e-ISSN: 0976-822X, p-ISSN:2961-6042

Available online on http://www.ijcpr.com/

International Journal of Current Pharmaceutical Review and Research 2026; 18(7); 855-865

Case Series

Clinicoradiological Correlation in Vagal Nerve Schwannomas with Jugular Foramen and Carotid Space Extension: A Retrospective Case Series of Four Patients

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Received: 01-04-2026 / Revised: 15-05-2026 / Accepted: 21-06-2026

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Conflict of interest: Nil

Abstract

Background: Vagal nerve schwannoma is a rare benign peripheral nerve sheath tumor arising from the vagus nerve, commonly involving the carotid space and jugular foramen. Owing to its indolent growth and nonspecific clinical manifestations, diagnosis is frequently delayed. Magnetic resonance imaging (MRI), complemented by computed tomography (CT), plays a pivotal role in defining tumor origin, extent, vascular displacement, and skull-base involvement. This case series highlights the clinic-radiological correlation of vagal nerve schwannomas and emphasizes the role of imaging in diagnosis and surgical planning.

Methods: A retrospective descriptive case series was conducted at Maharishi Markandeshwar Medical College, Mullana, Ambala, including four adult patients with radiologically suspected and histopathologically confirmed vagal nerve schwannomas managed during 2025. Clinical presentation, MRI and CT findings, operative details, histopathological features, and postoperative outcomes were reviewed. Particular emphasis was placed on correlating radiological characteristics with the presenting clinical manifestations.

Results: The patients presented with dizziness, gait imbalance, dysphagia, and hoarseness of voice, choking episodes, and painless neck swelling. MRI consistently demonstrated well-defined enhancing lesions involving the jugular foramen and/or carotid space with characteristic displacement of the internal carotid artery and internal jugular vein, strongly suggesting a vagal nerve origin. CT accurately demonstrated jugular foramen widening and skull-base erosion in tumors with cranial extension. Clinical manifestations closely corresponded to the anatomical extent of the lesions, with medullary compression associated with neurological symptoms and carotid space lesions presenting predominantly with hoarseness or neck swelling. Complete surgical excision was achieved in all patients, and histopathological examination confirmed benign schwannoma. Postoperative outcomes were favorable, with only transient lower cranial nerve deficits in selected cases.

Conclusion: This case series demonstrates a strong clinicoradiological correlation between the anatomical location, imaging characteristics, and clinical presentation of vagal nerve schwannomas. Recognition of characteristic MRI and CT findings, including jugular foramen involvement, carotid space extension, vascular displacement, and skull-base erosion—facilitates accurate preoperative diagnosis, differentiation from other skull-base lesions, and optimal surgical planning, resulting in excellent postoperative outcomes.

Keywords: Case series; Clinicoradiological correlation; Carotid space; Jugular foramen; Magnetic resonance imaging; Peripheral nerve sheath tumor; Vagal nerve schwannoma.

DOI: 10.25258/ijcpr.18.7.132

Introduction

Vagal nerve schwannoma is a rare benign, slow-growing neurogenic tumor arising from Schwann cells of the vagus nerve and constitutes only a small proportion of head and neck schwannomas. Owing to its indolent growth and deep anatomical location, patients often remain asymptomatic until the lesion attains sufficient size to produce compressive symptoms involving adjacent neurovascular

structures. Consequently, diagnosis is frequently delayed, posing significant challenges in clinical evaluation and management. [1,2] The jugular foramen is a complex skull-base region traversed by the glossopharyngeal, vagus, and accessory nerves, along with the internal jugular vein. Schwannomas arising in this region may extend into the posterior cranial fossa or carotid space and commonly present with progressive hoarseness, dysphagia, dizziness, lower cranial nerve palsies, hearing disturbances, gait imbalance, or painless neck swelling, depending on the site of origin and direction of tumor growth. Larger lesions may also compress the medulla or cerebellum, resulting in significant neurological manifestations. [2,3]

Magnetic resonance imaging (MRI) is the imaging modality of choice for the evaluation of vagal nerve schwannomas because of its excellent soft-tissue resolution and ability to accurately delineate tumor extent and relationship to adjacent neurovascular structures. Typical MRI findings include a well-defined encapsulated lesion that is hypointense on T1-weighted images, hyperintense on T2-weighted images, and demonstrates heterogeneous post-contrast enhancement. Computed tomography (CT) complements MRI by demonstrating widening or erosion of the jugular foramen and assessing skull-base involvement. Furthermore, characteristic separation of the internal carotid artery and internal jugular vein within the carotid sheath is an important radiological feature that strongly suggests a vagal nerve origin and assists in differentiating these tumors from paragangliomas and other skull-base masses. [4-6]

Despite advances in neuroimaging, vagal nerve schwannomas remain uncommon, and the available literature is largely limited to isolated case reports and small institutional case series. Consequently, comprehensive characterization of their clinicoradiological spectrum remains limited. Correlating clinical presentation with radiological findings is essential for accurate preoperative diagnosis, differentiation from other skull-base lesions, assessment of tumor extent, and appropriate surgical planning.

