

# Cranial nerve schwannoma - A pictorial essay

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## Abstract

Schwannomas are peripheral nerve sheath tumours arising from cranial, spinal or peripheral nerves. Most of the schwannomas are benign with the rare possibility of malignant transformation. Cranial nerve schwannomas can be seen along the course of any cranial nerve in the intracranial region or head and neck location. Although a majority are solitary sporadic lesions, multiple schwannomas can be seen in syndromes like neurofibromatosis type 2 and rarely in type 1. Since intracranial schwannomas are slow-growing, clinical presentation varies between no symptoms to cranial nerve palsy. Most of the times, the symptoms are due to mass effect over the adjacent structures, foraminal widening, compression of other cranial nerves, denervation injury or hydrocephalus. Familiarity with the course of the cranial nerves, imaging appearances and clinical presentation of schwannomas helps in accurate diagnosis and possible differential diagnosis, especially in uncommon clinical and radiological appearances. In this pictorial review, we illustrate relevant anatomy of cranial nerves, imaging features of schwannomas of most of the cranial nerves, clinical presentation and differential diagnosis.

**Key words:** Anatomy; clinical presentation; cranial nerve; differential diagnosis; magnetic resonance imaging; schwannoma

## Introduction

Schwannoma, also known as neurilemmoma and neurofibroma, are two major types of benign peripheral nerve sheath tumours. Schwannoma arises from the myelinating cells of the cranial or peripheral nervous system, composed of Schwann cells that normally produce myelin sheath covering the nerve.<sup>[1]</sup> Schwannoma grows eccentrically within a capsule of parent nerve. By contrast, neurofibroma contains cellular elements of peripheral nerves such as axons, perineural cells, fibroblasts and Schwann cells. Neurofibroma grows diffusely within and along the involved nerves, expanding radially entrapping the neural elements. Schwannoma has a typical histological

pattern, namely, Antoni Type A and B.<sup>[1]</sup> Type A is highly cellular and demonstrates nuclear palisading and Verocay bodies. Type B is loosely organised microcystic tissue which may represent degenerated Antoni A tissue. Some authors found that heterogeneous signal intensity of larger lesions on T2-weighted imaging is more commonly associated with a higher ratio of type B to type A tissue.<sup>[2]</sup> Ancient schwannoma is a rare subtype of schwannoma with degeneration and hypocellular matrix.<sup>[3]</sup> Histopathological features include relative reduction of hypercellular Antoni type A tissue, cystic necrosis, calcifications, hyalinisation and degenerative

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nuclei which may be misdiagnosed as pleomorphism of sarcoma.<sup>[4]</sup>

Since schwannoma is a slow-growing tumour, the clinical presentation of intracranial schwannomas varies between no symptoms to cranial nerve palsy. Symptoms may also be due to mass effect over the adjacent structures, denervation injury or hydrocephalus. Herein, we present schwannomas of most of the cranial nerves, relevant anatomy of cranial nerves, clinical presentation and differential diagnoses.

## Imaging Features of Cranial Nerve Schwannoma

Among intracranial schwannomas, vestibular schwannoma constitutes 90%, followed by trigeminal, facial and other lower cranial nerve schwannomas. Schwannoma is typically iso-hypointense on T1-weighted images, hyperintense on T2 and FLAIR images and shows variable enhancement on contrast administration. Heterogeneous appearance and enhancement pattern are due to necrosis, cystic degeneration and haemorrhage. Haemorrhage is seen as a loss of signal on gradient imaging. 3D heavily T2-weighted fast spin-echo and fast gradient echo techniques are useful for assessing the fine anatomic details of the cranial nerve and its relationship with the lesion. Target appearance on T2-weighted image with central hypointensity and peripheral hyperintensity which is typically described in neurofibroma can also be observed in schwannoma.<sup>[5]</sup> On computed tomography (CT), associated bony changes like bone remodelling and widening of neural foramen are better visualised.

## Olfactory Schwannoma

Schwannoma can arise from almost all cranial nerves with exception of olfactory and optic nerves which lacks Schwann cell layer and only have oligodendrocytes. Developmental and non-developmental hypothesis explain the origin of olfactory schwannoma. The developmental hypothesis states that ectodermal Schwann cells are transformed from mesenchymal pial cells while non-developmental hypothesis states that olfactory schwannoma arises from the adjoining perivascular nerve plexus, meningeal branches of 5<sup>th</sup> cranial nerve and ethmoidal nerves in the anterior cranial fossa and olfactory groove.<sup>[6]</sup> Murakami *et al.* state that the fila olfactoria has Schwann cell sheath at approximately 0.5 mm beyond the level of the olfactory bulb and can thus give rise to a schwannoma.<sup>[7]</sup>

Sensory cells for smell are placed in the olfactory epithelium in the superior nasal cavity, penetrating axons pass through the cribriform plate, the expanded portion of the nerve which is the olfactory bulb is placed in the olfactory groove and the olfactory nerve courses between the gyrus rectus and medial orbital gyrus. Therefore, olfactory nerve schwannomas may involve the superior nasal cavity, olfactory groove and anterior cranial fossa. Clinical

