Austin Journal of Cancer and Clinical Research

Open Access
Full Text Article

Special Issue Article: Colorectal Cancer

Robotic Surgery in Colorectal Cancer

Taggarshe D[1]*, Attuwaybi BO[2] and Butler BN[2]

[1]Department of Surgery, Virginia Commonwealth University, USA

[2]Department of Surgery, University at Buffalo, USA

***Corresponding author:** Taggarshe D, Department of Surgery, Virginia Commonwealth University, West Hospital 15th Floor, Room 15-408, Richmond Virginia 23298, USA, Tel: 804-628-3215; Fax: 804-827-1016; Email: dstaggarshe@vcu.edu

Received: September 16, 2014; Accepted: October 04, 2014; Published: October 09, 2014

Abstract

Background: In the last two decades, colorectal surgery has seen a dramatic advancement in from open to laparoscopic and now, robotic surgery. The aim of this article is to review the role of robotic surgery in colorectal cancer, especially in comparison with laparoscopic surgery.

Methods: A literature search was performed using PUBMED and Google-Scholar for all papers published discussing Robotic surgery in colorectal cancer upto July 2014. We also reviewed articles comparing laparoscopic colorectal surgery versus robotic colorectal surgery.

Results: Robotic colectomies had a mean operative time of 224 minutes and mean estimated blood loss of 47.67 mls. The rate of conversions to open varied from 0% to 5%. Robotic colectomies were slightly longer compared to laparoscopic colectomies. But comparable with number of retrieved lymph nodes and postoperative morbidity.

Robotic rectal surgery had a mean operative time of 269 minutes (range, 170-700 minutes). Conversion rates for the robotic group were 0% - 8% in comparison with 0% - 22% for the laparoscopic group. The median anastomotic leak rate was 7.3% for the robotic group and 6.3% for the laparoscopic group. Rates of erectile dysfunction varied from 0% -36.6% after robotic surgery to 1% - 56.5% after laparoscopic surgery. With oncologic outcomes, robotic surgery was comparable with laparoscopic surgery.

Conclusions: Robotic surgery is safe, feasible and suitable for colorectal cancer. Compared to laparoscopic surgeries there are fewer conversions to open and blood loss, with comparable postoperative and oncologic outcomes.

Keywords: Robotic surgery; Colon cancer; Rectal cancer; Laparoscopic surgery

Introduction

The surgical management of colorectal cancer has changed since the inception of minimally invasive techniques. Major international trials have established the safety of laparoscopic surgery, with oncological outcomes comparable to open surgery in colorectal cancer [1-3]. Laparoscopic surgery has an edge over conventional open surgery with a decreased analgesia requirement, shorter length of stay, and an improved quality of life [4]. Laparoscopic surgery is associated with decreased postoperative morbidity and incisional hernias.

However, laparoscopic surgery has not gained wide acceptance and majority of colorectal resections in USA are still being performed open [5]. This has been due to a combination of the steep learning curve and the inherent limitations with laparoscopic surgery. Limitations of laparoscopic surgery include poor visualization with a two –dimension view resulting in poor depth perception, need of a trained assistant to hold the camera, poor ergonomics, straight instruments and enhanced tremor effects. Alternatives for laparoscopic surgery have been developed to overcome some of these limitations.

The Food and Drug Administration approved robotic assisted surgery with the da Vinci operating console in 2000. Weber et al demonstrated the feasibility of robotic assisted colectomies in 2002 [6]. The advantages of the da Vinci platform – da Vinci Si HD, which was used in most of the publications, include a three dimensional high definition camera, articulating instruments with seven degrees of freedom, a stable camera and operating platform, reduced physiological tremors, ergonomic comfort and superior dexterity. Robotic surgery can enable precision surgery in conditions with difficult target organ exposure such as narrow male pelvis, distal tumors and obese patients. Robotic surgery has exponentially increased in all specialties worldwide and in the US, along with a similar increase in robotic colorectal surgery [7].

The aim of this article is to review the use of robotic surgery in colon and rectal cancer and determine its safety and feasibility. The article also aims to compare it with laparoscopic surgery for colon and rectal cancers.

Materials and Methods

A literature search was performed using PUBMED and Google Scholar for all articles involving robotic surgery in colorectal cancer up to July 2014. The keywords used for search in combinations were “robotic surgery”, “colorectal cancer”, “rectal cancer”, “proctectomy”, “colectomy”, and “sigmoid resection”. The abstracts were examined and articles with application of robotic surgery in colorectal cancers were further reviewed. Furthermore, the reference lists of selected articles were searched manually. Only articles published in English

ISSN : 2381-909X | www.austinpublishinggroup.org

Citation: Taggarshe D, Attuwaybi BO and Butler BN. Robotic Surgery in Colorectal Cancer. Austin J Cancer Clin Res 2014;1(4): 1018.

were included. The included articles included randomized clinical trials, comparative studies and case series.

Data extracted included number of patients, operative details and outcomes. Costs involved with robotic surgery were included if mentioned in the articles. Operative details included type of surgery, operating time, estimated blood loss and intra operative complications. Pathological features included were number of retrieved lymph nodes in all cases and circumferential resection margin (CRM) status and distal resection margin (DRM) in rectal cancer. Postoperative outcomes included length of stay and postoperative complications.

