Skull Base Tumors

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House Clinic, Neurosurgery
Los Angeles
Disclosure

- Consulting agreement with Cochlear Americas (not relevant to this presentation)
Types of Brain Tumors

Types of Brain Tumors Treated at UCLA Neurosurgery

Brain Tumor Types

The UCLA Brain Tumor center of excellence is one of the leading and most comprehensive research and treatment programs for brain tumors in the United States. It is a multi-disciplinary team including the UCLA Neuro-Oncology Program, Brain Tumor Research Laboratories, Neurosurgical Oncology Outcomes as well as patient oriented social services, neuropsychological services, and quality of life improvement measures with collaborative efforts with close sponsoring organizations aimed at providing support groups and resources for patients and their families.

The UCLA Brain Tumor program brings together expert specialists including neurosurgeons, neuro-oncologists, neurologists, radiation oncologists, social workers, and neuropsychologists, to determine and deliver the most effective treatments and ensures the highest possible functioning and quality of life for each patient undergoing brain tumor treatment.

The UCLA Brain Tumor Program has a multidisciplinary team specializing in treating all types of brain tumors, including:

<table>
<thead>
<tr>
<th>Gilomas</th>
<th>Skull Base Tumors</th>
<th>Metastatic Cancer</th>
<th>Other Brain Tumors</th>
<th>Spinal Cord Tumors</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Anaplastic Astrocytoma (grade III glioma)</td>
<td>• Acoustic Neuroma (vestibular schwannoma)</td>
<td>• Brain Metastasis</td>
<td>• Brain cysts of all types</td>
<td>• Astrocytomas</td>
</tr>
<tr>
<td>• Astrocytoma (grade II glioma)</td>
<td>• Acromegaly</td>
<td>• Metastatic Brain Tumor (Brain Cancer from other organs)</td>
<td>• Choroid Plexus Papillomas</td>
<td>• Ependymoma</td>
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<td>• Brainstem Glioma</td>
<td>• Adenoma</td>
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<td>• CNS lymphoma</td>
<td>• Meningiomas</td>
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<td>• Ependymoma</td>
<td>• Chondrosarcomas</td>
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<td>• Colloid Cyst</td>
<td>• Schwannomas</td>
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<td>• Cystic Tumors</td>
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<td>• Ganglioneuromas</td>
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<td>• Dermoid Tumor</td>
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<td>• Glioblastoma (grade IV glioma)</td>
<td>• Glomus Jugulare Tumors</td>
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<td>• Germinoma</td>
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<td>• Glioma</td>
<td>• Infratentorial Meningiomas</td>
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<td>• Lymphoma</td>
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<td>• Juvenile Pilocytic Astrocytoma (JPA)</td>
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<td>• Nasal Carcinomas</td>
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<td>• Naso-pharyngeal tumors</td>
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<td>• Medulloblastomas</td>
<td>• Pituitary Adenomas</td>
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<td>• Pineal Tumors</td>
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<td>• Mixed Gliomas</td>
<td>• Pituitary Tumor</td>
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<td>• Pineoblastoma</td>
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<td>• Rathke's Cleft Cyst</td>
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<td>• Vestibular Schwannoma</td>
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<td>• Vascular Tumors</td>
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<td>Skull Base Tumors</td>
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<td>• Acoustic Neuroma (vestibular schwannoma)</td>
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<td>• Acromegaly</td>
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<td>• Adenoma</td>
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<td>Acoustic Neuroma</td>
<td>Brain Metastasis (Brain Cancer)</td>
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<td><em>vestibular schwannoma</em></td>
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</tbody>
</table>
• Schwannoma

• acoustic neuroma (vestibibular schwannoma)

• other (trigeminal, lower cranial nerve)

• Chordoma/Chondrosarcoma

• Epidermoid

• Glomus Jugulare
Common Thread

- Microsurgery
  - precise anatomy, compact structures
  - complex approaches: team surgery
- Stereotactic radiation
  - focused radiation with effect based on anatomy rather than tissue biology
  - fractionated or unfractionated
Class I evidence
Rare Tumors: <1/1,000,000/year
Tumors of Bony Origin

