Original Research Paper

Volume - 16 | Issue - 11 | November - 2026 | PRINT ISSN No. 2249 - 555X | DOI : 10.36106/ijar

Radio-Diagnosis

RADIOLOGICAL SPECTRUM OF VESTIBULAR SCHWANNOMAS: A THREE-CASE SERIES WITH MRI AND CT FEATURES.

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ABSTRACT Vestibular schwannoma is the most common benign neoplasm of the cerebellopontine angle and is most often identified by its characteristic relationship with the internal auditory canal. Magnetic resonance imaging is the principal modality for diagnosis, lesion characterization, assessment of intracanalicular extension, brainstem involvement, and treatment planning, while computed tomography provides complementary information regarding bony anatomy and mass effect. We present three radiologically diagnosed cases demonstrating a spectrum of imaging appearances of vestibular schwannoma. Case 1 was a 52-year-old woman with headache and tinnitus, showing a left cerebellopontine angle lesion with intracanalicular component, internal auditory canal widening, homogeneous enhancement, and compression of the pons and middle cerebellar peduncle, corresponding to Koos grade IV. Case 2 was a 61-year-old woman with giddiness CE-MRI brain shows left cerebellopontine angle mass with internal auditory canal extension, heterogeneous enhancement, diffusion restriction, microhemorrhagic foci, and extensive brainstem, cerebellar, and fourth ventricular mass effect with edema. Case 3 was a 40-year-old woman evaluated for a cerebellopontine angle tumor; non-contrast CT demonstrated a multiloculated solid-cystic lesion with hemorrhagic components, internal auditory canal extension, severe posterior fossa mass effect, fourth ventricular effacement, obstructive hydrocephalus, and periventricular edema. These cases emphasize the importance of evaluating the internal auditory canal, tumor composition, enhancement, hemorrhage, brainstem compression, hydrocephalus, and associated edema when characterizing cerebellopontine angle schwannomas.

KEYWORDS : Vestibular Schwannoma; Acoustic Neuroma; Cerebellopontine Angle; Internal Auditory Canal; Magnetic Resonance Imaging; Computed Tomography; Koos Grading.

INTRODUCTION

Vestibular schwannomas (VS), historically termed acoustic neuromas, are benign nerve sheath tumors arising most commonly from the vestibular division of cranial nerve VIII. They account for the majority of tumors arising in the cerebellopontine angle (CPA) and characteristically originate in the internal auditory canal (IAC) before extending into the CPA cistern. Although usually slow growing, larger tumors can produce clinically important mass effect on the brainstem, cerebellum, middle cerebellar peduncle and fourth ventricle. Clinical manifestations vary with tumor size and location and include unilateral sensorineural hearing loss, tinnitus, imbalance or vertigo, headache, and, in advanced lesions, multiple cranial neuropathies and raised intracranial pressure. [6,7,8]

MRI is the imaging modality of choice for suspected Vestibular schwannomas. High-resolution T2-weighted imaging and contrast-enhanced T1-weighted imaging are central to diagnosis, with thin-section heavily T2-weighted sequences such as CISS or FIESTA providing excellent depiction of the cranial nerves, IAC and cisternal anatomy. CT has a complementary role, particularly for assessment of the temporal bone, IAC remodeling or widening, calcification, and complications such as hydrocephalus. The Koos classification is widely used to describe the degree of extrameatal extension and brainstem involvement. [1,2,6,7,8]

The present case series illustrates three different radiological phenotypes of left-sided cerebellopontine angle schwannoma, ranging from a relatively compact enhancing tumor with a measurable intracanalicular component to large tumors with heterogeneous/cystic change, hemorrhage, extensive brainstem compression and obstructive hydrocephalus. [9,10]

Methods

Three radiologically diagnosed cases of cerebellopontine angle vestibular schwannoma were included in this case series. The cases were evaluated using the available cross-sectional imaging examinations, including contrast-enhanced magnetic resonance imaging in Cases 1 and 2 and noncontrast computed tomography in Case 3. Imaging assessment focused on lesion size and epicentre, internal auditory canal involvement, signal characteristics, diffusion restriction and susceptibility features, enhancement pattern, solid-cystic composition, brainstem and cerebellar mass effect, fourth ventricular involvement, hydrocephalus, and associated edema. Koos grading was reported where explicitly available in the supplied radiology record.

Case Report

Case 1

A 52-year-old woman presented with headache and a ringing sensation in the ear for approximately 7 months. Contrast-enhanced MRI of the brain demonstrated a well-defined extra-axial mass in the left cerebellopontine angle cistern measuring approximately 2.0 × 1.8 × 2.1 cm (AP × TR × CC). The lesion was isointense on T1-weighted imaging (Figure 1a) and heterogeneously hyperintense on T2-weighted and FLAIR images (Figure 1b and 1c), with foci of susceptibility/blooming on GRE (Figure 2c). Post-contrast images (Figure 2a & 2b) showed homogeneous enhancement. An intracanalicular component measuring approximately 8 mm extended into the left internal auditory canal, which was widened. There was substantial cerebellopontine angle extension with compression of the left hemipons and middle cerebellar peduncle and mild rightward displacement of the pons. The adjacent brainstem was mildly compressed. The imaging appearance was considered characteristic of a left vestibular schwannoma with advanced cerebellopontine angle extension, reported as Koos grade IV in the supplied radiology record. No significant midline shift was identified. The right cerebellopontine angle and internal auditory canal were unremarkable, and the visualized cochlea, vestibule and semicircular canals were grossly preserved.

