

Robotic surgery vs conventional laparoscopy for the treatment of rectal cancer: Review of the literature

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of instruments with fixed tips, assistant-dependant two-dimensional view, easy camera fogging, and poor ergonomics. The introduction of robotic surgery and its application in particular to pelvic surgery, has potentially resolved many of these issues. To define the role of robotic surgery in total mesorectal excision for rectal cancer, a review of the current literature was performed using PubMed, Embase, Cochrane Library, and Google databases, identifying clinical trials comparing short-term outcomes of conventional laparoscopic total mesorectal excision with the robotic approach. Robotic surgery for rectal cancer is a safe alternative to conventional laparoscopy. However, randomised trials are needed to clearly establish its role.

Key words: Rectal cancer; Total mesorectal excision; Laparoscopic surgery; Robotic surgery

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Core tip: Robotic surgery for rectal cancer is a promising approach since it allows a better view of the pelvic cavity and enhanced freedom of instrument movements when compared to conventional laparoscopy. This would potentially translate into a better oncological dissection, and reduced risk of injury to neurovascular structures. This review of the literature shows that no definite conclusion of the potential benefits of robotic surgery can be drawn, and that larger prospective studies with long-term follow up are needed to establish the role of the procedure.

Abstract

Laparoscopic surgery has established itself as a safe and effective alternative to open surgery for the treatment of colorectal cancer. However, laparoscopic resection of rectal cancer, and in particular of the lower rectum, remains challenging in view of the limitations of operating in the confined pelvic space, limited movement

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INTRODUCTION

Laparoscopic colorectal surgery has been shown to be a safe and effective approach offering similar outcomes to open surgery. Advantages of laparoscopy in terms of pain reduction, lower incidence of postoperative ileus, shorter hospital stay and early return to unrestricted activities, have promoted the widespread use of this technique^[1-3]. Fast track and enhanced recovery programs have greatly been facilitated by the introduction of laparoscopy that has been shown to reduce peri-operative stress response^[4]. Laparoscopic surgery for colonic cancer has been well accepted and is currently widely practised, however, the application of the technique to rectal cancer, in particular of the lower rectum necessitating a total mesorectal excision (TME), has been limited^[5]. In fact, laparoscopic surgery in the narrow pelvic space is challenging and requires a steep learning curve. Limitations include poor ergonomics, easy crowding and clashing of instruments, tremor, fogging of camera, assistant-dependent 2-dimensional view, and difficulty in performing high precision suturing^[5-7]. The recent introduction of robotic surgery could overcome the limitations of conventional laparoscopy in technically demanding rectal procedures. In fact, it offers a 3-dimensional 10-fold magnification, articulating instruments, comfortable and ergonomic operating position, and other features including motion scaling and possibility of remote tele-surgical applications^[8-10]. The similarity of robotic surgery to the open approach could significantly shorten the learning curve for minimally invasive TME, leading to a widespread use of this technique^[11]. However, limiting factors of the robotic system include: lack of tactile and tensile sensation, cumbersome and time-consuming docking of the robotic cart, and possible delay to open conversion should serious intra-operative complications occur. Also, the high cost of the device and its maintenance have prevented many units to adopt the procedure^[12,13].

The aim of this study was to analyse the current literature to evaluate whether robotic total mesorectal excision offers better short-term outcomes when compared with conventional laparoscopic surgery.

LITERATURE RESEARCH

An extensive search was conducted through electronic databases (PubMed, Embase, Cochrane Library, Science Direct, Google Scholar) by using the key words "rectal surgery," "rectal cancer", "laparoscopic", "robotic". The reference lists provided by the identified articles were additionally hand-searched for studies missed by the search strategy, and this method of cross-referencing was continued until no further relevant publications were identified. Only articles in the English language were selected. All studies comparing outcomes of robotic and laparoscopic resection for extra-peritoneal and intra-peritoneal rectal cancer were selected and

included in the review process. One three-arm study (open, laparoscopic and robotic) was also selected, but studies including hand-assisted with no data separation from the purely laparoscopic cases were excluded. Studies on colonic cancer including recto-sigmoid and benign disease were excluded. Of similar studies pertaining to the same institution only the largest series was considered, unless a different design methodology was used.

The primary outcome measured was whether robotic rectal cancer surgery provides improved postoperative outcomes in comparison with the standard laparoscopic approach. Selected peri-operative variables included mean operating time, conversion to open procedure, complication rate, anastomotic leakage, and length of stay. Pathological variables included distal resection margin (DRM), number of lymph nodes harvested, and circumferential resection margin (CRM). Urinary dysfunction and erectile dysfunction (ED) data were also included.

RESULTS

Ten studies met predefined inclusion criteria^[14-23]. These were all retrospective comparative studies including a case-control study^[19]. Operative data showed conversion rate was significantly higher in the laparoscopic group (LG) than the robotic group (RG) in three of the studies. Robotic surgery had longer operative time in five studies (Table 1). There was no difference in complication rate including anastomotic leakage in the two groups. As regards length of stay, this was longer in the LG in three studies. In one study length of stay was longer in the RG (Table 2). No significant differences were noted between the RG and LG as regards distal resection margins and only one study showed a higher number of lymph nodes harvested in the RG. One study showed CRM positivity to be significantly higher in the laparoscopic group (Table 3). No significant difference in urinary dysfunction was reported. In one study erectile dysfunction in sexually active patients was significantly higher in the LG (Table 4).

