JOURNAL OF SURGICAL RESEARCH 188 (2014) 404–414

Available online at www.sciencedirect.com

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journal homepage: www.JournalofSurgicalResearch.com

Robotic *versus* laparoscopic total mesorectal excision for rectal cancer: a meta-analysis

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ARTICLE INFO

Article history:
Received 12 November 2013
Received in revised form
5 January 2014
Accepted 16 January 2014
Available online 22 January 2014

Keywords:
Rectal cancer
Robotic
Laparoscopy
Total mesorectal excision
Meta-analysis

ABSTRACT

Background: Robotic surgery has been used successfully in many branches of surgery; but there is little evidence in the literature on its use in rectal cancer (RC). We conducted this meta-analysis that included randomized controlled trials and nonrandomized controlled trials of robotic total mesorectal excision (RTME) *versus* laparoscopic total mesorectal excision (LTME) to evaluate whether the safety and efficacy of RTME in patients with RC are equivalent to those of LTME.

Materials and methods: Pubmed, Embase, Cochrane Library, Ovid, and Web of Science databases were searched. Studies clearly documenting a comparison of RTME with LTME for RC were selected. Operative and recovery outcomes, early postoperative morbidity, and oncological parameters were evaluated.

Results: Eight studies were identified that included 1229 patients in total, 554 (45.08%) in the RTME and 675 (54.92%) in the LTME. Meta-analysis suggested that the conversion rate to open surgery in RTME was significantly lower than in LTME ($P = 0.0004$). There were no significant differences in operation time, estimated blood loss, recovery outcome, postoperative morbidity and mortality, length of hospital stay, and the oncological accuracy of resection and local recurrence between the two groups. The positive rate of circumferential resection margins ($P = 0.04$) and the incidence of erectile dysfunction ($P = 0.002$) were lower in RTME compared with LTME.

Conclusions: RTME for RC is safe and feasible, and the short- and medium-term oncological and functional outcomes are equivalent or preferable to LTME. It may be an alternative treatment for RC. More multicenter randomized controlled trials investigating the long-term oncological and functional outcomes are required to determine the advantages of RTME over LTME in RC.

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0022-4804/$ – see front matter

http://dx.doi.org/10.1016/j.jss.2014.01.027

1. Introduction

Since the introduction of laparoscopy, it has been widely accepted in colorectal surgery because it results in decreased postoperative pain, an improved cosmetic outcome, shorter length of hospitalization, and earlier returns to normal functioning [1–3]. However, laparoscopic rectal cancer (RC) surgery is a more technically demanding and has a steep learning curve (LC) than laparoscopic colon cancer surgery [4] because it is performed in the narrow pelvic cavity. Total mesorectal excision (TME) introduced by Heald *et al.* [5] has revolutionized the surgical management of RC. TME has gained worldwide acceptance as a standard surgical technique for RC because it can decrease the local recurrence rate of RC. Both retrospective series and prospective randomized trials and meta-analysis have indicated that TME can be safely performed laparoscopically [6–20]. In experienced hands, laparoscopic and open TME procedures appear to provide similar short- and long-term oncologic results. However, widespread use of laparoscopic TME (LTME) with a conventional approach is limited by technical drawbacks such as fixed instrument tips with only four degrees of freedom, limited dexterity of the instruments within the confines of the abdominal space, limited two-dimensional view, possible misalignment of hands and instruments and poor ergonomic position, an assistant-dependent unstable camera platform, and an assistant's traction, which are not under the surgeon's control [21], all of them contributing to a steep and long LC [22]. The emergence of the robotic surgical system can overcome these disadvantages, and to shorten the LC, provides several advantages [23], including superior three-dimensional vision, EndoWrist (Intuitive Surgical, the da Vinci Surgical System) instruments with seven degrees of freedom that truly mimic the movements made by a surgeon's hands, a lack of tremor, and far superior ergonomics compared with conventional laparoscopy.

Robotic surgery was naturally introduced to the field of general surgery. This modality gained particular traction in RC resection because its technological advantages can be maximized when operating in the narrow pelvis [21].

To date, there are some studies comparing the safety, feasibility, and efficacy of robotic TME (RTME) *versus* LTME in RC, but the numbers of cases are small, and most of the studies are nonrandomized controlled trials (NRCTs), so inconsistent and indefinite results may be drawn. To demonstrate an objective advantage for the RTME, we performed a meta-analysis to compare the clinical and functional outcomes of RTME and LTME.

2. Materials and methods

2.1. Study selection

The Pubmed, Embase, Cochrane Library, Ovid, and Web of Science databases were searched systematically for all articles published before June 2013 to compare RTME and LTME for RC. The following terms are used for the search: "robotic," "TME," and "RC," and we used both free text and Medical Subject Headings searches for keywords. We also manually searched the abstracts published at major international conferences. The "related articles" function was used to broaden the search, and all abstracts, studies, and citations were reviewed. A manual search of the bibliographies of relevant articles was also carried out to identify trials for possible inclusion. There was no language restriction, except that abstracts not written in English were excluded. Reference lists of all retrieved articles were manually searched for additional studies. The latest date for this search was June 24, 2013.

2.2. Data extraction

Two reviewers (B.X., L.M.) independently extracted the following parameters from each study: (1) first author and year of publication; (2) study population characteristics, study design (prospective, retrospective, or other); (3) inclusion and exclusion criteria; (4) quality of study; (5) number of subjects operated on with each technique; and (6) intraoperative data, postoperative data, pathologic details, and long-term outcomes. All relevant text, tables, and figures were reviewed for data extraction. Discrepancies between the two reviewers were resolved by discussion and consensus.

The study was performed in line with the recommendations of the proposal for reporting meta-analysis of observational studies in epidemiology, which was produced in Atlanta [24]. The quality of the randomized controlled trials (RCTs) was assessed by using the Cochrane reviewer's handbook [25]. The quality of the NRCTs was assessed by using the Newcastle-Ottawa Scale [26]. The quality of the NRCTs was evaluated by examining the following three items: patient selection, comparability of RTME and LTME groups, and exposure [23].

2.3. Inclusion criteria

For inclusion in the meta-analysis, a study had to fulfill the following criteria: (1) compare the outcomes of RTME and LTME for RC; (2) report on at least one of the outcome measures mentioned in the following; and (3) if dual (or multiple) studies were reported by the same institution and/or authors, either the one of higher qualities or the most recent publication was included in the analysis.

2.4. Exclusion criteria

Abstracts, letters, editorials and expert opinions, reviews without original data, case reports, and studies lacking control groups were excluded. The following studies or data were also excluded: (1) they reported on rectal surgery for benign lesions and did not contain a distinct group of patients with RC; (2) the outcomes and parameters of patients were not clearly reported; (3) it was impossible to extract the appropriate data from the published results; and (4) there was an overlap between authors or centers in the published literature.

2.5. Outcomes of interest

The following outcomes were used to compare the two operative techniques: (1) intraoperative data, which included