Middle ear endoscopy and trans-tympanic drug delivery using an interventional sialendoscope: a feasibility study in human cadaveric temporal bones

Geoffrey Peters, MD; James Lin, MD; Moises A. Arriaga MD; Dan W. Nuss, MD; Barry Schaitkin, MD; Rohan R. Walvekar, MD

1Department of Otolaryngology Head Neck Surgery, LSU Health Sciences Center, New Orleans, LA
2Department of Otolaryngology Head Neck Surgery, University of Pittsburgh, Pittsburgh, PA

Abstract

Objectives: The aim of our study was to assess feasibility of using a 1.3mm semi-rigid interventional salivary endoscope for middle ear endoscopy and as a route for trans-tympanic delivery of medication in human cadaveric temporal bones.

Methods: Five temporal bones harvested from human cadavers were examined. A 1.3mm diameter Marchal interventional sialendoscope equipped with an interventional channel (0.4 mm) and an irrigation/suction channel was used. Middle ear endoscopy was performed via endoscopic guided postero-inferior and antero-superior myringotomies. The round window niche (RWN) was easily identified, and a guide wire was placed within the RWN after navigating the ET. The round window niche was again identified and cannulated with a guide wire.

Results: Access to the RWN was obtained via a postero-inferior myringotomy in all five temporal bones (100%). A guide wire could be navigated to the RWN without difficulty in all patients. The opening to the ET was visualized and cannulated with a guide wire in all patients where it was attempted (N=3). In one case, ET access was obtained via an existing perforation in the TM without the need for an additional incision. Middle ear examination was successful in all specimens (N=5). Four temporal bones had intact tympanic membranes while one tympanic membrane had a perforation in the antero-inferior quadrant. Access to the RWN was obtained via a postero-inferior myringotomy in all five temporal bones (100%). A guide wire could be navigated to the RWN without difficulty in all patients. The endoscope provided adequate visualization of the RW. Other structures identified included the incudostapedial joint, stapedius tendon, pyramidal eminence, and facial nerve. Adequate visualization of the contents of the postero-superior quadrant required an extension or widening of the incision. The anterior middle ear space was also successfully examined through an endoscopic guided antero-superior myringotomy. The opening to the ET was visualized and could be cannulated with a guide wire in all patients where it was attempted (N=3). In one case, ET access was obtained via an existing perforation in the TM without the need for an additional incision.

Conclusions: The 1.3 mm interventional sialendoscope allowed adequate visualization of the ET, middle ear space, and the RWN with interventional capabilities in a cadaveric model. Our result validates the feasibility of this use for trans-tympanic drug delivery. However, the proposed indication for the use of the sialendoscope needs to be evaluated in a clinical setting.

