10.5005/jp-journals-10007-1332

REVIEW ARTICLE

Laparoscopic *vs* Robotic Surgery in Colorectal Cases

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ABSTRACT

Minimally invasive techniques have become the new norm in the arena of colorectal cases with surgeons preferring laparoscopic commonly and robotics occasionally and sometimes hand-assisted laparoscopic surgery to deal with a variety of conditions in the colorectal region. Minimally invasive techniques have resulted in better and smaller postoperative scars, lesser postoperative pain, reduced hospital stay, and resultant faster return to daily activities and work. The aim of this review article is to compare the short-term outcomes of laparoscopic colorectal surgery and robotic colorectal surgery as also the cost *vs* overall benefit of both techniques. The studies have been taken from reputed institutes (both teaching and non-teaching) from across the world and have been sourced from Medline, Cochrane Central, and PubMed which have compared laparoscopic *vs* robotic techniques in colorectal cases on various parameters.

The two methods have shown fairly comparable duration of hospital stay and postoperative recovery and places performing higher load of robotics are having cost benefit over open surgeries in colorectal cases owing to faster discharge from hospital comparable to laparoscopic approach. This promising factor will probably enable further widespread use of robotics in colorectal cases.

Keywords: Colorectal surgery, Cost *vs* benefit, Laparoscopic surgery, Learning curve, Robotic surgery.

How to cite this article: Alva S. Laparoscopic *vs* Robotic Surgery in Colorectal Cases. World J Lap Surg 2018;11(1):43-47.

Source of support: Nil

Conflict of interest: None

INTRODUCTION

The last two and half decades have seen a rapid and ever-growing presence of minimally invasive surgical techniques in every arena of surgery. When laparoscopy made its advent in the surgical world more than two and half decades ago, it met with lot of skepticism about intraoperative complications, postoperative complications, reasons for conversion to open surgery, and prohibitive cost compared with open surgery. Now, we are in an era where laparoscopy surgery is the new norm. Along with increasing number of surgeons able to handle a variety of cases in completely minimally invasive ways, the faster recovery and discharge from hospital set-up have dramatically brought down costs too.

Similar to the environment laparoscopy met with in the 1990s, robotics has also met with the contention being put forward about exorbitant costs and lack of adequate trained personnel. As robotics is not being practiced in every surgical center as of now and also not for every surgical procedure, the appreciation and uptake of robotics in surgery have been slower. It has also been noticed that robotics has already made a huge impact in urologic and pelvic surgery compared with certain other areas. Notably, in urologic and pelvic and rectal surgeries, robotics has been a boon, as these are areas with minimal room for surgical manipulation and with robotic arms, the surgeon has greatly increased degrees of freedom as well as tactile feedback for precise movements. The technological advantages of the robotic system are a three-dimensional surgical view using a stable camera platform, fine and free movements of the robotic arm in the surgical fields, tremor elimination, motion scaling, dexterity, and ambidextrous capability.[1-4] Despite tremendous advances in laparoscopy, there are still persisting limitations. Of late, the emergence of robotic-assisted colectomy combines the advantages of laparoscopic colectomy with advantages of open approach including better body mechanics and better visualization.

Although robotic colorectal surgery has proven to be comparable to laparoscopic colorectal surgery in terms of postoperative hospital stay and recovery time, robotic surgery has been studied only on few large-scale studies yet to conclusively comment on various parameters.[1,2,5-14] Hence, the use of robotic colorectal surgery will require further evaluation and widespread use for deliberating on long-term outcomes. Hence, in this article, we will only study the short-term outcomes of laparoscopic *vs* robotic colorectal surgery (Table 1).

Aim

The aim of this study is to compare laparoscopic colorectal procedures with robotic colorectal procedures, their intraoperative advantages, hospital stay, recovery time, and cost *vs* benefit analysis over a short-term course.

