Total Mesorectal Excision: Open, Laparoscopic or Robotic

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Abstract

Goals Total mesorectal excision (TME) is the gold standard technique for the surgical treatment of rectal cancer. Despite the benefits of minimally invasive surgery, laparoscopic TME (LTME) is a technically challenging procedure with a long learning curve. Robotic TME (RTME) has been advocated as an alternative to conventional LTME, but large studies supporting the efficacy or RTME are scarce. This work will review the current literature on minimally invasive surgery for rectal cancer and discuss future directions in the field. *Methods* A review of recent large single and multicenter studies on minimally invasive surgery for rectal cancer was conducted. *Results* Based on two large randomized clinical studies (CLASICC (Green et al. 2013) and COLOR II (van der Pas et al. 2013)). LTME is safe and feasible for the treatment of rectal cancer. Compared to open surgery, LTME has been shown to result in superior postoperative outcomes and similar oncologic results. However, the conversion rate of LTME is around 17 %. The literature supporting RTME is more limited. Robotic rectal resection appears to have similar postoperative and oncologic outcomes compared to LTME. RTME results in higher costs and possibly lower conversion rates. A large randomized clinical trial (ROLARR) comparing robotic to laparoscopic surgery for rectal cancer is underway. *Conclusions* Despite the technical challenges, current data supports the use of minimally invasive technique for rectal cancer surgery with superior short-term outcomes

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compared to an open approach. The use of robotic surgery is promising, but still limited and awaiting the conclusion of randomized clinical trials.

Keywords
Total mesorectal excision · Laparoscopic TME · Minimally invasive rectal surgery · Robotic TME · Robotic rectal surgery

1 Introduction

Since its introduction by Heald (1979), total mesorectal excision (TME) has been found to reduce local recurrence rates and improve oncologic outcomes (Stewart and Dietz 2007). A sharp, meticulous, en bloc resection of the cancer and surrounding perirectal lymphatic tissue along fascial planes produced superior control of local recurrence compared with nonstandardized surgery (Stewart and Dietz 2007). TME soon emerged as the gold standard technique for the surgical treatment of rectal cancer. Advances in minimally invasive surgery have resulted in the development of laparoscopic as well as robotic TME (RTME). Laparoscopic techniques offer advantages, such as decreased length of hospital stay, reduced postoperative pain, and improved cosmesis (D'Annibale et al. 2013; Jayne et al. 2007; Colon Cancer Laparoscopic or Open Resection Study Groupet al. 2009; Fleshman et al. 2007). However, minimally invasive rectal surgery is technically challenging with a steep learning curve. The pelvis is limited in space and width, making retraction and rectal dissection difficult, especially with laparoscopic instrumentation. Furthermore, concerns have been raised regarding the oncologic outcomes associated with this approach. The advent of a robotic platform has added even more alternatives to the minimally invasive rectal surgery armamentarium. This chapter will review the current literature on minimally invasive surgery for rectal cancer as well as discuss future directions in the field.

2 Open TME

The primary goal of surgical resection in rectal cancer is complete removal of the primary tumor as well as radially spread cancer cells in the mesorectum (van der Pas et al. 2013). The most important variables influencing local recurrence are the presence of involved lymph nodes, lymphovascular invasion, and circumferential resection margin positivity (Stewart and Dietz 2007; Chapuis et al. 2002; Bissett and Hill 2000). While different methods of rectal mobilization have been described, all share the common principle of removing the rectum with its perirectal fat and mesorectal fascia intact (Enker et al. 1995; Heald et al. 1998; Tiret and Pocard 1999; Killingback et al. 2001). The retrorectal plane is key to correct surgical

technique during posterior mobilization of the rectum, as is the retroprostatic or retrovaginal planes for the anterior dissection. Although this dissection historically was done using a blunt or manual technique (Goligher 1960), sharp dissection is now considered the standard operative approach (Beck and Steven 1998). When TME is performed with the proper surgical techniques, local recurrence rates have been reported in the range of less than 10 % (Enker et al. 1995; Aitken 1996). The impact of this proper surgical technique compared to nonstandardized methods has been well described in the literature. Kapiteijn et al. (2002) showed that local recurrence was improved with the adoption of TME techniques and that TME, when compared to conventional rectal resection, was an independent predictor of overall survival.

One of the first large studies published on TME was by Heald and colleagues, who reviewed their experience with 519 patients at North Hampshire Hospital in Basingstoke, England from 1978 to 1997 (Heald et al. 1998). Local recurrence rates were 6 % at 5 years and 8 % at 10 years. The clinically apparent anastomotic leak rate for patients undergoing anterior resection with curative intent was 6.5 %. Law et al. later published another large study on the outcomes of 622 patients with rectal cancer who underwent anterior resection at Queen Mary Hospital in Hong Kong from 1993 to 2002 (Law and Chu 2004). Patients with mid or low rectal cancers were treated with TME (64 %), while rectosigmoid and upper rectal cancers were treated with a partial mesorectal excision (PME, 36 %). The anastomotic leak rate for patients undergoing TME was reported as 8.1 %. On multivariate analysis, TME, male gender, absence of a stoma, and blood loss >500 mL were reported as independent risk factors for anastomotic leak. Local and distant recurrent rates were reported together, and were 6.0 % at 2-year and 9.7 % at 5-year. Due to longer operative times, higher anastomotic leak rates, technically challenging surgery and higher incidence of stoma formation, Law and colleagues concluded that TME should be used selectively, but does produce a good oncologic outcome.