Results

Sixty-five articles met the initial criteria for robotic surgery in colorectal cancer. Twelve articles with benign and malignant disease and six articles with inseparable colonic and rectal data were excluded. Articles (n=10) with data in overlapping periods from the same institutions were excluded. Nine articles meeting the criteria for robotic colectomies [8-16] and twenty-eight articles for robotic rectal surgery for cancer [11,17-43] were included for this review.

Robotic Colonic Surgery for Cancer

Clinical outcomes

The review identified 316 robotic colectomies for cancer. This included 233 right colectomies, 68 sigmoid resections, 3 total abdominal colectomies and 12 left hemicolectomies (Table 1). Ballantyne et al compared robotic right colectomies with medial to lateral dissection versus robotic colectomies with lateral to medial dissection [8]. Two articles reported on right colectomies with intracorporeal anastomosis [15,16].

The mean operative time was 224 minutes and mean estimated blood loss was 47.67 mls. The rate of conversions to open varied from 0% to 5%. Ballantyne et al reported one conversion to laparoscopy in the medial to lateral dissection for right colectomy due to bleeding [8]. The mean number of retrieved lymph nodes ranged from 12 to 30. Overall postoperative morbidity varied from 2% to 33%. This included wound infections, post op ileus, small bowel obstructions, anastomotic leaks and pneumonia. Reported anastomotic leak rates varied from 0% to 5.1%.

Laparoscopic vs. robotic colon surgery for cancer

Three articles (Table 2) compared robotic and laparoscopic colectomies for cancer: Park et al [12] reported on a randomized controlled trial for right colectomy and Lim et al [14] compared laparoscopic and robotic anterior resections for sigmoid cancer. Robotic colectomies were slightly longer. However they were comparable with regards to number of retrieved lymph nodes and postoperative morbidity.

Robotic Rectal Surgery for Cancer

Surgical technique

The two well recognized techniques for robotic rectal surgery are: Total robotic technique and Hybrid technique. The total robotic technique involves performing the entire operation robotically which can be either via (1) single docking technique – requiring only one docking of the robotic cart but repositioning of the robotic arms depending on the operative fields, or (2) dual docking technique – requiring two separate dockings of the robotic cart for the separate operative fields. The hybrid technique on the other hand, uses laparoscopic surgery along with robotic surgery in combination for various aspects of the operation. The advantage of this hybrid approach is a shorter operating time, especially in rectal surgery as the splenic flexure can be mobilized laparoscopically, followed by robotic pelvic dissection. In this review, there were 10 articles using total robot technique, 10 articles using the hybrid technique, and 7 articles using a combination of either total robot or hybrid techniques. Park et al [33] used a reverse hybrid technique – which involves reversal of the operative sequence with robotic lymphovascular and rectal dissection prior to proximal laparoscopic colonic mobilization.

Clinical outcomes

The review identified 1895 robotic rectal resections for rectal cancer. This included 1389 anterior or low anterior resections, 333 coloanal anastomoses and 170 abdominal perineal resections. (Table 3) The remainder procedures were Hartmann's procedures. The mean operative time was 269 minutes (range, 170-700 minutes). Estimated blood loss varied from minimal to 2000mls. There were no conversions from robotic rectal resections in seventeen articles. The remainder had varying conversion rates ranging from 0.7 -10%.

Table 1: Studies on robotic colectomies for cancer.

Author	Study Design	Number of cases	Type of colectomy: Right colectomy	Sigmoid resection	Total abd colectomy	Left hemi	Operative time (Mean) In minutes	EBL (ml)	Conversion (%)	LN retrieved (mean)	Postop Morbidity %	Leaks %	LOS in days	OS	DFS
8	Comparative	16	8 (Med to Lat) 8 (Lat to med)				253* (180-309) 256* (228-350)		12.5% to lap	18* (3-35) 12* (3-20)	25% 25%	0 0	4* (2-9) 5*(3-10)		
9	Case series	50	50				223.5* (180-270)	20* (0-100)	None	18.76* (12-44)	2%	0	7	92% @3 yrs	90% @3yrs
10	Case series	3	3				130						4.5		
11	Case series	42	42				158.9	73.2	2.38%	19	11.9%		5.4		
12	RCT	35	35				195	35.8	None	29.9	17.14%	2.85%	7.9		
13	Comparative	101	52	34	3	12	243		5%		22%	5.1%	6.42		
14	Comparative	34		34			252.5	60.3	None	12	10.3%	0	5.5	92.1% @ 3 yrs	
15	Case series (ICA)	15	15				201.4	41.7	None	24.2	33.3%	0	7* (6-21)		
16	Case series (ICA)	20	20				327.5	55	None	17.6	3.33%	0	4.5		

* - Values indicate median with range in parentheses
EBL – Estimated blood loss, LN – lymph node, LOS – length of stay, OS – Overall survival, DFS- Disease free survival.
ICA – Intracorporeal anastomosis.

Table 2: Studies comparing robotic and laparoscopic colectomies.

