Imaging of the Cerebellopontine Angle: An Illustrative Case of Vestibular Schwannoma
Outline

- Patient AB*: Presentation
- Anatomy Review
  - Posterior Cranial Fossa
    - Cerebellopontine Angle (CPA)
    - Internal Auditory Canal (IAC)
- Imaging Modalities and Characteristics of CPA Lesions
  - Differential Diagnosis
  - Focus on Vestibular Schwannoma (VS)
- Role of Imaging in Surgical Planning
- Patient AB: Post-operative Course

*ALL patient identifiers have been falsified for this educational presentation.
HPI: AB is a 58 year-old man with 5 years of progressive left-sided hearing loss. Increasingly using right ear for phone calls. Over the past few months, new onset dysequilibrium with walking and slight left facial numbness. Mild tinnitus. Denies vertigo.

Physical Exam: CN 5 – decreased sensation to light touch on left, V1>V2 V3 normal. CN 8 – Weber lateralizes to right. Rinne AS (Left) no air or bone conduction. Difficulty with Fukuda Stepping Test.

Studies: Audiogram showed mild to profound left-sided sensorineural hearing loss; unable to test word recognition CN 5, CN 8 and cerebellum all “live” in or near the cerebellopontine angle.
Anatomy of the Posterior Cranial Fossa


Brigham and Women’s Hospital PACS Companion Case 1
Cerebellopontine Angle (CPA)

- CPA describes the obtuse angle formed where the pons and cerebellum meet. The adjacent triangular (axial view) subarachnoid space contains cranial nerves and vessels bathed in CSF.

- CPA lesions
  - Pre-operative diagnosis mainly based on imaging
  - Symptoms related to mass effect rather than the nature of the lesion itself
Anatomical Borders of the CPA

- Anterolateral – posterior dural surface of petrous bone and clivus
- Posterior – ventral surface of pons and cerebellum
- Medial – pons and medulla
- Superior – middle cerebella peduncle and cerebellum
- Inferior – CN IX-X-XI complex
- Openings – internal auditory canal (lateral) and foramen of Luschka (medial)
CPA and IAC Anatomy: Important Considerations

The Obersteiner-Redlich zone, near the Interface of Lateral CPA and Medial IAC marks transition from central myelin produced by neuroglial cells to peripheral myelin produced by Schwann Cells.

Posterior fossa dura continues to line IAC; therefore, surgical access to IAC requires violation of the subarachnoid space.
Anatomy of the Medial IAC

- **SUPERIOR**
  - Bill's Bar (Bony)

- **ANTERIOR**
  - Facial Nerve (CN 7)

- **POSTERIOR**
  - Superior Vestibular Nerve (CN 8)
  - Transverse Crest (Bony)

- **INFERIOR**
  - Cochlear Nerve (CN 8)
  - Inferior Vestibular Nerve (CN 8)
Anatomy of the Medial IAC: “7-Up and Coke” Configuration

SUPERIOR

Bill's Bar (Bony)

ANTERIOR

Superior Vestibular Nerve (CN 8)

Inferior Vestibular Nerve (CN 8)

POSTERIOR

Transverse Crest (Bony)

INFERIOR
Imaging of CPA Lesions

- **Modalities**
  - CT
  - MRI (T1, T2, FLAIR, DWI, Gad, Heavily Weighted T2)

- **Imaging characteristics**
  - Location
  - Shape
  - Density
  - Enhancement
## ACR Appropriateness Criteria

### Variant 2: Sensorineural hearing loss, no vertigo.

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<th>Rating</th>
<th>Comments</th>
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**Rating Scale:** 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate

*Relative Radiation Level*
Patient AB: Avid, Heterogeneous Enhancement

Axial MRI T1 C-

Axial MRI T1 C+

Heterogeneous enhancement in lesions over 25 mm due to cystic and necrotic components
Patient AB: Extra-axial lesion

Extra-axial lesions arise from outside the brain and brainstem parenchyma.

Separated from brain parenchyma by cleft of CSF

Mass effect on brainstem and anterior aspect of cerebellum

“Ice cream on-cone” sign

Axial MRI T2W C-

CPA portion of VS

IAC portion of VS

Axial MRI T2W FLAIR C-
Patient AB: Extra-axial lesion

Mass effect on brainstem and anterior aspect of cerebellum

Lack of edema in surrounding brain parenchyma

Mass enlarges CPA cistern

Coronal MRI T1W C+
Patient AB: Heavily T2W MRI, Superior for Visualization of the IAC

Axial MRI Heavily T2W (CISS)

Intracanalicular portion of lesion

Massachusetts Eye and Ear Infirmary PACS
Companion Case: CT is Inferior to MRI for CPA Imaging

Axial CT Temporal Bone C+ (Soft Tissue Window)

CPA tumors >1.5 cm or >5 mm CPA component can be seen on CT with contrast.

Significant bone signal artifact makes CT much less ideal for posterior cranial fossa imaging as compared to MRI.
Bony expansion of the IAC is often the only CT finding with predominantly intracanalicular tumors. It may only be seen at a later stage, precluding hearing preservation.
Segmental Approach to Lesions of the CPA


Pratik B. Patel, MS IV
Gillian Lieberman, MD
Based on our imaging findings, we can narrow our differential diagnosis for Patient AB.

The lesion most likely has nervous, meningeal or vascular origin.