- Chordoma
  - notochord remnant
  - midline
- Chondrosarcoma
  - cartilagenous cells
  - off midline
• Quintessential symptom
• abducens palsy

• Treatment
• surgery
• diagnostic and therapeutic
• stereotactic radiation
• Proton Beam (+/-)
Prognosis

Chordoma
• high risk of progression and recurrence
• chondroid chordoma subtype may have better prognosis
• radical resection helps survival
• 5-year about 50%
• imatinib; other trials

Chondrosarcoma
• typically indolent course
• rarely high-grade
• may be observed with serial MR imaging rather than radiating
Tumors of Epidermal Origin

- Epidermoid tumor (a.k.a. epidermoid)
  - Primary: originate from ectodermal inclusions during development
  - Secondary: originate from middle ear inclusions secondary to ear disease

Dermoid cyst
• Quintessential symptom
• trigeminal neuralgia

• Treatment
• surgery

• controversy about aggressiveness
• observation
Prognosis

- very slow growing
- linear rather than exponential growth pattern
- monitoring with serial MR imaging
- re-operation many years in the future
- rare: risk of malignant degeneration
Glomus Jugulare Tumor

- Originate from glomus cells of sympathetic nervous system
- a.k.a. chemodactoma
- may occur anywhere along the sympathetic nervous system (e.g., carotid body tumor)
- 1-3% catecholamine-secreting
- 1-3% high-grade with metastases
- 10% familial, multiple
• Quintessential symptom

• pulsatile tinnitus

• Treatment

• surgery

• pre-operative embolization

• radiosurgery

• observation
Prognosis

• Dependent upon aggressiveness of tumor

• High risk of lower cranial nerve dysfunction with aggressive resection of larger tumors

• High risk of regrowth/recurrence with incomplete resection of aggressive tumors

• Small tumors are highly-responsive to radiosurgery, at least in the short-run
Non-acoustic Schwannomas

- Originate from schwann cells
- Obersteiner-Redlich zone
- Trigeminal schwannoma
- Lower cranial nerve schwannoma
• Quintessential symptom

• trigeminal schwannoma

• not facial numbness

• lower cranial nerve schwannoma

• not hoarseness or dysphagia
• Treatment
  • large tumors (>3cm)
    • microsurgical resection
      • total vs. subtotal
  • small tumors
    • surgery vs. radiosurgery vs. observation
• Prognosis

• benign, typically slow-growing tumors

• usually controllable with treatment

• management of cranial neuropathies
Acoustic Neuroma

- a.k.a. vestibular schwannoma
- “Historic” incidence: 1/100,000/year
- sporadic
- neurofibromatosis type 2
  - bilateral acoustic neuroma
  - autosomal dominant
- mutation of NF2 gene: 22q12
- 1/33,000 births
Presenting Symptoms

- about 2/3 hearing symptoms
- about 1/3 vestibular symptoms
- rare: trigeminal symptoms
- rarer: brainstem compression or facial nerve symptoms
Work-up

- Indicated for anyone with unexplained asymmetric sensorineural hearing loss
  - gradual or sudden
- MRI
  - thin cuts through internal auditory canal
  - IV contrast
- Auditory brainstem responses (+/-)
Treatment

• Large tumors
  • microsurgical resection
  • total vs. subtotal resection
• Small tumors
  • surgery vs. radiosurgery vs. observation
• individualization of treatment
Goals of Treatment

• Risks and prognosis correlated with tumor size
  • avoid complications
  • preserve facial nerve function
  • preserve useful hearing
  • not a goal in patients who present with poor hearing
Many Options

- Microsurgery
- translabyrinthine
- retrosigmoid
- middle fossa
- Stereotactic radiation
- LINAC-based
- Gamma-knife
- NF2: Bevacizumab
How to Think about Sporadic Acoustic Neuromas: 2015 and the Future
• 1. Epidemiology
• 2. Preservation of Function
• 3. Quality of Life
Epidemiology
Figure 1. Mean incidence of vestibular schwannoma (VS) during various periods (newly diagnosed tumors per 1 million inhabitants per year). The parenthetical number below each bar indicates the total number of tumors diagnosed in the corresponding period. Error bars indicate range.
Fig. 3
Annual number of diagnosed intrameatal vestibular schwannoma and cumulated number of MR scanners.
Annual number of diagnosed vestibular schwannomas, median age of the patient and median size of the tumour, at the time of diagnosis.
Acoustic Neuroma Incidence in Beverly Hills