Author	Procedure	Number of cases	Type of colectomy: Right colectomy	Sigmoid resection	Total abd colectomy	Left hemi	Operative time (Mean) In minutes	EBL (ml)	Conversion (%)	LN retrieved (mean)	Postop Morbidity %	Leaks %	LOS in days	Costs
12	Robot	35	35				195	35.8	None	29.9	17.14%	2.85%	7.9	$1907.9#
	Lap	35	35				130	56.8	None	30.8	20%	0	8.3	$1607.7
13	Robot	101	52	34	3	12	243		5%		22%	5.1%	6.42	
	Lap	162	88	59	0	14	254		2%		22%	5.5%	6.74	
14	Robot	34		34			252.5	60.3	None	12	5.9%	0	5.5	
	Lap	146		146			217.6	78.2	0.68%	16.5	10.3%	1.4%	6.2	

* - Values indicate median with range in parentheses

- Costs were calculated from Korean won to US dollars in this study based on an exchange rate of 1020 Korean won to US $1

EBL – Estimated blood loss, LN – lymph nodes. LOS – length of stay.

Table 3: Studies on robotic rectal resections with outcomes.

Author	Study Design	Procedure	Number of cases	Type of proctectomy: AR/ LAR	Coloanal anastom-osis	APR	Mean Operative time (minutes)	Mean EBL (mls)	Conversion	LN retrieved (Mean)	CRM positive	DRM	Postop Morbidity	Leaks	LOS (days)
17	Case series	Total	2	2			240	185	50%	NA	NA	NA	-	-	18
18	Comparative	Hybrid	56	56			190.1		None	18.4	7.1%	4	10.7%	1.8%	5.7
19	Case series	Hybrid	8	2	6		193.8	Minimal	None	15* (2-26)	None	>2	12.5%	0	5* (4-30)
20	Comparative	Hybrid	29	19	5	5	202	137	None	10.3	None	2.1	26%	6.8%	11.9
21	Comparative	Total/ hybrid	25	18		7	240* (170-420)			18* (7-34)	None	2* (1.5-4.5)	16%	4%	6.5* (4-15)
22	Case series	Total/ hybrid	143	80	32	31	297		4.7%	14.1	0.7%	2.9	41.3%	10.5%	8.3
11	Case series	Hybrid	58	47		11	338	232	1.7%	14.1	None	NA	25.9%	3.44%	7.76
23	Comparative	Hybrid	41	33	2	6	296	200* (20-2000)	7.31%	13.1	2.4%	3.6	22%	7.3%	6.5
24	Comparative	Total	52	48		4	260* (190-570)	100* (50-1000)	4%	20.5*	4%	2.6* (0.1-7)	27%	12%	6* (4-51)
25	Case series	Total/ Hybrid	389	382		6	322.35		0.7%	15.7	3.6%		19%	7%	13.15
26	Case series	Total	20	14	5	1	306.75		None	17.8	5.26%	3.7	23.8%	0	6.4
27	Comparative	Total	59	54	5		270* (241-325)		None	20* (12-27)	1.7%	2.2* (1.5-3)	32.2%	13.6%	
28	Case series	Total	29		29		325* (235-435)	<50* (<50-1000)	None	16* (1-44)	7%	0.8* (0-4)	37.93%	10%	9* (5-15)
29	Comparative	Hybrid	52	52			232.6		None	19.4	1.9%	2.8	19.2%	9.6%	10.4
30	Comparative	Hybrid	80	40	21	19	303.5	225	10	14.2	None	3.25	33.75%	9.83%	7.55
31	Case series	Total/ hybrid	30	27		3	270* (175-480)	50* (20-100)	None	15* (3-38)	None	4* (2-8)	13.3%		4* (4-20)
32	Comparative	Total	100	55	45		188		None	20	1%	2.7	11%	2%	7.1
33	Case series	Reverse hybrid	30	5	19	6	369* (306-410)	100* (75-200)	None	20* (14-25)	None		36.67%	4.2%	4* (3-6)
34	Comparative	Total/ hybrid	17	10	7		396.5	188.8	None	16.5	-	-	16.7%	0	10.7
35	Comparative	Total	50	50#			270* (240-315)		None	16.5	None	3	10%	10%	8* (7-11)
36	Comparative	Hybrid	13	5		8	528* (416-700)	157* (50-550)	8%	16	None	-	-	20%	13
37	Case series	Total	74	49	20	5	276	53	None	20.5	None	3.1	17.4%	1.3%	6.9
38	Comparative	Hybrid	40		40		235.5	45.7	None	12.9	7.5%	1.4	15%	7.5%	10.6
39	Case series	Total/ hybrid	100	69	8	23	180* (100-330)	150* (0-250)	4%	14* (4-32)	1%	3* (0.2-7)	30%	9%	10* (6-38)
40	Case series	Total	200	131	55	13	270* (130-515)	190* 0-1500)	None	17* (3-83)	2.5%	1.8* (0-22)	33.5%	9.5%	
41	Case series	Total/ hybrid	113	82	23	8	302* (135-683)	17* (0-690)	None	32* (11-112)	None	2.6* (0.5-10)	19.46%	1.8%	7* (6-24)
42	Comparative	Total	65	44	11	9	299	0* (0-175)	1.5%	20.1	None	2.7* (1.6-4.4)	41.5%	7.1%	6* (5-8)
43	Comparative	Hybrid	20	15		5	240* (150-540)	125* (50-650)	None	14* (3-22)	None	2* (0.5-5)	40%	0	6* (4-31)

AR- anterior resection, LAR – low anterior resection, APR - abdominal perineal resection, EBL – estimated blood loss, LN- lymph node, CRM – circumferential resection margin, DRM – distal resection margin, LOS – length of stay in days

* - Values indicate median with range in parentheses

- The article did not indicate the type of rectal resections i.e. low anterior resection or coloanal anastomosis.

