



INTERNATIONAL JOURNAL OF ADVANCE RESEARCH, IDEAS AND INNOVATIONS IN TECHNOLOGY

ISSN: 2454-132X

Impact factor: 4.295

(Volume 4, Issue 3)

Available online at: www.ijariit.com

A review of the recent advances in Laparoscopic colorectal surgery, its present status, and logistic requirements for further advancement in the field

Dick Brashier

drdickbrashier@gmail.com

2009 Field Hospital, Joshimath,
Uttarakhand

Dr. Samrat Sunkar

samratmohansunkar@outlook.com

2009 Field Hospital, Joshimath,
Uttarakhand

Piyush Angrish

piyang.37751@gov.in

2009 Field Hospital, Joshimath,
Uttarakhand

ABSTRACT

The purpose of our study was to review the literature of advances made in the field of laparoscopic colorectal surgery and propose ways in which the roadblocks in the way to its wider acceptance can be removed. We studied online, the large body of Randomised trials, Meta-analyses and reviews that have been published in a bid to showcase the benefits of laparoscopically performed procedures, which include lesser pain, earlier recovery of bowel transit and shorter hospital stay. We found many well-designed studies that have demonstrated that oncological outcomes of laparoscopy and open surgery are similar. The percentage of patients treated with surgery using minimally invasive techniques is still quite small and there is significant inter-center variability. The number of surgeons possessing the necessary skill set needed for successful execution of a laparoscopic colorectal procedure is increasing slowly but steadily. Conclusions: We have attempted to describe advances in the field of laparoscopic colorectal surgery, single incision laparoscopic surgery, robotic surgery and natural orifice transluminal endoscopic surgery. Finally, we have drawn broad conclusions about the efforts required to be made in order to increase the use of Laparoscopically performed colorectal surgery.

Keywords: Colorectal, Surgery, Robotic, Transluminal, Single incision

1. INTRODUCTION

Laparoscopy has become the preferred operative approach for most intra-abdominal pathologic conditions including Colorectal Carcinomas. The results of large randomized controlled trials such as the Clinical Outcomes of Surgical Therapy (COST) trial have largely repudiated concerns regarding oncological margins and safety.^[1]

The benefits of laparoscopic hemicolectomy include the following:

1. Smaller wounds and improved cosmesis
2. Shorter hospital stay
3. Less postoperative pain
4. Earlier return to normal activity
5. Quicker recovery of pulmonary function
6. Lower incidence and quicker resolution of postoperative ileus
7. Lower incidence of surgical site complications
8. Lower incidence of postoperative adhesions ^[2]

The first laparoscopically-assisted colectomy was reported by Jacobs et al ^[3] in 1991. The advantages of laparoscopy arise from a significantly blunted inflammatory response. The latter results in lesser pain, earlier recovery of bowel transit and shorter hospital stay as compared to open surgery.^[4-10] Significantly lower levels of Interleukin 6 and C reactive protein have been reported after laparoscopy than after open procedures.^[7,11] In the present article, we have attempted to review the latest advances in the use of laparoscopy for colorectal surgery, such as complete mesocolon excision for rectal cancer, and the benefits of intra-corporeal anastomosis after right hemicolectomy. We have also drawn broad conclusions regarding the efforts that need to be made in order to popularise the use of Laparoscopic colorectal surgery

2. LAPAROSCOPIC COLORECTAL SURGERY

A thorough online search was conducted and the pertinent literature available on the subject matter was perused in detail. The results that we arrived at are a reflection of the following parameters:

1. Current status of Laparoscopic colorectal surgery
2. Controversies in laparoscopic colorectal surgery
3. Recent advances in Laparoscopic Colorectal Surgery
4. Logistic requirements for wider acceptance of Laparoscopy in the management of Colorectal Diseases.