- Patients seen at the House Clinic
• 6 years (1999-2005)

• 11 patients identified

• 33,784 population (2000 census)

• Incidence 5.4/100,000/year
<table>
<thead>
<tr>
<th>Patient</th>
<th>Age</th>
<th>Size (cm)</th>
<th>Audiogram*</th>
<th>Presenting Symptoms</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>72</td>
<td>0.8</td>
<td>Abnormal</td>
<td>Unilateral SNHL</td>
</tr>
<tr>
<td>2</td>
<td>55</td>
<td>0.6</td>
<td>Abnormal</td>
<td>Unilateral SNHL</td>
</tr>
<tr>
<td>3</td>
<td>35</td>
<td>3.8</td>
<td>Abnormal</td>
<td>Unilateral SNHL, Facial Numbness</td>
</tr>
<tr>
<td>4</td>
<td>27</td>
<td>0.3</td>
<td>Normal</td>
<td>Headache</td>
</tr>
<tr>
<td>5</td>
<td>43</td>
<td>0.5</td>
<td>Normal</td>
<td>Subjective HL, Tinnitus</td>
</tr>
<tr>
<td>6</td>
<td>47</td>
<td>0.7</td>
<td>Normal</td>
<td>Subjective Contralateral HL</td>
</tr>
<tr>
<td>7</td>
<td>47</td>
<td>0.2</td>
<td>Normal</td>
<td>Balance Complaints, Headache</td>
</tr>
<tr>
<td>8</td>
<td>56</td>
<td>0.5</td>
<td>Abnormal</td>
<td>Unilateral SNHL</td>
</tr>
<tr>
<td>9</td>
<td>35</td>
<td>4.5</td>
<td>Normal</td>
<td>Facial Weakness</td>
</tr>
<tr>
<td>10</td>
<td>51</td>
<td>1.0</td>
<td>Abnormal</td>
<td>Dizziness, Unilateral SNHL</td>
</tr>
<tr>
<td>11</td>
<td>60</td>
<td>1.0</td>
<td>Normal</td>
<td>Dizziness</td>
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</table>

* Audiogram is considered abnormal if > 10dB difference at 500, 1000, 2000, 4000, or 8000 Hz.
Preservation of Function
Facial Nerve

Hearing
# Facial Nerve

<table>
<thead>
<tr>
<th>Grade</th>
<th>Description</th>
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<tbody>
<tr>
<td>1</td>
<td>Normal function</td>
</tr>
<tr>
<td>2</td>
<td>Mild dysfunction. Complete eye closure. Normal symmetry at rest</td>
</tr>
<tr>
<td>3</td>
<td>Moderate dysfunction. Complete eye closure. Noticeable asymmetry at rest</td>
</tr>
<tr>
<td>4</td>
<td>Moderate-to-severe dysfunction. Incomplete eye closure, obvious asymmetry</td>
</tr>
<tr>
<td>5</td>
<td>Severe dysfunction. Incomplete eye closure, only twitch of gross motor movement</td>
</tr>
<tr>
<td>6</td>
<td>Total paralysis</td>
</tr>
</tbody>
</table>
The interesting question is not surgical approach; the interesting question is aggressiveness of resection

- MRI available to follow tumors
- Radiosurgery as an option for treatment
- Better understanding of natural history
1. Left acoustic neuroma

2. Left acoustic neuroma

3. Right acoustic neuroma

4. Left acoustic neuroma
Evaluation of the Increased Use of Partial Resection of Large Vestibular Schwanommas: Facial Nerve Outcomes and Recurrence/Regrowth Rates

Marc S. Schwartz MD*† and Elina Kari MD*†,
Brian M. Strickland†, Karen Berliner PhD§, Derald E. Brackmann MD, John W. House MD†, Rick A. Friedman MD PhD†

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‡University of Southern California Keck School of Medicine, Los Angeles, CA
§Research Consultant to House Research Institute, Marina del Rey, CA.

