Exoscopes for mastoid and lateral skull base surgery

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Disclosures

3NT Medical
Akousos
Agilis
Auregen BioTherapeutics
Frequency Therapeutics
Triton Systems
Three main options for surgical visualization and magnification:

<table>
<thead>
<tr>
<th></th>
<th>Operating Microscope</th>
<th>Traditional 2D Endoscope</th>
<th>3D Exoscope</th>
</tr>
</thead>
<tbody>
<tr>
<td>3D Image</td>
<td>✓</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Focal distance</td>
<td>20-50 cm</td>
<td>1-3 cm</td>
<td>20-50 cm</td>
</tr>
<tr>
<td>Visualization</td>
<td>Line of Sight</td>
<td>HD Monitor</td>
<td>HD Monitor + 3D Glasses</td>
</tr>
</tbody>
</table>

Smith et al, 2019
“Heads up ear surgery”

**Endoscopes** for *small surgical corridors* (e.g. transcanal middle ear surgery)

**Exoscopes** for *open surgical corridors* (e.g. mastoidectomy, craniotomy)
  - extra-corporeal scope
Exoscopes have several common features

- 3D HD or 4K video camera
- High-intensity light source
- Camera holder / arm
- Foot/hand controller
- Immersive 3D video panel
- 3D glasses for users
Heads-up ear surgery with exoscopes:

Initial Experience with 3-Dimensional Exoscope-Assisted Transmastoid and Lateral Skull Base Surgery.

Smith S¹,², Kozin ED¹,², Kanumuri VV¹,², Barber SR¹,³, Backous D⁴, Flávio Nogueira J⁵, Lee DJ¹,².
11 cases, no complications

- 4 canal up mastoidectomies
- 3 canal wall down mastoidectomies
- 1 postauricular tympanoplasty
- 1 subtotal petrosectomy
- 2 suboccipital craniotomies for tumor resection
VAS Survey Results

<table>
<thead>
<tr>
<th>Category</th>
<th>Exoscope</th>
<th>Operating Microscope</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ease of Manipulation</td>
<td>8</td>
<td>7</td>
<td>0.26</td>
</tr>
<tr>
<td>Lack of Neck Strain/Fatigue</td>
<td>9</td>
<td>8</td>
<td>0.03</td>
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<tr>
<td>Ergonomics</td>
<td>8</td>
<td>7</td>
<td>0.44</td>
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<tr>
<td>Image Quality</td>
<td>9</td>
<td>8</td>
<td>0.23</td>
</tr>
</tbody>
</table>

Visual Analog Scale Scores
Exoscope: Initial Impressions vs. microscope?

ADVANTAGES
• Compact camera unit
• Superior ergonomics, less neck strain
• Immersive video experience is better for teaching

DISADVANTAGES
• Inadequate lighting in narrow spaces
• Pixilation at high magnification
• Video system challenges small Ols
• 3D experience not for everyone
What do we want to see in future exoscope designs?
Compact camera head that does not obscure the video monitor
Optical zoom
A camera head that can be easily manipulated manually or through a powered / robotic controller
Video quality = glass lens microscopic image quality

8K? 16K?
3D video monitors that do NOT require 3D glasses