Therefore, the present retrospective case series was undertaken to describe the clinical presentation, radiological characteristics, management, and short-term outcomes of patients with histopathologically confirmed vagal nerve schwannoma, with particular emphasis on clinicoradiological correlation. By correlating MRI and CT findings with the presenting clinical manifestations and postoperative outcomes, this study aims to emphasize the diagnostic value of imaging in optimizing the management of this rare entity, at Maharishi Markandeshwar Medical College, Mullana, and Ambala.

Material and Methods

Study Design: This retrospective descriptive case series was conducted to evaluate the clinicoradiological spectrum of histopathologically confirmed vagal nerve schwannomas, with particular emphasis on magnetic resonance imaging (MRI) and computed tomography (CT) findings and their correlation with clinical presentation, surgical findings, and postoperative outcomes.

Study Setting: The study was conducted in the Department of Radiodiagnosis, Maharishi Markandeshwar Medical College, Mullana, Ambala, Haryana, in collaboration with the Departments of Otorhinolaryngology–Head and Neck Surgery, Neurosurgery, and Pathology. The study focused on the radiological evaluation of vagal nerve schwannomas and the correlation of imaging findings with clinical manifestations, operative findings, histopathological diagnosis, and postoperative outcomes.

Study Duration: The study included patients managed during 2025 after obtaining approval from the Institutional Ethics Committee. Patient confidentiality was maintained throughout the study in accordance with institutional ethical guidelines.

Study Population: A total of four adult patients diagnosed with vagal nerve schwannoma during the study period were included. The diagnosis was established based on characteristic MRI and CT findings and subsequently confirmed by histopathological examination following surgical excision.

Inclusion Criteria

- Adult patients (≥18 years) with radiological findings suggestive of vagal nerve schwannoma.
- Histopathological confirmation following surgical excision.
- Availability of complete clinical, radiological, operative, and follow-up records.

Exclusion Criteria

- Schwannomas arising from cranial nerves other than the vagus nerve.
- Paragangliomas, meningiomas, neurofibromas, or other skull-base tumors.
- Patients with incomplete clinical or radiological records.

Data Collection: Clinical records were retrospectively reviewed to obtain demographic characteristics, presenting symptoms, duration of illness, neurological findings, lower cranial nerve involvement, surgical details, histopathological diagnosis, postoperative complications, and follow-up outcomes. Radiological evaluation was performed using MRI and CT examinations. MRI

studies were assessed for tumor location, maximum dimensions, signal intensity characteristics on T1- and T2-weighted sequences, contrast enhancement pattern, involvement of the jugular foramen, intracranial extension, carotid space extension, displacement of the internal carotid artery and internal jugular vein, relationship to adjacent neurovascular structures, and evidence of brainstem compression. CT images were evaluated for jugular foramen widening, skull-base erosion, and associated osseous changes.

Clinicoradiological Correlation: The radiological findings were systematically correlated with the presenting clinical manifestations to evaluate the relationship between anatomical location, tumor extent, and neurological symptoms. Particular emphasis was placed on correlating jugular foramen involvement with lower cranial nerve deficits, carotid space extension with cervical symptoms, vascular displacement with tumor origin, and brainstem compression with neurological manifestations. Imaging findings were further correlated with operative findings, histopathological diagnosis, and postoperative functional outcomes.

Study Variables: The following variables were evaluated:

- Age and gender
- Presenting clinical manifestations
- Tumor location and maximum dimensions
- MRI signal characteristics and contrast enhancement
- Jugular foramen widening or erosion
- Carotid space and intracranial extension
- Internal carotid artery–internal jugular vein displacement
- Brainstem compression
- Lower cranial nerve involvement
- Histopathological diagnosis
- Surgical management
- Postoperative neurological outcome
- Tumor recurrence during follow-up

Statistical Analysis: As this was a retrospective descriptive case series involving only four patients, inferential statistical analysis was not performed. Continuous variables were summarized as mean ± standard deviation or median (range), whereas categorical variables were expressed as frequencies and percentages. Clinicoradiological correlation was evaluated descriptively by comparing the clinical presentation of each patient with the corresponding MRI and CT findings, operative observations, histopathological diagnosis, and postoperative outcomes.

Case Presentation (Result): Four adult patients (three females and one male) with histopathologically confirmed vagal nerve schwannoma were included in this retrospective case series. The mean age was 57.5 years (range: 48–67 years). Clinical presentation varied according to the anatomical location and extent of the lesion, with patients presenting with dizziness, gait imbalance, dysphagia, hoarseness of voice, choking episodes, and painless neck swelling. Lower cranial nerve dysfunction was observed in patients with jugular foramen involvement, whereas lesions confined predominantly to the carotid space presented mainly with cervical symptoms and vagal nerve-related voice changes.

