



# Radiologic Pearls of Vestibular Schwannomas

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# Outline

- Our Patient Clinical Presentation
- Our Patient Radiologic Findings
- Cerebellopontine Angle Anatomy
- Differential Diagnosis Based on Imaging Findings
- General Considerations on Vestibular Schwannomas
- Clinical Findings in Vestibular Schwannomas
- Menu of Tests for Vestibular Schwannomas
- Radiographic Features of Vestibular Schwannomas
- Differential Diagnosis Revisited



# Our Patient: Clinical Presentation

- HPI: Mr. P is 63-year-old male with recent onset **left-sided hearing loss** and slight occasional imbalance. Denies vertigo.
- Physical Examination: Neurological exam was unremarkable. Facial sensation, strength were intact bilaterally. No gait abnormalities.
- Audiometry:
  - Audiogram showed mild-moderate **left-sided sensorineural hearing loss** of high frequencies .
  - Brainstem auditory evoked potential showed no response on the left.



Now we will look at the **ACR appropriateness criteria** for the imaging diagnostic evaluation of a patient with **sensorineural hearing loss without vertigo.**



# ACR Appropriateness Criteria

## Variant 2:

**Sensorineural hearing loss, no vertigo.**

Radiologic Procedure	Rating	Comments	<u>RRL*</u>
MRI head and internal auditory canal without and with contrast	8	See statement regarding contrast in text under "Anticipated Exceptions."	0
MRI head and internal auditory canal without contrast	7		0
CT temporal bone without contrast	5		☢☢☢
CT head without and with contrast	4		☢☢☢

Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate

\*Relative Radiation Level

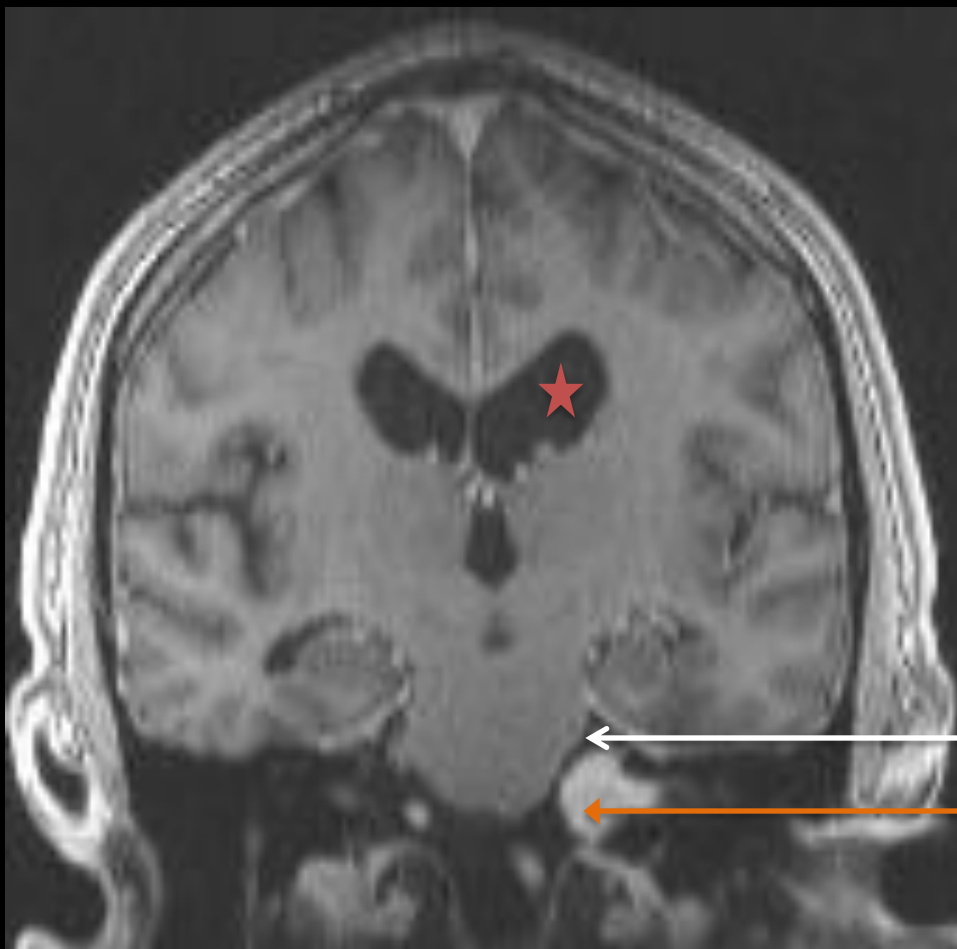
American College of Radiology. ACR Appropriateness Criteria: Vertigo and Hearing Loss. Available at: [http://www.acr.org/SecondaryMainMenuCategories/quality\\_safety/app\\_criteria.aspx](http://www.acr.org/SecondaryMainMenuCategories/quality_safety/app_criteria.aspx)



