Review Article

Robotic lobectomy: how to teach thoracic residents

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Abstract: Robotic thoracic surgery emerged at the beginning of the 21st century and keep presenting the continuous development of its robotic systems, tools, and associated techniques. Strong clinical results including safety and oncological outcomes have fostered the dissemination of the robotic platform all over the world. However, there are still some safety concerns, especially regarding more elaborated procedures as lung resections, during the learning curve. In consequence, training programs for surgeons and surgery residents have been proposed to put into operation a strong and complete curriculum for robotic surgery and increase safety during the learning process. Also, the implementation of the training program makes the process complete and efficient. Lung lobectomies are complex procedures especially because of pulmonary arteries and pulmonary veins dissection, which demands quite accurate skills. Consequently, it is believed that specific training of thoracic surgery residents in robotic lobectomy is capital. The ideal curriculum must include technical content and broad psychomotor training using virtual reality models and also physical and animal models. Valid evaluation methods can be used from the first skill training to daily clinical practice. At the beginning as a console surgeon, the resident must initiate gradually with small procedures and progress to more complex surgeries before performing the whole lobectomy.

Keywords: Robotic thoracic surgery; training residents RATS; structured RATS training

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Introduction

Robotic thoracic surgery emerged in the early 2000s and since then it has been widely disseminated across the world. The continuous development of the robot system and its tools, allied to consistent clinical results including safety and oncological outcomes, has stimulated its already vast adoption (1-4). However, as occurred when video-assisted thoracic surgery (VATS) emerged, there are safety concerns during the learning curve, especially regarding lung resections (5).

With the bases of the new technology already settled and many experienced surgeons trained, it is imperative to develop training programs for thoracic surgery residents that could be both complete and efficient. Complete to include all the technical aspects of the machine itself and clinical specificities of the main procedures, and efficient to avoid high costs and excessive use of time. Because of this, some training programs for surgeons have been developed to standardize the curriculum for robotic surgery and increase safety during the learning process (6-9). To achieve a straightforward process, we believe that the adoption of structured training is of a major utility. The steps are going to be depicted hereupon.

Structured training

To achieve the best results in robotic thoracic surgery, structured training must include:

- ❖ Online Education;

- Bedside experience;
- Simulation;
- Supervised procedures;
- Evaluation;
- Credentialing.

Online education

The most traditional access to the online part of the training consists of accessing the Da Vinci Surgery Online Community, which has been developed by Intuitive Surgical, Inc (Sunnyvale, CA, USA). This website provides access to videos and documents that depict in detail the principles of the robotic platform. Its objective is to provide knowledge concerning instruments and accessories management, port placement, docking, intraoperative setup, surgeon console interaction, troubleshooting, and safety features (8).

A different initiative that has emerged is the fundamentals of robotic surgery (FRS). FRS is a curriculum developed by more than 80 experts that aim at training and assessing surgeons that want to perform robotic surgery intended to be adapted for use in different robotic platforms. It encompasses not only the online material but all the phases of training, including a basic introduction to robotic system training, a detailed psychomotor skills program, and a test-specific checklist for assessment. Perioperative checklists and team communication were also included. The program has developed specific physical training models and 3D virtual models derived from them with similar efficiency in training (10). Satava *et al.* published the results of a randomized controlled trial that showed positive results in the use of the FRS method (11).

Veronesi *et al.* analyzed the results of a method based on surveys that target to find consensus about robotic surgery training and found more than 90% consensus in four aspects of e-learning. The responders agreed that it should include information on troubleshooting, docking the robot card, port placement for index procedures, and patient selection (5).

We consider online education a key point in robotic surgery training, once having it, the resident will be able to take part in the procedure, firstly as an observer and then, after getting more experience, to participate actively as a bedside assistant.

Bedside experience

The bedside experience is such an important phase once it allows the trainee to internalize part of the concepts that were thought in the online step. As a supervised bedside assistant, the resident will practice how to correctly position the patient, how to do the port placement and docking, and how to deal with instruments and devices.

Besides that, being in the surgical field is a good way to get more familiarity with the standardization of the lobectomy. Since in the majority of the centers the stapling is performed by the assistant, being at this position helps the candidate to understand how the surgical field has to be positioned and dissected. The assistant also gets used to the pitfalls and tricks of the technique. Putting all this together, it helps to reduce the learning curve when the surgeon is on the console (12).

Simulation

The robotic surgery systems have brought to the surgeon a range of new capabilities, but also the necessity of new skills that are unfamiliar for the one who performs open or video-assisted thoracic surgery (VATS). Due to the cost of the robotic equipment, a great number of medical institutions have problems with designating a robot just for physical training. As a result, the use of virtual reality simulators has a paramount role in the major part of the robotic training.

For laparoscopic surgery, the role of simulation and virtual reality simulation is established. For this kind of procedure, the time "spent" on virtual training results in shorter operation times and better surgical performance, although the results of surgical outcomes are uncertain (13,14). On the other hand, for robotic surgery, the literature available is not so robust. In a paper published in 2015, Moglia *et al.* brought to discussion the need for large RCTs in this topic.

Although laparoscopic and robotic techniques share some psychomotor skills and the training for the latter could be aided by the former, robotic training has joysticks and other robotics controls that have no parallel with VATS or open surgery instrument (15). Through the simulators, the trainee can practice robotic abilities such as endo wrist manipulation, camera handling, needle control, and driving, suturing and knot tying, energy application, and dissection (8).

The most used and tested VR simulators are the Da Vinci Skills Simulator dVSS (3-D Systems/Simbionix, Tel Aviv, Israel) that is adapted in the console cart of the da Vinci Robot and the DV-trainer (Mimic Technologies, Inc., Seattle, WA, USA). Both platforms provide an objective assessment of technical skill proficiency and give feedback through a scoreboard, which results in motivation for residents in training, as well as quantifies the progress in the acquired skills. Some studies have shown better results of dVSS over DV-trainer but there are still little data on this point (11,16).

