

Introduction

In 2009, the Food and Drug Administration (FDA) approved Transoral Robotic Surgery (TORS) as an approved method of surgical treatment for selected patients with head and neck pathology.¹ Since that time, TORS has been widely popularized but those who seek credentialing in TORS must obtain certification from an approved TORS training program.^{2,4-5} The TORS Training and Certification Program at the University of Pennsylvania was established in 2006 and Co-Directed by Drs. Gregory S. Weinstein and Bert W. O'Malley, Jr. Over 400 surgeons from over 20 countries have completed training in our TORS training lab. The value of this formal training program has been evident in the successful adoption of TORS worldwide.

The limitations set forth in response to the novel coronavirus (COVID-19) pandemic have been substantial. For much of the year 2020 to present, many institutions have limited trainee participation in transoral surgery cases due to the aerosolization risk of viral particles. Work-related travel including for courses or conferences has also been shut down for many physicians.

While currently available TORS videos and lectures provide some educational value, they only provide a single view of the operation, typically of the surgical field. The ability to ask questions of experts is limited at best. Other aspects learned through an in-person observership include proper robotic equipment and patient setup, surgeon positioning and ergonomics, functions of the primary surgical assistant, and case-specific surgical pearls.

Because of the current limitations to standard TORS training, a virtual training platform is critical. The high definition (HD) video capabilities already standard for robotic surgical systems make TORS well-positioned for rapid adoption of a fully virtual training model. Here, we describe a novel, interactive virtual TORS training platform for undergraduate, graduate, and continuing medical education.

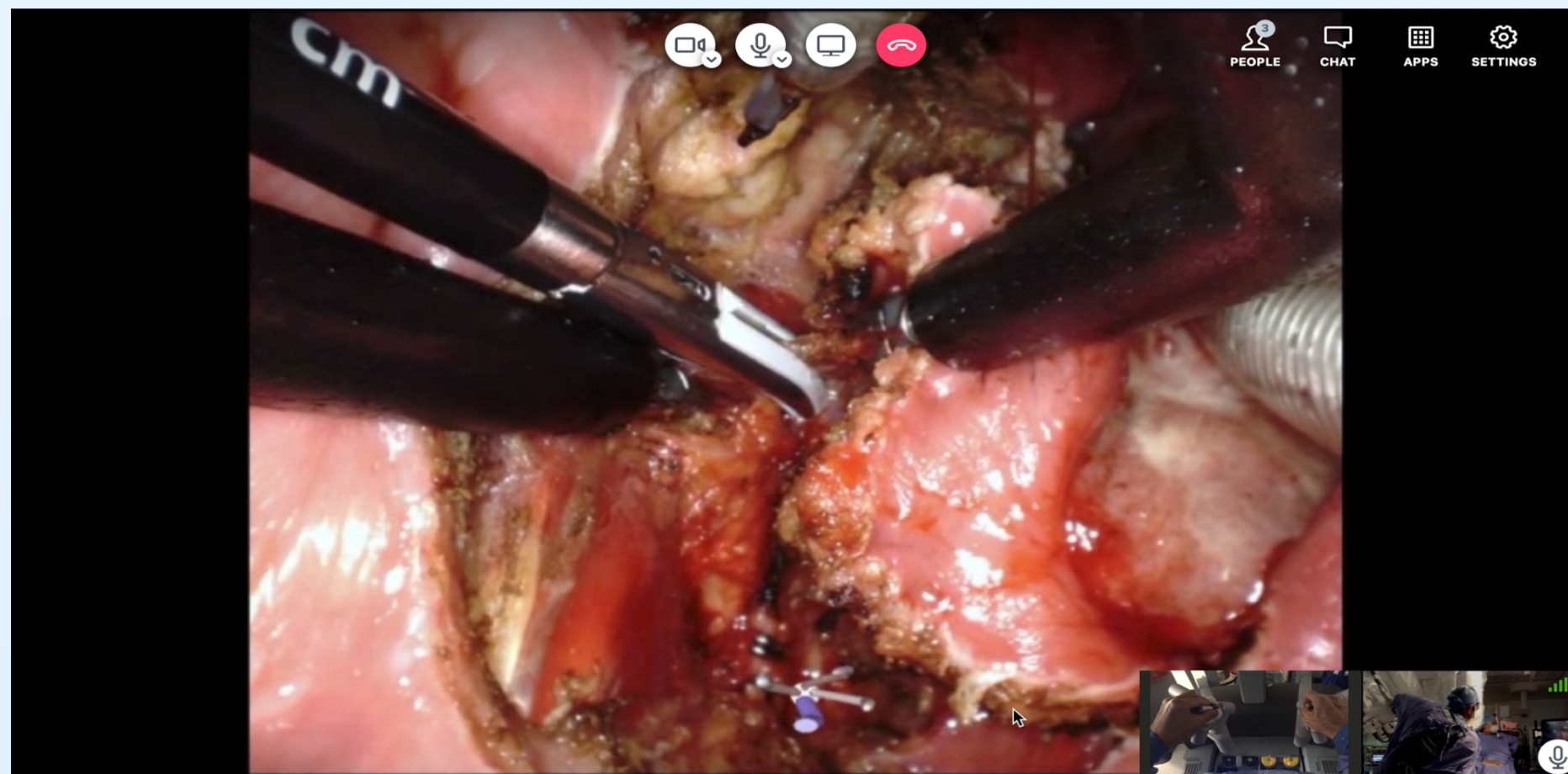


Figure 1 Participant's view of surgical field, operating room setup, and console surgeon positioning. The operative field is pinned as the primary view which can be seen encompassing most of the screen, but this can be switched to views of the operating room setup or surgeon positioning at the console depending on the stage of the procedure.