As part of his diagnostic workup, our index patient underwent an **MRI with/without contrast of the head and internal acoustic canal**. We will now see some of his images.



# Our Patient: MRI



**Minimally enlarged ventricles**

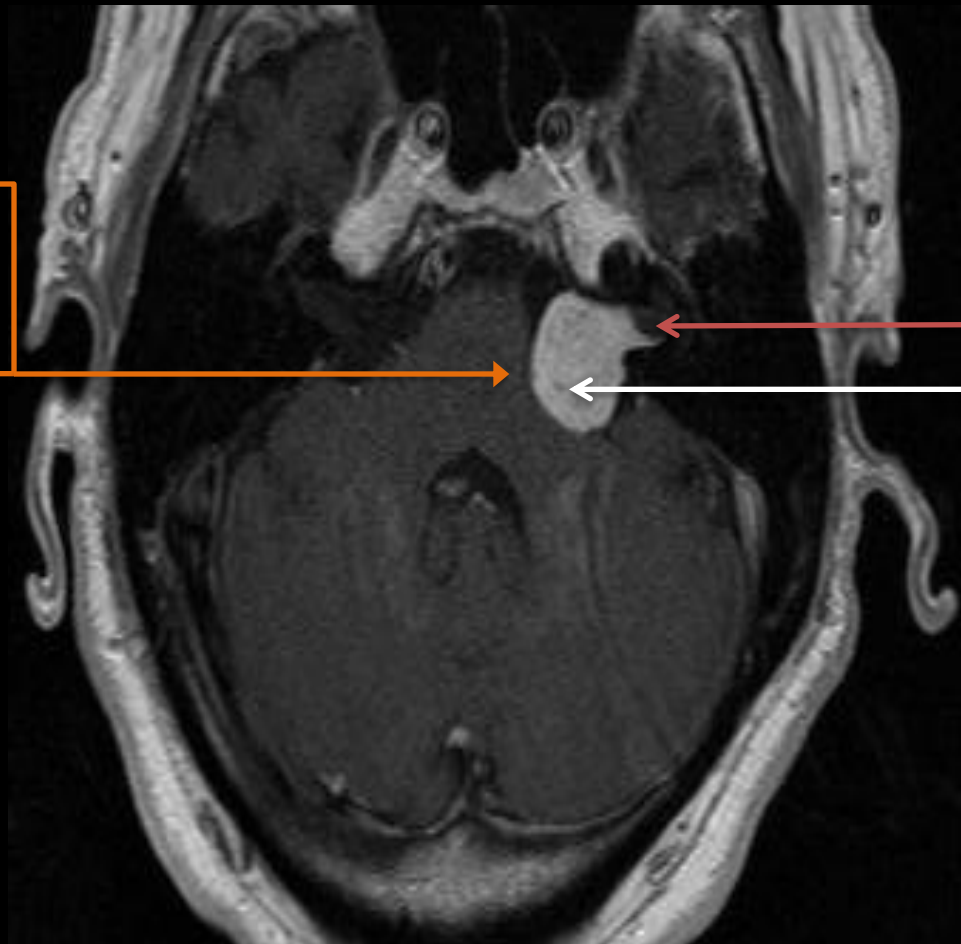
- Extra-axial mass:**
- Tumor-parenchyma interface
  - Surrounded by CSF
  - No peritumoral edema

**Homogenously enhancing Left CPA mass.**

PACS, BIDMC

T1W MRI C+ (Coronal View)

