Review Article



# Secrets for successful laparoscopic antireflux surgery: robotic surgery

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**Abstract:** Surgical technique for antireflux surgery has been benefited by technology, including robotics, to achieve improved outcomes. Robotic surgery does not call for a different preoperative workup or patient selection although there are arguments that robotic surgery should be left to complex cases and reoperative surgery not to routine cases. The evaluation of current published results shows that robotic fundoplication and hiatoplasty is safe and produces outcomes similar to laparoscopic surgery. Higher operative time and costs are frequently cited as drawbacks for robotic antireflux surgery although improved experience and technology may equalize these disadvantages. At present, robotic fundoplication and hiatoplasty is comparable to laparoscopic surgery.

**Keywords:** Gastroesophageal reflux disease (GERD); fundoplication; surgery; robotic

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## Introduction

A successful antireflux operation depends on a proper preoperative workup, patient selection, surgical technique and follow-up (1). All these topics have been covered-up in the papers of this especial issue. Technology has also been contributory to a successful antireflux operation from evaluation to follow-up. Surgical technique has been benefited by technology. Thus, laparoscopic access (2), new materials to reinforce the hiatus (3) and robotic arms (4) are available today.

Robotic surgery has the advantages of 3D imaging, tremor filter, and articulated instruments and it also compensates some limitations of the laparoscopic surgery such as restricted range of motion of the instruments, and poor ergonomic positioning of the surgeon (5). Although this brings clear recompenses for certain operations, it is still elusive if operations on the esophagus, and especially at the esophagogastric junction, have real gains with a robotic platform.

This review focuses on the current knowledge about antireflux robotic operations in order to evaluate if robotic arms may improve the success rate. Although different procedures to control reflux have been made via a robotic platform (4), fundoplication and hiatoplasty is the most common performed procedure and the subject of this review.

## Patient selection

Robotic surgery does not call for a different preoperative workup. Patient's selection based on clinical status, desire to be operated and gastroesophageal reflux disease (GERD) pattern does not differentiate robotic surgery from laparoscopic surgery; however, robotic operations may be more expensive, time consuming, less available and demand a higher degree of expertize (5). Thus, some argue that robotic surgery should be left to complex cases and reoperative surgery not to routine cases (4,6-9).

## Surgical technique

Surgical technique is not different from conventional

**Table 1** Comparative papers between laparoscopic versus robotic antireflux surgery as primary operation

| Author | Type of study | n | Operative time | Cost | Complications | Follow-up | Outcomes |
|---|---|---|---|---|---|---|---|
| Morino *et al*., 2005 (12) | Randomized trial | Laparoscopic: 25; robotic: 25 | Higher for robotic arm | Higher for robotic arm | Similar | 22 months | Similar |
| Nakadi *et al*., 2006 (13) | Randomized trial | Laparoscopic: 11; robotic: 9 | Higher for robotic arm | Higher for robotic arm | Similar | 3 months | More symptoms for robotic at 3 months |
| Draaisma *et al.*, 2006 (14) | Randomized trial | Laparoscopic: 25; robotic: 25 | Similar | N/E | Similar | 6 months | Similar including objective evaluation by manometry and pH monitoring |
| Müller-Stich *et al.*, 2007 (15) | Randomized trial | Laparoscopic: 20; robotic: 20 | Shorter for robotic arm | Higher for robotic arm | 2 minor bleedings for laparoscopy, 1 pneumothorax for robotic | Short-term | Similar |
| Heemskerk *et al.*, 2007 (7) | Case series | Laparoscopic: 11; robotic: 11 | Higher for robotic arm | Higher for robotic arm | No differences | N/E | Similar |
| Müller-Stich *et al.*, 2009 (6) | Randomized trial | Laparoscopic: 20; robotic: 20 | N/E | N/E | 1 reoperation due to dysphagia in the robotic arm | 12 months | Similar, including quality of life |
| Hartmann *et al*., 2009 (16) | Selection based on patient's preference | Laparoscopic:62; robotic: 18 | Shorter for robotic arm | N/E | Similar | 4 years | Similar, including quality of life |

N/E, not evaluated.

laparoscopic surgery with the patient in a French reversed Trendelenburg position. Five trocars are commonly used, again similarly to conventional laparoscopy, allowing the robotic arms to manipulate the camera and two working ports (surgeon's right and left hands) and two non-robotic ports for liver retraction and other commanded by the scrubbed assistant.