Study Design and Measures

All patients scheduled for TORS were asked to sign a video recording and streaming consent form preoperatively. The primary surgeon's view on the da Vinci SP robotic surgical system (Intuitive Surgical, Sunnyvale, CA) was captured from the digital visual interface (DVI) output on the robot tower and converted using a DVI to HDMI cable (Amazon Basics, Amazon.com Inc., Seattle, WA) connected to a HDMI to USB video capture card (HDMI to USB Audio Video Capture Card, MavisLink, China). This allowed the surgeon's console view to be converted to a webcam signal and stream HD video with a high frame-rate and minimal lag time on a video conferencing platform (BlueJeans Network, SanJose, CA). This video conferencing system was licensed to and supported by the authors' institution, compliant with the Health Insurance Portability and Accountability Act (HIPAA), and further secured with password protection.

A second computer with a webcam facing the surgical assistant and scrub nurse provided a global view of room layout, robot positioning, scrub setup, and surgical assistant tasks and techniques. A third view of the primary surgeon's hands and feet was captured with a smartphone mounted near the eyepiece at the surgical console. These two devices were also connected to the video conference. Bluetooth headphones worn by the primary surgeon were connected to the smartphone while the other recording devices were muted. This provided live audio communication between the surgeon and virtual learners via the video conferencing platform while reducing background noise from the operating room (OR). All three views were visible simultaneously. The operative field was pinned as the primary view (**Figure 1**) but can be switched to views of the operating room setup or surgeon positioning at the console depending on the stage of the procedure.

Results

The implementation of this interactive training platform is extremely cost effective (**Table 1**). Most of the necessary equipment and software is already present in a standard TORS OR, owned by the surgeon, or available through an institutional subscription. This system has been used to remotely teach transoral robotic surgery to medical students, residents, and fellows during the COVID-19 pandemic.

Table 1 Comparison of demographics and outcomes between the traditional TORS and TORS with free flap groups

Purpose	Equipment Details	Cost
Video capture	HDMI to USB 2.0 video audio capture card 1080p	\$ 46.99
Cables	DVI to HDMI cable (25 ft)	\$ 14.49
Mounting	Universal Smartphone Car Suction Mount	\$ 12.99
Audio capture	Bluetooth headphones	\$ 29.99
	Total	\$ 104.46

Discussion & Conclusions

Here, we outline a novel approach to teach medical students, residents, fellows, and surgeons to perform TORS on a fully virtual platform. Our approach is simple, cost-effective, and applicable well beyond the pandemic.

Virtual surgical training systems are nonetheless limited by the lack of hands-on experience, which is normally accomplished through cadaver dissections. Given the relative ease of implementation for the system described here, remote precepting of cadaver dissections or utilization of high-fidelity simulations may be considered. Additionally, this platform could be used for precepting early cases of a novice by an experienced TORS surgeon.

This virtual training methodology is a critical adjunct to surgical education, particularly since the onset of the COVID-19 pandemic. This platform has the potential for widespread utilization in any type of robotic surgery, making surgical expertise readily available to learners around the world.

References

1. Holsinger FC, Sweeney AD, Jantharapattana K, et al. The Emergence of Endoscopic Head and Neck Surgery. *Curr Oncol Rep*. 2010;12(3):216-222. doi:10.1007/s11912-010-0097-0
2. Gross ND, Holsinger FC, Magnuson JS, et al. Robotics in otolaryngology and head and neck surgery: Recommendations for training and credentialing: A report of the 2015 AHNS education committee, AAO-HNS robotic task force and AAO-HNS sleep disorders committee. *Head & Neck*. 2016;38(S1):E151-E158. doi:10.1002/hed.24207
3. Plonowska KA, Ha PK, Ryan WR. Advanced head and neck surgical techniques: A survey of US otolaryngology resident perspectives. *Auris Nasus Larynx*. 2019;46(2):272-278. doi:10.1016/j.anl.2018.08.007
4. Weinstein GS, O'Malley BWJ, Desai SC, Quon H. Transoral robotic surgery: does the ends justify the means? *Current Opinion in Otolaryngology & Head and Neck Surgery*. 2009;17(2):126–131. doi:10.1097/MOO.0b013e32832924f5
5. Jain K, Weinstein GS, O'Malley BW, Newman JG. Robotic Surgery Training. In: Gil Z, Amit M, Kupferman ME, eds. *Atlas of Head and Neck Robotic Surgery*. Springer International Publishing; 2017:p 27-31. doi:10.1007/978-3-319-49578-1_4