MRI successfully identified the anatomical origin and extent of the tumour in all four patients. All lesions appeared as well-defined encapsulated masses demonstrating low signal intensity on T1-weighted images, high signal intensity on T2-weighted images, and heterogeneous contrast enhancement. Two tumours involved the jugular foramen with associated carotid space extension, while two were predominantly confined to the carotid sheath. Characteristic separation of the internal carotid artery and internal jugular vein was observed in all patients, strongly suggesting a vagal nerve origin. CT imaging complemented MRI by demonstrating jugular foramen widening and skull-base erosion in lesions with cranial extension.

A close clinicoradiological correlation was observed between imaging findings and neurological manifestations. Patients with jugular foramen involvement and mild brainstem compression predominantly presented with dizziness, gait imbalance, dysphagia, or lower cranial nerve dysfunction, whereas patients with carotid space lesions without intracranial extension primarily presented with painless neck swelling and hoarseness of voice.

The characteristic vascular displacement pattern, together with the imaging appearance, facilitated differentiation of vagal nerve schwannoma from other jugular foramen and carotid space lesions, particularly paraganglioma. Complete surgical excision was achieved in all four patients. Histopathological examination confirmed benign schwannoma in every case, demonstrating characteristic Antoni A and Antoni B areas. Postoperative outcomes were favourable, with only transient lower cranial nerve deficits in selected patients that resolved during follow-up. No tumour recurrence was observed during the available follow-up period.

Case 1

A 67-year-old woman presented with intermittent dizziness for approximately two years, accompanied by progressive blurring of vision and gait imbalance. She also reported bilateral hip pain for the preceding 3–4 years, for which MRI of the spine had been performed previously. There was no history of

hearing loss, tinnitus, facial weakness, seizures, or head trauma. Neurological examination demonstrated mild gait instability without focal motor deficits, and flexible fibreoptic laryngoscopy revealed normal bilateral vocal cord mobility.

Radiological Findings: Contrast-enhanced MRI demonstrated a well-defined multilobulated extra-axial lesion measuring 35.9 × 19.5 × 37 mm, centred in the right jugular foramen. The lesion was hypointense on T1-weighted images, hyperintense on T2-weighted and FLAIR sequences, and showed heterogeneous post-contrast enhancement. Inferior extension into the right carotid space resulted in characteristic separation of the internal carotid artery and internal jugular vein, strongly suggesting a vagal nerve origin. The lesion also produced widening and erosion of the jugular foramen with mild compression of the medulla oblongata. CT examination confirmed erosion of the posterolateral wall of the jugular foramen without evidence of extensive skull-base destruction. Based on the characteristic imaging features, the primary radiological differential diagnoses included vagal nerve schwannoma and jugular paraganglioma; however, the pattern of vascular displacement, encapsulation, and relatively heterogeneous enhancement favoured vagal nerve schwannoma.

Clinicoradiological Correlation: The patient's dizziness and gait imbalance correlated well with the MRI evidence of mild medullary compression caused by the jugular foramen component of the tumour. The absence of vocal cord palsy was consistent with preserved vagal motor function despite tumour origin from the vagus nerve. Extension into the carotid space with characteristic separation of the internal carotid artery and internal jugular vein represented a key radiological sign supporting the diagnosis of vagal nerve schwannoma. Furthermore, CT demonstration of jugular foramen widening and erosion indicated skull-base involvement, providing valuable information for surgical planning.

Management and Histopathological Findings: The patient underwent complete surgical excision through a combined skull-base approach. Histopathological examination demonstrated a benign schwannoma composed of Antoni A and Antoni B areas with characteristic Verocay bodies, confirming the radiological diagnosis.

Outcome: The postoperative course was uneventful. The patient experienced gradual improvement in dizziness and gait imbalance, with preservation of lower cranial nerve function during follow-up, and no evidence of residual neurological deficit.

Case 2

A 54-year-old man presented with progressive hoarseness of voice and dysphagia for six months, accompanied by a gradually enlarging painless swelling on the right side of the neck. There was no history of fever, weight loss, aspiration, or other constitutional symptoms. Clinical examination revealed a soft, non-tender swelling deep to the upper part of the right sternocleidomastoid muscle. Indirect laryngoscopy demonstrated right vocal cord paresis, indicating vagal nerve dysfunction.

Radiological Findings: Contrast-enhanced MRI revealed a well-circumscribed enhancing lesion measuring 3.2 × 2.8 × 4.0 cm arising within the right carotid sheath, consistent with the anatomical course of the vagus nerve. The lesion demonstrated low signal intensity on T1-weighted images, high signal intensity on T2-weighted images, and heterogeneous post-contrast enhancement. Characteristic medial displacement of the internal carotid artery and lateral displacement of the internal jugular vein was observed without evidence of vascular encasement or invasion, a radiological feature strongly suggestive of vagal nerve schwannoma. No intracranial extension, jugular foramen widening, or skull-base erosion was identified. Based on these imaging characteristics, vagal nerve schwannoma was considered the most likely diagnosis.