# Our Patient: MRI



**Mass effect upon adjacent Brachium Pontis**

**Mass extends into porus acusticus and internal auditory canal (IAC).**

**Non-enhancing foci most likely secondary to cystic degeneration**

PACS, BIDMC

T1W MRI C+ (Axial View)



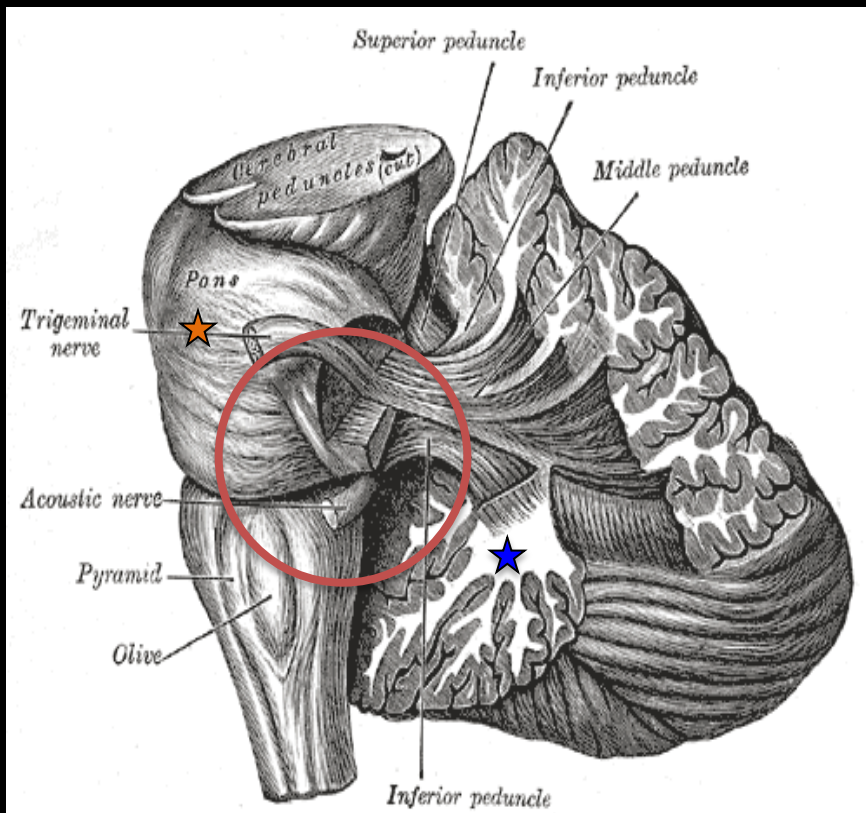


Before we continue exploring our patient's lesion, it is important to review some pertinent neuroanatomical landmarks. We will focus mainly in the **cerebellopontine angle (CPA) region.**