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Table 1: Data comparison between robotic and laparoscopic colorectal surgery

Name of author	*Date of publication*	*Type of study*	*Patient subset*	*Conclusion*
Anuradha Bhama et al,[38] Dept of Surgery, St. Joseph Mercy Health Center, Ann Arbor, USA	Jul 14, 2015	Comparative studies included RCT and cohort studies and propensity score matching	ACSNSQIP database 11,477 cases taken (year 2013)	Hospital stay shorter in robotic colectomy. Conversion rates lesser in robotic colectomy
Scott C Dolejs et al,[39] Dept of surgery, Indiana University, School of Medicine, USA	Sep 21, 2016	Bivariate data analysis and logistic regression modeling	ASCNSQIP targeted colectomy database from 2012 to 2014; cases numbering 25,998	In robotic colectomy, postoperative hospital stay was shorter but mean operative time was longer by 40 minutes
Binghong Xiog et al,[40] Dept of Surgery, Peking University, Shougang Hospital, Peoples Republic of China	Nov 2014	Meta-analysis of RCT and non-RCT	Subset of 1,229 patients who underwent total mesorectal excision	Robotic-assisted cases, lower conversion rate to open, and lesser incidence of positive circumferential margin. Operative time, recovery outcomes, length of hospital stay: there was no difference in robotic and laparoscopic cases
Brian Ezekian et al,[41] Dept of Surgery, Duke University, USA	Mar 10, 2016	RCT	Patients who underwent colectomy between 2012 and 2013: 15,976 cases, of which only 498 (3%) were robotic-assisted	Similar perioperative outcome but robotic procedure was associated with longer operative time than laparoscopic procedure
Chang W Kim et al,[42] Dept of Surgery, Severance Hospital, Seoul, Korea	Feb 5, 2014	Review of one RCT and 39 case series and 29 comparative studies	Patients included from January 2001 to January 2013	Robotic cases had comparable short-term outcome to laparoscopic or open surgical cases. Cost factor less economical than laparoscopic procedure
Deborah S Keller et al,[43] Dept of Surgery, Case Western University, Cleveland, OH, USA	Aug 31, 2013	Multivariate analysis from PPD Robotic-assisted laparoscopic resection to laparoscopic resection	Total of 17,265 laparoscopic cases and 744 robotic cases over a 30-month period	Robotic cases had higher cost and slightly longer mean average operative time than laparoscopic cases
Gary B Deutsch et al,[44] Dept of Surgery, St. Francis Hospital, Roselyn, NY, USA	Nov 2, 2011	Retrospective review between November 2004 and November 2009	171 cases (robotic 79 and laparoscopic 92)	No statistical difference in length of hospital stay. Time to return of bowel function and need for patient-controlled analgesia
Huirong Xu et al,[45] Shandong Cancer Hospital, Jinan, China	Aug 16, 2014	Meta-analysis of 7 studies of robotic and laparoscopic right colectomy (last search Nov 2013)	234 robotic cases and 415 laparoscopic cases	Robotic has longer operative time but shorter hospital stay and lower estimated blood loss compared with laparoscopic. Equivalent clinical outcome
Jun S Park et al,[46] Dept of Surgery, Kyungpook, National University Hospital, Daegu, Korea	Jun 30, 2010	Consecutive case series (Prospective case series)	From December 2007 to June 2009; 41 consecutive patients	Robotic was safe and effective for low rectal cancer
Katelin A Mirkin et al,[47] College of Medicine, The Pennsylvania State University, PA, USA	Dec 2017	Multivariate analysis and propensity score matching	Of 15,112 patients, 5.1% underwent robotic and 94.9% underwent laparoscopic surgery (US National cancer database from 2010 to 2012) reviewed for stage one to three adenocarcinoma colon	Robotic offers comparable oncologic outcome to laparoscopic approach. Robotic appears to offer better long-term survival
Leonardo Solaini et al,[48] Morgagni Pierantoni Hospital, Italy	Dec 7, 2017	Meta-analysis	Between January 1, 2000 and May 11, 2017. 8,257 patients were included from 11 articles	Operative time shorter for laparoscopic cases. Conversion to open surgery is lesser in robotic cases. No difference in mortality or postoperative complications

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Name of author	*Date of publication*	*Type of study*	*Patient subset*	*Conclusion*
Neel M Helvind et al,[49] Copenhagen University Hospital, Denmark	Feb 7, 2013	Retrospective case–control study from March 2010 to March 2012 for robotic and from January 2009 to December 2011 for laparoscopic cases	Total 263 patients of which 101 were robotic cases and 162 laparoscopic cases	Results were comparable in laparoscopic and robotic surgery. Only set-up time was longer in robotic surgery
Nicola De Angelis et al,[50] Unit of digestive and HPB, Henri Mondor Hospital, Cretell, France	Oct 9, 2015	Case–control studies for transverse colon adenocarcinoma	22 patients underwent robotic (between March 2013 and December 2014) and 22 patients underwent laparoscopic (between December 2010 and February 2013)	No difference in intraoperative complications, blood loss, and postoperative pain. Operative time reduced in robotic cases with time and experience. No conversion to open surgery in robotic cases, two cases converted to open in laparoscopic cases
Vanitha Vasudevan et al,[51] Centre for Advanced Surgical Oncology, Palmetto General Hospital, Florida, USA	Apr 28, 2016	Retrospective review	131 patients underwent laparoscopic colorectal surgery and 96 underwent robotic surgery	Robotic surgery comparable to laparoscopic in outcome

