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Original research

Is robot-assisted laparoscopic right colectomy more effective than the conventional laparoscopic procedure? A meta-analysis of short-term outcomes

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HIGHLIGHTS

- The role of robotic assistance (RA) in right colectomy is still not demonstrated.
- RA decreases operative blood loss and time to 1st flatus, increasing surgery-related costs.
- RA does not condition leakage, retrieved lymphnodes, ileus and hospital stay.
- RA increases operative time and procedural costs, not enhancing oncological accuracy.

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ABSTRACT

Aim: The use of robotic technology procedures has proved to be safe and effective, arising as a helpful alternative to standard laparoscopic surgery in a variety of colorectal procedures. However, the role of robotic assistance in laparoscopic right colectomy is still not demonstrated.
Methods: A systematic review of the literature was carried out performing an unrestricted search in MEDLINE, EMBASE, the Cochrane Library and Google Scholar up to 30th August 2014. Reference lists of retrieved articles and review articles were manually searched for other relevant studies. We meta-analyzed the currently available data regarding the incidence of anastomotic leakage, operative time, intra-operative blood loss, conversion rate, retrieved lymphnodes, post-operative hemorrhage, intra-abdominal abscess, time to 1st flatus, post-operative ileus, wound infection, incisional hernia, not-surgical complications, total complications, hospital stay, post-operative mortality, surgery-related costs and total costs, in conventional laparoscopic right colectomy (LRC) compared to robot-assisted laparoscopic right colectomy (RRC).
Results: Overall 8 studies were included, thus resulting in 616 patients. The meta-analysis showed that the RRC decreases the intra-operative blood loss and the time to the 1st flatus, if compared to the LRC. On the other hand, the robotic assistance increases the operative time and the surgery-related costs. No statistically significant differences were found about the other post-operative outcomes.
Conclusion: RRC may ensure limited improvements in post-operative outcome, thus increasing procedural costs and without a proved enhanced oncological accuracy to date, if compared to the LRC.

1. Introduction

Laparoscopic colorectal surgery for cancer has gained popularity in the past decade, arising as the most widespread approach for both benign and malignant colorectal pathologies, thanks to its improved short-term results (as decreased post-operative pain,

Abbreviations: LRC, laparoscopic right colectomy; ORC, open right colectomy; RRC, robotic right colectomy; RCT, randomized clinical trial.

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shorter hospital stay) and comparable long-term oncologic outcomes to those of open surgery, and to the significant advancement in minimally invasive technologies [1–3].

The first laparoscopic right colectomy (LRC) was performed in 1990 [4] and a recent meta-analysis showed that, compared with the open right colectomy (ORC), it resulted in a shorter hospital stay, less intra-operative blood loss and less short-term overall morbidity, with a comparable oncological outcome in terms of radical resection of the tumor and subsequent local and distant recurrence rates [5].

The Food and Drug Administration approved the "Da Vinci" Robotic System (Intuitive Surgical Inc, Sunnyvale, CA, USA) for intra-abdominal surgery in 2000 in the U.S.A. and the first reported colon resection was performed in 2001 [6,7]. The use of robotic technology procedures has proved to be safe and effective, arising as a helpful alternative to standard laparoscopic surgery in a variety of colorectal procedures, specially when dealing with complex pathology [8,9]. The advantages of robotic surgical system are the increased freedom degrees of the devices, the three-dimensional viewing system, the tremor filtering and the motion scaling, which simplifies the performance of surgical procedures if compared to conventional laparoscopy [10,11]. However, some disadvantages of robot-assisted laparoscopic procedures must be considered, such as the loss of haptic feedback, the limited range of movement of the robotic arms, the increased operative time and the higher costs. Thus, the theoretical advantages and disadvantages of robotic surgical procedures might be carefully considered in order to justify the higher costs, in particular relatively straightforward procedure which can safely and effectively be performed using conventional laparoscopy, as LRC [12].