A very early case series from Braumann et al in 2005 [17] consisting of five robotic cases had three conversions (including two robotic rectal resections with one conversion resulting in conversion in 50% of proctectomies).

In terms of postoperative outcomes, the median morbidity rate after robotic rectal surgery was 23% (range, 10%-40%) These include anastomotic leaks, postoperative bleeding, wound infections, pelvic abscesses, postoperative ileus, small bowel obstructions, pneumonia, urinary retentions and sexual dysfunctions. Reported anastomotic leaks ranged from 0% -14%; with a median rate of 7%. The median length of stay after robotic rectal surgery was 7.3 days (range, 4-51 days).

Table 4: Comparison of robotic and laparoscopic rectal resections.

Author	Procedure	Number of cases	Mean Operative time (minutes)	Mean EBL (mls)	Conversion	LN retrieved (Mean)	CRM positive	DRM in cm	Postop Morbidity	Leaks	Voiding dysfunction	Erectile dysfunction	LOS (days)
18	Robot	56	190.1		None	18.4	7.1%	4	10.7%	1.8%			5.7
	Lap	57	191.1		10.5%	18.7	8.8%	3.6	19.3%	7.0%			7.6
20	Robot	29	202	137.4	None	10.3	None	2.1	26%	6.8%		5.5%	11.9
	Lap	37	208	127	18.9%	11.2	None	4.5	32.8%	2.7%		16.6%	9.6
21	Robot	25	240* (170-420)		None	18* (7-34)	None	2* (1.5-4.5)	16%	4%			6.5* (4-15)
	Lap	25	237* (170-545)		4%	17* (8-37)	4%	2* (1.8-3.5)	24%	8%			6* (4-20)
23	Robot	41	296	200* (20-2000)	7.31%	13.1	2.4%	3.6	22%	7.3%			6.5
	Lap	41	315	300* (17-1000)	22%	16.2	4.9%	3.8	26%	2.43%			6.6
27	Robot	59	270* (241-325)		None	20* (12-27)	1.7%	2.2* (1.5-3)	32.2%	13.6%			
	Lap	59	228* (177-254)		3.4%	21* (14-28)	None	2* (1.2-3.5)	27.11%	10.2%			
29	Robot	52	232.6		None	19.4	1.9%	2.8	19.2%	9.6%			10.4
	Lap	123	158.1		None	15.9	2.4%	3.2	12.2%	5.6%			9.8
34	Robot	17	396.5	188.8	None	16.5	-	-	16.7%	0			10.7
	Lap	12	298.8	229.2	8.33%	14.1			20%	0			9.6
35	Robot	50	270* (240-315)		None	16.5	None	3	10%	10%			8* (7-11)
	Lap	50	280* (240-350)		12%	13.8	12%	3	22%	14%			10* (8-14)
36	Robot	13	528* (416-700)	157* (50-550)	8%	16	None	-	-	20%			13
	Lap	59	344* (183-735)	200* (25-1500)	17%	20	2%	-	-	7%			8
44	Robot	165	309.7	133.0	0.6%	15.0	4.2%	1.9	20.6%	7.3%	2.4%		10.8
	Lap	165	277.8	140.1	1.8%	15.6	6.7%	2.0	27.9%	10.8%	4.2%		13.5
38	Robot	40	235.5	45.7	None	12.9	7.5%	1.4	15%	7.5%			10.6
	Lap	40	185.4	59.2	None	13.3	5%	1.3	12.5%	5%			11.3
43	Robot	20	240* (150-540)	125* (50-650)	None	14* (3-22)		2* (0.5-5)	40%	0			6* (4-31)
	Lap	20	180* (140-480)	175* (50-900)	10%	11* (4-18)		2.1* (0.1-5.5)	20%	0			7* (5-36)

EBL – estimated blood loss, LN – lymph node, CRM – circumferential resection margin, DRM – distal resection margin, LOS – length of stay in days

* - Values indicate median with range in parentheses

With oncological resections, the median number of lymph nodes harvested was 16.5 (range, 0-83). In thirteen articles, the circumferential resection margin was negative in all cases. In the remainder of the articles, when reported the circumferential resection margin positivity ranged from 0.7% - 7.1%. The median distal resection margin was 2.6 cm.

Laparoscopic vs. robotic rectal surgery

The review identified 12 articles comparing laparoscopic versus robotic rectal resections (Table 4) with 608 laparoscopic rectal resections and 567 robotic rectal resections. The mean operation time was longer with robotic surgery (284.2 minutes vs. 241.93 minutes for laparoscopic surgery). Conversion rates for the robotic group were 0% - 8% in comparison with 0% - 22% for the laparoscopic group. Nevertheless, nine articles had no conversions in the robotic group. The reasons cited for conversions in both groups were adhesions, obesity, narrow pelvis and bulky tumor.

