



## Introduction

Extracorporeal video microscopes, or exoscopes, are a new method of surgical visualization designed to replace operating microscopes. Although it is well described in the field of neurosurgery and lateral skull base surgery, its viability in transcanal microsurgery has not been described in the literature. In the present study, we describe our initial experience with high definition, 3-dimensional exoscope-assisted in transcanal and endaural middle ear surgery.

## Methods and Materials

### Operating Room

Setup Cases were prepared similarly, with the 55 inch 4K 3D monitor placed at eye level across the operating table from the surgeon and the camera positioned in front of the surgeon or over the shoulder. Both the operator as well as observers (residents, medical students) wore 3D polarized eyeglasses to visualize depth. 2D images were also projected onto other monitors present within the room (Figure 1).

Two patients, one who underwent endaural revision tympanomastoidectomy for cholesteatoma (their initial case was performed at outside institution), and another who underwent transcanal stapedectomy were identified. The procedures were performed by the attending surgeon, the otology fellow, and the resident. An ORBEYE™ 3D Exoscope was used exclusively and in lieu of an operating microscope.

Images were selected based on the type of surgery performed and the medical images available. Patients undergoing otologic surgery provided informed consent for nonidentifiable medical imaging to be performed for scientific purposes. Medical images are stored on the exoscope by date and operating surgeon. Tympanoplasty, and Tympanomastoidectomy images taken from April 1, 2019 to June 10, 2019 were collected from the exoscope.

## Results

In one case the exoscope was used to perform a stapedectomy and successfully place a lippy bucket handle prosthesis. In the other, exoscope was used to successfully perform a revision radical canal wall down tympanomastoidectomy for cholesteatoma adherent to dehiscent facial nerve (Figure 2).

Operative time for our cases was 91 minutes for the stapedectomy and 154 minutes for a meatoplasty, revision radical canal wall down tympanomastoidectomy, and eustachian tube plugging. The surgical team was able to rapidly adapt to the Exoscope and all cases were successfully completed with no complications. No cases required conversion to traditional operative microscope.

Based on our experiences, we propose several perceived advantages and limitations of the use of the exoscope in otologic surgery.

### Advantages:

- The use of a 3D monitor untethers the surgeon from the traditional ocular lens of a microscope and allows for a near limitless array of surgical angles without compromising ergonomics.
- The extracorporeal nature of the exoscope increases the working room and allows for easier introduction and withdrawal of instruments.
- The exoscope allows all participants in the operating room to view the same 3D image, allowing optimizing the educational experience for all participants in the room and allowing trainees (fellows, residents, and medical students) to understand 3D ear anatomy.
- Due to the exoscope's autofocus as well as plug and play nature, all surgeons, resident, fellow, and attending, were able to use the exoscope almost immediately, making the learning curve extremely short.

### Disadvantages:

- The use of a 3-D monitor requires the use of non-sterile polarized glasses. Any adjustments or repositioning of the glasses would require assistance from the OR staff.
- Wearing 3D glasses for a prolonged period of time, which would lead to headaches and eye strain.
- Due to the stereopsis produced by a 3-D monitor, one of the residents experienced motion sickness and nausea.
- partial occlusion of the exoscope resulted in loss of stereopsis. Operators had to be cognizant of this limitation and avoid blocking the surgical field.

## Operating Room Setup



**Figure 1.** Demonstration of the exoscope set-up and position of the surgeon in relation to the system. The video display demonstrates placement of a Lippy Bucket handle stapes prosthesis.

## Exoscope-Assisted Tympanomastoidectomy



**Figure 2** Demonstration of enaural revision tympanomastoidectomy as viewed with ORBEYETM Exoscope.

## Conclusion

The exoscope is a safe and viable alternative to the operative microscope for transcanal otologic procedures. It is able to provide a high resolution, three-dimensional display in this narrow operative corridor without compromising patient safety or surgical exposure.

## Contact

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