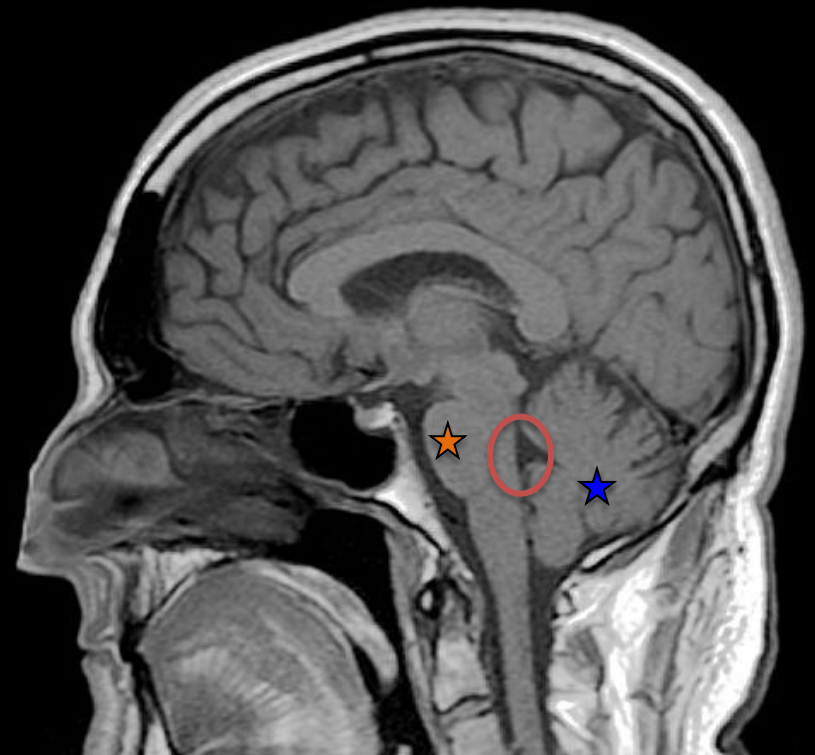


# Companion Case #1: CPA Anatomy

The **Cerebellopontine Angle (CPA)** is a CSF-bathed space surrounded by the temporal bone, **cerebellum** and **pons**.



Gray's Anatomy



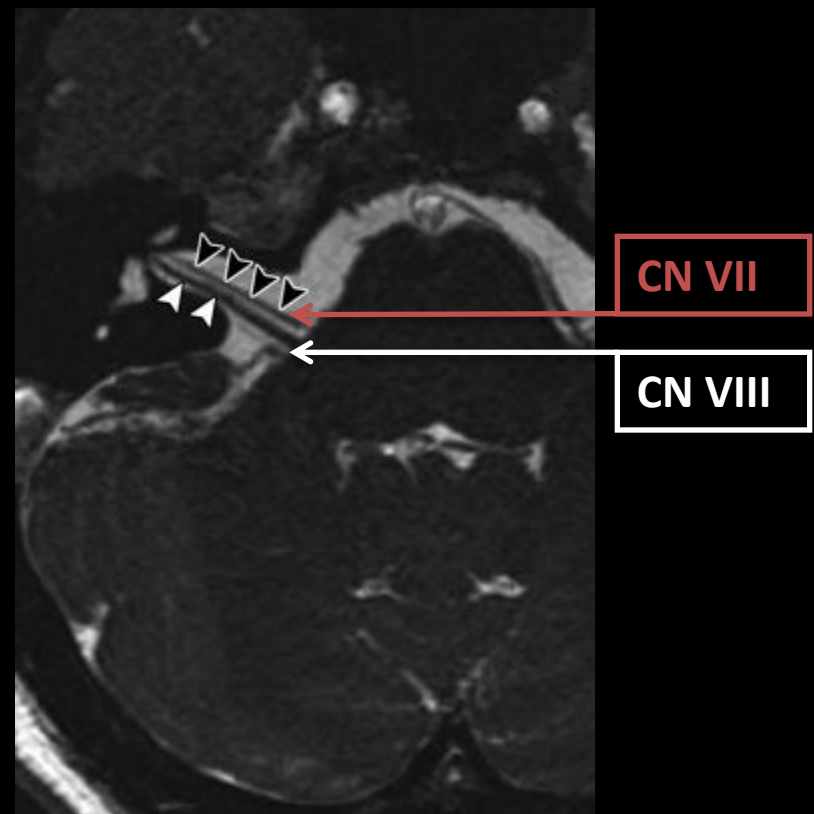
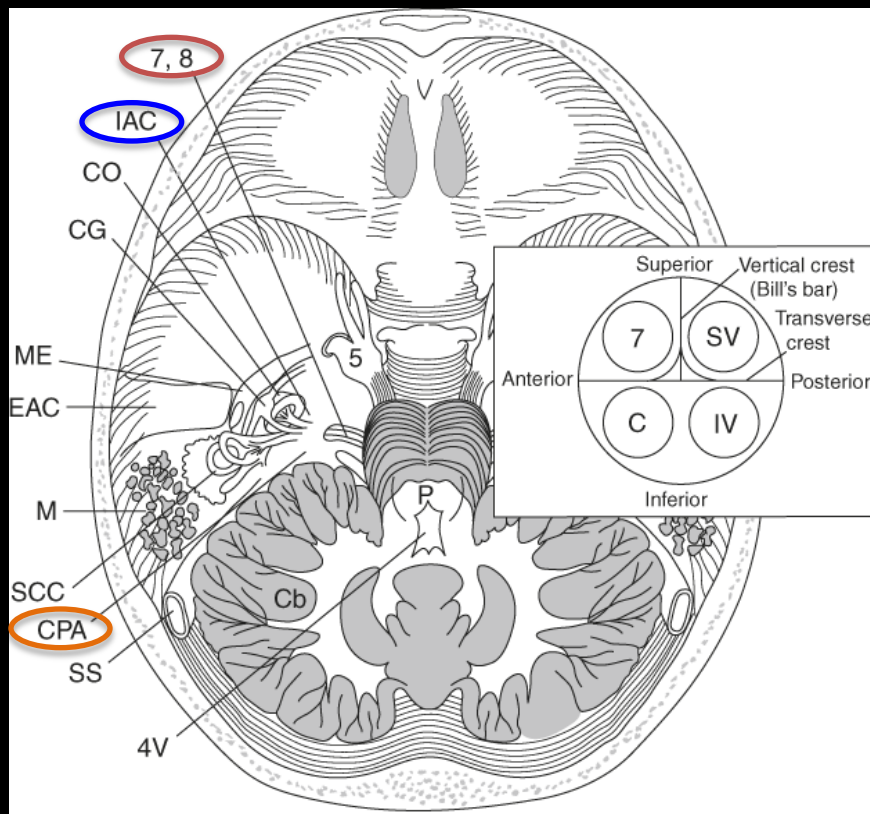
PACS, BIDMC