Further simulation options include Physical modes. This kind of prototype is made of different kinds of materials and can be developed for training different tasks. The FRS has developed "domes" and methods for 3D printing such devices with the same characteristics of the tasks in VR simulation (10). There are commercial options in the market e.g. the simulators developed by Kindheart (www.Kindheart.com) that are made with porcine heart and left lung placed inside a silicone manikin, can be stored frozen or refrigerated and are designed to mimic physiological functions like beating and bleeding (17).

Porcine and other animal models are used to provide a more realistic touch to the robotic training as it can provide vivid tissue sense. Due to its costs and need for structure organization of the institution, animal models are normally reserved for assessing the results of training, events of immersion in robotic training, or for certification process (15,18,19). Cadaver training is also an option used but it demands a highly complex organization and structure at high costs. The study conducted by Veronesi *et al.*, 100% of the participants agreed that VR simulation must be part of the curriculum, 84.6% said so for the dry lab (physical model) 76.9% for Wetlab (animal model), and only 53.8% for cadaver training (5).

Supervised procedures

After having had an overview of the robotic system through online training, participated in the procedures as bedside assistance, learned the surgical setup, and developed the robotic skills in the simulator, the resident is ready to start his training in the surgeon's console. Participation in clinical discussions and extensive surgery videos review will also be a key part of the training at this point.

Robotic lobectomies, although somehow standardized procedures, comprehend a complex group of operations, presenting high intraoperative risks especially during the dissection of vascular structures. Hence the surgeon should start the robotic training with more "simple" procedures, e.g., resection of small mediastinal tumors, move forward for performing parts of the lobectomy (dissecting just the vein for example), and just then perform the entire procedure. Lymph node excision, esophageal cyst, small mediastinal tumors are examples of procedures that can be used to initiate the learning curve (12). However, even in these cases, it is also necessary attention in patient selection.

Regarding lung lobectomies, it is recommended to segment the surgery in a sequence of steps with increasing difficulty. The first objective of the resident should be to complete the basic tasks and only then go to the difficult parts (15). Following this strategy, the procedures can be done safely while gradually increasing the resident's confidence. Cerfolio *et al.* standardized the robotic lobectomy technique in a reproducible way, which can reduce the operative time and improve the safety of the surgery (20).

The robotic system has several features that make the training safe and effective, such as the drawing function, video recording system, and the possibility to use dual consoles surgeon (15). With the drawing function, the proctor can indicate with arrows or even to draw on the screen the task to be done in the surgery and mark which place, or structure should be dissected and/or preserved. This feature allows an improvement in the safety of the procedure during the learning curve (15). Operations are recorded with a great quality of the image (15). It allows the resident to review surgeries and discuss with his proctor critical points to be improved in his performance.

The use of dual consoles permits the proctor to has the same 3D view and "same hands" of the resident in training. During a critical maneuver, the proctor can assume the control of the robotic arms with ease, by pressing a few buttons on the console and show how to perform that one step. With this tool, the trainer can teach with more quality, safety, comfort, and can reduce surgical time and accidental injuries (15).

Evaluation

During the training process, the surgeon needs to have metrics for evaluating skills and abilities progression. GEARS (Global Evaluative Assessment of Robotic Skills) is a method to evaluate the performance of robotic surgeons based on the evaluation of other exp erienced colleagues. It is based on the GOALS (global assessment of laparoscopic skills) a proven method to evaluate performance for laparoscopic surgery. It is composed of scale measures of surgical abilities as depth perception, bimanual skill, efficiency, force control, autonomy, and robot control. The validity of the method has been described in the literature (21-23). Raad *et al.* in his prosed curriculum, used Objective Structured Assessments of Technical Skills (OSATS) as an option to GEARS to evaluate trainees as console surgeons.

Another evaluation initiative is called C-STAS (Crowd-Sourced Assessment of Technical Skills, https://www.csats.com), it was born as a startup and was acquired by Johnson & Johnson. C-SATS uses surgical videos to evaluate the performance of surgeons. Through this cloud-based platform, the surgeon can anonymously send videos and receive feedback from a list of experts in the area.

Credentialing

Currently, the certification provided by Vinci System requires attending the on-line course followed by extensive VR simulation assessed by the scoreboard in one of the VR simulators. After this training, the surgeon is submitted to an in-service practice when some aspects of the robot positioning, port placement, and troubleshooting are reviewed to get used to the robot in a surgical setting. Thereafter the thoracic surgeon has to visit a training center to be evaluated in VR, physical models, animal tissue, and cadavers.

As the necessity for training a greater number of surgeons arises, this structure of training tends to become insufficient and more centers are required. The onset of decentralized training centers with a strong structured curriculum is needed. Besides that, it is also important for the centers to stimulate proctoring that are essential for the initial phase of the learning curve.

New robotic platforms

There is a great number of robotic systems available for different uses, but the Intuitive Surgical da Vinci robot is currently the only approved system for clinical use in thoracic surgery. New platforms are in development by big medical supply companies. It is not possible to predict how the training curriculum will be impacted by the advent of new technology. Therefore, the adoption of a complete curriculum that encompasses broad psychomotor skills training open to the new technologies is paramount (10,24).

Conclusions

Training thoracic surgery residents in robotic lobectomy is capital. The ideal curriculum must include technical content and broad psychomotor training using VR models and also physical and animal models. Valid evaluation methods can be used from the first skill training to daily clinical practice. At the beginning as a console surgeon, the resident must initiate gradually with small procedures and progress to more complex surgeries before performing the whole lobectomy.

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Footnote

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