Clinicoradiological Correlation: The patient's hoarseness of voice and right vocal cord paresis correlated well with the tumour arising along the cervical course of the vagus nerve within the carotid sheath. Dysphagia was consistent with vagal nerve dysfunction resulting from local compression. The absence of intracranial extension, brainstem compression, or jugular foramen involvement explained the lack of additional lower cranial nerve deficits or neurological manifestations. Furthermore, the characteristic separation of the internal carotid artery and internal jugular vein served as an important imaging sign favouring vagal nerve schwannoma over carotid body paraganglioma and other carotid space lesions, thereby facilitating accurate preoperative diagnosis.

Management and Histopathological Findings: The patient underwent complete surgical excision of the tumour with preservation of the adjacent major neurovascular structures. Histopathological examination confirmed a benign vagal nerve schwannoma, consistent with the preoperative radiological diagnosis.

Outcome: The postoperative recovery was uneventful. Hoarseness improved progressively over three months with speech therapy, while swallowing function returned to normal. No evidence of recurrence or persistent neurological deficit was observed during follow-up.

Case 3

A 61-year-old woman presented with progressively worsening dysphagia, occasional choking while

swallowing liquids, and intermittent right-sided neck discomfort of approximately one year's duration. There was no history of hearing loss, tinnitus, or facial weakness. Neurological examination demonstrated mild weakness of the right soft palate with a diminished gag reflex, suggesting involvement of the lower cranial nerves.

Radiological Findings: Contrast-enhanced MRI demonstrated a well-defined heterogeneously enhancing lesion measuring 4.1 × 3.0 × 3.8 cm, centred at the right jugular foramen with inferior extension into the carotid space. The lesion appeared hypointense on T1-weighted images and hyperintense on T2-weighted images, with heterogeneous post-contrast enhancement. Mild widening of the jugular foramen and compression of the adjacent medulla were evident without hydrocephalus. The imaging characteristics, together with the anatomical location and pattern of extension, were highly suggestive of vagal nerve schwannoma.

Clinicoradiological Correlation: The patient's progressive dysphagia, choking episodes, reduced gag reflex, and palatal weakness closely correlated with the lesion involving the jugular foramen, where the glossopharyngeal and vagus nerves traverse the skull base. Inferior extension into the carotid space accounted for the cervical symptoms, whereas mild medullary compression explained the neurological manifestations without producing significant brainstem dysfunction. The imaging findings accurately delineated the tumour extent and its relationship to adjacent neurovascular structures, facilitating preoperative diagnosis and surgical planning.

Management and Histopathological Findings: The patient underwent complete surgical excision of the tumour. Histopathological examination demonstrated the characteristic Antoni A and Antoni B patterns with diffuse S-100 protein positivity, confirming the diagnosis of benign vagal nerve schwannoma and corroborating the preoperative radiological impression.

Outcome: The postoperative course was uneventful except for transient dysphagia, which resolved completely within six weeks with conservative rehabilitation. No persistent neurological deficit or evidence of recurrence was observed during follow-up.

Case 4

A 48-year-old woman presented with a painless right-sided neck swelling of eight months' duration, associated with intermittent hoarseness of voice. She denied dysphagia, hearing impairment, lower cranial nerve symptoms, facial weakness, or constitutional complaints. Clinical examination revealed a well-defined, non-tender cervical swelling without evidence of neurological deficit.

Radiological Findings: Contrast-enhanced MRI demonstrated a well-encapsulated lesion measuring 2.9 × 2.4 × 3.6 cm within the right carotid sheath. The lesion appeared hypointense on T1-weighted images, hyperintense on T2-weighted images, and demonstrated heterogeneous enhancement following gadolinium administration. Characteristic medial displacement of the internal carotid artery and lateral displacement of the internal jugular vein was noted, consistent with the typical vascular displacement pattern of a vagal nerve schwannoma. There was no evidence of jugular foramen widening, skull-base erosion, intracranial extension, or brainstem compression. Based on the characteristic MRI appearance and anatomical location, a radiological diagnosis of vagal nerve schwannoma was made.

Clinicoradiological Correlation: The patient's painless cervical swelling correlated with the tumour being confined to the carotid space, while the intermittent hoarseness reflected mild involvement of the cervical vagus nerve. The absence of dysphagia, lower cranial nerve deficits, or neurological manifestations was consistent with the lack of jugular foramen involvement, intracranial extension, and brainstem compression on MRI. Furthermore, the characteristic pattern of vascular displacement within the carotid sheath strongly favoured vagal nerve schwannoma over carotid body paraganglioma and other carotid space lesions, thereby facilitating accurate preoperative diagnosis.

