Virtual Interactive Presence for Surgical Assistance: an Intraoperative Feasibility Study

INTRODUCTION
Surgical care has increasingly trended towards minimally invasive techniques in recent years (1). This is particularly true in otolaryngology where trainees are required to master an increasing number of procedures guided by the assistance of an endoscope or microscope. While minimally invasive surgery offers clear benefits to patients, it does often preclude the traditional side-by-side mentoring and assistance that is possible with open techniques. Virtual reality simulation (VRS) has been increasingly utilized in surgical training to provide monitored yet meaningful surgical experience to novice surgeons (2, 3).

Virtual Interactive Presence (VIP) is a novel technology that has the ability to facilitate real-time assistance in surgery. It accomplishes this through the use of augmented reality or the convergence of two live fields. Anything in the field of the instructor’s station can be merged with the remote video signal resulting in the “ghosting” of the instructor’s hand or instrumentation into the main video display. (Figure 1) The VIPAAR Operating Room Station consists of a cart-mounted CPU, display, and camera and is capable of connecting to an operating microscope or endoscope. The VIP software uses image processing to composite two camera fields such that the remote individual can overlay his/her hands or instruments directly onto the surgical field. In this manner, a remote surgeon can see what the surgeon performing the case sees and thus direct their movements. This type of work has typically been accomplished with robotic assistance, and reports exist of cases either procured (5) or performed (6) by surgeons located as far from the patient as the other side of the Atlantic Ocean. Although certainly hurdles such as proving the adequacy of the technology as well as legal liability of the “teaching” physicians have been concerns, VIP technology may be able to increase the portability of operative expertise either for training or treatment purposes. Applications might include transmission of expertise forward in a battlefield scenario or extension to countries with more limited access to specialty care. More trials must be performed with the system with the next potential step involving interaction during the operative phase, as a case incorporating guidance by a surgical proctor located at a more remote location.

METHODS
Recruitment and Inclusion criteria
After Institutional Review Board approval was obtained, patients in an otolaryngology practice at a Veteran’s Affairs teaching hospital were recruited to participate in the study. A total of 8 patients were recruited (2 laryngeal microsurgery and 6 nasal endoscopy).

Setup
During the initial room setup, the Operating Room Station was positioned within the surgical suite out of the view of the operating surgeon (Figure 2). The attached monitor was placed in clear view of the surgeon, usually behind the primary surgical monitor.

Figure 2: (A) Example of the OR configuration of personnel. (B) The VIPAAR Operating Room Station.

Intra-operative VIP exercises (Figure 3)
During the case, the surgeon planned to participate in three short sessions of interaction with the VIP system. A proctor guided the surgeon through three simple exercises at an Operating Room Station positioned out of direct view.

- **Interaction #1** - Following virtual pointing. The surgeon aimed the scope toward a non-operative part of the sterile field, and the proctor virtually pointed and guided the surgeon’s hands across the field of view. The proctor was tasked with following the proctor’s hand movements.

- **Interaction #2** - Virtual guidance of instrument movement: Again, the surgeon aimed the scope toward a non-operative part of the sterile field. The proctor then guided the surgeon to pick up a forceps, perform several specific manipulations of the instrument, and grasp a cottonoid in a indicated location.

- **Interaction #3** - Identification of anatomy: The proctor used the system to virtually point at various anatomic structures in the surgical field. The surgeon was asked to identify the structures.

Figure 3: OR Interaction Exercsises: Interaction #1 Interaction #2 Interaction #3

Data collection
During the cases, observations regarding the surgeon’s interaction with the Operating Room Station were recorded including any comments that were made and difficulties experienced. Additionally, the time required for setup of the system both pre-operatively and during the case was recorded.

After the conclusion of the procedure, the surgeon and the OR staff (scrub tech, circulating nurse, and anesthesia personnel) completed 12 question Likert-style questionnaires in a private setting. Participants were given a scale of 1-5 for each question, with 1 being strongly disagree and 5 being strongly agree. (Figure 4) Additionally, participants were allowed to provide comments regarding the experience of using the system. Responses were compiled and analyzed.

Figure 4: Survey Responses

RESULTS AND DISCUSSION
There were no adverse outcomes related to the use of the Operating Room Station, and no safety concerns were recognized by either the surgeon or OR staff. Average setup time was 4.5 minutes at the outset of the case with an additional 2.4 minutes of setup intra-operatively. The majority of responses on the staff survey questionnaires (n=24) were positive. 100% of OR staff surveyed agreed that the system was safe. 92% disagreed or strongly disagreed with the statement: “Testing the VIP system during the surgery case interfered with my OR duties,” while 8% agreed or strongly agreed.

Some of the positive comments from the OR staff regarding the system included the sentiment that the system will increase patient safety from the improved visualization of the case. Other staff remarked that they enjoyed the equipment and would like to see it used on a diversity of cases.

One of the negative observations included that the VIP cart further crowded an OR which contained a number of other items for the case. Surgeon responses (n=20) were uniformly positive towards the system's safety and its usefulness as a teaching tool. Strengths were noted in the system's clarity of picture, its portability and the ease of setup and interface. One representative comment was that the station was an "easy to use, effective tool for integrating [the proctor] into the procedure being taught.

The observations of the research coordinator during the testing of the system reflected the Operating Room Station's ease of setup, use, and small footprint within the OR. The system performed well with excellent visualization and no significant delay in display projection. The relative sizing of the overlaid images within the operative view was accurate. In one of the cases, it was noted that the background settings of the proctor station had to be adjusted for adequate visualization on the display panel.

CONCLUSION
The practice of otolaryngology requires a highly technical skill set based on learned dexterity during training. As surgical care evolves and more minimally invasive surgical techniques are adopted, training of new surgeons must evolve accordingly. Residency programs must explore alternative options for providing meaningful, monitored surgical experience to trainees. Initial impressions obtained from this feasibility study suggest that VIP technology is a safe and useful adjunct for intra-operative mentorship and could play a role in the training of new, modern surgeons.

Although not addressed within this project, VIP technology has potential applications within the evolving fields of telemedicine and telesurgery. In this context, these terms refer to scenarios in which a remote surgeon assists a less experienced surgeon during an actual surgical procedure through visual presence. This type of work has typically been accomplished with robotic assistance, and reports exist of cases either procured (5) or performed (6) by surgeons located as far from the patient as the other side of the Atlantic Ocean. Although certainly hurdles such as proving the adequacy of the technology as well as legal liability of the “teaching” physicians have been concerns, VIP technology may be able to increase the portability of operative expertise either for training or treatment purposes. Applications might include transmission of expertise forward in a battlefield scenario or extension to countries with more limited access to specialty care. More trials must be performed with the system with the next potential step involving interaction during the operative phase, as a case incorporating guidance by a surgical proctor located at a more remote location.

REFERENCES

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