The postoperative overall morbidity rates were similar in both groups with median morbidity of 19% (range, 10.7% - 40%) in the robotic group and 22% (range12%-32.8%) in the laparoscopic group. The median anastomotic leak rate was 7.3% (range 0% -20%) for the robotic group and 6.3% (range 0% - 14%) for the laparoscopic group. Maintenance of the integrity of the pelvic autonomic nervous system is essential during rectal surgery to avoid sexual and urinary dysfunction. The conventional open total mesorectal excision is associated with 0–12% patient urinary dysfunction and 10–35% sexual dysfunction [45-50]. In this review, eight articles assessed sexual and urinary dysfunction with rates of erectile dysfunction varying between 0% -36.6% after robotic surgery and 1% - 56.5% after laparoscopic surgery [20,32,33,35,38,39,51,52]. Functional outcomes were evaluated using the International Prostate Symptom Score (IPSS) and the International Index of Erectile Function (IIEF) in three articles [35,38,52]. D'Annibale et al found that the IPSS scores were significantly increased 1 month after surgery in both laparoscopic and robotic surgery groups but normalized a year after surgery [35]. Erectile function was significantly worse a month after surgery in both groups, but completely restored a year later in the robotic group. The recovery was partial in the laparoscopic group. Park et al using questionnaire at 3 and 6 months post surgery, found worsening of erectile functional scores in both groups at 3 months [38]. However, the scores were significantly worse in the laparoscopic group. The scores improved in the 6-month questionnaire in both groups, with much better improvement in the robotic group. Kim et al reported that the IPSS scores worsened a month post surgery, but the recovery in urinary function was faster in the robotic group (3 months) versus the laparoscopic group (6 months) [52]. With regards to the IIEF scores, they reported worsening of scores at 1-month post surgery in both groups, but again a faster recovery in the robotic group at six months whereas the laparoscopic group had a gradual recovery in a year.

With oncological outcomes, robotic surgery was comparable with laparoscopic surgery. The median numbers of retrieved lymph nodes were 16.25 (range, 10-19.4) in the robotic group and 15.75 (range, 11-20) in the laparoscopic group. There was minimal difference in the two groups with regards to distal resection margins and status of circumferential resection margin.

Discussion

The role of laparoscopic colorectal cancer surgery has been established by the major trials (COST, COLOR and CLASSICC) [1-3,53]. However, it has its limitations. Laparoscopic surgery can be technically demanding, especially in the pelvis and has a long learning curve. The main limitations of laparoscopic surgery lie in loss of depth perception, poor ergonomics, loss of dexterity and the need for a trained assistant. Physiological tremors of the camera holder can be a major disadvantage, especially at the end of a long case. Robotic surgery has been developed to overcome the limitations of laparoscopic surgery and improve the capability of colorectal surgery.

This review shows that robotic surgery for colorectal cancer is safe and feasible. We specifically selected only nine articles for robotic assisted colectomies and twenty-eight articles for robotic assisted rectal resections, as these are the ones on the use of robotic surgery in cancer. Similar to prior reports, we have found that robotic surgery is comparable to laparoscopic surgery with outcomes.

With colectomies and rectal surgery, robotic surgery had lower conversions. Better visualization with the robot, especially in the pelvis could be a factor for the same. Lower conversion rates have been shown to be associated with decreased postoperative morbidity and recurrence rates. The operative time was longer in the robotic groups, in both colectomies and rectal resections. Most of this is due to the time taken for docking the robot and undocking the robot. As surgeons are becoming proficient in robotic surgery, this time has decreased. Use of hybrid technique with laparoscopic mobilization of splenic flexure has helped in keeping operative times low, by avoiding the need for double docking.

Robotic surgery has been shown to have lower blood loss compared to laparoscopic surgery. However, with regards to other postoperative outcomes, the two techniques are comparable, except with sexual and urinary dysfunction after rectal surgery. In terms of oncologic outcomes, this review shows that robotic surgery is comparable with laparoscopic surgery with the number of retrieved lymph nodes. In rectal cancer, the circumferential margin and distal resection margins are comparable with laparoscopic rectal surgery. Identification and preservation of the pelvic autonomic nervous system is an integral part of rectal surgery. Urinary and sexual functional complications can occur due to injury to the superior hypogastric plexus, or pelvic plexus or both. The MRC CLASICC trial raised concerns that the rate of pelvic autonomic nerve injury maybe higher with laparoscopic total mesenteric excision compared to open [54]. Robotic surgery with its better visuals could enable identification of the nerves and the improved dexterity with the increased range of motion enable better dissection without injury to the nerves. In this review, we found that there was worsening of urinary and sexual dysfunctions in both robotic and laparoscopic surgery, but comparatively lower in robotic surgery. Furthermore studies showed that there was earlier recovery in function in the robotic group. One can therefore conclude that robotic surgery does enable in better dissection and lesser injury to pelvic autonomic system.

Robotic surgery is associated with higher costs. This includes the high cost of equipment and instrumentation, with a capital purchase cost of upto $2 Million. Maintenance of the robot can cost $100,000-$150,000 per year. The instruments have a ten-procedure life span that adds to the costs. Furthermore there are increased costs in setting up a specialized team, with the need for specialized training. The increase in operating time also contributes to increased costs. Studies have compared the costs with robotic and laparoscopic surgery in both benign and malignant colorectal disease [18,27,28,32,55-57]. These studies have shown that robotic surgery is more expensive than laparoscopic surgery. Most of these studies are from groups based in different countries. The differences in costs in health systems across the world can impact these costs.