The results of the present review show that the use of colorectal laparoscopic procedures has increased all over the world and particularly in the United States over the past few years. The Surgical Care and Outcomes Assessment Program evaluated the use of laparoscopy for elective colorectal resection at 48 hospitals in the United States from 2005 to 2010. The use of laparoscopic procedures increased from 23.3% in 2005 to 41.6% in 2010.^[12] In a 2012 study using the University Health System Consortium administrative database, which included more than 300 academic hospitals, laparoscopic colorectal resection was conducted for 36228 (42.2%) out of 85712 patients, with 15.8% requiring conversion to open surgery.^[13] A lower recurrence rate and better survival have been demonstrated in patients with stage III colonic cancer undergoing laparoscopic resection as compared with laparotomy.^[14] Studies conducted in 2011, 2013, and 2014 have established that laparoscopy and open surgery are equally effective for managing inflammatory bowel disease.^[15,16,17] An Indian study from 2013 concluded that Laparoscopic Ileal pouch-anal anastomosis performs better than the open approach in terms of operative blood loss, and wound infection.^[18] Studies conducted in the years 2007–2014 have shown that Hand-assisted laparoscopic surgery is safe and compensates for the lack of tactile feedback.^[19-25] An Indian observational study from 2017 concluded that the use of laparoscopy-assisted Duhamel to pull through in pediatric patients results in improved exposure and better postoperative outcomes.^[26] The long-term oncological results of the 2014 COLOR II multicentre trial show that laparoscopic surgery in patients with rectal cancer is oncologically safe, with rates of locoregional recurrence, disease-free survival and overall survival similar to those of open surgery.^[27,28] Several studies have compared short-term clinical outcomes between laparoscopic and open surgery approaches in rectal cancer (Table 1).

Table 1: Summary of key studies comparing the use of laparoscopy and open surgery in patients with cancer

Reference	Number of patients (open vs Lap)	Study	Type	Intra op Blood loss, time to return of bowel movements, hospital stay	Locoregional recurrence, disease-free survival, and overall survival
Guillou et al[6] 2005	794 (268/526)	RCT multicentre	Short term	Similar for both groups	Similar for both groups
Lujan et al[29] 2009	204 (103/101)	RCT unicentre	Short term	-do-	-do-
Trastulli et al[30] 2012	1544 (703/841)	Meta-analysis	Short term	-do-	-do-
Xiong et al[31] 2012	624 (316/308)	Meta-analysis	Short term	-do-	-do-
van der Pas et al[27] 2013	1103 (364/739)	RCT multicentre	Short term	-do-	-do-
Ng et al[32] 2014	278 (142/136)	3 RCT	Long-term	-do-	-do-
Chen et al[33] 2014	953	Meta-analysis	Short-term	-do-	-do-
Arezzo et al[34] 2015	10861	Systematic review	Short term	-do-	-do-

Several reports have demonstrated that laparoscopic resection for transverse colon cancer is feasible and safe with short- and long-term outcomes comparable to open surgery.^[35, 36] Further evidence is needed.^[37]

The results of studies comparing intracorporeal and extracorporeal anastomosis during laparoscopic right colectomy are summarised in table 2 below:

Table 2: Intracorporeal (IC) vs extracorporeal anastomosis (EC) in right laparoscopic colectomy

Reference	Number (IC/EC)	Study	Results
Scatizzi et al[38] 2010	80 (40/40)	Case-control	Similar for both groups
Grams et al[39] 2012	105 (54/51)	Restrospective	Better for IC
Carnuccio et al [40] 2014	484 (272/212)	Systematic Review	Similar for both groups
Milone et al[41] 2015	512 (286/226)	Multicentre	-do-

A randomized study including 25 patients per group, Poon et al.^[42] showed that Single Incision Laparoscopic Surgery was associated with lesser pain and shorter hospital stay. In the same year, the first meta-analysis including 14 studies,^[43] reported that SILS was a viable alternative for colorectal cancer surgery. However, A systematic review published in 2012^[44] confirmed the lack of superiority of SILS over conventional laparoscopy.

Robotic surgery is expensive, which is a major drawback to its widespread adoption^[45] Evidence of the usefulness of robotic surgery was first reported in prostate, gynecological and cardiac surgery. In a 2012 study of right-sided colonic cancer patients undergoing right hemicolectomy the duration of surgery was longer and the overall cost greater in the robotic group compared with the conventional laparoscopic group.^[46] Studies on Robotic Colorectal cancer surgery include clinical series.^[47,48] comparative studies^[49, 50] and one randomized controlled trial.^[51] All of the authors agree that robotic surgery is safe and can be reproduced, with a higher cost and longer operative time.