This dramatic improvement in local control due to TME sparked debate as to whether neoadjuvant or adjuvant therapy was still significantly beneficial. As a result, two prospective randomized trials were undertaken to investigate the efficacy of radiation and chemotherapy in combination with TME for the treatment of rectal cancer. The Dutch Colorectal Cancer Group studied 1,861 patients, 924 who underwent preoperative radiotherapy followed by TME and 937 who underwent surgery alone (Kapiteijn et al. 2001). Local recurrence rate was 2.4 % in the radiation group and 8.2 % in the surgery alone group. However, overall survival at 2 years was not significantly different, with a rate of 82 % in the radiation group and 81.8 % in the group treated with surgery alone. The German trial CAO/ARO/AIO-94 examined the efficacy of neoadjuvant chemoradiation versus postoperative radiation in patients undergoing TME for locally advanced (T3/T4) disease (Sauer et al. 2001, 2003). A total of 805 patients were enrolled, with 355 in the neoadjuvant group and 363 in the adjuvant group. Patients in the neoadjuvant group had significantly lower rates of local recurrence, 6 % compared to 13 % local recurrence in the adjuvant group at 5 years. There was no difference in postoperative

morbidity or mortality between treatment groups. Neoadjuvant chemoradiation has subsequently become the standard of care, largely due to the results of this trial.

3 Laparoscopic TME

The widespread adoption of TME in the 1990s to early 2000s was congruent with the implementation of laparoscopy in colorectal operations. Laparoscopic colectomy in the setting of colon cancer was first examined and proved to be safe with less postoperative pain, earlier recovery, and comparable oncologic outcomes with traditional open resection (Colon Cancer Laparoscopic or Open Resection Study Group et al. 2009; Veldkamp et al. 2005; Leung et al. 2004). Although several reports were published demonstrating the safety and feasibility of LTME (Zhou et al. 2004; Scheidbach et al. 2002; Pasupathy et al. 2001), there was limited data regarding long-term impact on oncologic outcomes. These results were summarized in the Cochrane review of laparoscopic versus open TME for rectal cancer in 2006 (Breukink et al. 2006). A total of 48 studies met inclusion criteria, but 28 were case series and only one randomized controlled trial described primary outcome, 3- and 5-year survival rates (Leung et al. 2004). Since this time, additional randomized controlled trials have been performed specifically comparing laparoscopic versus open TME. In 2008, Anderson and colleagues reported a meta-analysis on oncologic outcomes of laparoscopic surgery for rectal cancer (Anderson et al. 2008). Their meta-analysis included 24 publications and examined 1,403 laparoscopic and 1,755 open rectal resections. Overall survival at 3 years was similar between treatment groups (76 % in laparoscopic and 69 % in open cases), as was mean local recurrence rates (7 % for laparoscopic and 8 % for open procedures). Another more recent meta-analysis by Qu et al. analyzed eight randomized controlled trials reported in the Chinese and English literature (Qu et al. 2013). The meta-analysis reviewed 863 patients with middle and low rectal cancers, 438 who underwent LTME and 435 cases of open TME. LTME was associated with significantly less intraoperative blood loss, earlier return of bowel function, shorter hospital length of stay, lower wound infection and lower postoperative bleeding rates compared to open TME. There were no significant differences noted in operative time, number of resected lymph nodes, anastomotic leak, ileus, or abscess formation.

Two large randomized clinical studies have recently been published assessing outcomes of laparoscopic compared to open rectal resection. The COLOR II trial included 30 medical centers across eight countries. A total of 1,044 patients with rectal cancer within 15 cm from the anal verge and no evidence of distant metastases were randomized, 739 in the laparoscopic, and 364 in the open surgery group. The laparoscopic arm was found to have less blood loss, faster return of bowel function, and shorter length of hospital stay, with longer operative time compared to the open arm. The conversion rate was approximately 17 %. There was no difference in oncologic resection margin between groups; the rate of

positive margins (defined as <2 mm) was 10 % in both cohorts. There were no differences in morbidity and mortality.

The UK Medical Research Council recently published their long-term follow-up of the CLASICC trial, which examined outcomes after conventional versus laparoscopic resection in colorectal cancer (Green et al. 2013). A total of 794 patients with colon and rectal cancer at 27 UK medical centers were randomized to laparoscopically assisted or open surgery from 1995 to 2002. For patients with rectal cancer, no statistically significant differences were found between open and laparoscopic groups in median overall survival (65.8 months open vs. 82.7 months laparoscopic, respectively, $p = 0.147$) or median disease-free survival (67.1 months open vs. 70.8 months laparoscopic, respectively, $p = 0.925$). Overall local recurrence was 10.9 % at 10 years and there was no significant difference found between randomized groups.

