Two-Port Endoscopy of the Middle Ear

Endoscopic Anatomy

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Objectives: To shed light on the endoscopic anatomy of the middle ear seen on 2-port endoscopy and to describe potential clinical applications.

Design: Anatomical structures were visualized by transmeatal or transtympanic rigid scopes of different angles and by a flexible scope in the eustachian tube. This arrangement ensured reciprocal guidance of the scopes and provided access to regions not seen otherwise.

Setting: The Department of Anatomy I, University of Vienna, Vienna, Austria.

Materials: Forty tympanic cavities obtained from cadaver skulls without prior fixation were examined. Specimens did not show any abnormalities and were chosen without regard to age or sex.

Results: Depending on the angle of view, rigid transmeatal or transtympanic endoscopes provided a full view of the entire tympanic cavity except for the epitympanum, access to which was barred by the incudomalleal joint, the malleal folds, and the tympanic chord, but the epitympanum was well visualized through the flexible, steerable, transtubal scope.

Conclusions: Two-port endoscopy of the middle ear offers a full view of all structures in the tympanic cavity. The atraumatic transtubal approach to the tympanic cavity enhances the safety of transmeatal interventions and facilitates postoperative follow-up.


Ever since endoscopic techniques were introduced into otorhinolaryngology by Mer et al in 1967, endoscopy has become a practicable procedure. In general, 2 approaches are used: (1) transmeatal after raising a tympanomeatal flap, and (2) transtympanic through a tympanic incision. Both approaches are, albeit minimally, invasive. Transmeatal and transtympanic scopes offer more or less the same view of the middle ear structures as the operating microscope, but thanks to angled optics that provide access around bends, these scope’s field of view is superior to that of the microscope. The only noninvasive approach to the middle ear is through the preformed channel of the eustachian tube. First described by Kimura et al in 1989, transtubal endoscopy only recently gained ground in some centers as fiberoptic systems were technically perfected. This study was designed to examine the potentialities of combining the 2 approaches, with a view to extending the field of view and reciprocally guiding the optical instruments.

For 2-port (transtubal plus transtympanic or transmeatal) endoscopy, the scopes are arranged at an angle of roughly 70° to one another. This arrangement offers a double advantage: (1) the dead angle of one scope (area not accessible to it) can be inspected through the other scope, and (2) the movements of the scopes in relation the tympanic structures can be followed so that the safety of the procedure is enhanced.

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MATERIAL AND METHODS

Forty tympanic cavities were examined without prior fixation in intact skulls. Specimens were chosen without regard to sex or age and did not show any visible abnormalities. In 20 of them, the vessels were injected with colored latex for easier identification. The transtympanic (or transmeatal) scope was inserted by one examiner, while another examiner handled the transtubal scope. In some cases, the transtympanic scope was held in a special support (Unitrac Aesculap, Tuttingen, Germany).

A flexible, steerable scope with an outside diameter of 0.8 mm (technical specifications, 12,000 pixels; angle of view, 70°; total length, 650 mm; deflection angle, 90°; and length of deflectable part, 25 mm; Micromed Co, Dornbirn, Austria) was used for transtubal endoscopy. Heads were positioned in 30° lateral decubitus. The scope was introduced through a tubal catheter placed at the pharyngeal orifice of the eustachian tube under endoscopic guidance (rigid 70° scope) through the contralateral nasal airway. After removing the rigid scope, the same examiner advanced the flexible steerable scope into the middle ear through the tubal catheter. Successful advancement of the scope to the middle ear requires an adequate width of the tubal isthmus (mean, 1.0 mm wide and 2 mm high, as reported by Proctor). In our study, the isthmus was successfully negotiated with the 0.8-mm scope in 37 (92.5%) of 40 cases.

Transmeatal or transtympanic endoscopy was performed with a rigid scope by the second examiner. Transtympanic endoscopy was done as suggested by Poe. Depending on the approach chosen, the outside diameter of the scope was either 2.3 or 1.9 mm, with angles of 0°, 30°, or 70° (Karl Storz, Tuttingen, and Aesculap).

For the transmeatal approach, the tympanic cavity was opened by endoscopically raising a tympanomeatal flap so that the scope entered the posterior part of the cavity below the incudostapedial joint. For the transtympanic approach, radial incisions were made in the tympanic membrane either between the posterosuperior and the posteroinferior quadrant or in the anteroinferior quadrant, depending on the region of interest. Images were recorded on a digital image recording device from S-VHS video sources (Digi-Still Unit and S-VHS Video Recorder; Sony, Vienna, Austria).

by several anatomical structures, such as the incudomalleolar joint and the tympanic chord with the malleol folds. The 70° scopes offer a very limited view anteriorly because of the extra length of the tip, which is necessary to achieve this large angle. As a result, maneuvering them is difficult and, as the tip of the scope lies beyond the field of view, safety is at risk. The use of 90° scopes does not appear to be necessary, because structures located at 90° to the scope axis can be seen well enough with 70° scopes because of their adequate lens-opening angle.