Case 2

A 61-year-old woman presented with giddiness for approximately 2 months. Plain and contrast MRI of the brain with MR angiography showed a well-defined extra-axial left cerebellopontine angle mass

measuring approximately 3.1 × 3.7 × 3.4 cm (AP × TR × CC). The lesion was T1 isointense (Figure 3b) and heterogeneously hyperintense on T2/FLAIR imaging (Figure 3a and 3c). Diffusion restriction was reported, with a few susceptibility foci on SWI (Figure 4c) compatible with micro-hemorrhagic products. The mass extended into the left internal acoustic meatus and demonstrated heterogeneous post-contrast enhancement (Figure 4a & 4b). Marked mass effect involved the left middle cerebellar peduncle, left cerebellar hemisphere, fourth ventricle, medulla, pons and midbrain. Associated T2/FLAIR hyperintensity in the left cerebellar hemisphere, middle cerebellar peduncle and brainstem was interpreted as vasogenic edema. The overall imaging impression was a large left cerebellopontine angle extra-axial mass, likely schwannoma which was confirmed on histopathology.

Case 3

A 40-year-old woman was referred for evaluation of a cerebello-pontine angle tumor. Non-contrast CT of the brain demonstrated a well-defined left cerebellopontine angle solid-cystic mass (Figure 5) with multiple locules and dependent hyperdense components suggestive of hemorrhage. The overall lesion measured approximately 4.4 × 3.3 × 3.9 cm (AP × TR × CC), with a solid component measuring approximately 2.3 × 1.0 × 1.2 cm. The lesion widened the adjacent CSF space and exerted significant mass effect on the cerebellum, left middle and inferior cerebellar peduncles, pons and medulla. Mild widening of the left internal auditory canal with extension of the solid component was present. The fourth ventricle was effaced, resulting in upstream dilatation of the lateral and third ventricles resulting in obstructive hydrocephalus. Periventricular white-matter hypodensity was present, compatible with transependymal/periventricular edema in the setting of obstructive hydrocephalus. The imaging impression favored a cystic schwannoma with hemorrhagic components which was confirmed on histopathology.

DISCUSSION

The three cases demonstrate the broad radiological spectrum of vestibular schwannoma. The key diagnostic clue is the relationship of the cerebellopontine angle mass to the internal auditory canal. Vestibular schwannomas typically has an intracanalicular component and may produce smooth expansion or widening of the internal auditory canal. In contrast, cerebellopontine angle meningioma more often demonstrates a broad dural attachment, dural tail and hyperostotic change, and may extend along the skull base without the characteristic internal auditory canal -centered configuration. Epidermoid cyst is another important differential diagnosis but generally follows CSF signal on conventional sequences and demonstrates characteristic diffusion restriction, whereas vestibular schwannomas enhances following contrast administration. [6,7,10,11]

On MRI, vestibular schwannomas are commonly isointense to brain on T1-weighted images and hyperintense on T2-weighted images, with enhancement after gadolinium. Small tumors may enhance relatively homogeneously. With increasing size, internal heterogeneity becomes more common because of cystic degeneration, necrosis and hemorrhage. Case 1 represents a predominantly solid, avidly enhancing tumor, whereas Cases 2 and 3 illustrate progressively heterogeneous or cystic phenotypes. The susceptibility foci in Cases 1 and 2 and the dependent hyperdensity in Case 3 emphasize that hemorrhagic components can be encountered, particularly in larger lesions. [6,7,11,12]

Diffusion-weighted imaging can provide useful differential information, although diffusion characteristics of schwannomas can vary. The diffusion restriction reported in Case 2 should therefore be interpreted together with the lesion's enhancement, internal auditory canal extension and overall cerebellopontine angle anatomy rather than used in isolation. The presence of a clearly enhancing internal auditory canal -centered cerebellopontine angle mass favors schwannoma over non-enhancing CSF-containing lesions such as arachnoid cyst, while an epidermoid is expected to show more pronounced diffusion restriction and typically lacks solid homo-geneous enhancement. [6,7,10,11]

The Koos classification is useful for communicating tumor extent. In simplified terms, Koos I is confined to the internal auditory canal, Koos II extends into the cerebellopontine angle without brainstem contact, Koos III contacts the brainstem without significant compression, and Koos IV produces significant brainstem compression. Case 1 was explicitly assigned Koos grade IV in the source report because of brainstem and middle cerebellar peduncle compression. The larger lesions in Cases 2 and 3 also demonstrate advanced mass effect; however, formal Koos grading should ideally be assigned using dedicated high-resolution MRI and the exact criteria of the reporting system. [9,10]