In 2009, Velhote et al^[52] published a pure NOTES in a patient in which they performed a transanal endorectal pull-through sigmoidectomy. Recently, The German NOTES registry analyzed the first 139 colonic NOTES procedures showing that transvaginal or transrectal NOTES colectomy is feasible and can be performed safely.^[53] A modification of the TEM technique named Trans Anal Minimally Invasive Surgery and was first described in 2010 by Atallah et al.^[54] The first case report of a Transanal NOTES rectosigmoid resection assisted by laparoscopy was reported in 2010 by Sylla and Lacy groups.^[55]

Manuel Palazuelos et al^[55] measured the impact on clinical practice of a laparoscopic colorectal resection training programme based on surgical simulation. In a prospective study, 163 surgeons participated in 30 courses of 35 h (18 h in the operating room, 12 h practicing with animal models and 4 h in seminars). Participants were asked *via* an online survey about the degree of implementation of the techniques in their day-to-day work. Average time elapsed after the course was 11.5 months (2-60 months). 75% of participants initiated or increased the number of laparoscopic surgeries performed after the training experience

3. CURRENT STATUS

Hospital characteristics (urban location and less than 200 beds), diverticular disease, and right hemicolectomies were factors associated with the laparoscopy use.^[12] The authors a 2012 study using the University Health System Consortium administrative database concluded that there is a trend of increasing use of laparoscopy in colorectal surgery, across the hospital in the United States in the recent years^[13] with acceptable conversion rates.

3.1 Laparoscopy and colon cancer

Initial detractors expressed reservations regarding the lower number of lymph nodes retrieved.^[56-59] Metastasis of malignancy was a major concern with some 1990s series reporting port site metastases and peritoneal dissemination in 10%-20% of patients.^[56-59] The “chimney effect” referring to leakage of CO₂ alongside trocars and aerosolization of tumor cells has been proposed as a causative factor.^[60] Subsequent well-designed prospective randomized multicentre trials have dispelled the myth to some extent.^[61-65] The use of laparoscopy for the management of colorectal cancer is presently well accepted.^[14]

3.2 Laparoscopy and inflammatory bowel disease

Several studies and randomized trials have demonstrated that a laparoscopic approach to ileocolic and colonic disease is as effective as open surgery with many short-term benefits.^[15, 16]

3.3 Crohn’s disease.

A meta-analysis published by the Cochrane Collaboration found no significant differences in perioperative outcomes between laparoscopic and open surgery for Crohn’s disease.^[17]

3.4 Ileal Pouch Anal Anastomosis

A 2013 meta-analysis from India included 27 comparative studies with 2428 patients, 1097 (45%) of which underwent laparoscopic surgery.^[18] The laparoscopic approach was associated with a significantly longer operative time, reduced intraoperative blood loss and lower incidence of wound infection. No significant differences were observed in the rate of pouch failure.

3.5 HALS

Hand-assisted laparoscopic surgery (HALS) is a hybrid approach by which the surgeon inserts a hand into the abdomen through a small incision to facilitate exposing the colon^[19-25] A few studies have compared HALS with open surgery^[19-25] and with conventional laparoscopic surgery.^[19-25] These studies have concluded that this approach combines all the advantages of minimally invasive surgery while compensating for the lack of tactile feedback. HALS is emerging as an alternative to laparoscopic colectomy, in more difficult cases such as complex diverticular disease or total colostomy.^[66]

3.6 Laparoscopy and paediatric surgery.

A study from India published in 2017 compared 25 cases with record analysis for two-stage Open Duhamel pull-through the procedure. The authors found that LADPT provides for excellent exposure of peritoneal cavity and minimal pelvic dissection. It preserves vital pelvic structures, reduces perioperative third space fluid loss and decreases the risk of immediate/ long term postoperative adhesive obstruction The authors think that despite their difficulties due to lack of experience with LADPT, this technique is quick, effective and has excellent early result^[26]

4. CONTROVERSIES IN COLORECTAL LAPAROSCOPIC SURGERY

The safety and effectiveness of the use of laparoscopy in patients with rectal cancer have been a topic of debate.^[67, 68] The areas of concern are enumerated below:

- (a) Rates of locoregional recurrence,
- (b) disease-free survival
- (c) overall survival as compared to open surgery
- (d) The ability to achieve Total mesorectal excision by laparoscopy without oncological compromise.
- (e) Advantages of intracorporeal vs extracorporeal anastomosis in patients undergoing laparoscopic right colectomy

4.1 Out Comes Related To Recurrence And Survival: The European multicentre COLOR II trial^[27] conducted in 30 hospitals, in which 1103 patients were randomized, showed reduced blood loss, earlier return of bowel function and shorter hospital stay in the laparoscopic group than in the open surgery group.^[27] There were no differences in postoperative morbidity and mortality.