DISCUSSION

Robotic TME has mainly been introduced in centers with a high volume of rectal cancer surgery and expertise in minimally invasive procedures^[5]. The reports in the literature relate to small, non randomised, single centre experiences with consequent inability to draw definitive conclusions. An important feature of robotic surgery is the improved exposure and visualization of the surgical field, allowing for a precise dissection in the narrow pelvic cavity. Also, the free range of instrument movements, the aid offered by the fourth arm, may contribute to a less challenging dissection than laparoscopy with consequent reduction in intra-operative complications and conversion rate^[21]. In our

Table 1 Intraoperative data

Ref.	Technique (n)		Conversion (%)			Operative time (min, mean)		
	RG	LG	RG	LG	P value	RG	LG	P value
Baek <i>et al</i> ^[14]	41	41	7.3	22	NS	296	315	NS
Baik <i>et al</i> ^[15]	56	57	0	10.5	0.013	178	179	NS
Patriti <i>et al</i> ^[16]	29	37	0	19	< 0.05	202	208	NS
Bianchi <i>et al</i> ^[17]	25	25	0	4	NS	240	237	NS
Park <i>et al</i> ^[18]	41	82	0	0	NS	231.9	168.6	< 0.001
Kwak <i>et al</i> ^[19]	59	59	0	3.4	NS	270	228	< 0.0001
Baek <i>et al</i> ^[20]	154	150	NA	NA	NA	285.2	219.7	0.018
D'Annibale <i>et al</i> ^[21]	50	50	0	6	0.011	270	275	NS
Kang <i>et al</i> ^[22]	165	165	0.6	1.8	NS	309	277	< 0.001
Tam <i>et al</i> ^[23]	21	21	5	0	NS	260	240	0.04

NS: Non significant; NA: Not available; RG: Robotic group; LG: Laparoscopic group.

Table 2 Postoperative outcomes

Ref.	Complications (%)			AL (%)			LOS (d, mean)		
	RG	LG	P value	RG	LG	P value	RG	LG	P value
Baek <i>et al</i> ^[14]	21.9	26.8	NS	8.6	2.9	NS	6.5	6.6	NS
Baik <i>et al</i> ^[15]	10.7	19.3	NS	1.7	7.6	NA	5.7	7.6	0.001
Patriti <i>et al</i> ^[16]	30.6	18.9	NS	6.8	2.7	NS	11.9	9.6	NS
Bianchi <i>et al</i> ^[17]	16	24	NS	1.8	8	NS	6.5	6.4	NS
Park <i>et al</i> ^[18]	29.3	23.2	NS	9.7	7.3	NS	9.9	9.4	NS
Kwak <i>et al</i> ^[19]	32.1	27.1	NS	13.6	10.2	NS	NA	NA	NA
Baek <i>et al</i> ^[20]	32.4	27.3	NS	11	12	NS	11.1	10.8	NS
D'Annibale <i>et al</i> ^[21]	5	11	NS	10	14	NS	8	10	0.03
Kang <i>et al</i> ^[22]	20.6	27.9	NS	7.3	10.8	NS	10.8	13.5	0.003
Tam <i>et al</i> ^[23]	43	33	NS	0	14	NS	6	5	0.05

AL: Anastomotic leakage; LOS: Length of stay; NS: Non significant; NA: Not available; RG: Robotic group; LG: Laparoscopic group.

Table 3 Postoperative outcomes

Ref.	DRM (cm)			LN (n)			CRM (%)		
	RG	LG	P value	RG	LG	P value	RG	LG	P value
Baek <i>et al</i> ^[14]	3.6	3.8	NS	13.1	16.2	NS	2.4	4.9	NS
Baik <i>et al</i> ^[15]	4	3.6	NS	17.5	17	NS	4	5	NS
Patriti <i>et al</i> ^[16]	2.1	4.5	NS	10.3	11.2	NS	0	0	NS
Bianchi <i>et al</i> ^[17]	2	2	NS	18	17	NS	0	4	NS
Park <i>et al</i> ^[18]	2.1	2.3	NS	14.2	17.3	NS	3.9	5.6	NS
Kwak <i>et al</i> ^[19]	2.2	2	NS	20	21	NS	1.7	0	NS
Baek <i>et al</i> ^[20]	NA	NA	NA	NA	NA	NA	NA	NA	NA
D'Annibale <i>et al</i> ^[21]	3	3	NS	13.1	16.2	NS	0	12	0.011
Kang <i>et al</i> ^[22]	1.9	2	NS	16.5	13.8	NS	4.2	6.7	NS
Tam <i>et al</i> ^[23]	3.9	5.5	NS	17	15	0.03	0	5	NS

DRM: Distal resection margin; LN: Lymph nodes harvested; CRM: Circumferential resection margin; NS: Non significant; NA: Not available; RG: Robotic group; LG: Laparoscopic group.

review, conversion rates were significantly lower in the RG in 3 studies. The common reasons for conversion included pelvic wall bleeding, restricted movement in very narrow pelvic cavity, and perforation of the rectal wall^[15,16,21].