Differential Diagnosis

- Schwannoma (CN V-XII)
  - Avid enhancement on T1
  - Ice cream on-cone sign for VS
  - Labyrinthine involvement for CN 7 Schwannoma

- Meningioma
  - Dural tail (50-75%),
  - Calcifications (25%)
  - Pial blood vessels with flow voids present at margins
Differential Diagnosis (Cont’d)

- Epidermoid
  - Dumbell into middle fossa
  - Hypodense mass on CT
  - Moderate intensity on DWI vs. Low intensity on DWI for arachnoid cyst
- Vascular lesion
- Arachnoid Cyst
- Extension of intra-axial (parenchymal) malignancy
- Other rare CPA lesions (<1%)
Summary of Patient AB’s Imaging Findings

- We have now looked at a focused differential diagnosis for Patient AB’s CPA lesion.
- Based on imaging findings, our patient was given a pre-operative diagnosis of vestibular schwannoma with a primarily CPA lesion.
- Companion case highlighted CT imaging findings seen in CPA and VS lesions.
- Now let’s focus on vestibular schwannoma.
Vestibular Schwannoma (VS)

- Benign nerve sheath tumors of the superior (10%) and inferior (90%) vestibular nerve (CN VIII)
- 85% of CPA tumors, 8% of all intracranial tumors
- Incidence 10/1,000,000; M=F; onset age 40-60
- 95% sporadic; 5% NF2 or familial VS (earlier onset)
Clinical Presentation of VS

- Unilateral hearing loss (95%)
- Dysequilibrium (60%)
  - Central compensation for slowly evolving vestibular injury sometimes masks peripheral vestibular injury
- Tinnitus (65%)
- Facial weakness or spasm (17%) – V2 most often
- CN 2-12 Palsy – ophthalmoplegia, dysphagia, hoarseness
- Increased ICP – nausea, vomiting, headache, hydrocephalus and rarely, herniation
Treatment for VS

- Observation: 75-80% of monitored patients do not ever require resection
- Stereotactic radiation
- Surgery: best potential for hearing preservation in large or rapidly progressive lesions
- Recurrence rate <1% after surgery
Imaging Guides Preoperative Management and Surgical Planning

- Tumor size
- Extent of IAC penetration
- Relationship of tumor to cranial nerves
- CPA involvement
- Anatomic variants

PRE-OP IMAGING

Pratik B. Patel, MS IV
Gillian Lieberman, MD
Imaging Considerations

- Full IAC exposure

- Minimal CPA exposure due to risk of excess temporal lobe elevation

- Best for small, laterally extending intracanalicular tumors with minimal (<1 cm) CPA extension

- Hearing preservation (33-76%) correlates to tumor size and lateral extent of tumor

Silk PS, Lane JI, Driscoll CL. Surgical approaches to vestibular schwannomas: what the radiologist needs to know. Radiographics. 2009 Nov;29(7):1955-70.
Suboccipital (Retrosigmoid) Approach

Imaging Considerations

- Greater access to CPA, while maintaining hearing preservation (22-58%)
- Limited exposure of lateral IAC (maximum 2/3), concern for residual tumor
- No tumor size limitation
- Favorable position of the facial nerve (deep to the tumor from surgeon’s viewpoint)

Silk PS, Lane JI, Driscoll CL. Surgical approaches to vestibular schwannomas: what the radiologist needs to know. Radiographics. 2009 Nov;29(7):1955-70.
Translabyrinthine Approach

Imaging Considerations

- Maximal CPA exposure
- Extradural bone drilling (limits post-op headache)
- Consistent and early facial nerve identification
- Less cerebella retraction compared to suboccipital, less risk of cerebella atrophy
- Anterior sigmoid sinus or high-riding jugular bulb can make dissection of the CPA more difficult compared to suboccipital approach
- Eliminates hearing, but lowest recurrence
- Requires abdominal fat graft to repack middle ear and limit risk of CSF leak

Silk PS, Lane JI, Driscoll CL. Surgical approaches to vestibular schwannomas: what the radiologist needs to know. Radiographics. 2009 Nov;29(7):1955-70.
Monitoring for tumor recurrence (suppress fat graft signal)

POST-OP IMAGING
MRI T1-weighted, frequently with fat sat

Extent of residual tumor if total resection was not possible intraoperatively

CSF leak

Meningitis

Postoperative Complications

Parenchymal injury

Vascular injury

Inner ear disruption
Patient AB: Post-Operative Course

- Status post suboccipital craniectomy for VS resection.
- 8 months post-operative, developed CSF leak, presenting as otorhinorrhea and bacterial meningitis.
- Status post mastoid obliteration using abdominal fat graft with plugging of the Eustachian tube orifice for the left ear.
- Now doing well, has not regained left-sided functional hearing.
Patient AB:
Post-Operative Imaging

Axial MRI Heavily T2W (CISS)

- Fat graft and surgical packing material
- Trace fluid in mastoid air cells, source of earlier CSF leak
- Stable sub-galeal and extra-axial fluid collections consistent with pseudomeningocele or seroma
Summary

- Review of classic and radiographic anatomy of the CPA and IAC
- Review of characteristic radiographic findings of VS and correlation to clinical presentation
- Review of role of imaging in diagnosis, surgical planning and post-operative management of CPA lesions
References

Dr. Gillian Lieberman (BIDMC Radiology)
Dr. Hugh Curtin (MEEI Radiology)
Claire Odom (BIDMC)