved case-matching and comparing short-term and long-term results of laparoscopic colectomy; the result confirmed that the surgery is safe and effective. However, unlike open surgery, one requirement was that the procedure last longer. If we take conversion rates as our benchmark, laparoscopic colon resection with ileocecal resection is the better choice. However, issues like intra-abdominal abscesses, fissures and more can be primary causes of the need for conversion. The results indicate that the wisdom and tact of surgeons and choosing the patients appropriately ensure more successful results within the frame of the laparoscopic colectomy of the CD cases [24, 25].

The terminal ileum is the thickened area for Crohn's disease (CD). Therefore, ileocolic resection is the main surgical intervention for those cases, mostly in strictures limited to the terminal ileum. Later on, this procedure became more prevalent and was considered the gold standard in ECCO (European Crohn's and Colitis Organization) guidelines for CD (Crohn's disease), laparoscopic ileocolic and small bowel resections. When conventional methods of treatment fail, beginning anti-TN therapy at an early stage is preferred. The quality-of-life outcomes were the same in a randomized trial comparing laparoscopic ileocecal resection to infliximab therapy in constricting ileocecal CD. It is paramount to underline that laparoscopic resection surgery was associated with lower healthcare expenses and long-term disease control. Half the patients did not require further medical intervention within the first five years. Complications such as perforation and anastomotic leakage can occur when performing -ileocecal dissection using different methods. Therefore, the retro-mesenteric approach might be safer due to the issues mentioned, as it allows mobilization of the ileo-colon away from inflammatory sites. Extended mesenteric resection during laparoscopic operation suggests lower surgical recurrence for chronic diverticulitis, demonstrating a significant role of surgical skills in treatment [26, 27, 28].

In CD (Crohn's Disease) surgery, ICA is IntraCorporeal Anastomosis which means a process of creating a connection between two pieces of the intestine from within the body, while ECA involves making the connections outside the body. There are advantages of ICA IntraCorporeal Anastomosis , such as adding fewer complications during postoperative, decreasing the time of return to bowel function and creating better cosmesis. In ICA for CD, the surgeon creates a connection among two pieces of the intestine from outside the body. Among the many benefits of this technique are fewer complications, a faster recovery, and more appealing aesthetic outcomes. Studies have revealed that laparoscopic ileocolic resection with digital anastomosis is associated with good outcomes and low conversion and complication rates. As cited by Bergamaschi et al., the laparoscopic ileocolic resection with the use of ICA has generated excellent outcomes with commendable conversion and complication rates [30]. ICA has superior bowel motility recovery even though the operation takes longer and the complication rates are similar. ECA Extracorporeal Anastomosis stands for ex vivo, a surgical method where the connections between two parts of the intestine are made separately away from the body [31, 32].

Regarding recovery time, ICA has an advantage; even though it previously required operations, ECA has just as many complications. Transrectal specimen excision method involves the extraction of the tumour and the colonic specimen using the colonoscope. This procedure uses a colonoscope for specimen removal through the trans-colonic approach, similar to standard laparoscopically assisted resection. However, it is feasible without large masses of inflammation. Ileocolonic anastomosis is a technique of the Kono-S type, which allows the creation of an antimesenteric, intact, and hand-sewn, end-to- It may trigger the recurrence of intestinal connections. It has a positive influence, as it minimizes that probability. Robotic surgery is next step of modified Kono-S anastomosis is now possible but might be a challenge that will require steep training. Kono-S Anastomosis Omission, EXSAN or Stapled Anastomosis Excluding the Mesentes, could reduce early recurrence of CD after surgery. This technique makes incisions and connects two small intestine segments while removing the mesentery. More studies are required to weigh the effects of the approach in improving educational outcomes [7].

Strictureplasty, a surgery used to widen the narrow areas of the intestines, is usually done to strictures associated with diseases like Crohn's. Instead of resecting the fibrous strained segment common in traditional resection surgery, Strictureplasty only involves widening the narrowed section to preserve most of the intestine. This is accomplished by using different techniques, including incising the stricture in the lengthwise direction and then closing it at right angles (known as Heineke-Mikulicz strictureplasty). Strictureplasty tries to treat obstruction of the bowel, which largely assists the risk of malabsorption but at the same time keeps the removal of the intestine to the minimum possible. Multi-infusion therapy has significant benefits in multiple strictures and also for patients susceptible to short bowel syndrome [7].

CONCLUSION

From all above research, we can conclude that minimally invasive surgery (MIS) greatly contributed to managing Crohn's disease (CD), offering many advantages of open surgery. The research shows that MIS methods are advancing, particularly laparoscopic and robotic-assisted procedures, which improve the patients' recuperation, leading to shorter hospital stays, faster recovery times, and fewer complications. Such results support the hypothesis that MIS can be used to improve the treatment quality for people with CD. Laparoscopic ileocolic resections bring optimistic results, and the cost is minimized with the long-term

management of the patient's health being better than therapy alone. ICA techniques, which are more rapid in recovery than open surgery, also provide a better cosmetic outcome, making laparoscopic surgery an attractive solution for CD management. Furthermore, novel techniques like trans colonic specimen removal and modified Kono-S anastomosis have shown the potential to decrease postoperative recurrence and lead to better patient health. Strictureplasty becomes a perfectly viable procedure that achieves the same purpose with less tissue removal and reduced overall impact. Undoubtedly, the advancing landscape of operation methods for CD shows the indication of more and more minimally invasive approaches that have resulted in improved outcomes, reduced complications, and patient satisfaction. As a result of the perfecting of these methods, future researchers must continue their work to improve surgical outcomes and care quality for those with CD illnesses.

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