T1W MRI C- (Sagittal View)



# Companion Case #2: CPA Anatomy

CN VII & VIII exit brainstem at CPA. From there they enter the internal acoustic meatus (IAC).



Lalwani AK: Current Diagnosis & Treatment in Otolaryngology- Head and Neck Surgery, 3<sup>rd</sup> Edition. Accessed at: <http://www.accessmedicine.com.ezp-prod1.hul.harvard.edu/content.aspx?aID=55772548>

Sheth S, Branstetter B, Escott EJ. Appearance of Normal Cranial Nerves on Steady-State Free Precession MR Images. July 2009 *RadioGraphics*. 2009; 29, 1045-1055.



The differential diagnosis for a CPA lesion is extensive. We will approach it by classifying the different etiologies according to **their contrast-enhancing properties on MRI**. We will subsequently differentiate the lesions according to their site of origin.

- Extra-axial lesion (from outside CNS)
- Intra-axial lesion (from within the CNS)
- Arising from skull base

# Differential Diagnosis for CPA Lesions: MRI

## Non-enhancing CPA lesions

High T1

- Lipoma**  
subcutaneous fat signal on all sequences
- Dermoid cyst**  
fat and calcifications, fat-fluid levels
- Neurenteric cyst**  
round, iso or hyperintense on T1-WI
- Cholesterol granuloma**  
peripheral T1 and T2 hypointense rim

Low T1

- Epidermoid cyst**  
lobulated margins, hyperintense on DWI
- Arachnoid cyst**  
CSF signal intensity on all sequences
- Neurocysticercosis**  
racemous form may mimic arachnoid cyst but without bone erosion

Adapted from: Bonneville F, Savatovsky J, Chiras J. Imaging of cerebellopontine angle lesions: an update. Part 1: enhancing extra-axial lesions. *Eur Radiol.* 2007; 17(10):2472-92.