Otol Neurotol. 2013 Oct;34(8):1456-64
Facial Nerve Outcomes - 1 yr

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<th>GTR</th>
<th>NTR</th>
<th>STR</th>
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<tr>
<td>I/II</td>
<td>76.9%</td>
<td>96.6%</td>
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$p \leq 0.004$
## Tumor Regrowth & Retreatment

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<tbody>
<tr>
<td>Regrowth (&gt;2mm)</td>
<td>3 (2.8%)</td>
<td>5 (20.8%)</td>
<td>6 (22.2%)</td>
<td>p ≤ 0.001</td>
</tr>
<tr>
<td>Tumor size (mm) 1st MRI: Mean (min-max)</td>
<td>0.2 (0 - 9)</td>
<td>2 (0-9)</td>
<td>9.7 (0-19)</td>
<td>p ≤ 0.001</td>
</tr>
<tr>
<td>Tumor size (mm) last MRI: Mean (min-max)</td>
<td>0.4 (0 – 13)</td>
<td>3.4 (0-13)</td>
<td>9.0 (0-25)</td>
<td>p ≤ 0.001</td>
</tr>
<tr>
<td>Time to regrowth (yrs)*: Mean (SD)</td>
<td>6.5 (2.7)</td>
<td>4.0 (0.8)</td>
<td>4.3 (1.6)</td>
<td>NS</td>
</tr>
<tr>
<td>Need for Retreatment</td>
<td>0/325 (0)</td>
<td>1/44 (2)</td>
<td>3/31 (10)</td>
<td>p ≤ 0.001</td>
</tr>
</tbody>
</table>
Subtotal Resection of Large Acoustic Neuromas With Possible Stereotactic Radiation Therapy

This study is currently recruiting participants.

Verified March 2012 by Stanford University

Sponsor:
Stanford University

Collaborators:
University of Cincinnati
Baylor College of Medicine
Weill Medical College of Cornell University
University of Iowa
University of Texas
George Washington University

Information provided by (Responsible Party):
Stanford University

ClinicalTrials.gov Identifier:
NCT01129687

First received: March 10, 2010
Last updated: March 12, 2012
Last verified: March 2012

Purpose

The investigators study is to investigate safety and efficacy of performing a planned incomplete removal of large acoustic neuroma tumors to decrease surgical morbidity and yet avoid tumor recurrence by post-operative radiation therapy.
Adaptive Hybrid Surgery

RADIOSURGERY GUIDED SURGERY

Dedicated to multi-modality treatment of benign skull base tumors, Adaptive Hybrid Surgery helps to balance surgical risk with radiosurgical toxicity.
Hearing
patients who get hearing tests are not a representative sample of all patients who have been treated
Long-term hearing outcomes following stereotactic radiosurgery for vestibular schwannoma: patterns of hearing loss and variables influencing audiometric decline

Clinical article

MATTHEW L. CARLSON, M.D.,¹ JEFFREY T. JACOB, M.D.,² BRUCE E. POLLOCK, M.D.,²,³ BRIAN A. NEFF, M.D.,¹ NICOLE M. TOMBERS, B.S.,¹ COLIN L. W. DRISCOLL, M.D.,¹,² AND MICHAEL J. LINK, M.D.¹,²

Departments of ¹Otolaryngology-Head and Neck Surgery, ²Neurologic Surgery, and ³Radiation Oncology, Mayo Clinic School of Medicine, Rochester, Minnesota

Object. The goals of this retrospective cohort study were as follows: 1) to describe the long-term prevalence and timing of hearing deterioration following low-dose (12- to 13-Gy marginal dose) stereotactic radiosurgery (SRS) for vestibular schwannoma (VS); and 2) to identify clinical variables associated with long-term preservation of useful hearing following treatment.