Management and Histopathological Findings:

Complete microsurgical excision of the lesion was performed with preservation of the major cervical neurovascular structures. Histopathological examination confirmed a benign vagal nerve schwannoma, consistent with the preoperative radiological diagnosis.

Outcome: The postoperative course was uneventful except for mild transient hoarseness, which improved significantly during follow-up. No tumour recurrence or additional neurological deficit was observed during the six-month follow-up period.

Summary of Cases

Table 1: Clinicoradiological Characteristics of Patients with Vagal Nerve Schwannoma

Case	Age / Gender	Presenting Symptoms	MRI/CT Findings	Clinicoradiological Correlation	Surgical Outcome
1	67/F	Dizziness, gait imbalance, visual blurring	Right jugular foramen lesion (3.6 × 2.0 × 3.7 cm) with carotid space extension, heterogeneous enhancement, ICA-IJV separation, jugular foramen widening, mild medullary compression	Medullary compression correlated with dizziness and gait imbalance. ICA-IJV separation indicated vagal nerve origin. Jugular foramen erosion confirmed skull-base involvement.	Complete excision; neurological improvement
2	54/M	Hoarseness, dysphagia, neck swelling	Right carotid sheath lesion (3.2 × 2.8 × 4.0 cm), heterogeneous enhancement, medial ICA displacement, lateral IJV displacement, no intracranial extension	Cervical vagal nerve involvement correlated with vocal cord paresis and dysphagia. Absence of skull-base involvement explained lack of neurological deficits.	Complete excision; improvement in voice
3	61/F	Dysphagia, choking, neck discomfort	Right jugular foramen lesion (4.1 × 3.0 × 3.8 cm) with carotid space extension, mild medullary compression, jugular foramen widening	Jugular foramen involvement correlated with lower cranial nerve dysfunction. Medullary compression explained neurological symptoms.	Complete excision; transient dysphagia resolved
4	48/F	Neck swelling, intermittent hoarseness	Right carotid sheath lesion (2.9 × 2.4 × 3.6 cm), heterogeneous enhancement, ICA-IJV separation, no skull-base erosion or intracranial extension	Carotid space location explained isolated neck swelling and mild hoarseness. Absence of jugular foramen involvement correlated with absence of neurological deficits.	Complete excision; no recurrence

These four cases illustrate the varied clinical manifestations and characteristic radiological features of vagal nerve schwannoma, highlighting the importance of MRI and CT in diagnosis, differentiation from paraganglioma, surgical planning, and achieving favorable postoperative outcomes.

Table 2: Radiological Characteristics of Vagal Nerve Schwannomas

Parameter	Case 1	Case 2	Case 3	Case 4
T1 signal	Hypointense	Hypointense	Hypointense	Hypointense
T2 signal	Hyperintense	Hyperintense	Hyperintense	Hyperintense
Contrast enhancement	Heterogeneous	Heterogeneous	Heterogeneous	Heterogeneous
Jugular foramen involvement	Yes	No	Yes	No
Carotid space extension	Yes	Yes	Yes	Yes
ICA-IJV separation	Yes	Yes	Yes	Yes
Skull-base erosion	Yes	No	Mild	No
Brainstem compression	Mild	No	Mild	No
Histopathology	Schwannoma	Schwannoma	Schwannoma	Schwannoma

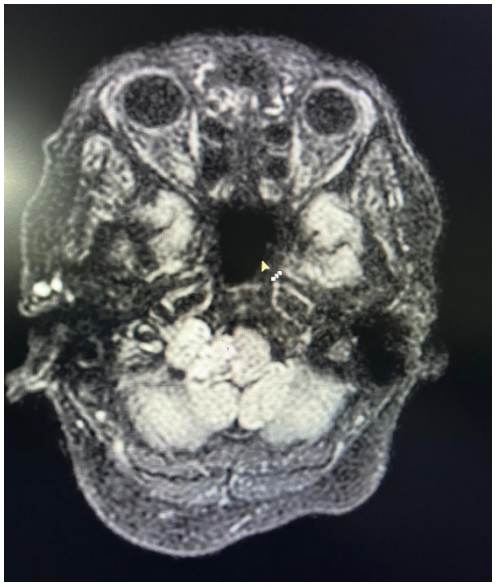

Figure 1: Coronal contrast-enhanced MRI showing a multilobulated right jugular foramen mass with mild compression of the medulla, suggestive of a vagal nerve schwannoma.

