



Introduction

- Recent advancements in high-definition (4K) and real-time three-dimensional (3D) visualization technology have introduced new possibilities for stereoscopic visualization and depth perception, particularly when coupled with an external telescope.
- Three-dimensional, high-definition (3D-HD) exoscopes have been extensively explored and found to be efficacious in the domain of lateral skull base surgery.^{1,2}
- The use of 3D-HD exoscopes in transcanal and endaural otologic surgeries, which often require a narrower field of view, remains relatively unexplored. To bridge this knowledge gap, we conducted a feasibility study to evaluate the initial implementation of a 3D-HD exoscope in transcanal and endaural middle ear surgeries.

Methods and Materials

- Institutional Review Board exemption #STUDY0012997
- Retrospective case series from a tertiary academic medical center
- Inclusion criteria: patients undergoing exoscope-assisted otologic surgery using a transcanal or endaural approach
- Main outcome measures: surgical approach/procedure type, operative time, feasibility, complications, and surgeon comfort

Results

- Two procedures were performed using the ORBEYE™ extracorporeal video microscope (Olympus America):
 - (1) Transcanal stapedectomy including placement of a Lippy bucket handle prosthesis
 - (2) Endaural revision radical canal wall down tympanomastoidectomy with eustachian tube obliteration for cholesteatoma with adherence to a dehiscent facial nerve
- Both procedures were successful without intraoperative complications or conversion to binocular operative microscopy
- Operative times were 91 minutes for the transcanal stapedectomy and 154 minutes for the endaural tympanomastoidectomy
- Positive feedback: high quality of the 3D-HD display, improved visualization secondary to increased degrees of freedom of exoscope adjustment, superior ergonomics, and overall reduction in surgeon fatigue
- Negative feedback: smaller focal window despite wider range of focal lengths when compared to the binocular microscope, increased eyestrain with prolonged eyeglass and monitor use, and occasional unconventional adjustments to hand positioning to accommodate the exoscope at certain angles

Discussion

The introduction of the operating microscope revolutionized otology and neurotology but also introduced challenges due to spatial constraints, a narrow focal length, and limited flexibility. These issues often necessitate that surgeons work in uncomfortable positions, leading to fatigue and discomfort. The microscope's large size and narrow range of focal lengths require frequent surgeon adjustments and impose limitations on operating room setup. 3D-HD exoscopes may overcome some of these limitations, even when working in a narrow operative corridor. This study describes the use of the exoscope for transcanal and endaural otologic procedures.

Advantages

- Increased maneuverability and improved ergonomics, resulting in decreased surgeon fatigue
- Short learning curve and comparable operative times to procedures using binocular operative microscopy
- Improved visualization for all participants in the operating room

Disadvantages

- Increased eyestrain with prolonged eyeglass and monitor use
- Smaller area of focus and increased incidence of loss of stereopsis due to partial scope occlusion, limiting certain hand positions

Limitations of Study

- Retrospective review of a small patient population measuring mostly subjective surgeon feedback
- Limited prior exoscope experience, increasing the potential for future improvements in efficiency and operative time
- Future prospective studies including a wider array of otologic procedures and more robust objective comparisons are necessary

Conclusion

The exoscope is a safe and viable alternative to the operative microscope for transcanal and endaural otologic procedures. It can provide excellent visualization in these narrow operative corridors without compromising patient safety or surgical exposure.

Figure 1. Exoscope Setup



Figure 1. Depicts the setup of the exoscope and position of the surgeon in relation to the system. The video display demonstrates placement of a Lippy bucket handle stapes prosthesis.

Figure 2. Endaural Tympanomastoidectomy



Figure 2. Demonstrates the view obtained during an endaural revision tympanomastoidectomy.

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