



The key procedures endoscopy potentially has advantages over microscopy

- Cholesteatoma surgery — especially in early/limited disease
- Chronic suppurative otitis media
- Tympanic membrane retraction/atelectasis
- Myringoplasty/tympanoplasty
- Ossicular chain reconstruction
- Revision surgery of any of the above

Yet-to-be-defined extension procedures where endoscopy use has clear advantages over microscopy

- Stapedectomy/stapedotomy
- Cochlear implant surgery
- Inner-ear and lateral skull-base access

Ear to stay

ENT

Exciting advances in endoscopic surgery techniques offer useful new options for otology patients.

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IN the 1980s, two Austrian rhinologists added functional concepts of sinonasal mucociliary patterns to endoscopic endonasal surgical interventions, previously published by two German rhinologists.¹ Thus was the birth of functional endoscopic sinus surgery. Today, this approach is the gold standard in sinonasal disease surgery. Why did a similar transition not occur in ear surgery?

Otologic surgery had been dominated by the operating microscope from the early 1920s by two German otologists. Early microscope use was slow, had limited vision, a small working distance, poor illumination, instability and lack of manoeuvrability.

These issues were rectified and the operating microscope was used widely by the 1950s.²

Problems with ear surgery

Functional endoscopic sinus surgery was increasing in use, and endoscopic ear surgery was being used as an adjunct to the microscope and as a primary treatment.^{3,4} There were, however, three key limitations that prevented its full transition to ear surgery.

First, the light source converted significantly to heat at the endoscope tip, risking damage to critical structures, for example, the facial nerve. With newer xenon, and then LED light sources, there is minimal heat dissipation when using lower light source settings.⁵

Second, endoscopes small enough to fit in the middle ear had very limited magnification and field of view.

A newer, smaller 3mm endoscope has been introduced.⁶ This allows sufficient space for simultaneous insertion of instrumentation through the ear canal, even

in small children.

Finally, there were many issues relating to the endoscope's camera. Single-chip cameras were prone to “red-out” in small areas because of bleeding saturating the field and minimising identification of anatomical

pictures and improved image magnification.⁷ This makes it possible to see individual red blood cell clusters travelling through capillaries in the middle ear intra-operatively.

International collaboration and adoption of this

This technology is in its infancy and, with the goalposts constantly shifting, defining a clear set of indications is difficult.

structures. These have been replaced with triple charge-coupled device cameras, without this effect occurring.

High-definition video has replaced standard-definition, creating crisper, clearer

technology has now begun in earnest, with the formation of the International Working Group on Endoscopic Ear Surgery, and its first world congress in 2015. This technology is here to

stay — but what does it mean to patients in practical terms?

Indications for endoscopic ear surgery

Some argue that the endoscope is now indicated in any and all otologic surgical procedures. Previously, otological procedures were exclusively performed with the microscope. Recently, the endoscope has had limited use as an adjunct to the microscope to assess whether areas blindly dissected via the microscope were disease-free.

Many International Working Group members now claim to perform all otologic procedures endoscopically, mostly with microscopic guidance, but occasionally on its own.

This technology is in its infancy and, with the goalposts constantly shifting, defining a clear set of indications is difficult.

With time and more otologists using endoscopy, benefits and limitations will be better defined.

Advantages of endoscopic ear surgery

Lack of external scar

The incision is made within the ear canal incorporating the tympanic membrane, creating a tympanomeatal flap. This incision is generally made with a large post-auricular approach in most major ear surgeries.

With endoscopic surgery,

the tympanomeatal flap does not require suturing at the end, as it is placed back into position, healing remarkably well, often with no evidence of scar, even on otoscopy.

A less than 1cm incision is often made behind the tragus to take a cartilage or perichondrial graft — it is small and completely hidden.

Less-deforming surgery

Under microscopy, other than the post-auricular scar and necessary hair shaving, many major ear surgeries involve the creation of a canal wall or modified radical mastoid cavity.