# Differential Diagnosis for CPA Lesions: MRI

## Enhancing CPA lesions

Extra-axial	Intra-axial and Intraventricular	Skull Base
<p><b>Vestibular schwannoma</b> "Ice cream on cone" mass along nerve VIII</p> <p><b>Trigeminal schwannoma</b> extends to Meckel's cave</p> <p><b>Facial nerve schwannoma</b> extends to geniculate fossa</p> <p><b>Mixed nerves schwannoma</b> extends to jugular foramen</p>	<p><b>Lymphoma</b> T2 hypointensity, restricted diffusion</p> <p><b>Glioma</b> enlarges brain stem, surrounded by oedema</p> <p><b>Metastasis</b> multiple lesions, peritumoral oedema</p> <p><b>Hemangioblastoma</b> solid or cystic with nodule, hypervascular</p> <p><b>Medulloblastoma</b> low T2-SI, restricted diffusion, CSF spreading</p> <p><b>Papilloma</b> hypervascular, extends through foramen of Lushka</p> <p><b>Ependymoma</b> heterogeneous, extends through foramen of Lushka</p> <p><b>DNET</b> heterogeneous, impinges adjacent bone</p>	<p><b>Paraganglioma</b> "salt and pepper" appearance, flow voids</p> <p><b>Chondromatous tumours</b> rise from synchondrosis, calcification</p> <p><b>Chordoma</b> rises midline, destructs the clivus</p> <p><b>Endolymphatic sac tumour</b> destroys retrosabyrinthine petrous bone</p>
<p><b>Meningioma</b> broad base, hemispheric shape</p> <p><b>Metastasis</b> associated multifocal lesions</p> <p><b>Melanoma</b> spontaneous T1 hyperintense lesion</p> <p><b>Sarcoidosis</b> hypointense on T2-WI, associated lesions</p> <p><b>Tuberculosis</b> central T2 hypointensity, ring enhancement</p>		
<p><b>Aneurysm</b> round, well-defined T2 hypointense lesion</p>		

Adapted from: Bonneville F, Savatovsky J, Chiras J. Imaging of cerebellopontine angle lesions: an update. Part 1: enhancing extra-axial lesions. *Eur Radiol.* 2007; 17(10):2472-92.



# Radiographic Features: Enhancing CPA Lesions

## Extra-axial lesions:

- Surrounded by CSF
- Enlarge CPA cistern
- Displace brainstem and cerebellum

## Intra-axial lesions:

- Extensive peritumoral edema
- Lack of brain-tumor interface

## Skull base lesions:

- Associated bony erosions



Given that our index patient's imaging showed radiologic findings consistent with an **extra-axial lesion** (i.e. contrast enhancement, a clear tumor-parenchymal interface and no peritumoral edema), the remainder of our discussion will focus on such lesions. Furthermore, it will emphasize the **commonest lesion: vestibular schwannomas**.



Adapted from: Bonneville F, Savatovsky J, Chiras J. Imaging of cerebellopontine angle lesions: an update. Part 1: enhancing extra-axial lesions. *Eur Radiol.* 2007; 17(10):2472-92.





# Vestibular Schwannomas: General Considerations

- Account for 80-90% of **all** CPA tumors
- Schwann cell-derived tumors most commonly arising from CNVIII
- Symptoms most commonly due to **mass effect** on adjacent posterior fossa structures



# Vestibular Schwannomas: Clinical Findings

- **Sensorineural hearing loss: 95%** of patients
- Tinnitus: 65% patients
- Facial weakness or spasm: 17%
- If tumor is sufficiently large may affect lower cranial nerves (IX & X) causing dysphagia, aspiration and hoarseness.
- **Vertigo is uncommon** due to compensation in the setting of slow tumor growth.