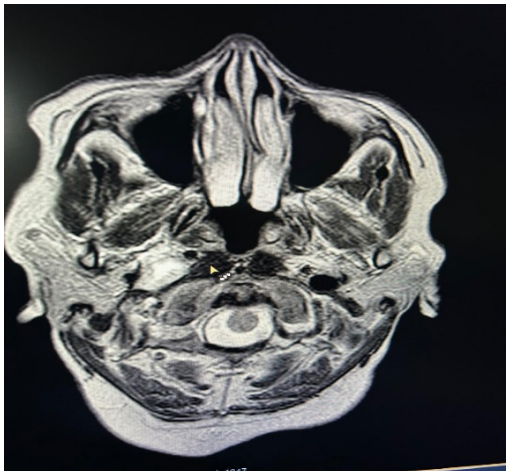

Figure 2: Axial T2-weighted MRI demonstrating a right jugular foramen lesion extending into the carotid sheath with characteristic separation of the internal carotid artery and internal jugular vein.

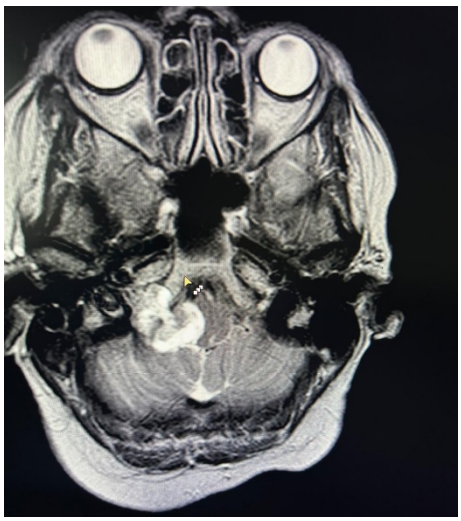

Figure 3: Axial contrast-enhanced MRI demonstrating a heterogeneously enhancing right jugular foramen mass with extension into the cerebellomedullary angle, causing mild compression of the medulla.

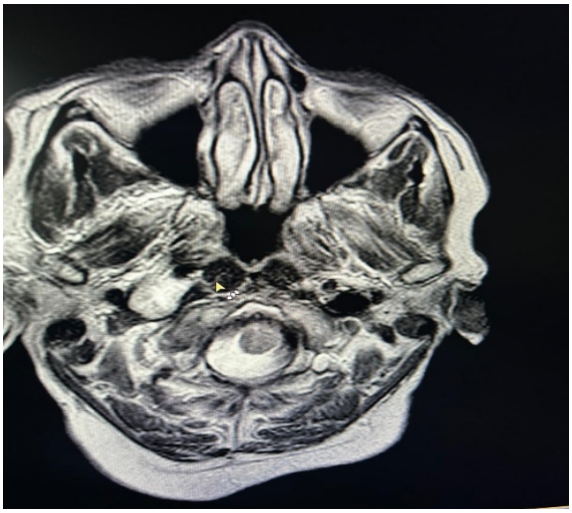

Figure 4: Axial T2-weighted MRI demonstrating a right jugular foramen vagal nerve schwannoma extending into the carotid sheath with displacement of adjacent neurovascular structures.

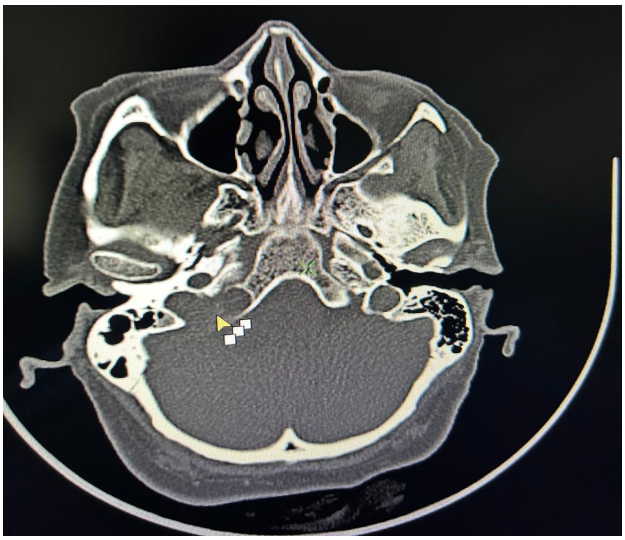

Figure 5: Axial CT scan of the temporal bone at the level of the cerebellopontine angle demonstrating the internal auditory canals and adjacent petrous temporal bone anatomy.

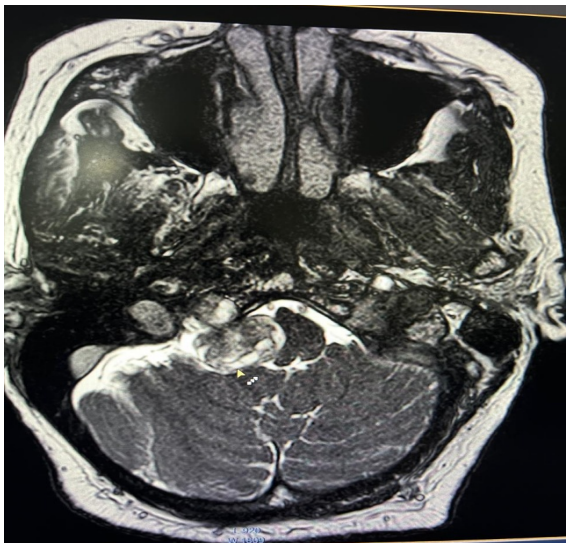

Figure 6: Axial T2-weighted MRI demonstrating a right cerebellopontine angle lesion extending into the internal auditory canal, suggestive of a vestibular schwannoma.

