ABSTRACT

Aim: The purpose of our systematic review is to clarify the current data in the domain of colorectal surgery regarding minimally invasive surgery (MIS).

Introduction: Two new methods have been recently introduced in the MIS arena. Most of the studies are in favor of robotic surgery (RS), whereas the literature lacks statistically significant results.

Results: Totally, only 19 articles fulfilled the prerequisites and our research was mainly based on meta-analyses. Some parameters were established, in order to investigate the oncologic and clinical outcomes. Heterogeneity is the existing condition, which means that robotics is more beneficial than laparoscopic surgery in some parameters in a specific procedure and the opposite.

Conclusion: There is no clear conclusion in the literature whether RS is indeed more advantageous than laparoscopic ones, so it is recommended that long-term meta-analyses and reviews be conducted, in order to specify the effectiveness of each method in every surgical procedure.

Clinical significance: It would be really beneficial for the patients to be informed in detail of the clinical and oncologic outcomes for each method.

Keywords: Colorectal malignancies, Comparison, Laparoscopic, Robotic, Surgery, Systematic review.

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INTRODUCTION

Two different main surgical methods are emerging in the field of minimally invasive surgery (MIS) over the past 20 years and they are being applied in colorectal domain. Laparoscopic surgery (LS) for colon cancer has a wide use due to its beneficial properties and has prevailed compared with open surgery. However, robotic surgery (RS) has been recently introduced as a new contemporary alternative because of its obvious advantages, including the three-dimensional view, the ability to use multidegree-of-freedom forceps, the elimination of physiological tremors, and the stable camera control, in order to broaden the horizons of MIS.

Initially, it was expected that RS would dominate the field of MIS related to colorectal surgery because of its obvious structural advantages and due to the limited space in the pelvis for the laparoscopic instruments and the restricted potential of movements even for an experienced surgeon to perform rectal dissection. However, it seems that there is no clear-cut answer in the literature determining the beneficial use of RS over LS in the field of colorectal cancer. In our review, we present the data regarding the use of both methods in the domain of colorectal surgery regarding all the surgical techniques. According to the New York Statewide Planning and Research Cooperative System administrative data, colectomy is one of the five most common laparoscopic procedures between 2008 and 2012, so a comparison between the laparoscopic and robotic colectomy is a matter of big significance and has to be clearly underscored. The first robotic colectomy was reported in 2002, and the use of robotic procedures has been increasing since then, while it has a more extensive use in the field of urology.

This is a retrospective comprehensive review of various publications comparing these two methods of surgical procedures separately and taking into consideration plenty of parameters, such as the clinical and the oncologic outcomes and how they can be affected, the body mass index (BMI), the total mean hospital costs for each procedure, and postoperative complications. Only studies that had classified their patients with similar criteria were taken into consideration (gender, BMI, American Society of Anesthesiologists [ASA] score, tumor location, previous abdominal surgery).

RESULTS

The review was built-up by downloading various articles regarding laparoscopic and robotic colectomy from
search engines like PubMed, MEDLINE, and so forth. “Laparoscopic vs robotic colectomy” and “comparing laparoscopic with robotic colectomy” were the search keywords that were used to find the publications that would conduct our research, and publications until March of 2016 were included. Our review contains retrospective studies, comparative studies, and meta-analyses. Only papers relevant to the laparoscopic and robotic colectomy have been taken into consideration in this review, focusing on the parameters mentioned above and also on the learning curve of young novice surgeons. Articles which compared the two methods with a separate specific surgical procedure, such as right colectomy are included, and reviewed and articles which do not classify the procedures separately are reviewed as well. Totally, 19 studies were reviewed.

At first, there were 56 articles related to our scientific interest identified after a long database search, but 10 of them were excluded after reading the abstract. Twenty-one of the remaining 46 records were excluded due to lack of full texts. Six more papers were excluded because they mentioned the comparison between hybrid robotic-assisted laparoscopy colectomy and conventional colectomy. The rest 19 papers were assessed for eligibility, screened in detail, and included in our review. Retrospective comparative studies and meta-analyses are the majority of the articles in our review. More importance is given to the findings of the meta-analyses due to their reliability. Heterogeneity can be found in the literature whether or not RS is indeed superior to LS in the colorectal field. Total operative time, estimated blood loss (EBL), conversion to open procedure, length of hospital stay (LOS), readmission rate, number of lymph nodes harvested, time to return of bowel function, time of initiation of soft diet, and perioperative complications are the main clinicopathologic and oncologic parameters that have been extensively assessed in our review (Flow Chart 1).