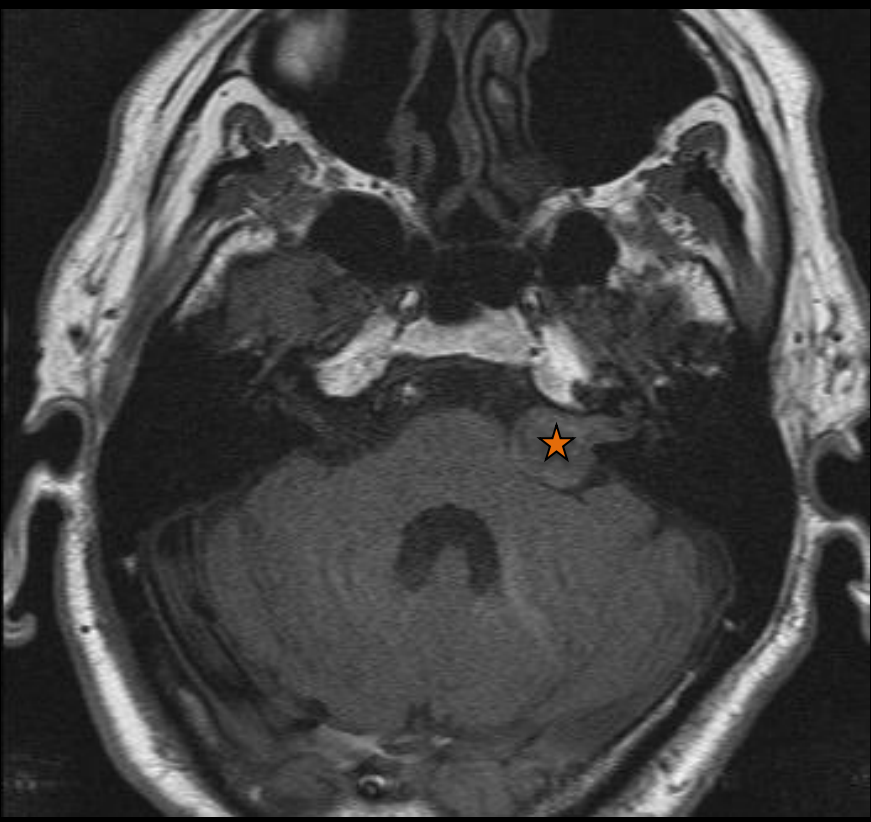


# Vestibular Schwannomas: Menu of Tests

- Magnetic Resonance Imaging (MRI)
  - Head and IAC MRI, +/- contrast
  - T1, MPRAGE, Heavily T2W, FLAIR
  - **Gold standard for diagnosis and surgical planning.**
- Computed Tomography (CT)
  - Head and IAC, + contrast
  - Useful for assessment of secondary bony changes.
  - Limited by artifacts

# Companion Case #3: MRI

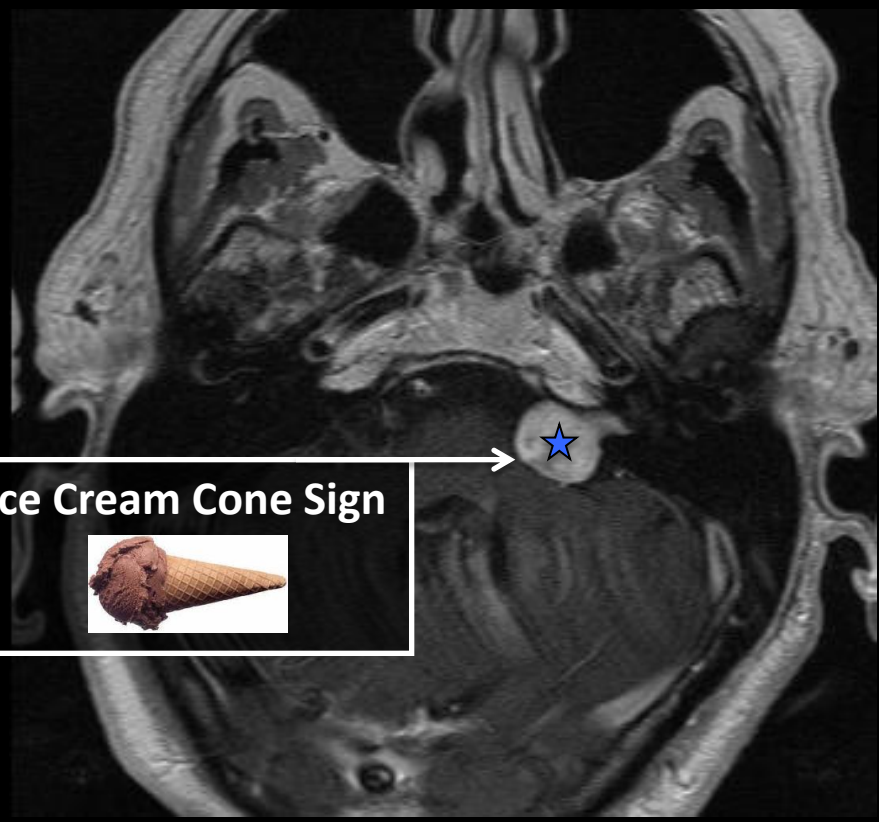
Isointense mass in T1 MRI C-



PACS, BIDMC

T1W MRI C- (Axial View)