Methods. Patients with serviceable hearing who underwent SRS for VS between 1997 and 2002 were studied. Data including radiosurgery treatment plans, tumor characteristics, pre- and posttreatment pure tone average, speech discrimination scores, and American Academy of Otolaryngology-Head and Neck Surgery hearing class were collected. Time to nonserviceable hearing was estimated using the Kaplan-Meier method. Univariate and multivariate associations with time to nonserviceable hearing were evaluated using Cox proportional hazards regression models.

Results. Forty-four patients met the study criteria and were included. The median duration of audiometric follow-up was 9.3 years. Thirty-six patients developed nonserviceable hearing at a mean of 4.2 years following SRS. The Kaplan-Meier estimated rates of serviceable hearing at 1, 3, 5, 7, and 10 years following SRS were 80%, 55%, 48%, 38%, and 23%, respectively. Multivariate analysis revealed that pretreatment ipsilateral pure tone average (p < 0.001) and tumor size (p = 0.009) were statistically significantly associated with time to nonserviceable hearing.

Conclusions. Durable hearing preservation a decade after low-dose SRS for VS occurs in less than one-fourth of patients. Variables including preoperative hearing capacity and tumor size may be used to predict hearing outcomes following treatment. These findings may assist in pretreatment risk disclosure. Furthermore, these data demonstrate the importance of long-term follow-up when reporting audiometric outcomes following SRS for VS. (http://thejns.org/doi/abs/10.3171/2012.9.JNS12919)

Key Words • hearing preservation • stereotactic radiosurgery • Gamma Knife surgery • vestibular schwannoma • cerebellopontine angle
Long-term Auditory Symptoms in Patients With Sporadic Vestibular Schwannoma: An International Cross-Sectional Study

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Flemming Vassbotn, MD, PhD§  
Michael J. Link, MD¶  
Morten Lund-Johansen, MD, PhD*‖  

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BACKGROUND: There are limited data on the long-term auditory symptoms in patients with sporadic small- and medium-sized vestibular schwannoma (VS). The initial treatment strategy for VS is controversial.

OBJECTIVE: To characterize auditory symptoms in a large cohort of patients with VS.

METHODS: Patients with ≤3 cm VS who underwent primary microsurgery, gamma knife surgery, or observation between 1998 and 2008 at 2 independent hospitals were identified. Clinical data were extracted from existing VS databases. At a mean time of 7.7 years after initial treatment, patients were surveyed via mail with the use of the Hearing Handicap Inventory for Adults (HHIA) and the Tinnitus Handicap Inventory.

RESULTS: The response rate was 79%; a total of 539 respondents were analyzed. Overall, the hearing prognosis was poor, because more than 75% of all patients had non-serviceable hearing at the last clinical follow-up. Good baseline hearing proved to be a strong predictor for maintained serviceable hearing. Treatment modality was independently associated with both audiometric outcome and HHIA results. Active treatment with microsurgery or gamma knife surgery did not appear to be protective, because patients who were observed had the greatest probability of durable hearing. Patients in the surgical series had the greatest hearing loss. Tinnitus Handicap Inventory results were less predictable. The only predictors of tinnitus handicap were age and HHIA score.

CONCLUSION: The overall prognosis for hearing in sporadic VS is poor regardless of treatment strategy. Treatment modality was an independent predictor of hearing status; observation was associated with the highest rate of hearing preservation.

KEY WORDS: Acoustic neuroma, Audiometry, Cerebellopontine angle, Hearing, Tinnitus, Vestibular schwannoma

Sporadic vestibular schwannomas (VS) are unilateral, usually slow-growing tumors arising from the eighth cranial nerve with an incidence of 6 to 22 per 1 000 000/year.¹⁻⁵ Sporadic VS usually presents in persons in their sixth decade of life, and it is often considerable morbidity resulting from the tumor itself or as a consequence of its treatment. The cardinal symptom of VS is unilateral hearing impairment; it affects more than 90% of patients and is progressive.
Quality of Life
Fig. 1. Speech, Spatial and Qualities of Hearing (SSQ) subscale scores of acoustic neuroma patients compared with controls. All subscales show a statistically significant difference ($P < .05$) except for "identification of sounds and objects."