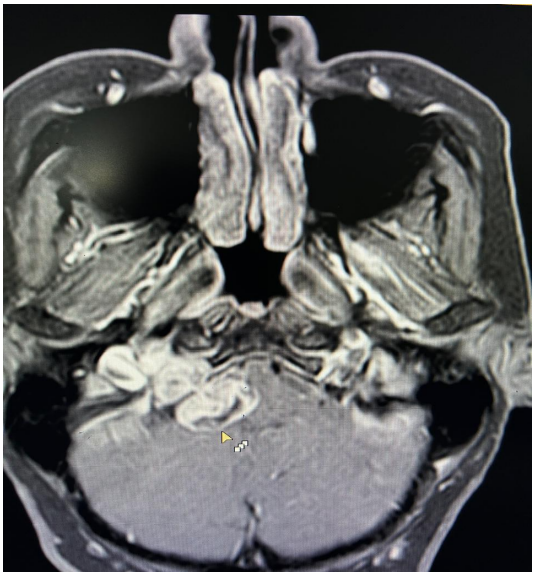

Figure 7: Contrast-enhanced axial T1-weighted MRI demonstrating an avidly enhancing right cerebellopontine angle mass with extension into the internal auditory canal, consistent with a vestibular schwannoma.

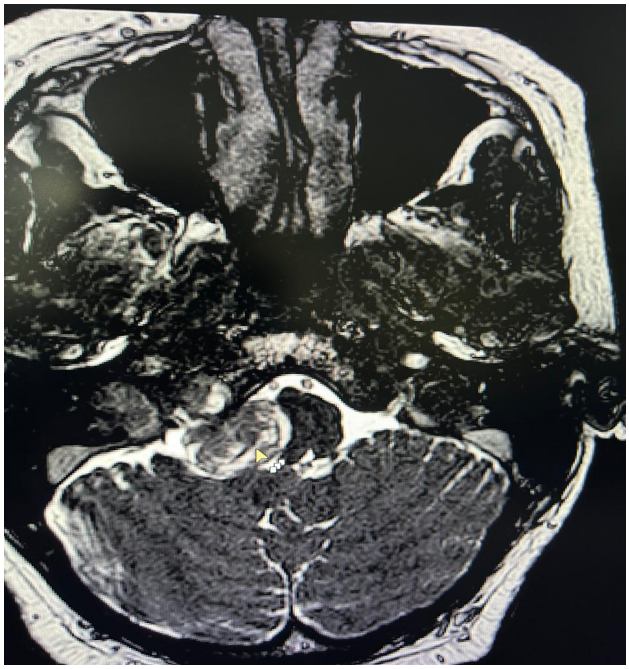

Figure 8: Contrast-enhanced axial MRI demonstrating a heterogeneously enhancing right cerebellopontine angle mass extending into the internal auditory canal, with mass effect on the adjacent brainstem, consistent with vestibular schwannoma.

Discussion

Vagal nerve schwannoma is an uncommon benign peripheral nerve sheath tumour arising from the vagus nerve and represents a rare cause of jugular foramen and carotid space masses. Owing to its slow growth and deep anatomical location, patients frequently present late with nonspecific symptoms, making preoperative diagnosis challenging. Previous surgical series have similarly reported that clinical manifestations largely depend on the anatomical location and extent of tumour involvement rather than tumour size alone. [1-4] In the present case series, the spectrum of clinical presentation ranged from dizziness, gait imbalance, and dysphagia to hoarseness of voice and painless cervical swelling, reflecting the variable anatomical extent of these lesions.

A major finding of the present study was the close clinicoradiological correlation between imaging characteristics and the patients' clinical manifestations. Lesions involving the jugular foramen were associated with lower cranial nerve dysfunction, presenting as dysphagia, gait imbalance, and neurological symptoms secondary to skull-base involvement and mild medullary compression. In contrast, tumours confined

predominantly to the carotid space presented mainly with painless neck swelling and hoarseness of voice without significant intracranial neurological deficits. These observations demonstrate that the anatomical location and extent of tumour involvement on imaging closely correspond to the presenting clinical features and are valuable in anticipating neurological deficits before surgery.