Current evidence-based guidance continues to support high-resolution T2-weighted and contrast-enhanced T1-weighted MRI for initial evaluation, with conventional T1, T2, FLAIR and DWI as useful adjuncts. CT remains complementary for bony anatomy and internal auditory canal assessment. Advanced techniques such as DTI/tractography, perfusion imaging, radiomics and artificial-intelligence-based segmentation are increasingly being studied for treatment planning, prediction of growth and surgical risk, but their routine clinical adoption remains variable. [1,2,6,7]

A practical radiology reporting approach should therefore document: side; epicenter; maximal three-dimensional dimensions; intracanalicular extension; internal auditory canal widening; solid versus cystic composition; hemorrhage/susceptibility; enhancement pattern; diffusion characteristics; relationship to the cochlea and vestibule when adequately assessed; brainstem and cerebellar compression; fourth ventricular effect; hydrocephalus; and associated edema. These elements improve communication with skull-base and neurosurgical teams and provide a reproducible baseline for future follow-up. [1,2,6,7]

CONCLUSION

This three-case imaging series demonstrates important phenotypic variation in vestibular schwannoma, including a predominantly solid enhancing lesion with intracanalicular extension, a large heterogeneous tumor with hemorrhagic foci and vasogenic edema, and a large multiloculated hemorrhagic solid-cystic lesion producing obstructive hydrocephalus. Recognition of the internal auditory canal -centered origin, characteristic enhancement, tumor composition, hemorrhage, brainstem relationship and hydrocephalus is central to accurate diagnosis and grading. High-resolution MRI remains the cornerstone of evaluation, while CT provides valuable complementary information about bony anatomy and acute mass effect.

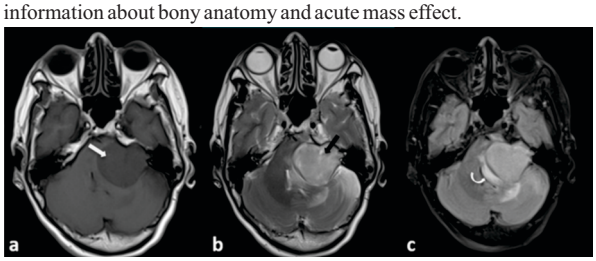


Figure 1: Axial (a) T1 isointense (white arrow), (b) T2 (black arrow) and (c) FLAIR heterogeneously hyperintense lesion is noted in the left cerebello-pontine angle cistern with extension into the left porus acusticus. FLAIR hyperintensity (curved white arrow) in the left cerebellar hemisphere, middle cerebellar peduncle and brainstem suggestive of vasogenic edema (c).

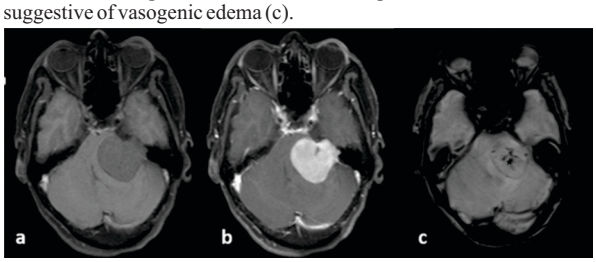


Figure 2: Axial T1-fat saturated pre-contrast (a) and post contrast (b) shows heterogeneous contrast enhancement. SWI (c) sequence shows few foci of blooming (black star) suggestive of microhemorrhage.

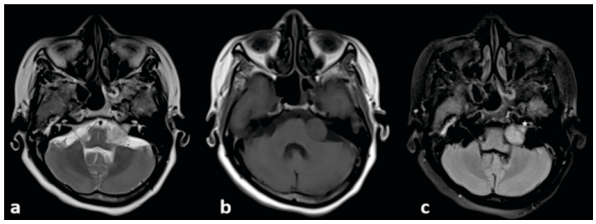


Figure 3: Axial (a) T2 and FLAIR (c) heterogeneously hyperintense,

T1 (b) isointense lesion is noted in the left cerebello-pontine angle cistern with extension into the left porus acusticus (white star).

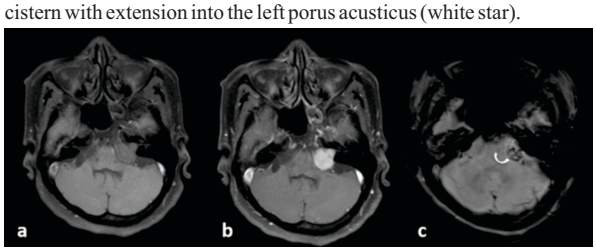


Figure 4: Axial T1-fat saturated pre-contrast (a) and post contrast (b) shows heterogeneous contrast enhancement. SWI (c) sequence shows few foci of blooming (curved white arrow) suggestive of microhemorrhage.



Figure 5: Axial (a) and Coronal (b) shows a well -defined solid (black star) –cystic (white arrow) lesion is seen in the left cerebellopontine angle region with widening of CSF space, mass effect on the cerebellum, pons and medulla. 4th ventricle is effaced due to mass effect resulting in upstream dilatation of the lateral and III ventricle.

Conflict of Interest: The authors declare no conflict of interest.
Funding: No external funding was received.
Data Availability: The imaging data are part of the institutional clinical record and are not publicly available.

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