PPD: Premiers Perspective Database; ACSNSQ: American College of Surgeons National Surgical Quality improvement project colectomy database

MATERIALS AND METHODS

The 14 studies included in the review article include single-center and multicenter studies, randomized controlled trials (RCTs), as well as retrospective studies and meta-analysis conducted in reputed institutes across the world published during the period from 2001 to 2017. The research material for the review article was sourced from Medline, PubMed, and Cochrane Central.

DISCUSSION

This review article deals with the comparison of laparoscopic surgery and robotic surgery in colorectal cases and has taken into account 14 articles which have a patient subset ranging from 2000 to 2017 included in retrospective studies, case–control studies, and meta-analysis.

The data from the various studies have shown that robotic colectomy can prove to be a safe and feasible approach comparable to laparoscopic colectomy. The short-term outcomes of robotic colectomy have indeed been favorable.[6,7,15,16]

Weber et al[17] reported performing the first robotic colonic resection using the Da Vinci system in 2001.[18] Since then, studies have been done on robotic colectomies and also comparing laparoscopic and robotic colorectal surgeries. Previous studies have suggested an improved conversion rate using robotic-assisted laparoscopic resection over laparoscopic resection in rectal cancer resections.[2,19-23] Recent meta-analyses have affirmed the statistically significant difference.[12-14]

It has been estimated that the learning curve is reached after approximately 20 cases for robotic colectomy even for surgeons who lack significant laparoscopic experience.[24] Because the robot affords improved visualization and manipulation, facilitating precise dissection within confines of bony pelvis, the use of robot-assisted resection for patients with rectal cancer has been increasing. Many groups have described application of technology to benign conditions like complicated diverticulitis also.[25]

There are now several nonrandomized comparison trials reporting lower conversion rates in robotic than in laparoscopy surgery, even in patients with tumors less than 5 cm from the anal verge.[23,26,27] This is likely due to the improved precision, retraction, and visualization afforded by the robotic arms. Most studies report no increase in complication rates including in anastomosis leak.[10,11,14,29,30] Most significantly, robotic colectomy is associated with lower risk of conversion to open surgery.[10,11,27,29,30] The robotic *vs* laparoscopic resection for rectal cancer trial addresses this issue.[4,31] Multiple meta-analyses conclude that robotic surgery does not appear to be associated with significantly longer operative times than laparoscopy. A three-phase learning curve has been

reported: (1) acquisition of basic robotic skills, (2) increasing competence and the addition of more complicated cases, and (3) achievement of robotic mastery, including the ability to tackle the most complicated cases.[24,32]

Robotic surgery, however, comes with higher costs than laparoscopic surgery or open surgery.[26,33-37] Of course, theoretically, potential benefits, such as functional and oncologic ones are better in robotic rectal surgery. But it may still not justify the higher costs at all centers. As with all new advances in surgery, as robotics in surgery become more commonplace, the costs also are bound to come down and make it more feasible to be readily applied for a variety of procedures. As the learning curve for robotic surgery is also shorter than laparoscopic surgery, a bright future awaits widespread robotics in surgery.

CONCLUSION

Robotic and laparoscopic colectomy have comparable intraoperative efficacy, with lesser conversion to open surgery seen in robotic-assisted cases. The postoperative morbidity, duration of hospital stay, and need for patient-controlled analgesia are comparable in most cases to laparoscopic surgery. In rectal cases, robotic surgery offers better operative expertise due to the presence of narrow bony pelvis limiting laparoscopic surgery. Robotic surgery has also proved effective in malignancy, as rates of positive circumferential margin are low and comparable to laparoscopic or open surgery. As the learning curve for robotic surgery is shorter than for laparoscopic surgery, and as the use of robotics becomes more widespread, the cost of robotic surgery will also likely be affordable by all.

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