This is disfiguring because: • Removal of cortical bone and the posterior canal wall creates a collapse of the post auricular skin, displacement of the pinna, and a visible and palpable divot in the bone.

• To facilitate surveillance and cleaning of this cavity, and ensure good aeration, a large meatoplasty is often performed. While functionally impressive, the procedure is unfortunately very disfiguring (see figures 1a and 1b).

Faster operating time

With any new technology, there is an inherent learning curve — most otologists have not noticed prolonged operating time. Endoscopic skills are already being used

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Visible post-auricular scar & mastoid defect



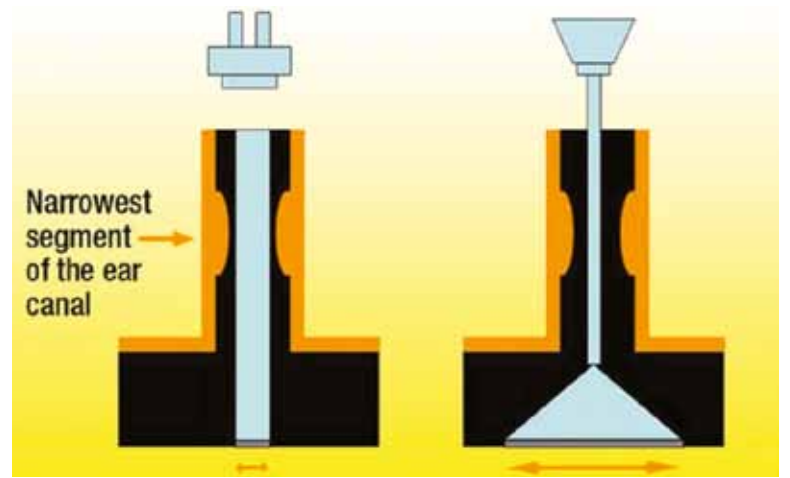
Large unsightly meatoplasty

Normal visibility of pinna



Figure 1b: Frontal view of same patient showing difference in pinna appearance

Posterior contraction of pinna from mastoid defect and post auricular scar



Limited microscopic field of view

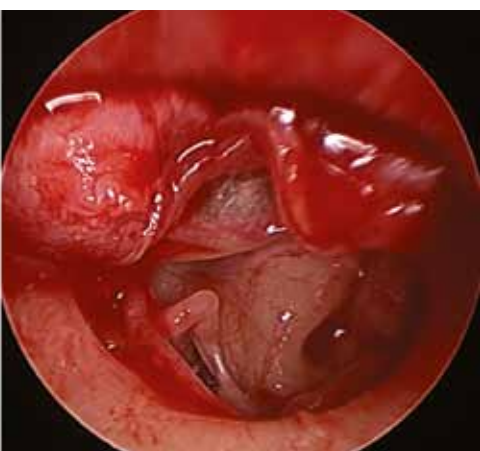
Wide endoscopic field of view

Figure 2: The view from the microscope in transcanal surgery is limited by the narrowest segment of the ear canal, whilst the endoscope bypasses this narrow segment. Source: Dr M.Tarabichi⁹

Figure 1a: View of external ear after canal wall down mastoidectomy



Microscopic view



Endoscope view

Figure 3: Microscope vs endoscope view of same ear



Dressing after transcanal approach (Typical of endoscopic ear surgery)



Dressing after post-auricular approach (Typical of microscopic ear surgery)

Figure 4: Typical dressing after microscopic surgery vs endoscopic surgery

from previous page by ENT surgeons for sinus surgery.

Familiarisation time is balanced by a reduction in time opening and closing a wound behind the ear.