This review is limited by the lack of studies of robotic colectomy for cancer. Most of the studies in the literature are case series or comparative studies. There is a need for a well-structured randomized controlled trial to ascertain the advantages of robotic surgery over laparoscopic surgery in colorectal cancer. The results of the ROLARR (Robotic versus Laparoscopic Resection for Rectal cancer) study, which is an international multicentric randomized trial, are much awaited [58].

In conclusion, we can opine from this review that robotic surgery is safe and feasible for colorectal cancer. Compared to laparoscopic surgery, there are fewer conversions and lesser blood loss, albeit with increased operating times. It is comparable with laparoscopic surgery for oncologic outcomes and postoperative outcomes. Although, robotic surgery is also associated with sexual and urinary dysfunction, an earlier recovery is seen in robotic surgery. The expenses associated with robotic surgery may need to be reduced in the future to increase its acceptance in colorectal cancer surgery.

References

1. Clinical Outcomes of Surgical Therapy Study Group. A comparison of laparoscopically assisted and open colectomy for colon cancer. N Engl J Med. 2004; 350: 2050-2059.
2. Jayne DG, Thorpe HC, Copeland J, Quirke P, Brown JM, Guillou PJ, et al. Five-year follow-up of the Medical Research Council CLASICC trial of laparoscopically assisted versus open surgery for colorectal cancer. Br J Surg. 2010; 97: 1638-1645.
3. van der Pas MH, Haglind E, Cuesta MA, Fürst A, Lacy AM, Hop WC. Laparoscopic versus open surgery for rectal cancer (COLOR II): short-term outcomes of a randomised, phase 3 trial. Lancet Oncol. 2013; 14: 210-218.
4. Weeks JC, Nelson H, Gelber S, Sargent D, Schroeder G, Clinical Outcomes of Surgical Therapy (COST) Study Group. Short-term quality-of-life outcomes following laparoscopic-assisted colectomy vs. open colectomy for colon cancer: a randomized trial. JAMA. 2002; 287: 321-8.
5. Rea JD, Cone MM, Diggs BS, Deveney KE, Lu KC, Herzig DO, et al. Utilization of laparoscopic colectomy in the United States before and after the clinical outcomes of surgical therapy study group trial. Ann Surg. 2011; 254: 281-288.
6. Weber PA, Merola S, Wasielewski A, Ballantyne GH. Telerobotic-assisted laparoscopic right and sigmoid colectomies for benign disease. Dis Colon Rectum. 2002; 45: 1689-1694.
7. Barbash GI, Glied SA. New technology and health care costs--the case of robot-assisted surgery. N Engl J Med. 2010; 363: 701-704.
8. Ballantyne GH, Ewing D, Pigazzi A, Wasielewski A. Telerobotic-assisted laparoscopic right hemicolectomy: lateral to medial or medial to lateral dissection? Surg Laparosc Endosc Percutan Tech. 2006; 16: 406-410.
9. D'Annibale A, Pernazza G, Morpurgo E, Monsellato I, Pende V, Lucandri G, et al. Robotic right colon resection: Evaluation of first 50 consecutive cases for malignant disease. Ann Surg Oncol. 2010; 17: 2856-2862.
10. Pandalai S, Kavanagh DO, Neary P. Robotic assisted laparoscopic colectomy. Ir Med J. 2010; 103: 181-182.
11. Zimmern A, Prasad L, Desouza A, Marecik S, Park J, Abcarian H, et al. Robotic colon and rectal surgery: a series of 131 cases. World J Surg. 2010; 34: 1954-1958.
12. Park JS, Choi GS, Park SY, Kim HJ, Ryuk JP. Randomized clinical trial of robot-assisted versus standard laparoscopic right colectomy. Br J Surg. 2012; 99: 1219-1226.
13. Helvind NM, Eriksen JR, Mogensen A, Tas B, Olsen J, Bundgaard M, et al. No differences in short term morbidity and mortality after robot assisted laparoscopic versus laparoscopic resection for colonic cancer: a case-control study of 263 patients. Surg Endosc. 2013; 27: 2575-2580.
14. Lim DR, Min BS, Kim MS, Alasari S, Kim G, Hur H, et al. Robotic versus laparoscopic anterior resection of sigmoid colon cancer: comparative study of long-term oncologic outcomes. Surg Endosc. 2013; 27: 1379-1385.

15. Park SY, Choi GS, Park JS, Kim HJ, Choi WH, Ryuk JP. Robot-assisted Right colectomy with lymphadenectomy and intracorporeal anastomosis with colon cancer: technical considerations. Surg Laparosc Endosc Percutan Tech. 2012; 22: e271-e276.

16. Trastulli S, Desiderio J, Farinacci F, Ricci F, Listorti C, Cirocchi R, et al. Robotic right colectomy for cancer with intracorporeal anastomosis: short-term outcomes from a single institution. Int J Colorectal Dis. 2013; 28: 807-814.

17. Braumann C, Jacobi CA, Menenakos C, Borchert U, Rueckert JC, Mueller JM, et al. Computer-assisted laparoscopic colon resection with the Da Vinci system: our first experiences. Dis Colon Rectum. 2005; 48: 1820-1827.