Ferrara et al mention that there are no differences between right, left, and rectal robotic colectomy and respective laparoscopic procedures in terms of mentioned parameters. In fact, RS shows larger number of harvested lymph nodes, while LS seems to have lower conversion rate (7.1% for robotics and 3.4% for laparoscopy) and operative time, but the results are not statistically significant.

**Comparison between RS and LS in the Field of Left Colon and/or Rectal Resections**

A matched case-control study indicates that there are no different short-term outcomes between the two methods regarding left-sided and rectal resections. The EBL, the need for open conversion, complications (anastomotic leakage, ileus, and wound infections), flatus passage, LOS, and the number of retrieved lymph nodes presented no significant difference, except for the operative time which was significantly longer in the RS colectomy. On the contrary, a recent meta-analysis conducted by Sun et al shows that robotic low anterior resection (R-LAR) for rectal cancer is proven to be more beneficial for LOS, the conversion to open surgery, the circumferential margin involvement, and the overall complications than the laparoscopic low anterior resection (L-LAR), whereas there was no difference regarding the operative time, the number of lymph nodes removed, and the return of bowel function.

**Comparison of RS with the LS in the Field of Right Colon Resections**

Because robotic right colectomy (RRC) and laparoscopic right colectomy (LRC) are less complicated as a surgical procedure than rectal resection due to the anatomy of the human body, there are fewer studies comparing these two methods with right colectomy. We included three meta-analyses in our research. Cumulatively, these three studies include 30 comparative studies, in which 1,322 patients underwent RRC and 4,185 were treated with LRC. The first one was recently conducted from the Surgery Department of Sapienza University and compared the indications, surgical and oncologic outcomes, and costs of RRC with the LRC ones. The EBL, the conversion to open procedure, the number of retrieved lymph nodes were similar in both of them. Unimportant statistical differences were presented regarding LOS and the overall complications. The RRC entails more expenses than LRC, although the difference is still not statistically important. On the contrary, the second meta-analysis which had the larger statistical sample was conducted by Trinh et al and yielded the following outcomes. No significant difference was spotted regarding the harvested lymph nodes, the bowel function, the

**Flow Chart 1: Literature research**

- Papers identified via database searching related to the parameters of LS and RS (n = 56)
- Remaining articles after reading the abstracts (n = 46)
- Remaining papers because of their availability of full text (n = 46)
- Remaining papers which compare the RS with the LS in the field of colectomy regarding the parameters mentioned above (n = 19)
days to soft diet, the LOS, the hospital readmission, and the postoperative complications. Based on this meta-analysis, the robotic approach showed longer operating times, less EBL, and a higher rate of conversion to an open procedure compared with that of LS. Xu et al considered in their meta-analysis which showed that RRC involves longer operative times, lower EBL, shorter LOS, lower overall complications, and, importantly, faster bowel function recovery. The rest clinical and oncological results seem to not have any statistical difference.

A newly comparative study by Cardinali et al indicates that RRC appears to have some advantages over the LRC like the lower time of first flatus, but it does not offer any benefit in obese patients due to the fact that both methods perform no significant difference in the conversion rate. Another comparative study points out that the RS could also shorten the learning curve, in case the respective strict protocols are applied.

**DISCUSSION**

In the field of colorectal cancer, LS and RS are both considered almost equally safe and effective methods, proving that radical prostatectomy was only the beginning of consolidation of RS and the use of RS can be more widespread. Our research focuses on the conventional laparoscopy and the RS as separate surgical methods and does not include their hybrid use. The confirmation of the existing heterogeneity between these two new surgical methods involves our reviewed parameters along with the clinicopathological, oncological, and financial ones. The accurate choice of these criteria was accomplished after a careful, long research via recent meta-analyses, control and statistically reliable comparative studies. Mainly, meta-analyses were reviewed due to their credibility compared with other studies, which are reviewed and included in our manuscript. More specifically, the criteria are presented in Table 1, but the research contains the rectal and left-sided colon resections as well.

