Middle Cranial Fossa Technique

Indications

- Acoustic Tumors
  - not touching brainstem
  - NF2 smaller tumor?
- Facial Nerve Decompression
  - Bells Palsy, Trauma, Tumors
- Vestibular Nerve Section
- Petrous Apex Disease
  - Petrous Apeclitis, Cholesterol Granuloma?
- CSF Otorrhea
- Extended MCF+Temporal
  - Tentorial-Petroclival Meningioma, Clivus Chordoma
Microsurgical Acoustic Neuroma Excision
Middle Cranial Fossa Approach

• Advantages
  – Best hearing preservation rates
    • 60-80% in large series
  – Better exposure of lateral IAC
  – Tumor separation from VII under direct vision
  – Minimal incidence of headache compared to retrosigmoid
Microsurgical Acoustic Neuroma Excision
Middle Cranial Fossa Approach

• **Disadvantages**
  – Limited exposure of C-P angle
    • difficult if tumor touches brainstem
  – Difficult anatomy - few landmarks
  – Increased risk to facial nerve??
  – Temporal lobe retraction:
    • seizures??
    • aphasia??
    • intracranial hemorrhage??
Middle Cranial Fossa Technique

- Stenvers View Plain Film
- Location of Superior Semicircular Canal
- Facial Nerve Monitor
- Click Generator for BSER and EAP Measure
- Urinary Catheter
- Mannitol (250 cc 20%)
- Decadron (6 mg q 6 hr)
- Antibiotics (q 6 hr)
Stenvers View Plane Film Xray

Thickness of Bone Over SCC
Middle Cranial Fossa Technique

Instrumentation

- 2.5 mm & 1 mm right angle hooks
- Fisch Raspatory- right and left
- Dental Excavator- right and left
- assortment of 13 cm straight and angled cup forceps
- Cueva 1mm recording electrode for real time EAP measures CN VII

Important Concepts

- Elevate Dura Posterior to Anterior
- Tumor Dissection Always Medial to Lateral
- Decompress Tumor Posterior-Medial Before Working Lateral
2.5 mm Right Angle Hook

1 mm Hook

Fisch Elevator

5 mm Dental Excavator
Craniotomy

Inferior Margin at Zygomatic Root

Dural Elevation

IAC Exposure

3.5-4cm

6cm
Preventing Errors:
Middle Cranial Fossa Surgery

Dura Elevation:

- Check Stever’s view to determine SSC depth
- Elevate posterior to anterior
- Find petrous ridge posterior and elevate anterior direction
- SSC and Geniculate Ganglion may be exposed
- Identify Arcuate Eminence and Meatal Plane
- Retractor blade should hook under petrous ridge
Petrous Ridge
Preventing Errors:
Middle Cranial Fossa Surgery

IAC Exposure

Identify the “blue line” of the superior semicircular canal

• slowly remove bone with 3-4 mm diamond burr over arcuate eminence - does not always predict SSC
• SSC always perpendicular to petrous ridge
• Otic Capsule bone more dense and yellow
• If open into canal, bone wax immediately, no suction
Preventing Errors:

Middle Cranial Fossa Surgery

IAC Exposure:

• Begin IAC exposure anteriomedial to SSC at the petrous ridge
  • Leave 1mm bone at petrous ridge to hold retractor blade
  • Cochlea immediately caudal to labyrinthine segment of VII
  • Expose 270 degrees around IAC medial to Bill’s Bar
  • Watch for ampulla of SSC and Cochlea medially
Preventing Errors:
Middle Cranial Fossa Surgery

• Tumor Removal
  • Always dissect tumor medial to lateral
    Prevents disruption of fragile auditory nerve entering cribrosa
  • Use fine micro instruments such as 1 – 2.5 mm right angle hooks
  • Dental excavators used for most lateral portion of IAC
  • Real time VIII EAP monitoring
  • Papaverin topical if begin to see changes in EAP
  • Remove both the inferior and superior vestibular
Auditory Nerve Monitoring for MCF Surgery

- Hearing preservation realistic goal if tumor does not broadly touch brainstem
- MCF route provides complete exposure lateral aspect IAC & early VII identification
- Hearing preservation
  - Iowa 81% Tumors < 1 cm (2006)
  - House Ear Clinic 70% (1994)
Auditory Nerve Monitoring for MCF Surgery

Problems with Auditory Monitoring

- Poor preop ABR due to hearing loss
- Time required for averaging ABR
  - 1,000 sweep ≈ 45 sec to see latency change
- Placement & stability of direct VIIIth nerve monitoring electrode
Auditory Nerve Monitoring for MCF Surgery