18. Baik SH, Kwon HY, Kim JS, Hur H, Sohn SK, Cho CH. Robotic versus laparoscopic low anterior resection of rectal cancer: short-term outcome of a prospective comparative study. Ann Surg Oncol. 2009; 16: 1480-1487.

19. Ng KH, Lim YK, Ho KS, Ooi BS, Eu KW. Robotic-assisted surgery for low rectal dissection: from better views to better outcome. Singapore Med J. 2009; 50: 763-767.

20. Patriti A, Ceccarelli G, Bartoli A, Spaziani A, Biancafarina A, Casciola L. Short and medium term outcome of Robot assisted and Traditional Laparoscopic Rectal Resection. JSLS. 2009; 13: 176-183.

21. Bianchi PP, Ceriani C, Locatelli A, Spinoglio G, Zampino MG, Sonzogni A, et al. Robotic versus laparoscopic total mesorectal excision for rectal cancer: a comparative analysis of oncological safety and short-term outcomes. Surg Endosc. 2010; 24: 2888-2894.

22. Pigazzi A, Luca F, Patriti A, Valvo M, Ceccarelli G, Casciola L. Multicentric study on robotic tumor-specific mesorectal excision for the treatment of rectal cancer. Ann Surg Oncol. 2010; 17: 1614-1620.

23. Baek JH, Pastor C, Pigazzi A. Robotic and laparoscopic total mesorectal excision for rectal cancer: a case-matched study. Surg Endosc. 2011; 25: 521-525.

24. Bertani E, Chiappa A, Biffi R, Bianchi PP, Radice D, Branchi V, et al. Assessing appropriateness for elective colorectal cancer surgery: clinical, oncological, and quality-of-life short-term outcomes employing different treatment approaches. Int J Colorectal Dis. 2011; 26: 1317-1327.

25. Kang J, Min BS, Park YA, Hur H, Baik SH, Kim NK, et al. Risk factor analysis of postoperative complications after robotic rectal cancer surgery. World J Surg. 2011; 35: 2555-2562.

26. Koh DC, Tsang CB, Kim SH. A new application of the four-arm standard da Vinci® surgical system: totally robotic-assisted left-sided colon or rectal resection. Surg Endosc. 2011; 25: 1945-1952.

27. Kwak JM, Kim SH, Kim J, Son DN, Baek SJ, Cho JS. Robotic vs laparoscopic resection of rectal cancer: short-term outcomes of a case-control study. Dis Colon Rectum. 2011; 54: 151-156.

28. Leong QM, Son DN, Cho JS, Baek SJ, Kwak JM, Amar AH, et al. Robot-assisted intersphincteric resection for low rectal cancer: technique and short-term outcome for 29 consecutive patients. Surg Endosc. 2011; 25: 2987-2992.

29. Park JS, Choi GS, Lim KH, Jang YS, Jun SH. S052: a comparison of robot-assisted, laparoscopic, and open surgery in the treatment of rectal cancer. Surg Endosc. 2011; 25: 240-248.

30. Akmal Y, Baek JH, McKenzie S, Garcia-Aguilar J, Pigazzi A. Robot-assisted total mesorectal excision: is there a learning curve? Surg Endosc. 2012; 26: 2471-2476.

31. Karahasanoglu T, Hamzaoglu I, Baca B, Aytac E, Erguner I, Uras C, et al. Robotic surgery for rectal cancer: initial experience from 30 consecutive patients. J Gastrointest Surg. 2012; 16: 401-407.

32. Kim JC, Yang SS, Jang TY, Kwak JY, Yun MJ, Lim SB. Open versus robot-assisted sphincter saving operations in rectal cancer patients: techniques and comparison of outcomes between groups of 100 matched patients. Int J Med Robotics Comput Assist Surg. 2012; 8: 468-475.

33. Park IJ, You YN, Schlette E, Nguyen S, Skibber JM, Rodriguez-Bigas MA. Reverse-hybrid robotic mesorectal excision for rectal cancer. Dis Colon Rectum. 2012; 55: 228-233.

34. Shin JY. Comparison of Short-term Surgical Outcomes between a Robotic Colectomy and a Laparoscopic Colectomy during Early Experience. J Korean Soc Coloproctol. 2012; 28: 19-26.

35. D'Annibale A, Pernazza G, Monsellato I, Pende V, Lucandri G, Mazzocchi P, et al. Total mesorectal excision: a comparison of oncological and functional outcomes between robotic and laparoscopic surgery for rectal cancer. Surg Endosc. 2013; 27: 1887-1895.

36. Fernandez R, Anaya DA, Li LT, Orcutt ST, Balentine CJ, Awad SA, et al. Laparoscopic versus robotic rectal resection for rectal cancer in a veteran population. Am J Surg. 2013; 206: 509-517.

37. Luca F, Valvo M, Ghezzi TL, Zuccaro M, Cenciarelli S, Trovato C. Impact of robotic surgery on sexual and urinary functions after fully robotic nerve-sparing total mesorectal excision for rectal cancer. Ann Surg. 2013; 257: 672-678.

38. Park SY, Choi GS, Park JS, Kim HJ, Ryuk JP. Short-term clinical outcome of robot-assisted intersphincteric resection for low rectal cancer: a retrospective comparison with conventional laparoscopy. Surg Endosc. 2013; 27: 48-55.