These studies confirm that minimally invasive rectal surgery is oncologically safe and a suitable alternative to open operations. In-hospital recovery after laparoscopic surgery has been shown to be better than after open surgery. Therefore, in selected patients treated by surgeons skilled in minimally invasive surgery, laparoscopic resection of rectal cancer should be considered (van der Pas et al. 2013). Debate persists on the impact of conversion from laparoscopic to open, as the CLASICC trial previously reported worse outcomes associated with conversion (Green et al. 2013; Jayne et al. 2007). However, in the most recent analysis, reduced disease free survival was only noted in converted patients with colon cancer. Intraoperative conversion did not appear to affect overall survival or disease free survival in patients with rectal cancer. Furthermore, conversion rates appear reduced in nonrandomized studies, ranging from 4.3 % (Yu et al. 2009) to 12 % (Morino et al. 2003).

4 Robotic TME

Robotic rectal resection appears to have similar postoperative and oncologic outcomes compared to LTME; however, the literature supporting RTME is more limited. Several studies have examined the short-term and long-term outcomes of robotic rectal resection (D'Annibale et al. 2013; Baik et al. 2009; Baek et al. 2013a; Biffi et al. 2011; Du et al. 2013; Luca et al. 2013). For a completely robotically performed TME mean operative times ranged from 220 to 270 min and length of stay was reported as 7–8 days. Mean length of stay following hybrid robotic-assisted laparoscopic rectal surgery is slightly lower at 6 days, with a range of 3–9 days. One of the main perceived advantages of robotic-assisted rectal resection is the lower conversion rate to open surgery. This finding was reported in a meta-analysis by Trastulli et al. (2012) who identified eight nonrandomized studies with a total of 854 patients comparing robotic and laparoscopic resection for rectal cancer. The robotic group was found to have a lower conversion rate and no significant differences in operative time, length of hospital stay, postoperative morbidity, postoperative mortality, or oncologic outcomes. A meta-analysis by

Memon et al. (2012) found similar results. However, as large randomized controlled trials are lacking, these lower conversion rates may be due to patient selection or surgeon bias. The majority of the published studies to date are retrospective or prospective nonrandomized trials. A systematic review of the literature published February 2014 by Kim and colleagues found 13 studies examining various types of robotic-assisted rectal resection such as anterior resection, low anterior resection, intersphincteric resection, or abdominoperineal resection (Kim et al. 2014); however, the majority of these publications were comparative studies. Although short-term outcomes appear to be acceptable, oncologic and long-term outcomes of RTME remain unknown. Evidence suggests that robotics may allow for better preservation of urinary and sexual function (Luca et al. 2013); however, further studies are needed to definitely make this conclusion. Randomized clinical trials and long-term follow-up are also needed to evaluate the influence of RTME on recurrence and survival. The ROLARR trial, an international, randomized controlled trial comparing robotic-assisted to laparoscopic resection for rectal cancer is currently in progress. Results of this study should help assess the future impact of RTME.

Key arguments against robotics are longer operative times and higher costs compared to laparoscopic surgery (Baek et al. 2013b). Longer operative times are attributed to setup, docking time of the robot, and time for surgeon to adapt to the robotic system (Kim et al. 2014). Costs are elevated due to longer operative times, robotic instruments, and the initial capital cost of the robotic platform itself. As surgeons and operating room staff become more experienced with robotics, operative times will likely decrease. Modifications have also been made to previously describe robotic techniques as a way to shorten operative time (Pigazzi et al. 2006). Despite the drawback of higher costs, use of robotics is increasing, as shown by Halabi et al. (2013) in his review of the Nationwide Inpatient Sample database from 2009 to 2010. In this study, rectal cancer was the most common indication for robotic-assisted colorectal surgery and increased from 1,188 cases in 2009 to 2,380 cases in 2010. These numbers are expected to be significantly higher today.

5 Future Directions

Transanal TME is a new approach to performing minimally invasive surgery for rectal cancer. Surgical access from the abdomen to the mid and low rectum can be very technically challenging, even for surgeons skilled in laparoscopic techniques. Patients with very distal tumors are particularly good candidates for this minimally invasive approach (Atallah et al. 2013a). Literature published on the initial experience with transanal TME has reported excellent exposure, even in male patients with difficult body habitus and a narrow pelvis (Atallah et al. 2013b). Although this early evidence appears promising, further studies are needed to evaluate the oncological safety and surgical outcomes of this approach.

6 Conclusion

Despite the technical challenges, current data supports the use of minimally invasive techniques for rectal cancer surgery. A review of the literature shows superior short-term outcomes and equivalent oncologic outcomes with LTME compared to an open approach. The use of robotics in rectal surgery is promising but still limited. Further randomized clinical trials are necessary to fully understand the outcomes of RTME. The ROLARR trial is currently in progress to assess outcomes between laparoscopic and robotic surgery for rectal cancer.

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