The same steps of hiatal and distal esophageal dissection, hiatal closure and a short-floppy fundoplication (10) apply to robotic surgery. Particularly for robotic surgery adequate trocar placement and robotic arms docking must be carefully observed to avoid instruments collision. Very interestingly, Tolboom *et al.* (8) found that surgeons were more prone to reinforce the hiatus with prosthetic mesh when operating via a robotic platform compared to laparoscopy.

Robotic surgery has the pro of easier handling of instruments on a reduced space and easier knotting but the field of vision is narrower and interaction with the team at the patient's side is more difficult (11). A more recent 4-arm platform reduces the tasks of the scrubbed assistant fixing this disadvantage.

## Learning curve

There are no papers dedicated to a learning curve analysis on robotic antireflux surgery. Few mentioned how experience changed results. A 61% reduction in operative time has been reported after five cases (4). When analyzed collectively, however, small series show a higher operative time compared to larger series and the operative time for the first cases from the beginning of experience either for laparoscopic or robotic surgery are similar (11).

## Outcomes

Robotic antireflux operations have been consistently reported to be safe. The number of complications is minimal and comparable to laparoscopic surgery (*Table 1*), even as reoperative surgery (*Table 2*). Procedure-related mortality is nihil in all series and in nationwide databases (17). Conversion rate is 0 in most series (4,6,15). Few series

 

**Table 2** Comparative papers between laparoscopic versus robotic antireflux surgery as secondary operation (reoperation)

| Author | Type of study | n | Operative time | Cost | Complications | Follow-up | Outcomes |
|---|---|---|---|---|---|---|---|
| Tolboom *et al.*, 2016 (8) | Case series | Laparoscopic: 30; robotic: 45 | Similar | N/E | Fewer conversions to open for robotic | Laparoscopic: 10 months; robotic: 3 months | Similar for symptoms. Laparoscopic: 13% recurrence; robotic: 9% recurrence |
| Ceccarelli *et al.*, 2009 (9) | Case series | Laparoscopic: 137; robotic: 45 | Shorter for robotic arm | N/E | Similar | Laparoscopic: 8 years; robotic: 4 years | Similar |

N/E, not evaluated.

that reported convertions to open surgery do not show a consistent pattern. While some depicted less chance for conversion for the robotic platform (9,14), others reported a small rate for laparoscopic surgery (12,13).

Costs are consistently higher for robotic surgery (*Table 1*) and considered a serious limitation of the method. Operative time, another drawback frequently quoted, is not consistently worse for robotic surgery (*Table 1*). Probably, surgeons are gaining expertize and abbreviating time for docking and undocking and knotting more efficiently with the help of robotic arms.

Short and mid-term follow-up, as present in the majority of reports, is also comparable to laparoscopic surgery, including symptoms, quality of life and objective evaluation of esophageal function (*Table 1*). Publications on long-term outcomes and systematic and objective evaluation of hernia recurrence are too few to draw conclusions. Five meta-analyses comparing robotic versus laparoscopic fundoplication are available (18-22). Most of them showed consistently the intuitive thinking of higher costs (18,19) and operative time (18,19,21,22) for robotic with similarities for complications, length of stay and outcomes. Other (20) did not disclose any difference between methods for all outcome measures.

## Discussion

Robotic antireflux operation is a safe technique that seems to be easily learned by surgeons trained in laparoscopic surgery or other robotic operations. Results are similar to laparoscopy with the exception of higher costs. The costs and accessibility to the technology may be the main reasons for the low number of procedures compare to laparoscopic surgery (3%) in nationwide US databases (17) and the reason for patient's preference for conventional laparoscopy (16). Technology improvements may decrease costs in the future. Longer operative time, usually quoted as a drawback as well, seems to be vanishing with increased experience.

In conclusion, robotic antireflux surgery currently brings similar outcomes to laparoscopic surgery and it is not essential to achieve optimal outcomes.

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appropriately investigated and resolved.



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