To date there are just a few publications comparing LRC with robotic right colectomy (RRC) available in literature. A systematic review of the literature and a meta-analysis of the studies comparing the short-term outcomes of LRC and RRC were carried out with the aim to demonstrate the role of robotic assistance in laparoscopic right colectomy.

2. Materials and methods

A systematic review and a meta-analysis about the short-term outcomes of LRC compared to RRC in patients undergoing elective colonic resection for benign and malignant diseases were performed.

A protocol was prospectively developed, detailing the specific objectives, criteria for study selection, approach to assess study quality, outcomes and statistical methods.

2.1. Study outcomes

The primary outcome of the study was to assess the incidence of anastomotic leakage in patients who underwent laparoscopic right colectomy with or without the use of robotic assistance.

The secondary outcomes were operative time, intra-operative blood loss, conversion rate, number of harvested lymphnodes, post-operative hemorrhage, intra-abdominal abscess, time to 1st flatus, post-operative ileus, wound infection, incisional hernia, not-surgical complications, total post-operative complications, hospital stay, post-operative mortality, surgery-related costs and total costs.

2.2. Search strategy and eligibility criteria

An unrestricted search was performed in MEDLINE, EMBASE, the Cochrane Library, and Google Scholar up to 30th August 2014. Research criteria included the terms "robotic", "robot-assisted", "laparoscopy", "laparoscopic", "colectomy", and "colonic resection". Furthermore, reference lists of retrieved articles and review articles were searched manually for other relevant studies.

Two authors (FR and FV) independently performed the searches and reviewed all identified publications and abstracts for inclusion by using predetermined criteria. In order to be included in this review, studies needed to be reported on patients including what follows: number of patients who underwent LRC and RRC and incidence of anastomotic leakage in the two subgroups of patients. Disagreements were resolved by consensus with a third investigator (RB) and by means of discussion.

2.3. Data extraction and quality assessment

Data from included studies were independently extracted by 2 authors (FV and WB) and were confirmed by both. The following individual data were extracted for each study by using standardized extraction forms: general data (study design, year), characteristics of patients (number, age, gender, indication to colonic surgery), main features of the interventions (surgical approach, type of the ileo-colic anastomosis), clinical outcome (anastomotic leakage, operative time, intra-operative blood loss, conversion rate, retrieved lymphnodes, post-operative hemorrhage, intra-abdominal abscess, time to 1st flatus, post-operative ileus, wound infection, incisional hernia, not-surgical complications, total complications, hospital stay, post-operative mortality, surgery-related costs and total costs).

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) checklist was used [13]. The quality of RCT was evaluated using the Cochrane Collaboration Handbook for systematic reviews of interventions ('Risk of bias' assessment tool) [14]. The quality of cohort studies was evaluated using the Newcastle–Ottawa quality assessment scale [15].

2.4. Selection of studies for meta-analysis

Data about patients with/without study outcomes and operated on with conventional/robot-assisted laparoscopy were required to be included in the meta analysis, thus allowing the creation of a 2×2 table.

2.5. Statistical analysis

We reported results according to fixed-effects model in absence of significant heterogeneity and to random-effects model in presence of significant heterogeneity. We used the random effects model because it accounts for variations between studies in addition to sampling error within studies. The appropriateness of pooling data across studies was assessed using the Cochran's χ-squared test and the I-squared test for heterogeneity, which measures the inconsistency across the study results and describes the proportion of total variation in study estimates that is due to heterogeneity rather than sampling error. Statistically significant heterogeneity was considered to be present in case $p < 0.10$ and I squared greater than 50% [16]. Pooled odds ratios were reported with 95% confidence intervals (CIs). Funnel plots were used to assess for publication bias [17]. We planned to perform separate analyses of studies according to the different outcomes.

Analyses were performed using Review Manager 5.2 (The Cochrane Collaboration, Oxford, England).

The authors had full access to and take full responsibility for the integrity of all the data. All authors have read and agreed to the manuscript as written.