

A Steerable Trans-Eustachian Endoscope for Middle Ear Examination

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Hypothesis: A custom-built miniature endoscope can traverse the Eustachian tube and provide diagnostic-quality visualization of the middle ear space.

Background: In patients with middle ear pathology, surgical exploration is often necessary to confirm diagnosis and/or survey for recurrent disease. We hypothesized that surveillance surgery could be avoided if a miniature endoscope could be used to inspect the middle ear via the Eustachian tube.

Methods: Three formalin-preserved cadaveric temporal bones with fully intact Eustachian tubes were used for this pilot study. A custom-built, 1.6mm-diameter, steerable, flexible endoscope with integrated digital camera was used for video surveillance. An Eustachian tube dilation system was utilized to dilate soft tissues following which the endoscope was inserted into the middle ear space through the Eustachian tube. The camera was steered in multiple directions to provide wide-field views. Diagnostic validity was assessed using a 5-point Likert-scale survey distributed to attending otolaryngologists, neurotology fellows, and senior otolaryngology residents.

Results:

Grading of the quality of endoscopic examinations in terms of illumination, focus, and overall experience yielded a mean score of 4.05/5 (standard deviation =1.00), corresponding to an adequate view for diagnostic purposes. The sinus tympani was the most difficult subsite to visualize (3.36/5), while ossicular chain and mesotympanum were the easiest to visualize (4.20/5 and 4.42/5, respectively).

Conclusions: The steerable flexible endoscope designed for this work provides diagnostic-quality video of a wide anatomic range of the middle ear space. This cadaver study is an important step towards the goal of in-vivo trans-Eustachian tube middle ear endoscopy.

REQUIRED:

Define Professional Practice Gap & Educational Need: 1. Diagnostic and surveillance surgeries for middle ear pathology are common but have associated morbidity. 2. Portions of the middle ear cavity are not easily visible through traditional transcanal or transmastoid approaches.

Learning Objective: The latest miniature chip tip cameras and novel endoscope designs make trans-Eustachian tube middle ear endoscopy technically feasible.

Desired Result: Attendees will understand the current status of, and potential future applications for, transeustachian middle ear endoscopy

Level of Evidence – Not Applicable (cadaveric studies with proprietary device)

Indicate IRB or IACUC : Exempt