Better visualisation

Endoscopy provides a stunning view — the field is significantly wider. With the light source delivered to the tip of the endoscope, illumination, even on low levels, is excellent. Angled scopes allow vision around corners. A distinct disadvantage of the microscope is it relies on direct line of sight (see figure 2).⁸

Three key areas in the middle ear — retrotympanum, anterior epitympanum and protympanum — are not seen well with a microscope, even with surrounding bone removed. They can easily be seen by endoscopy, often without any bone removal, and sometimes without using an angled endoscope. Better visualisation significantly improves the understanding of key middle ear ventilation pathways, and how they relate to disease (see figure 3).¹⁰

Less pain and faster healing

A significantly smaller incision, plus decreased normal tissue and bone removal, results in less pain — leading to decreased/nil post-opera-

tive analgesia. Healing time is faster and hospital stay reduced to day-only.

Potentially better function

Extensive mastoid surgery may result in patients having their lateral semicircular canal exposed. Cold water (or air) enters the ear canal causing profound, disabling vertigo. Widespread mastoid surgery is generally not self-cleaning, and patients need lifelong ENT surgeon surveillance/toilet. Endoscopic ear surgery avoids both, better preserving the ear's innate function (see figure 4).

Improved teaching

Microscope view does not allow others to see the surgery. Teaching transpires as the view and detail from endoscopic ear surgery simultaneously engages all staff/students in the operating theatre.

Disadvantages and limitations

Proof of concept

Conceptually, endoscopic ear surgery is excellent. Unfortunately, medical literature is relatively scarce compared with literature on established open techniques.

There has been an exponential growth in more recent publications, encouraged by the International Working Group and the first world congress.

Short-term results on quality of life, including healing time and post-operative pain, plus long-term results on no disease recurrence (eg, cholesteatoma and ossicle or tympanic membrane reconstruction) are of great importance in further validating the technique.

'Loss of one hand'

This is one of the biggest downsides of endoscopy.



The best way to view endoscopic ear surgery is that it is at one end of a spectrum.

Microscopic work allows two hands to work simultaneously — needed during periods of excess bleeding or in delicate work around the ossicles. Using the microscope for these tasks remains the best option.

Loss of 3D perception

The binocular microscope can see in three dimensions. The endoscope cannot, being essentially monocular. The endoscope does have

two features giving a simulated three-dimensional experience — haptic feedback between scope-holding and operating hands, and the interplay of shadow and light within the ear, which constantly shifts slightly — assisting in creating the impression of depth.

Optimum instrumentation

Using the presently developed instruments can at

Retraining

While the endoscope offers improvements, the amount that can be done with the endoscope vs the microscope is minimal.

As a result, established surgeons are more likely to use the microscope, rather than adopt new technology for minimal gain. Eventually, if patient experience and long-term results prove the expected advantages, further uptake will ensue.

Final thoughts

Overall, the best way to view endoscopic ear surgery is that it is at one end of a spectrum, with microscopic surgery at the other — thus a need for both exists. There will be situations of use along that spectrum — microscope alone, microscope plus endoscope, and endoscope alone. Although indicative criteria will guide which to use for each case, it will likely always remain a fairly individual choice — and may vary from patient to patient with the same disease.

It is interesting that not one surgical specialty that has moved from larger-cut open surgery to a minimally invasive technique using scopes has ever reverted back. All have charged towards the newer technology. This is an exciting area of development, and defi-

nately one to watch — both now and into the future. ●

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References

1. *Journal of Laryngology and Otology* 2010; 124:242-50.
2. *American Journal of Otology* 2000; 21:877-86.
3. *Laryngoscope* 1993; 103:939-43.
4. *American Journal of Otology* 1997; 18:544-49.
5. Ito T, et al. Safety of Temperatures Generated by Endoscopes in Transcanal Endoscopic Ear Surgery. 147th Annual Meeting of the American Otological Society. Las Vegas, US. 2014.
6. *Otolaryngology Clinical North America* 2013; 46:245-55.
7. *Wideochir Inne Tech Maloimwazyjne* 2014; 9:276-81.
8. *Otolaryngology Clinical North America* 2013; 46:107-30.
9. *Laryngoscope* 2010; 120:1028-33.