Editorial

Innovations in robotic platforms for uniportal thoracic surgery

John Kit Chung Tam[1,2]^

[1]Department of Surgery, Yong Loo Lin School of Medicine, National University of Singapore, Singapore, Singapore; [2]Department of Cardiac, Thoracic, and Vascular Surgery, National University Heart Centre Singapore, Singapore, Singapore

Correspondence to: John Kit Chung Tam, MD, FRCSC. Head and Senior Consultant, Division of Thoracic Surgery, NUHCS, Associate Professor of Thoracic Surgery, Department of Surgery, Yong Loo Lin School of Medicine, National University of Singapore, Level 8, 1E Kent Ridge Rd, NUHS Tower Block, Singapore 119228, Singapore; Department of Cardiac, Thoracic, and Vascular Surgery, National University Heart Centre Singapore, Singapore, Singapore. Email: surjtkc@nus.edu.sg.

Comment on: Lin YY, Hsieh MJ, Wu CY, *et al.* Comparison of active versus passive robotic-endoscope-holder-assisted unisurgeon uniportal thoracoscopic surgery in terms of surgical efficacy and patient safety. J Thorac Dis 2023;15:3800-10.

Keywords: Robotic; uniportal; video-assisted thoracoscopic surgery (VATS)

Submitted Oct 04, 2023. Accepted for publication Nov 22, 2023. Published online Dec 26, 2023.
doi: 10.21037/jtd-23-1545
View this article at: https://dx.doi.org/10.21037/jtd-23-1545

Robotics and artificial intelligence (AI) have revolutionized many fields, and medicine is set to be the next great frontier (1-3). These technological advances hold the promise of reducing manpower needs which is often in great shortage in many societies (4). While medicine is traditionally a "high touch" discipline, technology can help health professionals work more efficiently and channel more time and energy towards direct patient care that requires more humanness.

Various robotic platforms are available in the market or under development (5-7). There are "passive" platforms that are semi-robotic and require more manual manipulation and positioning, and "active" platforms that are more hands-free using foot pedal or voice controls. Proper scientific evaluation of different platforms will help illuminate which one may be more suitable for future adoption.

Lin *et al.* (8) compared a passive robotic endoscopic holder ENDOFIX with an active robotic endoscopic holder MTG-100. ENDOFIX uses computerized joints with manual control, whereas MTG-100 is controlled using a foot pedal to adjust its movements. The study had one surgeon performing the "uni-surgeon" operation using the robotic endoscopic holder, but one surgical assistant was still available to offer help if and when needed during the operation. This was a retrospective feasibility cohort study with the sequential evaluation of human-assisted (HA, 156 patients), passive robotic arm-assisted (ENDOFIX-Assisted, EA, 57 patients), and active-robotic arm-assisted (MTG-100-Assisted, MA, 15 patients) uniportal video-assisted thoracoscopic surgery (VATS) robotic platforms.

The authors found that all unisurgeon uniportal wedge resections in the EA and MA groups could be performed successfully without help from a human assistant. Nevertheless, with anatomical resections, the success rate was found to be 95% in EA group and only 40% in the MA group, and lobectomy was not attempted with MA due to the high failure rate. The robotic platforms were not as nimble and agile as human camera operators. The reasons provided were that of sub-optimal distances, angles, and planes, resulting in collision of instruments and poor range of motion.

The authors also analysed the quality of endoscopic images on whether the target structure was visible at the centre of an intraoperative image during the application of surgical staplers. They found that intraoperative images taken in all three groups were of similar quality for wedge resections. However, the image quality was considerably higher in the HA group for anatomic resection, and this group had the lowest number of times in the marginal zone of visualization. All together, HA produced the highest image quality compared to EA and MA, indicating that

^ ORCID: 0000-0002-6269-3653.

current robotic platforms were not yet able to match human performance in providing surgical assistance.

Surgery is a dynamic process and the field of action during an operation is constantly changing. Minimally invasive surgery such as VATS requires precise and accurate visualization and dissection of critical broncho-vascular structures. Uniportal surgery, in particular, involves complex geometrical angulations within a small port to avoid crowding and collision of instruments, which will greatly impede the smooth execution of the surgery (9). Visualization is vital to the success of minimally invasive surgery. Inability to well visualize the operating field and vital structures during dissection will inevitably introduce undesirable variability and imprecision, with heightened risks of injury and failure to achieve set surgical objectives. Excellent visualization, in turn, makes the operations smoother and safer. Nevertheless, no difference was found in intraoperative and postoperative complication rates within the confines of this study.

While these new technological platforms hold the potential to reduce the need for surgical assistance, the impact on training requires further evaluation as traditional models of surgical teaching and learning are disrupted. Also, removing human assistance may have a potentially undesirable effect of inadvertently increasing the stress and fatigue of the main operator, and such possible consequences may require further study.