39. StÄƒnciulea O, Eftimie M, David L, Tomulescu V, Vasilescu C, Popescu I, et al. Robotic surgery for rectal cancer: a single center experience of 100 consecutive cases. Chirurgia (Bucur). 2013; 108: 143-151.

40. Hara M, Sng K, Yoo BE, Shin JW, Lee DW, Kim SH. Robotic-assisted surgery for rectal adenocarcinoma: short-term and midterm outcomes from 200 consecutive cases at a single institution. Dis Colon Rectum. 2014; 57: 570-577.

41. Shiomi A, Kinugasa Y, Yamaguchi T, Tomioka H, Kagawa H. Robot-assisted rectal cancer surgery: short-term outcomes for 113 consecutive patients. Int J Colorectal Dis. 2014; 29: 1105-1111.

42. Ghezzi TL, Luca F, Valvo M, Corleta OC, Zuccaro M, Cenciarelli S. Robotic versus open total mesorectal excision for rectal cancer: comparative study of short and long-term outcomes. Eur J Surg Oncol. 2014; 40: 1072-1079.

43. Barnajian M, Pettet D 3rd, Kazi E, Foppa C, Bergamaschi R. Quality of total mesorectal excision and depth of circumferential resection margin in rectal cancer: a matched comparison of the first 20 robotic cases. Colorectal Dis. 2014; 16: 603-609.

44. Kang J, Yoon KJ, Min BS, Hur H, Baik SH, Kim NK, et al. The impact of robotic surgery for mid and low rectal cancer: a case-matched analysis of a 3-arm comparison--open, laparoscopic, and robotic surgery. Ann Surg. 2013; 257: 95-101.

45. Chang PL, Fan HA. Urodynamic studies before and/or after abdominoperineal resection of the rectum for carcinoma. J Urol. 1983; 130: 948-951.

46. Santangelo ML, Romano G, Sassaroli C. Sexual function after resection for rectal cancer. Am J Surg. 1987; 154: 502-504.

47. Kinn AC, Ohman U. Bladder and sexual function after surgery for rectal cancer. Dis Colon Rectum. 1986; 29: 43-48.

48. Fazio VW, Fletcher J, Montague D. Prospective study of the effect of resection of the rectum on male sexual function. World J Surg. 1980; 4: 149-152.

49. Havenga K, DeRuiter MC, Enker WE, Welvaart K. Anatomical basis of autonomic nerve-preserving total mesorectal excision for rectal cancer. Br J Surg. 1996; 83: 384-388.

50. Kim NK, Aahn TW, Park JK, Lee KY, Lee WH, Sohn SK, et al. Assessment of sexual and voiding function after total mesorectal excision with pelvic autonomic nerve preservation in males with rectal cancer. Dis Colon Rectum. 2002; 45: 1178-1185.

51. Erguner I, Aytac E, Boler DE, Atalar B, Baca B, Karahasanoglu T. What have we gained by performing robotic rectal resection? Evaluation of 64 consecutive patients who underwent laparoscopic or robotic low anterior resection for rectal adenocarcinoma. Surg Laparosc Endosc Percutan Tech. 2013; 23: 316-319.

52. Kim JY, Kim NK, Lee KY,Hur H, Min BS, Kim JH. A comparative study of

voiding and sexual function after total mesorectal excision with autonomic nerve preservation for rectal cancer: Laparoscopic versus Robotic Surgery. Ann Surg Oncol. 2012; 19: 2485-2493.

53. Guillou PJ, Quirke P, Thorpe H, Walker J, Jayne DG, Smith AM, et al. Short-term endpoints of conventional versus laparoscopic-assisted surgery in patients with colorectal cancer (MRC CLASICC trial): multicentre, randomized controlled trial. Lancet. 2005; 365: 1718-1726.

54. Jayne DG, Brown JM, Thorpe H, Walker J, Quirke P, Guillou PJ. Bladder and sexual function following resection for rectal cancer in a randomized clinical trial of laparoscopic versus open technique. Br J Surg. 2005; 92: 1124-1132.

55. Delaney CP, Lynch AC, Senagore AJ, Fazio VW. Comparison of robotically performed and traditional laparoscopic colorectal surgery. Dis Colon Rectum. 2003; 46: 1633-1639.

56. Rawlings AL, Woodland JH, Vegunta RK, Crawford DL. Robotic versus laparoscopic colectomy. Surg Endosc. 2007; 21: 1701-1708.

57. deSouza AL, Prasad LM, Park JJ, Marecik SJ, Blumetti J, Abcarian H, et al. Robotic assistance in right hemicolectomy: is there a role? Dis Colon Rectum. 2010; 53: 1000-1006.

58. Collinson FJ, Jayne DG, Pigazzi A, Tsang C, Barrie JM, Edlin R, et al. An international, multicentre, prospective, randomised, controlled, unblinded, parallel-group trial of robotic-assisted versus standard laparoscopic surgery for the curative treatment of rectal cancer. Int J Colorectal Dis. 2012; 27: 233-241.

Austin J Cancer Clin Res - Volume 1 Issue 4 - 2014
ISSN : 2381-909X | www.austinpublishinggroup.org

Citation: Taggarshe D, Attuwaybi BO and Butler BN. Robotic Surgery in Colorectal Cancer. Austin J Cancer Clin Res 2014;1(4): 1018.