Radiological evaluation played a pivotal role in establishing the diagnosis in all patients. MRI demonstrated well-defined encapsulated lesions that were hypointense on T1-weighted images, hyperintense on T2-weighted images, and showed heterogeneous post-contrast enhancement. In addition to defining tumour extent, MRI accurately demonstrated carotid space extension, intracranial involvement, relationship to adjacent neurovascular structures, and evidence of brainstem compression where present. CT complemented MRI by demonstrating widening or erosion of the jugular foramen and associated skull-base changes in patients with cranial extension. These findings are consistent with previous reports describing MRI as the imaging modality of choice for determining tumour origin, anatomical extent, and relationship with surrounding vascular structures, while CT provides valuable assessment of osseous involvement. [5,6]

One of the most characteristic radiological findings observed in the present series was the separation of the internal carotid artery and internal jugular vein produced by tumour growth within the carotid sheath. This vascular displacement pattern strongly suggested a vagal nerve origin and facilitated differentiation from carotid body paraganglioma, which classically splays the carotid bifurcation rather than separating the carotid artery from the internal jugular vein. In all four patients, this imaging feature accurately indicated the site of tumour origin and contributed significantly to preoperative diagnostic confidence. Similar observations have been reported by Zhu et al., Prajapati et al., Thatal et al., and Honneshaiah et al., who highlighted the diagnostic value of vascular displacement patterns in cervical vagal schwannomas. [7-10] The principal radiological differential diagnosis in our series was paraganglioma. Although both lesions may demonstrate post-contrast enhancement, vagal schwannomas typically appear as well-encapsulated masses with heterogeneous enhancement and characteristic displacement of adjacent vascular structures without the marked hypervascularity usually associated with paragangliomas. Careful assessment of MRI signal characteristics together with CT findings enabled accurate differentiation in our patients and facilitated appropriate surgical planning, consistent with previous radiological reports. [5,6,9,10]

Complete surgical excision was successfully performed in all four patients, and histopathological examination confirmed benign schwannoma in every case. The radiological diagnosis correlated well with the histopathological findings, which demonstrated characteristic Antoni A and Antoni B areas, confirming the diagnostic accuracy of preoperative imaging. Postoperative outcomes were favourable, with only transient lower cranial nerve dysfunction observed in a few patients, followed by gradual neurological recovery during follow-up. Similar favourable surgical outcomes have been reported in previous surgical series and recent case reports, emphasising that meticulous preoperative radiological assessment contributes to optimal surgical planning and functional preservation. [1,4,8-11]

The present study has certain limitations, including its retrospective design and small sample size, which precluded statistical analysis and limit the generalisability of the findings. Nevertheless, considering the rarity of vagal nerve schwannomas, even a small institutional case series provides valuable clinical and radiological insights. A major strength of this study is the systematic clinicoradiological correlation of MRI and CT findings with clinical presentation, operative findings, histopathological confirmation, and postoperative outcomes. The present series reinforces the pivotal role of cross-sectional imaging not only in establishing the diagnosis but also in predicting neurological manifestations, differentiating vagal schwannoma from other jugular foramen and carotid space lesions, and facilitating appropriate surgical planning.

Conclusion

Vagal nerve schwannoma is a rare benign tumour of the head and neck that presents with diverse clinical manifestations depending on its anatomical location and extent of involvement.

The present case series demonstrates a strong clinicoradiological correlation, with lesions involving the jugular foramen predominantly presenting with lower cranial nerve dysfunction and neurological symptoms, whereas tumours confined to the carotid space manifested mainly as painless neck swelling and hoarseness of voice.

MRI proved to be the primary imaging modality for accurately defining tumour origin, anatomical extent, neurovascular relationships, and intracranial extension, while CT provided complementary information regarding jugular foramen widening and skull-base involvement. Characteristic vascular displacement, particularly separation of the internal carotid artery and internal jugular vein, served as a valuable radiological sign in differentiating vagal

nerve schwannoma from other carotid space and jugular foramen lesions.

Early recognition of these characteristic imaging features, combined with appropriate clinicoradiological correlation, facilitates accurate preoperative diagnosis, optimal surgical planning, and favourable postoperative outcomes.

Although limited by the small sample size, this case series highlights the diagnostic value of integrated MRI and CT evaluation in the management of this uncommon entity.

Strengths of the Study:

- Histopathologically confirmed cases of vagal nerve schwannoma.
- Detailed MRI and CT evaluation of all patients.
- Systematic clinicoradiological correlation between imaging findings and clinical manifestations.
- Correlation of radiological findings with operative and histopathological outcomes.
- Inclusion of both jugular foramen and cervical carotid space vagal schwannomas, demonstrating the complete clinicoradiological spectrum.

Limitations:

- Retrospective, single-centre study.
- Small sample size (n = 4), reflecting the rarity of the disease.
- Limited duration of postoperative follow-up.
- Statistical correlation could not be performed because of the descriptive nature of the case series.

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