Pelvis is the anatomical section of the human body where RS can be applied with its maximum benefits according to its adopters, but controversial studies’ results came up through our research. Studies which did not end up with this conclusion were reviewed, but the most statistically reliable meta-analysis, the one by Sun et al, clarifies the advantages of R-LAR over L-LAR for the LOS as mentioned earlier. Another randomized controlled study is in favor of the adoption of RS in rectal surgery, but tempers the encouraging conclusion from the former meta-analysis. The main reason why RS seems to be a more promising tool in the pelvis is because of the absence of the tremor, which implies less EBL and makes it easier to avoid the trauma to the nerves related to the sexual and urinary functions. Fabrizio Luca presented a paper in the 5th Congress of the Clinical Robotic Surgery Association (CRSHA) and mentioned that RS can enhance the nerve-sparing results of total mesorectal excision related to LS method regardless of the gender. However, during the paper’s discussion some doubts were posed about the preoperative reliability of the evaluation of these specific functions (urinary and sexual), so that they become more standardized in the future.

Undoubtedly, right colectomy is a less complicated procedure than rectal resection, but the use of both RS and LS has also been reviewed thoroughly. Two of the three recent meta-analyses concluded that there are some statistical differences between the RRC and the LRC in some of our parameters. Both studies agree that RRC is a longer procedure than LRC and that the EBL is less in the RRC. Huirong Xu et al deem that LOS, the overall complications, and the bowel function differ between the two methods in an important way, whereas the other respective meta-analysis’ results are considered controversial. The results of these three meta-analyses are summarized in Table 1 and the “YES” and “NO” are used as the answers to the question: “Is there a statistically significant result between the RRC and LRC regarding to a specific parameter each time?” while the choice “not available (NA)” is used for whether or not in this particular meta-analysis the mentioned appearing parameter is included.

In the CRSA Fifth Worldwide Congress in Washington DC from 3 to 5 October 2013, a controlled randomized trial ended up with the conclusion that RRC has no significant difference with the LRC and due to its expenses it should not be frequently used.

The intro of a learner in the MIS can be easier for the RRC than LRC in a specific center with rigorous protocols,

<table>
<thead>
<tr>
<th>Parameters</th>
<th>1st Meta-analysis</th>
<th>2nd Meta-analysis</th>
<th>3rd Meta-analysis</th>
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</thead>
<tbody>
<tr>
<td>Operative time</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>EBL</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Conversion to open procedure</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Number of retrieved lymph nodes</td>
<td>No</td>
<td>No</td>
<td>NA</td>
</tr>
<tr>
<td>LOS</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Overall complications</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Financial expenses</td>
<td>No</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Bowel function</td>
<td>NA</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Days of soft diet</td>
<td>NA</td>
<td>No</td>
<td>NA</td>
</tr>
<tr>
<td>Hospital readmission</td>
<td>NA</td>
<td>No</td>
<td>NA</td>
</tr>
<tr>
<td>Circumferential margin involvement</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
</tbody>
</table>

The meta-analyses are numbered according to their order in the text; NA: Not applicable.
which can be explained once more due to some of the structural advantages of the RS like the three-dimensional view, for instance.\textsuperscript{29} But, acceptable outcomes can be fulfilled with simultaneously practical exercise.\textsuperscript{29}

**CONCLUSION**

It is common even for meta-analyses reviewing the same parameters to present contradictory results in the literature. As a result, we conclude that the benefits from the RS in all the procedures related to colorectal cancer are currently under scientific investigation. Hopefully, the benefits will be more clearly defined in the near future. We suggest for more standardized controlled studies and meta-analyses to be performed in the future, as to evaluate the current data and the long-term outcomes of our parameters. The heterogeneity was more obvious in the right colectomy procedure than in the others, but all the results should be better stabilized.

**CLINICAL SIGNIFICANCE**

In fact, it is very crucial to establish whether the RS is more beneficial than the LS or the opposite. Patients with morbidity factors would have to be aware of the positive aspect of each method for every procedure.

**REFERENCES**