Avid enhancement post contrast



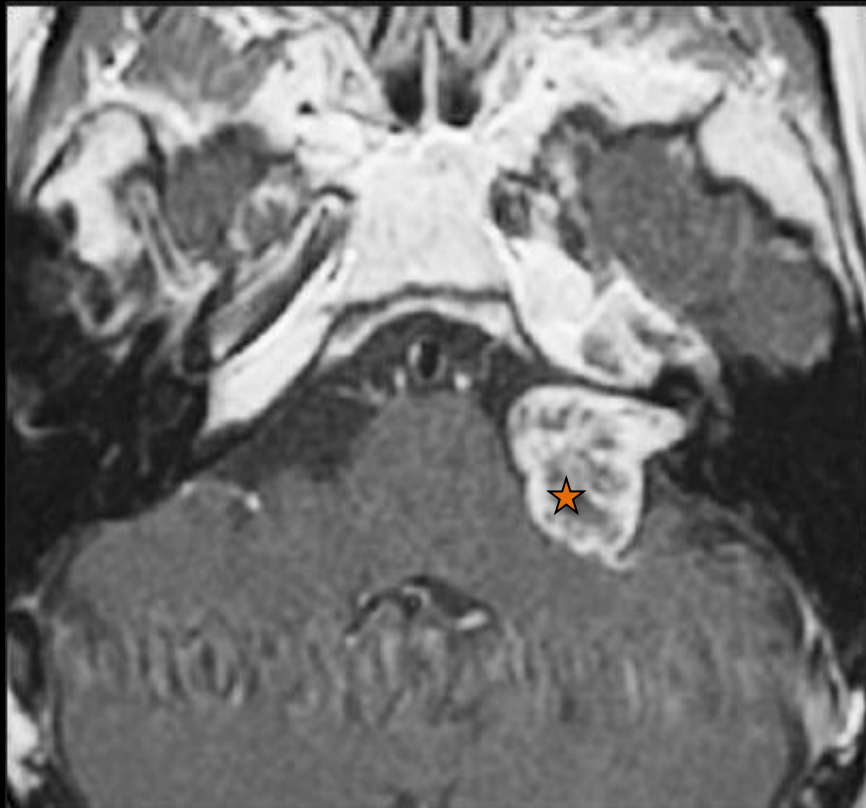
PACS, BIDMC

T1W MRI C+ (Axial View)



# Companion Cases #4, 5: MRI

**Large tumors may show cystic degeneration**



Rahmathulla G, Barnett G. Vestibular schwannoma of oscillating size: A case report and review of literature. *Surg Neurol Int.* 2011; 2: 187.

**T1W MRI C+ (Axial View)**

**Tumors appear hyperintense in T2W MRI**



Michael K. McLennan, MD. Accessed at: [http://www.parkhurstexchange.com/challenge/analyze/jun08/hearing\\_loss](http://www.parkhurstexchange.com/challenge/analyze/jun08/hearing_loss)

**Hi Res T2W MRI C- (Axial View)**



# Companion Case #6: CT



Trumpeted  
IAM sign



Vestibular  
Schwannoma

CT is useful for  
assessment of skull  
base changes

- Bony erosion (not visible)
- Widening of IAM (Trumpeted IAM sign)

Limited by artifacts

- Streaking by petrous bone

Dr. Frank Gaillard. Accessed at: <http://radiopaedia.org/cases/acoustic-schwannoma-2>

CT C+ (Axial View)



Now that we have discussed some of the characteristic findings seen in vestibular schwannomas, let's compare them to other CPA lesions.



# Differential Diagnosis Revisited

- Meningiomas
  - Often extend to middle fossa
  - Hemispheric shape
  - Broad base attachment to petrous bone
  - **Dural tail**
  - Homogenous in appearance
  - **Calcification more common**





# Differential Diagnosis Revisited

- Melanoma
  - T1 hyperintense
- Aneurysm
  - T2 hypointense
- Epidermoid/Dermoid Cysts
  - **No post-contrast enhancement**

# References

- American College of Radiology. ACR Appropriateness Criteria: Vertigo and Hearing Loss. Available at: [http://www.acr.org/SecondaryMainMenuCategories/quality\\_safety/app\\_criteria.aspx](http://www.acr.org/SecondaryMainMenuCategories/quality_safety/app_criteria.aspx). Accessed 08/16/12.
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# Acknowledgements

- Dr. Gillian Lieberman
- Dr. Behroze Vaccha
- Claire Odom