Introduction

Trans-tympanic injections are recommended for treating a variety of otologic conditions such as, idiopathic sudden sensorineural hearing loss, Meniere’s disease, vestibular disease, and immunemediated sensorineural hearing loss. However, the overall efficacy and appropriate dosage is variable from patient to patient. Determining effective dosage has proven to be difficult. Azarni and Linthicum have shown that there is an anatomical variation of the round window niche (RWN). In this study, 33.2% of temporal bones examined had obstruction of the round window (RW) membrane. In a retrospective study of 41 patients undergoing middle ear endoscopy to evaluate the RW, a significant portion of patients had partial or complete obstruction of the RW which required lysis of adhesions. The authors concluded that middle ear endoscopy should be contemplated in patients requiring intra-tympanic instillation of medication for inner ear disease to promote adequate drug delivery and diffusion. Consequently, middle ear endoscopy may have a role in trans-tympanic therapy. It can provide visualization of the RWN, identification and removal of obstructive tissue, and administration of medications under direct visualization. Endoscopic visualization of the middle ear space, and trans-tympanic instillation of medication, is an area of ongoing research and development in cadaveric and human subjects for several decades. Endoscopically-assisted diagnostic and surgical procedures have been described, but there have been few reports on the interventional capabilities of oto-endoendoscopes. Piontke et al (2002) described the use of a fiberoptic micro endoscope with a 1.2 mm working channel for ET exploration and diagnosis. Oto-endoendoscopy is currently used for diagnosis and treatment of cochlear implantation and labyrinthine congenital anomalies. The Marchal 1.3mm sialendoscope as well as the Erlangen (1.1 and 1.6 mm, 0.45 and 0.8 mm working) sialendoscopes are ‘compact scopes’ that have an infilled working and irrigation channel comparable to the oto-endoendoscopes. The interventional sialendoscopes have fiber optic capabilities similar to the oto-endoendoscopes currently in use and have been validated for the adequacy of their optics and interventional capabilities in clinical studies for salivary gland pathology. The irrigation port of the sialendoscope has proven valuable as a drug delivery mechanism in patients who require intra-glandular instillation of medication for conditions such as radio-iodine induced sialadenitis, or recurrent viral parotitis. In addition, the compact scopes have a larger working channel as compared to the 1.2 mm micro-endoendoscope described by Piontke (2002). This interventional port allows a variety of interventional tools to be housed such as a hand driven micro-burr/cup forceps, laser fibers, balloon dilators, and wire baskets at the expense of a slight increase in the diameter of the scope. In comparison, the oto-endoendoscope is currently not equipped to house these interventional tools. This does not require a larger incision to be made on the tympanic membrane. We found that the additional working length of the salivary endoscope as compared to the micro-endoendoscope (12cm vs. 5cm) does not hamper the use of second instrument in the external ear allowing a two handed technique for surgical maneuvers. The use of interventional sialendoscopes has not been investigated for middle ear procedures. Our study proves that the image quality, maneuverability, and interventional capabilities of the sialendoscope can be translated to the middle ear space. These capabilities are equivalent to those offered by oto-endoendoscopes with some additional interventional capability. Further validation of their use for otologic indications will also offer an extended application for the use of the sialendoscope and a more cost-effective use of financial resources. The disadvantage to the sialendoscope is that the zero degree angle does not allow visualization of the entire middle ear cavity. Also, the overall image quality is less when compared to the traditional 1.9 mm rigid telescope.

Discussion

Several types of flexible and rigid endoscopes have been investigated and are in use for middle ear endoscopy. Similarly, there are several configurations of the sialendoscope that are currently being used routinely for endoscopic visualization of the salivary duct and to perform interventional procedures such as fragmentation and removal of stones and dilation of strictures. The Marchal 1.3 mm (0.4mm working) sialendoscope as well as the Erlangen (1.1 and 1.6 mm, 0.45 and 0.8 mm working) sialendoscopes are ‘compact scopes’ that have an infilled working and irrigation channel comparable to the oto-endoendoscopes. The interventional sialendoscopes have fiber optic capabilities similar to the oto-endoendoscopes currently in use and have been validated for the adequacy of their optics and interventional capabilities in clinical studies for salivary gland pathology. The irrigation port of the sialendoscope has proven valuable as a drug delivery mechanism in patients who require intra-glandular instillation of medication for conditions such as radio-iodine induced sialadenitis, or recurrent viral parotitis. In addition, the compact scopes have a larger working channel as compared to the 1.2 mm micro-endoendoscope described by Piontke (2002). This interventional port allows a variety of interventional tools to be housed such as a hand driven micro-burr/cup forceps, laser fibers, balloon dilators, and wire baskets at the expense of a slight increase in the diameter of the scope. In comparison, the oto-endoendoscope is currently not equipped to house these interventional tools. This does not require a larger incision to be made on the tympanic membrane. We found that the additional working length of the salivary endoscope as compared to the micro-endoendoscope (12cm vs. 5cm) does not hamper the use of second instrument in the external ear allowing a two handed technique for surgical maneuvers. The use of interventional sialendoscopes has not been investigated for middle ear procedures. Our study proves that the image quality, maneuverability, and interventional capabilities of the sialendoscope can be translated to the middle ear space. These capabilities are equivalent to those offered by oto-endoendoscopes with some additional interventional capability. Further validation of their use for otologic indications will also offer an extended application for the use of the sialendoscope and a more cost-effective use of financial resources. The disadvantage to the sialendoscope is that the zero degree angle does not allow visualization of the entire middle ear cavity. Also, the overall image quality is less when compared to the traditional 1.9 mm rigid telescope.

Results

Conclusion

The 1.3 mm interventional sialendoscope allowed adequate visualization of the ET, middle ear space, and the RWN with interventional capabilities in a cadaveric model. Our result validates the feasibility of this use for trans-tympanic drug delivery. However, the proposed indication for the use of the sialendoscope needs to be evaluated in a clinical setting. Additional cadaveric and human studies are necessary to further investigate additional applications for its use in the field of otolaryngology.

References