Review Article

Does simulation help improve results for esophagectomy?

Francisco Schlottmann

Department of Surgery, Hospital Alemán of Buenos Aires, Buenos Aires, Argentina

Correspondence to: Francisco Schlottmann, MD, MPH. Department of Surgery, Hospital Alemán of Buenos Aires, Av. Pueyrredón 1640 (ATT 1118), Buenos Aires, Argentina. Email: fschlottmann@hotmail.com.

Abstract: Surgical simulation has been implemented over the past few decades in order to avoid learning and practicing skills in patients. Currently, there are few simulators designed for training in esophageal surgery. Virtual simulation is often used to teach esophageal endoscopic procedures. Porcine blocks have been developed to train different steps of an esophagectomy, with promising results in terms of skills acquisition by the trainee. However, none of the simulators have yet proven that the skills acquired during training are effectively transferable to the clinical setting. Establishing a lineal association between simulation training and patients' outcomes is challenging, and further research is needed to develop high fidelity simulators for esophageal surgeons and determine how this training may benefit our patients.

Keywords: Esophageal surgery; simulation; outcomes

Received: 03 December 2019; Accepted: 17 December 2019; Published: 25 March 2020.

doi: 10.21037/aoe.2019.12.04

View this article at: http://dx.doi.org/10.21037/aoe.2019.12.04

Introduction

Simulation can be defined as a "*situation in which a particular set of conditions is created artificially to experience something that could exist in reality*" (1). Surgical simulation has been implemented over the past few decades in order to avoid learning and practicing skills in patients. Reduction in resident work hours and concerns over patient safety have further motivated the creation of a simulation curricula in training programs (2,3).

There is a wide variety of surgical simulators such as box-trainers, virtual-reality platforms, human cadavers, and live animals. Box-lap trainers are usually used for training of basic laparoscopic skills (e.g., peg transfer or knot-tying). Virtual-reality simulators have evolved and now offer high fidelity training of full procedures, but are associated with greater expenses compared to lower fidelity models (4). Cadavers and live animals also offer realism and opportunities to train many procedures, but also have significant drawbacks such as costs, limited availability, and need for specialized facilities (5). Overall, there is no perfect simulator, and simulation should rather be tailored to the specifics needs of the trainee and the available resources of the institution.

Currently, there are few simulators designed for training in esophageal surgery. The aim of this study was to review the current literature regarding simulation in esophageal surgery.

Simulation in esophageal surgery

Attaining competence in advanced esophageal endoscopic procedures or developing knowledge in diagnostic procedures like high-resolution manometry is difficult because the technology and expertise is not widely available in many countries. A previous study tried to determine if an intensive training during a continuing medical education (CME) course could help fellows in esophageal diagnostic test interpretation and performance of endoscopic procedures (6). Standardized teaching and testing sessions proved to enhance skills and knowledge related to diagnosis and treatment of esophageal disorders (6). Therefore, intensive CME courses with standardized practice sessions and feedback from experts are an attractive training tool for gastroenterologists and/or surgeons dealing with esophageal diseases.

Virtual simulation is often used to teach esophageal endoscopic procedures. For instance, the GI-mentor

(*Simbionix*) consists in an endoscope that has motion sensors and force-feedback when it is advanced through a mannequin (7). A wide variety of patient cases (e.g., bleeding) are included in the platform, allowing the trainee to develop diagnostic and therapeutic skills. The Erlangen Endo-Trainer uses a porcine esophagus with an artificial human torso for endoscopic techniques, and can simulate bleeding, polyps, tumors, and varices (8).

The University of North Carolina (UNC) developed a high fidelity and economic simulation model for laparoscopic and robotic foregut surgery (9,10). The simulation model is based on a porcine tissue block that includes lungs, heart, aorta, esophagus, diaphragm, stomach, duodenum, liver, and spleen. After some anatomical modifications to mimic human anatomy and perfusion with artificial blood, the block is mounted in a human mannequin. Expert surgeons tried the model and performed laparoscopic Heller myotomy, Nissen fundoplication, and sleeve gastrectomy. Most of the participants considered that performing the procedure was as real as in the operating room, and that this model could even help practicing surgeons (9). The robotic model of UNC has also proven to increase confidence levels among senior residents for all the surgical steps analyzed (port placement, docking process, suturing, using energy devices, and using staplers) after a 3-day simulation training (11).

Specifically, for esophagectomy, Fann and colleagues (12) created a porcine heart-lung-esophagus for esophageal anastomosis. The block permits the alignment and approximation of the esophageal ends and the proper placement of sutures within the esophageal wall or use of stapling devices. The model showed high degree of perceived realism and was considered to enhance critical technical skills. The *Gooseman* simulator for transhiatal esophagectomy has a porcine organ block along with a plastic torso, artificial diaphragm, large foam lungs, an artificial pressure-detecting heart, aortic and azygous circulation. Esophageal mobilization and gastric tubularization can be trained, as well of management of simulated complications such as hypotension or aortic and azygous bleeding (13). Fabian *et al.* (14) described a simulator of thoracoscopic intrathoracic anastomosis that uses porcine tissue mounted in an artificial hemithorax and covered with synthetic skin. Participants showed improvement in the subjective measurement of the completed task after multiple repetitions, leading to improved speed to task completion and improved quality of the anastomosis (i.e., no leaks after testing with hydrostatic pressure of 60 mmHg).