4.2 Achieving Total Mesorectal Excision:

There are three essential components of complete mesocolon excision:

- Dissection between the mesentery and the parietal fascia and removal of the mesentery within a complete envelope of mesenteric fascia and visceral peritoneum that contains all lymph nodes draining the tumor area
- Central vascular tie
- Resection of an adequate length of the bowel to remove involved pericolic lymph nodes in the longitudinal direction.

It is known that complete mesocolic excision is associated with increased lymph node yield, reduced locoregional recurrences and increased disease-free survival in patients with colorectal cancer. [69,70] A 2015 study reported an increased lymph node harvest and a survival benefit. The authors concluded that laparoscopic complete mesocolic excision has the same oncological outcome as open surgery, although completeness of excision during laparoscopy may be compromised by tumors in the transverse colon. [71]

4.3 Intracorporeal Vs. extracorporeal anastomosis in patients undergoing laparoscopic right colectomy (Table2)

Although totally laparoscopic right colectomy with intracorporeal functional end-to-end anastomosis has been shown to be feasible and effective in terms of short- and long-term results and oncological radicality, this technique is still performed by a relatively small number of surgeons. [41] Future randomized, controlled trials are needed for further validating the procedure. [72, 73]

5. RECENT TECHNOLOGICAL ADVANCES

The evolution of new technology and improvement in skills and knowledge of surgeons has resulted in the development of new strategies. A few are enumerated below:

- (a) Single-incision Laparoscopic Surgery (SILS)
- (b) Robotic Colorectal Surgery.
- (c) Natural Orifices Transluminal Endoscopic Surgery (NOTES)

5.1 Single Incision Laparoscopic Surgery

In single incision laparoscopic surgery (SILS), only one port is used. The development of this approach is primarily intended to achieve two objectives:

- (i) To minimize the risks of trocar-related complications, and improve cosmetic results.
- (ii) To reduce the inflammatory response to surgical trauma.

For SILS the surgeon needs to develop new skills in handling special surgical instruments specifically designed for this procedure. [74, 75] SILS is more physically demanding than conventional laparoscopy. [76] Magnetic forceps have been specially designed for SILS. [77] The “colon-lifting technique” consists of suspending the colon from the abdominal wall with a suture. [78]

Two aspects need to be considered separately:

- a) Cosmesis.
- b) Cost.

Cosmesis: Although many studies have demonstrated, obviously, that SILS is associated with a shorter incision, [79] the majority of authors agree that cosmetic evaluation should only be performed after completion of the healing process by an independent clinician.

Cost: In the early years, SILS was more expensive than conventional laparoscopy due to the requirement of new trocars and instruments. [80] The cost of SILS port is a little higher than the four conventional laparoscopy ports. [81,82]

Based on the available evidence it cannot be concluded that SILS is better than conventional laparoscopy. Data regarding long-term oncological results for malignant diseases is still lacking.

5.2 Robotic Laparoscopic Colorectal Surgery

This new approach provides the following advantages among others:

- (i) three-dimensional image
- (ii) Diminishes surgeon tremor
- (iii) Allows dexterity and 7 degrees of ambidextrous capability
- (iv) Is associated with the shorter learning curve. [83]

Surgery of the colon requires access to more than one quadrant of the abdomen. This needs repositioning of the robotic arms, increasing the operative time. The first case series [84-87] reported the benefit of the new approach in specific steps of the surgical procedure, such as:

- During the takedown of the splenic flexure.
- Construction of hand-sewn anastomosis.
- Accurate lymphadenectomy around major vessels.
- Ability to perform the intracorporeal anastomosis. [85]

Robotic surgery permits the access to a narrow pelvic cavity with an excellent surgical view, reducing chances of oncological compromise. [88] Robotic total mesorectal excision ensures the preservation of urinary and sexual functions. [89] Some studies suggest that robotic surgery may shorten the learning curve for laparoscopic rectal resection. [90]

A 2015 study [91] found no significant differences in the 5-year overall, disease-free survival and local recurrence rates between robotic and laparoscopic surgical procedures.