- VIII CN Near Field EAP
  - 1X2mm Cueva Adtech recording electrode
  - place between dura & bone, anterior-lateral in IAC
  - stable position important
  - monitor amplitude (10-50 sweeps)
  - wave I can be seen on line without averaging
Auditory Nerve Monitoring for MCF Surgery
Subject CE:
Direct Recording from Auditory Nerve

1 Sweep
Wave I amp = 69.7 µV

100 Sweeps
Wave I amp = 33.2 µV
Amplitude Comparison Between Direct Nerve and ABR Recordings

Direct Recording from Auditory Nerve, 100 Sweeps

Wave I amp = 33.2μV

2 Channel ABR 1087 sweeps

Wave I amp = 0.30μV
Facial Nerve Decompression
Preventing Errors:
Middle Cranial Fossa Surgery

Closure:

- Bone Wax Opened Aircells
- Large Apical Air cells Drill Out and Place Muscle
- Muscle Plug + Fibrin Glue
- Fascia + Fibrin Glue
- Cortical Bone if Expose Ossicles
Management of Small Acoustic Neuromas

Surgical Excision

- Complications 1995-2004  N=162
  - CSF Leak  N=9 (5.5%)
  - Post Op Seizure  N=2 (1.2%)
    - Only seizures in N=254 (0.7%)
  - Meningitis  N=2 (1.2%)
  - Intra Cranial Bleed  N=0
  - Aphasia  N=0
  - Death  N=0
Management of Small Acoustic Neuromas
Surgical Excision

Facial Nerve Function 1 Year Postoperative

<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>I-II</td>
<td>85%</td>
<td>94%</td>
<td>97% (90%=I)</td>
</tr>
<tr>
<td>III</td>
<td>12%</td>
<td>6%</td>
<td>3%</td>
</tr>
<tr>
<td>IV</td>
<td>2%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>V-VI</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
</tbody>
</table>

*Gantz, Harker, et al 1986
Extended Middle Fossa Exposure
Extended Middle Fossa Approach
Long-Term Hearing Preservation Following Microsurgical Excision of Vestibular Schwannoma

Erika Woodson MD¹, Ryan Dempewolf MD¹, Samuel Gubbels MD², Marlan Hansen MD¹, Bruce Gantz MD¹

¹University of Iowa Hospitals and Clinics
²University of Wisconsin-Madison
What to do with an IAC VS?

Observation? 47%

Radiation? 61%

Microsurgical Excision? 76%

What to do with an IAC VS?

Hearing Preservation Rates

Observation
47%\(^1\)

Radiation
61%\(^2\)

Literature Review

- Long-term Hearing Preservation in Vestibular Schwannoma
  
  Stangerup, Thompsen, Tos, Cay-Thomasen; Otology-Neurotology epub Jan, 2010
  - 1144 patients 1976-2008 Watch and Rescan
  - 377 observation 5 yrs, 102 observation 10 yrs
  - At diagnosis 53% presented with >70% WRS

  » At 4.7 yrs 59% preserved >70% WRS
  Those with 100% WRS—69% maintained >70% WRS
  Those with >70% WRS—39% maintained >70% WRS
### AAO-HNS Hearing Classification System

<table>
<thead>
<tr>
<th>Class</th>
<th>Pure-Tone Thresholds (dB)</th>
<th>SDS %</th>
<th>New Proposal SDS%</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>&lt; 30 dB</td>
<td>≥ 70%</td>
<td>I ≥ 70%</td>
</tr>
<tr>
<td>B</td>
<td>&gt; 30- &gt;50 dB</td>
<td>≥ 50%</td>
<td>II ≥ 70-50%</td>
</tr>
<tr>
<td>C</td>
<td>&gt; 50 dB</td>
<td>≥ 50%</td>
<td>III &lt; 50%</td>
</tr>
<tr>
<td>D</td>
<td>Any Level</td>
<td>&lt; 50%</td>
<td>IV &lt;10%- NR</td>
</tr>
</tbody>
</table>

Would argue that classification should only consider SDS.
AAO-HNS Classification vs. New Proposed Classification

Diagram showing a scatter plot with axes labeled 'Word Recognition (SDS)' on the x-axis and 'Pure-tone Threshold Average (PTA)' on the y-axis. The scatter plot is divided into four quadrants (I, II, III, IV) with different colored circles and dashed lines indicating classification boundaries.
Management of Small Acoustic Neuroma
Microsurgical Excision

Methods:

– Retrospective Chart Review- IRB Approved

– All Patients Undergoing MCF Excision AN: January 1995-June 2004

– Grouped according to overall tumor length (0.2-2.3 cm)  N=162
  • Intracanalicular: (small)  0.2-1 cm  N= 93
  • Extending Into CPA: (medium)  1.1-1.4 cm N= 34
  • Filling CPA not touching stem: (large)  1.5-2.5 cm N= 35

– Audiogram under head phones  W-22 word lists recorded
  • Preop
  • 1 year Post Op

Meyer et al
Otology & Neurotology vol 27, 2006
Management of Small Acoustic Neuromas

Surgical Results: All Sizes  N=162  (1993-2004)

WRS Classification

<table>
<thead>
<tr>
<th></th>
<th>I</th>
<th>II</th>
<th>III</th>
<th>IV</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>56</td>
<td>7</td>
<td>7</td>
<td>43</td>
<td>113</td>
</tr>
<tr>
<td>II</td>
<td>9</td>
<td>3</td>
<td>2</td>
<td>5</td>
<td>19</td>
</tr>
<tr>
<td>III</td>
<td>2</td>
<td>1</td>
<td>5</td>
<td>16</td>
<td>24</td>
</tr>
<tr>
<td>IV</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>Total</td>
<td>68</td>
<td>11</td>
<td>15</td>
<td>68</td>
<td>162</td>
</tr>
</tbody>
</table>

Preserve I = 69/156 (44%)

I → I = 56/113 (50%)

II → I = 47% (9/19)

III → I = 13% (3/24)

IV → I = 17% (1/6)

Improved Hearing

Preserve any WRS = 93/156 (60%)

I = 70/113 (62%)

I+II = 84/132 (64%)
## Post Operative WRS Based on Tumor Size

<table>
<thead>
<tr>
<th>Tumor Size</th>
<th>Measurable Word Recognition (Class I, II, III WRS)</th>
<th>Class I WRS Maintaining Class I WRS</th>
<th>Overall Class I WRS</th>
</tr>
</thead>
</table>
| \( \leq 1.0 \text{ cm} \)  
N=93          | 73%                                              | 59%                               | 53%                 |
| 1.1-1.4 cm  
N=34          | 41%                                              | 39%                               | 36%                 |
| \( \geq 1.5 \text{ cm} \)  
N=35          | 43%                                              | 33%                               | 33%                 |
| All Tumors  
N=162        | 60%                                              | 50%                               | 44%                 |
Auditory Nerve Monitoring for MCF Surgery

Near-Field EAP Recording from Auditory Nerve, 1 Sweep

Wave I amp = 33.2μV
Post Operative Word Recognition Scores With and Without Near Field Direct CAP VIII Monitoring

<table>
<thead>
<tr>
<th>Tumor Size</th>
<th>Measurable Word Recognition (Class I, II, III WRS)</th>
<th>Class I WRS Maintaining Class I WRS</th>
<th>Overall Class I WRS</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 1 cm w/o Direct CAP 1995-2000 N=51</td>
<td>64%</td>
<td>43%</td>
<td>40%</td>
</tr>
<tr>
<td>&lt; 1 cm w/ Direct CAP 2000-2004 N=42</td>
<td>81%</td>
<td>77%**</td>
<td>67%**</td>
</tr>
<tr>
<td>1.1-1.4 cm w/o Direct CAP 1995-2000 N=12</td>
<td>17%</td>
<td>22%</td>
<td>17%</td>
</tr>
<tr>
<td>1.1-1.4 cm w/ Direct CAP 2000-2004 N=22</td>
<td>57%*</td>
<td>50%</td>
<td>50%</td>
</tr>
</tbody>
</table>
Management of Small Acoustic Neuromas

Surgical Excision

1995-2000  N=82

No CAP DN Monitor

2000-2004  N=79

DN CAP Monitor

Post Op SDS

Percent

Post Op SDS

Percent

0-1.0 cm
1.0-1.4 cm
>1.5 cm

No CAP DN Monitor

DN CAP Monitor
41 of these subjects + 8 patients after 2004
= 49 subjects
mean 70.5 mo, range 25-163 mo
29 subjects had >5 y f/u
Management of Small Acoustic Neuroma
Microsurgical Excision MCF

Methods:

- Retrospective Chart Review- IRB Approved

- All Patients Undergoing MCF Excision AN: January 1995-June 2004
  - All Patients with Hearing Preservation (Class 1, 2 WRS  N=79) Contacted by letter