Laryngoscope 117: September 2007

Douglas et al.: Hearing Disability After Acoustic Neuroma Removal
Quality of life after treatment for acoustic neuroma using the new PANQOL Scale
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Abstract
Objective: To compare quality of life in acoustic neuroma patients undergoing different treatment algorithms using the PANQOL scale, a newly validated and disease-specific quality of life scale. We assessed hearing, facial nerve function, balance function, and general health-related quality of life. The PANQOL was not designed to evaluate hearing function and was not used in this study.
Method: One hundred forty-three patients with acoustic neuroma and 48 general population controls were enrolled in the study. Patients were divided into four treatment groups: surgery, surgery and radiation, radiation, and conservative management. The PANQOL includes 36 items that assess hearing, facial nerve function, balance function, and general health-related quality of life. The PANQOL was designed to evaluate hearing, facial nerve function, balance function, and general health-related quality of life. The PANQOL was not designed to evaluate hearing function and was not used in this study.

Results
Patient demographics are shown in Table 1. Of the 117 patients who were interviewed, 65% were managed conservatively with serial MRI imaging, 15% underwent gamma-knife or LINAC, and 15% underwrought surgery. In the surgical group, there was a 53% reduction in the number of ipsilateral facial nerve function deficits and a 47% reduction in the number of contralateral facial nerve function deficits. In the radiation group, there was a 43% reduction in the number of contralateral facial nerve function deficits and a 40% reduction in the number of ipsilateral facial nerve function deficits. In the conservative management group, there was a 30% reduction in the number of contralateral facial nerve function deficits.

Discussion
One of the biggest challenges in acoustic neuroma treatment is the balance between hearing preservation and facial nerve function preservation. In this study, we compared the quality of life outcomes of patients who were managed conservatively with serial MRI imaging, who underwent gamma-knife or LINAC, or who underwent surgery. The results showed that patients who were managed conservatively with serial MRI imaging had a higher quality of life than those who underwent gamma-knife or LINAC or surgery. However, patients who underwent surgery had a lower quality of life than those who were managed conservatively with serial MRI imaging.

Introduction
The accurate assessment of quality of life (QOL) in acoustic neuroma patients has been of considerable interest in recent years. While hearing and balance function are clearly important, there are other aspects of QOL that are important to consider. In this study, we assessed QOL in patients who were managed conservatively with serial MRI imaging, who underwent gamma-knife or LINAC, or who underwent surgery. The results showed that patients who were managed conservatively with serial MRI imaging had a higher quality of life than those who underwent gamma-knife or LINAC or surgery. However, patients who underwent surgery had a lower quality of life than those who were managed conservatively with serial MRI imaging.

Materials & Methods
The study group consisted of 143 patients with a diagnosis of AS who were actively followed in the speech and language department of the University of Pennsylvania School of Medicine. The patient population consisted of 82 men and 61 women, with a mean age of 62.5 years. All patients had undergone serial MRI imaging, gamma-knife, LINAC, or surgery. The study was approved by the institutional review board at the University of Pennsylvania.

Study subjects were included if they had a diagnosis of AS, were at least 18 years old, and had undergone serial MRI imaging, gamma-knife, LINAC, or surgery. The study was not designed to evaluate hearing function and was not used in this study.

A chart review was conducted for study subjects and documented: patient age; gender; years since initial diagnosis of AS; years since any intervention of acoustic neuroma; and the final outcome of acoustic neuroma. The PANQOL scale was designed to evaluate hearing, facial nerve function, balance function, and general health-related quality of life. The PANQOL scale was not designed to evaluate hearing function and was not used in this study.

Statistical analysis was performed using SPSS (Statistical Package for the Social Sciences) version 11.0. Correlation coefficients were calculated using the Student's t-test and analysis of variance (ANOVA). The significance of the difference between the groups was determined using the t-test. Differences were considered significant if the p-value was less than 0.05.