Can robots replace humans in surgery yet? What defines robotics and distinguishes it from other machine systems? Is it the chip inside the machine, or automation to reduce human input or interferences, or enhancements and elevation of what humans are otherwise capable of performing towards a higher level? Perhaps the ideal robotic platform shall incorporate all of the above.

In the same line of thinking, does using a foot pedal rather than using hand controls really makes a system more active or passive? Or rather, are both platforms equally just as passive? If robotics is to be defined as truly more automated and more freedom from human involvement or human intelligence (HI), then both platforms under assessment have not yet reached the mark.

As technology continues to advance, the line becomes blurred as to whether the machine is human- or robotic-controlled, or whether it is robotic- or human-assisted (10). Automation is lacking in both platforms being tested in this study, and human input is still essential for movements to occur. As such, it may be asserted that the currently available platforms are actually more human-controlled and robotic-assisted than otherwise purported or advertised.

This study is limited by its small sample size, retrospective nature, single institution, and sequential design. Nevertheless, it is clear from the findings of this study that the platforms under evaluation are not ready for prime time yet, especially for major surgeries. Further improvements in flexibility, accuracy, and precision are necessary before they can be recommended for widespread adoption. To fulfil its promise of revolutionizing surgery, the ideal platform must be intuitive, with automation and AI that zooms over and homes into the field of action without the need for prompts or manipulation, reducing the need for both active or passive human adjustments. Systems that will incorporate the latest visualization systems with gaze or eye movement tracking may prove beneficial. Such platforms will apply next generation machine learning and AI to incorporate digital data from past surgeries to make increasingly accurate projections and predictions of where the field of action will be. Proper scientific evaluation of newer platforms will be necessary to determine their efficacy and benefits. With the rapid technological advances that we have witnessed in the past two decades, there is hope that this dream may become a reality in the coming future (11-14).

Acknowledgments

Funding: None.

Footnote

Provenance and Peer Review: This article was commissioned by the editorial office, *Journal of Thoracic Disease*. The article did not undergo external peer review.

Conflicts of Interest: The author has completed the ICMJE uniform disclosure form (available at https://jtd.amegroups.com/article/view/10.21037/jtd-23-1545/coif). The author has no 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. Terra RM, Leite PHC, Dela Vega AJM. Global status of the robotic thoracic surgery. J Thorac Dis 2021;13:6123-8.
2. Park SY, Lee JH, Stein H, et al. Initial experience with and surgical outcomes of da Vinci single-port system in general thoracic surgery. J Thorac Dis 2022;14:1933-40.
3. Rajpurkar P, Chen E, Banerjee O, et al. AI in health and medicine. Nat Med 2022;28:31-8.
4. Moffatt-Bruce S, Crestanello J, Way DP, et al. Providing cardiothoracic services in 2035: Signs of trouble ahead. J Thorac Cardiovasc Surg 2018;155:824-9.
5. Okada S, Tanaba Y, Sugawara H, et al. Thoracoscopic major lung resection for primary lung cancer by a single surgeon with a voice-controlled robot and an instrument retraction system. J Thorac Cardiovasc Surg 2000;120:414-5.
6. Takahashi M, Takahashi M, Nishinari N, et al. Clinical evaluation of complete solo surgery with the "ViKY(®)" robotic laparoscope manipulator. Surg Endosc 2017;31:981-6.
7. Chan JY, Leung I, Navarro-Alarcon D, et al. Foot-controlled robotic-enabled endoscope holder for endoscopic sinus surgery: A cadaveric feasibility study. Laryngoscope 2016;126:566-9.
8. Lin YY, Hsieh MJ, Wu CY, et al. Comparison of active versus passive robotic-endoscope-holder-assisted unisurgeon uniportal thoracoscopic surgery in terms of surgical efficacy and patient safety. J Thorac Dis 2023;15:3800-10.
9. Tam JK, Lim KS. Total muscle-sparing uniportal video-assisted thoracoscopic surgery lobectomy. Ann Thorac Surg 2013;96:1982-6.
10. Barlas Z. When robots tell you what to do: Sense of agency in human- and robot-guided actions. Conscious Cogn 2019;75:102819.
11. Wang R, Gonzalez-Rivas D, Wang C, et al. Non-intubated uniportal robotic-assisted thoracic surgery: the future of thoracic surgery? Ann Cardiothorac Surg 2023;12:49-51.
12. Lazar JF, Hwalek AE. A Review of Robotic Thoracic Surgery Adoption and Future Innovations. Thorac Surg Clin 2023;33:1-10.
13. Alip SL, Kim J, Rha KH, et al. Future Platforms of Robotic Surgery. Urol Clin North Am 2022;49:23-38.
14. Lazar JF. Envisioning the Future of Robotic Surgery: The Surgeon's Perspective. Ann Thorac Surg 2018;105:343-4.

Cite this article as: Tam JKC. Innovations in robotic platforms for uniportal thoracic surgery. J Thorac Dis 2023;15(12):6385-6387. doi: 10.21037/jtd-23-1545