Significant longer operative times in the RG were reported in 5 studies^[18-20,22,23]. This was mainly attributed to the time required to set up the robotic system and need for re-docking when starting the pelvic part of the procedure. However, adoption of particular trocar positions and technique modification may reduce total

operating time^[21,24]. An appealing feature of robotic surgery is the relatively short learning curve. Reports have shown that only 12 robotic operations are needed to become proficient in the technique, and achieve similar outcomes to those of a laparoscopic surgeon after one hundred procedures^[25]. Also, proficiency in robotic rectal cancer surgery can be achieved after 25 cases^[26].

Postoperative complication rates including anastomotic leakage were not statistically significant in the two groups. In one study there were fewer serious

Table 4 Postoperative outcomes

Ref.	ED (%)			UD (%)		
	RG	LG	P value	RG	LG	P value
Baek <i>et al</i> ^[14]	NA	NA	NA	NA	NA	NA
Baik <i>et al</i> ^[15]	NA	NA	NA	NA	NA	NA
Patrioti <i>et al</i> ^[16]	5.5	16.6	NS	3.4	2.7	NS
Bianchi <i>et al</i> ^[17]	NA	NA	NA	NA	NA	NA
Park <i>et al</i> ^[18]	NA	NA	NA	0	2.4	NS
Kwak <i>et al</i> ^[19]	NA	NA	NA	NA	NA	NA
Baek <i>et al</i> ^[20]	NA	NA	NA	NA	NA	NA
D'Annibale <i>et al</i> ^[21]	5.5	56.5	0.045	3.5	4.2	NS
Kang <i>et al</i> ^[22]	NA	NA	NA	2.4	4.2	NS
Tam <i>et al</i> ^[23]	NA	NA	NA	NA	NA	NA

ED: Erectile dysfunction; UD: Urinary dysfunction; NS: Non significant; NA: Not available; RG: Robotic group; LG: Laparoscopic group.

complications in the RG, however, the overall complication rate that included back pain and scrotal swelling, was not statistically different^[15]. Another study revealed no significant differences, though the RG had numerically fewer complications^[17]. As regards length of stay, this was longer in the LG in three studies^[15,21,22]. The shorter hospital stay may have been the result of a lower complication rate in robotic TME and quicker time to oral diet compared to laparoscopic TME^[21]. In one study the length of stay in the RG was longer. However, this was explained by the higher number of abdomino-perineal resection and procto-colectomy in the robotic group.

There are two key points in rectal surgery: oncological adequacy of the specimen and nerve-sparing technique. Total mesorectal excision was developed to allow a complete excision of the lymph node containing mesorectum, thus reducing local recurrence, improve overall survival, and providing good quality of life^[27]. The quality of the specimen is considered a parameter for the evaluation of prognosis^[28]. In our review, one study showed that the CRM involvement was significantly higher in the LG^[21]. Another study showed no significant differences in the CRM and DRM between the RG and LG, but the rectal cancer was closer to the anal verge in the RG. This finding together with a better macroscopic grading of quality of dissection in RG group, may support the potential benefit of robotic surgery to allow for optimal oncological resection of the lower rectum^[15].

Another important potential advantage of robotic surgery is the better visualisation, identification and protection of the autonomic innervation, thus minimising the risk of sexual and bladder dysfunction. The 3-dimensional image of the robotic system, the optimal counter traction of the robotic arm, and possibility of precise dissection in the virtually created wider operating space, are pivotal features of particular benefit in obese and male patients with narrow pelvis. Unfortunately, only few studies report data pertaining urinary and erectile dysfunction. In our review, there were no significant differences in urinary dysfunction in the two groups. One study showed worsening of the

International Prostate Symptom Score (IPSS) 1 mo after surgery in both groups, and a normalisation 1 year after surgery^[21]. A recent report in the literature showed that bladder function improved significantly over the first 6 mo after laparoscopic TME and 3 mo after robotic TME, with better outcomes in the RG in the IPSS score^[29].

As regards ED, only 2 studies reported comparative outcomes^[16,21]. In one study erectile function was impaired in 5% of sexually active patients in the RG compared to 57% in the LG 1 year after surgery. This was mainly attributed to the easier preservation of autonomic nerves in the RG with the added advantage of better control of energy delivery and consequent avoidance of inadvertent nerve cauterization^[21].

CONCLUSION

Robotic surgery for rectal cancer is a safe and effective alternative to conventional laparoscopic surgery. Potential benefits including shorter learning curve, better vision in the narrow surgical space facilitating better dissection with preservation of neuro-vascular structure, may well outweigh the high capital and running costs. However, only prospective clinical trials with larger number of patients and long-term follow-up can definitely answer the question of whether the advanced technology of the robotic system clearly offers advantages in terms of surgical and oncological outcomes.

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