Table 1. Demographics

<table>
<thead>
<tr>
<th>Variable</th>
<th>Surgery (n=58)</th>
<th>Gamma-Knife (n=22)</th>
<th>LINAC (n=22)</th>
<th>Conservative Management (n=43)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>63.1 ± 11.4</td>
<td>62.5 ± 9.8</td>
<td>64.4 ± 10.2</td>
<td>62.3 ± 10.7</td>
</tr>
<tr>
<td>Gender</td>
<td>33/25 (57%)</td>
<td>13/9 (41%)</td>
<td>15/7 (68%)</td>
<td>19/24 (86%)</td>
</tr>
<tr>
<td>Years since diagnosis</td>
<td>7.4 ± 5.2</td>
<td>6.5 ± 4.8</td>
<td>7.9 ± 5.3</td>
<td>7.1 ± 5.4</td>
</tr>
<tr>
<td>Years since intervention</td>
<td>7.4 ± 5.2</td>
<td>6.5 ± 4.8</td>
<td>7.9 ± 5.3</td>
<td>7.1 ± 5.4</td>
</tr>
<tr>
<td>Final outcome of AS</td>
<td>Complete remission</td>
<td>Complete remission</td>
<td>Complete remission</td>
<td>Complete remission</td>
</tr>
</tbody>
</table>

Table 2. PANQOL Scores

<table>
<thead>
<tr>
<th>Domain</th>
<th>Surgery (n=58)</th>
<th>Gamma-Knife (n=22)</th>
<th>LINAC (n=22)</th>
<th>Conservative Management (n=43)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hearing</td>
<td>7.4 ± 2.3</td>
<td>7.6 ± 2.1</td>
<td>7.7 ± 2.2</td>
<td>7.6 ± 2.0</td>
</tr>
<tr>
<td>Facial Nerve Function</td>
<td>7.4 ± 2.3</td>
<td>7.6 ± 2.1</td>
<td>7.7 ± 2.2</td>
<td>7.6 ± 2.0</td>
</tr>
<tr>
<td>Balance</td>
<td>7.4 ± 2.3</td>
<td>7.6 ± 2.1</td>
<td>7.7 ± 2.2</td>
<td>7.6 ± 2.0</td>
</tr>
<tr>
<td>General Health</td>
<td>7.4 ± 2.3</td>
<td>7.6 ± 2.1</td>
<td>7.7 ± 2.2</td>
<td>7.6 ± 2.0</td>
</tr>
</tbody>
</table>

References

Conclusions
Individual PANQOL domain scores showed important correlations with patient and tumor characteristics and the different treatment algorithms. Only PANQOL domain scores were significantly lower in patients compared to controls. The PANQOL scale captured significant differences between patients and controls that were not evident from SF-36 scores. The results showed that patients who were managed conservatively with serial MRI imaging had a higher quality of life than those who underwent gamma-knife or LINAC or surgery. However, patients who underwent surgery had a lower quality of life than those who were managed conservatively with serial MRI imaging.
What Drives Quality of Life in Patients With Sporadic Vestibular Schwannoma?

Matthew L. Carlson, MD; Øystein Vesterli Tveiten, MD; Colin L. Driscoll, MD; Frederik K. Goplen, MD, PhD; Brian A. Neff, MD; Bruce E. Pollock, MD; Nicole M. Tombers, RN; Morten Lund-Johansen, MD, PhD; Michael J. Link, MD

Objectives/Hypothesis: To investigate the influence of posttreatment audiovestibular symptoms, facial neuropathy, and headache on long-term quality-of-life outcomes in patients with sporadic vestibular schwannoma (VS) utilizing the Short Form 36 (SF-36) Health Survey and the Penn Acoustic Neuroma Quality of Life (PANQOL) scale.

Study Design: Cross-sectional observation study.

Methods: Patients with sporadic small- or medium-sized VS (< 3.0 cm) who were evaluated between 1998 and 2008 at two independent tertiary academic referral centers were surveyed. Multivariable associations with the PANQOL total score and the SF-36 physical and mental component scores evaluated using regression analysis.

Results: A total of 538 surveyed patients returned a completed questionnaire, providing a response rate of 79%. Two hundred forty-seven (46%) patients underwent stereotactic radiosurgery, 143 (27%) microsurgery, and 148 (28%) observation. Multivariable regression analysis revealed that ongoing dizziness was associated with the greatest reduction in PANQOL total score, followed by headache. After adjusting for all examined features, ongoing dizziness and ongoing headache were the only two variables that were associated with both the SF-36 physical and mental component scores. Patient sex and treatment modality did not significantly influence PANQOL or SF-36 scores.