5.3 Natural Orifice Transluminal Endoscopic Surgery

Natural orifice transluminal endoscopic surgery (NOTES) accesses the peritoneal cavity through natural openings such as mouth (transgastric), urethra (transversal), vagina (transvaginal) and anus (transcolonic). [92]

Nowadays, the hybrid technique using laparoscopic trocars and transvaginal [93] or transanal approach [94] to excise the specimen is better accepted among colorectal surgeons. TEM approach is a feasible alternative to radical excision of the rectum with lower

morbidity and mortality^[95] in low-risk T1 adenocarcinoma.^[96] TEM is a palliative technique in patients who refuse radical excision or are medically unfit for radical resection. Atallah et al^[54] proposed the use of a single port laparoscopic device transanally to excise rectal tumors instead of the rigid and longer rectoscope of the TEM. They showed that TAMIS is a feasible and safe alternative to TEM, with technical and cost-related advantages. Transanal NOTES seems particularly indicated in patients with unfavorable characteristics such as:

- (i) Male gender
- (ii) Obesity,
- (iii) Narrow pelvis and
- (iv) Bulky tumors T1 – T2, N0 tumors.^[97, 98]

6. LOGISTIC REQUIREMENTS FOR WIDER ACCEPTANCE OF LAPAROSCOPIC COLORECTAL SURGERY

studies conducted in 2014 - 15 have demonstrated the positive effect of a standardized technique, training courses and surgical simulation on the implementation of laparoscopic colorectal procedures.^[99,100] The use of workshops, symposia and video demonstrations are important resources to increase the implementation of colorectal laparoscopic surgery in daily practice.^[101] Some studies suggest that robotic surgery and training in robotics may shorten the learning curve for laparoscopic rectal resection.^[45]

7. CONCLUSION

From the present review, we drew the following broad conclusions:

- (a) Hospital characteristics (urban location and less than 200 beds), diverticular disease, and right hemicolectomies were factors associated with the laparoscopy use.
- (b) There is a trend of increasing use of laparoscopy in colorectal surgery, across hospitals in the recent years with acceptable conversion rates.
- (c) The use of laparoscopy for the management of colorectal cancer is presently well accepted
- (d) The laparoscopic approach to ileocolic and colonic disease is as effective as open surgery with many short-term benefits
- (e) There are no significant differences in perioperative outcomes between laparoscopic and open surgery for Crohn's disease.
- (f) For Ileal Pouch Anal Anastomosis with the laparoscopic approach, no significant differences were observed in the rate of pouch failure.
- (g) HALS is emerging as an alternative to laparoscopic colectomy, in more difficult cases such as complex diverticular disease or total colectomy
- (h) LADPT provides for excellent exposure of peritoneal cavity and minimal pelvic dissection.
- (i) Laparoscopic complete mesocolic excision has the same oncological outcome as open surgery, although completeness of excision during laparoscopy may be compromised by tumors in the transverse colon
- (j) Laparoscopic resection for transverse colon cancer is feasible and safe with short- and long-term outcomes comparable to open surgery
- (k) Right colectomy with intracorporeal functional end-to-end anastomosis is feasible and effective in terms of short- and long-term results and oncological radicality.
- (l) It cannot be concluded that SILS is better than conventional laparoscopy.
- (m) Robotic surgery permits the access to a narrow pelvic cavity with an excellent surgical view, reducing chances of oncological compromise
- (n) Robotic total mesorectal excision ensures the preservation of urinary and sexual functions
- (o) Robotic surgery is safe and can be reproduced, with a higher cost and longer operative time.
- (p) Transvaginal or transrectal NOTES colectomy is feasible and can be performed safely
- (q) TEM approach is a feasible alternative to radical excision of the rectum with lower morbidity and mortality
- (r) TEM palliation is effective in patients who refuse radical excision or are medically unfit for radical resection
- (s) TAMIS is a feasible and safe alternative to TEM, with technical and cost-related advantages
- (t) Transanal NOTES is particularly indicated in patients with unfavorable characteristics such as:
 - (i) Male gender
 - (ii) Obesity,
 - (iii) Narrow pelvis and
 - (iv) Bulky tumors T1 – T2, N0 tumors
- (u) The use of workshops, symposia and video demonstrations contribute significantly to increasing the implementation of colorectal laparoscopic surgery in daily practice

Although the use of laparoscopy in colorectal surgery has increased in recent years, its use is limited by lack of adequate training among surgeons. Inter-center variability of results makes comparison difficult. More investment of time and resources is required in imparting training in laparoscopic colorectal surgery to surgeons.

8. ACKNOWLEDGMENTS

We wish to express our sincere gratitude to the experts mentioned below for the invaluable hands-on the help they provided, in terms of training and access to libraries of literature:-

- (1) Dr. RK Mishra: Professor of Minimal Access Surgery, World Laparoscopy Hospital, Gurgaon, India.
- (2) Dr. JS Chauhan: Senior Consulting Surgeon, World Laparoscopy Hospital, Gurgaon, India.