A recent study showed that a modular step-up approach can be used for the introduction of a robot-assisted esophagectomy (15). The procedure is divided into different modules with increased level of difficulty, allowing the trainee to complete a complex operation without the substantial learning curve. For example, a total of 10 cases per surgeon were necessary to complete all modules in one patient. This sequential training can certainly help implementing new technologies in esophageal surgery.

Teamwork based training should also be explored including the complete surgical team: surgeon, assistants, nurses, and anesthesiologists. Preoperative anatomical simulation and intraoperative real-time navigation systems are currently investigated, and may also provide alternative means of improving performance during an esophagectomy.

Overall, none of these studies, simulators or educational approaches have yet proven that the skills acquired during training are effectively transferable to the clinical setting. In fact, determining if simulation improves results after esophagectomy is hard because patients' outcomes are affected by multiple factors such as preoperative work-up, surgical technique, and postoperative care. Therefore, establishing a lineal association between simulation training and outcomes is challenging. Further research is needed to develop high fidelity simulators for esophageal surgeons and determine how this training may benefit our patients.

Conclusions

Surgical simulation training has evolved during the last few decades. Unfortunately, few simulators are currently available to train complex procedures such as an esophagectomy. Further investigation and validation studies are needed to develop high fidelity esophageal simulators and determine how can we transfer the learned skills to the clinical setting in order to improve patients' outcomes.

Acknowledgments

Funding: None.

Footnote

Provenance and Peer Review: This article was commissioned by the Guest Editors (Fernando A. M. Herbella, Rafael M. Laurino Neto and Rafael C. Katayama) for the series "How Can We Improve Outcomes for Esophageal Cancer?"

published in *Annals of Esophagus*. The article has undergone external peer review.

Conflicts of Interest: The author has completed the ICMJE uniform disclosure form (available at http://dx.doi.org/10.21037/aoe.2019.12.04). The series "How Can We Improve Outcomes for Esophageal Cancer?" was commissioned by the editorial office without any funding or sponsorship. FS serves as an unpaid editorial board member of *Annals of Esophagus* from Aug. 2018 to Jul. 2020. The author has no other conflicts of interest to declare.

Ethical Statement: The author is accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

References

1. Oxford Advanced Learner's Dictionary. 8th edition. Oxford, UK: Oxford University Press, 2013.
2. Aggarwal R, Mytton OT, Derbrew M, et al. Training and simulation for patient safety. Qual Saf Health Care 2010;19:i34-43.
3. Reznick RK, MacRae H. Teaching surgical skills--changes in the wind. N Engl J Med 2006;355:2664-9.
4. Sutherland LM, Middleton PF, Anthony A, et al. Surgical simulation: a systematic review. Ann Surg 2006;243:291-300.
5. Sarker SK, Patel B. Simulation and surgical training. Int J Clin Pract 2007;61:2120-5.
6. Kim HC, Pandolfino JE, Komanduri S, et al. Use of a continuing medical education course to improve fellows' knowledge and skills in esophageal disorders. Dis Esophagus 2011;24:388-94.
7. Bar-Meir S. A new endoscopic simulator. Endoscopy 2000;32:898-900.
8. Neumann M, Mayer G, Ell C, et al. The Erlangen Endo-Trainer: life-like simulation for diagnostic and interventional endoscopic retrograde cholangiography. Endoscopy 2000;32:906-10.
9. Schlottmann F, Murty NS, Patti MG. Simulation Model for Laparoscopic Foregut Surgery: The University of North Carolina Foregut Model. J Laparoendosc Adv Surg Tech A 2017;27:661-5.
10. Schlottmann F, Patti MG. Novel simulator for robotic surgery. J Robot Surg 2017;11:463-5.
11. Schlottmann F, Long JM, Brown S, et al. Low confidence levels with the robotic platform among senior surgical residents: simulation training is needed. J Robot Surg 2019;13:155-8.
12. Fann JI, Feins RH, Hicks GL Jr, et al. Evaluation of simulation training in cardiothoracic surgery: the Senior Tour perspective. J Thorac Cardiovasc Surg 2012;143:264-72.
13. Trehan K, Zhou X, Tang Y, et al. THE GooseMan: a simulator for transhiatal esophagectomy. J Thorac Cardiovasc Surg 2013;145:1450-2.
14. Fabian T, Glotzer OS, Bakhos CT. Construct validation: simulation of thoracoscopic intrathoracic anastomosis. JSLS 2015. doi: 10.4293/JSLS.2015.00001.
15. Fuchs HF, Müller DT, Leers JM, et al. Modular step-up approach to robot-assisted transthoracic esophagectomy-experience of a German high volume center. Transl Gastroenterol Hepatol 2019;4:62.

doi: 10.21037/aoe.2019.12.04
Cite this article as: Schlottmann F. Does simulation help improve results for esophagectomy? Ann Esophagus 2020;3:8.