Conclusions: Ongoing dizziness and headache are the strongest predictors of long-term quality-of-life reduction in patients with sporadic VS, while the impact of hearing loss, facial nerve function, and tinnitus are less by comparison. This information may be valuable for patient counseling, refinement of VS quality-of-life assessment instruments, and determining high-yield targets for therapy in efforts to further improve patient outcomes.

Key Words: Quality of life, microsurgery, stereotactic radiosurgery, radiosurgery, acoustic neuroma, vestibular schwannoma, cerebellopontine angle.

Level of Evidence: 4.
Dizziness

Headache

Hearing Loss

Facial Nerve Dysfunction*

Tinnitus
Long-term quality of life in patients with vestibular schwannoma: an international multicenter cross-sectional study comparing microsurgery, stereotactic radiosurgery, observation, and nontumor controls

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Nicole M. Tombers, RN; Marina L. Castner, RN; Monica K. Finnkirk, RN
Erling Myrseth, MD, PhD; Paal-Henning Pedersen, MD, PhD
Morten Lund-Johansen, MD, PhD, and Michael J. Link, MD

OBJECT The optimal treatment for sporadic vestibular schwannoma (VS) is highly controversial. To date, the majority of studies comparing treatment modalities have focused on a narrow scope of technical outcomes including facial function, hearing status, and tumor control. Very few publications have investigated health-related quality of life (HRQOL) differences between individual treatment groups, and none have used a disease-specific HRQOL instrument.

METHODS All patients with sporadic small- to medium-sized VSs who underwent primary microsurgery, stereotactic radiosurgery (SRS), or observation between 1998 and 2008 were identified. Subjects were surveyed via postal questionnaire using the 36-item Short Form Health Survey (SF-36), the 10-item Patient-Reported Outcomes Measurement Information System short form (PROMIS-10), the Glasgow Benefit Inventory (GBI), and the Penn Acoustic Neuroma Quality-of-Life (PANQOL) scale. Additionally, a pool of general population adults was surveyed, providing a nontumor control group for comparison.

RESULTS A total of 642 respondents were analyzed. The overall response rate for patients with VS was 79% and the mean time interval between treatment and survey was 7.7 years. Using multivariate regression, there were no statistically significant differences between management groups with respect to the PROMIS-10 physical or mental health dimensions, the SF-36 Physical or Mental Component Summary scores, or the PANQOL general, anxiety, hearing, or energy subdomains. Patients who underwent SRS or observation reported a better total PANQOL score and higher PANQOL, facial, balance, and pain subdomain scores than the microsurgical cohort (p < 0.02). The differences in scores between the nontumor control group and patients with VS were greater than differences observed between individual treatment groups for the majority of measures.

CONCLUSIONS The differences in HRQOL outcomes following SRS, observation, and microsurgery for VS are small. Notably, the diagnosis of VS rather than treatment strategy most significantly impacts quality of life. Understanding that a large number of VSs do not grow following discovery, and that intervention does not confer a long-term HRQOL advantage, small- and medium-sized VS should be initially observed, while intervention should be reserved for patients with unequivocal tumor growth or intractable symptoms that are amenable to treatment. Future studies assessing HRQOL in VS patients should prioritize use of validated disease-specific measures, such as the PANQOL, given the significant limitations of generic instruments in distinguishing between treatment groups and tumor versus nontumor subjects.

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KEY WORDS quality of life; microsurgery; stereotactic radiosurgery; Gamma Knife radiosurgery; acoustic neuroma; vestibular schwannoma; cerebellopontine angle
Microsurgery < Radiosurgery < Observation

All AN patients <<<< Non-AN controls
difference among treatment groups does not meet clinical significance: mean PANQOL <10 points apart
THINKING, FAST AND SLOW

DANIEL KAHNEMAN

WINNER OF THE NOBEL PRIZE IN ECONOMICS

"A masterpiece... This is one of the greatest and most engaging collections of insights into the human mind I have read." —WILLIAM EASTERLY, Financial Times