TRANSTUBAL APPROACH

In our study, the isthmus was successfully negotiated in 37 (92.5%) of 40 cases. Passage was aided by subtly maneuvering and turning the scope tip. Once the steerable scope has reached the protympanum, it can be advanced along 2 alternative routes: (1) above the tensor tendon into the epitympanum (Figure 1) and then along the tegmen to the mastoid antrum; or (2) below the tensor tendon into the mesotympanum (Figure 2) toward...
the incudostapedial joint and then either (a) medial to the incus and above the stapes into the aditus ad antrum (Figure 3) or (b) lateral to the incus toward the tympanic chord (Figure 4) or (c) below the stapes toward the lateral sinus (Figure 2). As the scope is advanced through the mesotympanum, it passes the entire tympanic membrane, which forms the lateral wall and can be inspected in its entire extension. When the approach chosen dictates an anteroposterior angle of view, the round window niche is not seen at all, and the view into the tympanic recess is poor.

Along the routes described, the flexible scope was easily maneuvered past the ossicles in our anatomical specimens without injuring them. Still, it would seem useful to check the position of the scope, particularly that of the bend in the steerable part. Along route c, however, checking the position of the scope is mandatory.

TWO-PORT APPROACH

With 30° rigid scopes, the progress of the flexible, steerable scope can be monitored throughout the middle ear; conversely, movements of the rigid scopes can be monitored by the flexible, transtubal scope. Combining the 2 approaches extends the field of view so that the entire tympanic cavity, including all the recesses, can be explored.

When 2 ports are used, 70° scopes are dispensable, because the most important recesses in the posterior wall can be fully inspected with the transtubal scope, but they are still useful for viewing the stapes from below, as well as the tympanic orifice of the tube. Two-port endoscopy offers another invaluable advantage: it confers a sense of spatial depth so that the true distance of the front lens from vulnerable structures and their true size can be evaluated. In the middle ear, mucosal folds or adhesions may limit the field of view. These are usually very delicate and easily pierced by the scope and can only be safely manipulated if the space behind them is open to inspection from another vantage point.

COMMENT

First described by Kimura et al in 1989, transtubal endoscopy of the middle ear has not gained the acceptance...
The usefulness of the transtubal scope as a follow-up tool can easily be assessed intraoperatively with access from 2 ports, which will show whether the tubal isthmus can be negotiated and whether structures relevant for postoperative follow-up examinations will actually lie in the field of view. The transtubal approach has raised more than these diagnostic expectations: Chays et al6 believe that transtubal microendoscopic laser surgery is a realistic prospect, while Hopf et al7 hope that transtubal microendoscopy will eventually provide the basis for a causal treatment of tubotympanic abnormalities, eg, the aspiration of inspissated secretions or the release of adhesions in patients with tubal stenoses.

A full view of the entire tympanic cavity is of particular importance in cholesteatoma surgery. Rosenberg et al8 consider transmeatal endoscopy of the middle ear to be a valuable technique in this field, complementary to classic microscopy. They believe that the gain in sensitivity for evaluating residual cholesteatoma will reduce the invasiveness of surgery.

Karhuketo et al9 examined various transtympanic approaches for 0°, 30°, and 90° scopes to pinpoint the structures that the surgeon can visualize with each scope. They reported that endoscopes provided a much better view than the operating microscope and suggested that posterosuperior myringotomy was the best route of access. Comparing the 0°, 30°, and 70° scopes, Klug et al10 found access to the epitympanum to be barred by various anatomical barriers. However, the epitympanic region can be seen well enough through the transtubal scope, which, in turn, does not provide visualization of the round window niche. This flaw was confirmed by Ogawa et al,11 who reported that ruptures of the round window niche diagnosed by transtympanic endoscopy in 2 patients had been missed on prior transtubal endoscopy. In our view, 90° scopes do not offer more information than the 70° scopes, and they are less easily handled.

Two-port endoscopy of the middle ear, transmeatal or transtympanic and transtubal, offers a full view of the entire tympanic cavity. Areas not seen along one approach can be seen well along the other approach. Also, the tympanic cavity can be better inspected with controlled movements of the scope tip. The benefits obtained in terms of steerability and safety outweigh the loss of light and the poorer resolution due to the loss of pixels (given the same outside diameter, the steering unit, of necessity, reduces the size of the optical part). No doubt, fears of injuring the tiny middle ear structures with the flexible scope are well founded because the bend of the scope cannot be seen with the scope tip. Such injuries can be minimized, however, by follow-

Figure 4. The transmeatal scope (rigid; 2.3-mm outside diameter; 30° angle) allows visualization anteriorly and superiorly, enabling the surgeon to use the transtubal scope to negotiate the space between the handle of the malleus and the incus. The flexible, steerable, transtubal scope passes the tensor tendon superiorly and enters the epitympanum, allowing inspection of the incudomalleolar joint.
2-port endoscopy of the middle ear can be used to assess the ease of passage of the transtubal scope through anatomical structures (tubal isthmus), as well as to evaluate the diagnostic information that can be expected postoperatively.

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REFERENCES