- Audiogram under head phones  W-22 word lists recorded
  - Preop
  - 1 year Post Op
  - Last
Grading Scales

Word Recognition Scale (WRS)

AAO-HNS
One Year Post-Operative

42 (86%) WRS I
5 (10%) WRS II

31 (63%) AAO-HNS A
15 (31%) AAO-HNS B
WRS I
- 90% still WRS I
- 100% serviceable

WRS II
- 3/5 improved to WRS I
- 4/5 still serviceable

AAO-HNS A
- 37.5% still AAO-HNS A
- 87% serviceable

AAO-HNS B
- 48% still serviceable
Changes In Hearing

• 7 patients had significant PTA changes
  – 4/7 patients upgraded after correction
• 3 patients had significant SDS changes
  – Patient 4: symmetric, bilateral 68% SDS.
  – Patient 49: symmetric, bilateral 92% SDS
  – Patient 37: bilateral SNHL over 90 mo follow-up until lost residual hearing in operative ear
AAO-HNSc at latest follow-up

Preserved serviceable hearing (corrected)

100% of AAO-HNS A
81% of AAO-HNS B
Hearing Preservation (WRS)

• 100% with WRS I retained serviceable hearing
• 88% with WRS I retained WRS I
• 100% with WRS I/II retained serviceable hearing

#37 excluded
100% AAO-HNS A retained serviceable hearing
86% AAO-HNS A/B retained serviceable hearing

Only 2 pts >148 mo
SE=0.31
Compared to Gamma Knife

Niranjan et al, 2008

MCF: 86% preservation
GKRS: 61% preservation
MCF Microsurgery
PreOp WRS and WRS at Last Visit
Average F/U 6 Years N=49

Pre OP | Last evaluation
---|---
I: 89%  n=45 | I: 91%  n=41
II: 10%  n=4 | I: 75%  n=3
III: 1%  n=1 | II: 7%  n=3
IV: 0% | II: 100% n=1

WRS
100-90% = 52%
89-80% = 42%
79-70% = 5%
WRS class at diagnosis and at the last evaluation

<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>Last evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td>I: 51%</td>
<td>I: 62%</td>
</tr>
<tr>
<td>II: 14%</td>
<td>II: 13%</td>
</tr>
<tr>
<td>III: 19%</td>
<td>III: 17%</td>
</tr>
<tr>
<td>IV: 15%</td>
<td>IV: 9%</td>
</tr>
</tbody>
</table>

Sven-Eric Stangerup
Gentofte University Hospital,
Copenhagen, Denmark
Conclusions

• Most subjects maintain initial PO SDS after microsurgical VS removal.
  – Initial PO WRS is predictive of long-term hearing.
  – Better long-term outcomes than observation or Gamma Knife.

• WRS is more representative of serviceable hearing than AAO-HNS.
  – WRS is less affected by presbycusis.
  – We would argue that 90% SDS and 65dB SRT is serviceable with a HA.

• Post-surgical changes do not alter the natural pattern of progressive bilateral SNHL in individual subjects.
Hearing does deteriorate during watch and wait for most patients
  - Those with 100% WRS do not deteriorate as fast
Radiation: Long-term hearing continues to deteriorate
Small Tumor (intracanalicular <1cm):
  - 82% hearing preservation (intraop VIII monitoring)
  - 76% Chance of Saving 70% SDS if >70% preop
  - Some improve hearing with microsurgery
Microsurgery: Long-term (5.9 yrs) 89% preserve grade I hearing
Why Watch and Wait for Small Tumors in Younger Patients???
  - Most grow at rate of 1-3 mm/year
  - Lose Chance to preserve hearing
Management of Small Acoustic Neuromas
Watch and Wait / Microsurgical Excision

Iowa Algorithm

**Age >65**
Scan yearly

- **Minimal growth**
- Not touching BS
- Scan yearly

- **Growth (2-3mm)**
- Translab or RadRx

**Age <65**
Tumor < 1.5cm
Class I, II WRS

- **MCF Microsurg**

**Age <65**
Tumor > 2cm
Class III, IV WRS

- **Translab Microsurg**

**Age <65**
Tumor ≤ 1.5-2cm
Class I, II WRS

- **Retrosig Microsurg**
Middle Cranial Fossa: Acoustic Tumors

Summary

• Can maintain hearing in tumors that do not broadly touch the brainstem
• Character of tumor, more than size, dictates ability to preserve VII and VIII function
• Preoperative hearing and size does correlate with ability to save hearing
• Real time near-field VIII EAP monitoring helpful
• Complication rate low compared to other surgical approaches