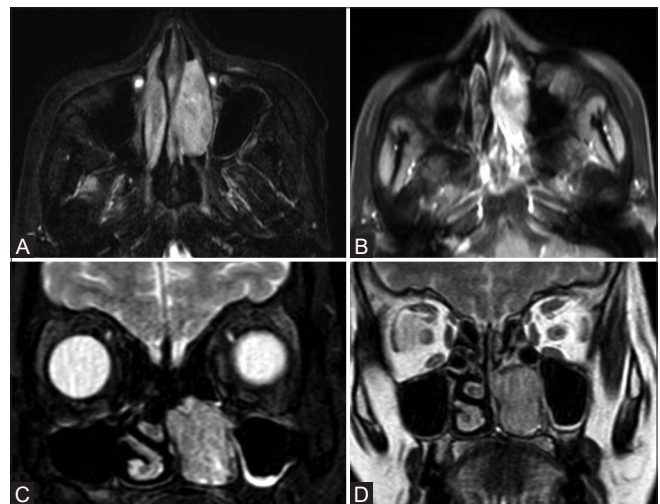
presentation is nasal block, anosmia and congestion. If there is an orbital or intracranial extension of the mass, the clinical presentation varies between proptosis, visual disturbances and raised intracranial pressure. Differential diagnoses to be considered are schwannoma from maxillary branches of the trigeminal nerve [Figure 1], squamous cell carcinoma, lymphoma, esthesioneuroblastoma which usually show aggressive imaging features.

## Orbital Schwannomas

Optic nerve schwannomas are rare as it is a white matter tract, lacks Schwann cells like olfactory nerve and myelinated by oligodendrocytes. Schwannomas may arise from the small sympathetic fibres of perivascular nerve plexus that innervate the vasculature around the optic nerve and sheath<sup>[8]</sup> [Figure 2]. Orbital schwannoma can arise from the cranial nerves 3, 4 and ophthalmic division of 5<sup>th</sup> cranial nerve which course from the cavernous sinus to the superior orbital fissure and orbit. Clinical presentation varies from headache, retro-orbital pain, proptosis to visual field defects. Differential diagnoses are haemangioma, neurofibroma, venovascular malformations, meningioma, lymphoma, glioma and metastases.

## Oculomotor Nerve

Oculomotor nerve arises from two nuclei in midbrain namely oculomotor nucleus and Edinger-Westpal nucleus (accessory parasympathetic) which are placed anterior to the aqueduct, the nerve traverses the midbrain

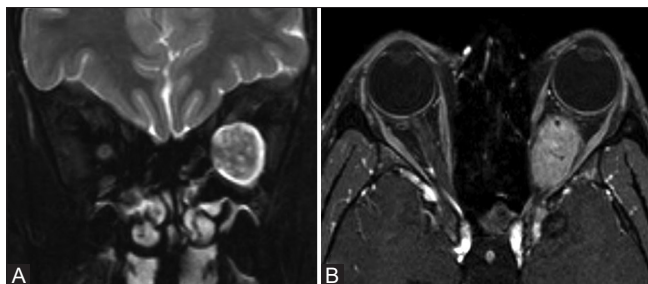


**Figure 1 (A-D):** Left sinonasal schwannoma. Axial T2 fat-suppressed (A) and axial post-contrast T1-weighted (B) images show a well-defined heterointense mass in the left nasal cavity and ethmoidal air cells which show inhomogeneous enhancement. Coronal T2 (C) and T2 fat-suppressed (D) images show the lesion is involving the left middle and inferior turbinates. This schwannoma is likely arising from the maxillary division of the trigeminal nerve. Preoperative biopsy revealed benign nerve sheath tumour and the postoperative histopathology confirmed schwannoma

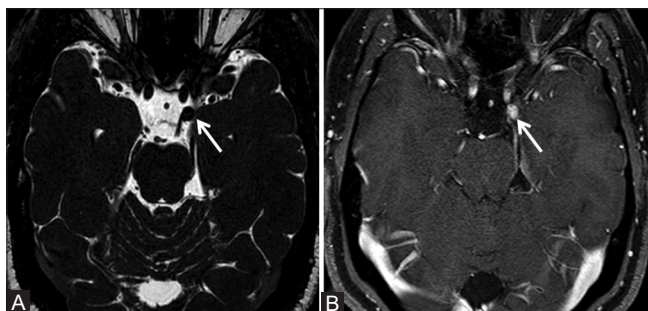
and emerges into the interpeduncular cistern.<sup>[9]</sup> The nerve travels the prepontine cistern between the superior cerebellar artery and posterior cerebral artery and enters the cavernous sinus, runs along the superolateral aspect and enters the orbit via superior orbital fissure.<sup>[10]</sup> Third cranial nerve innervates the extraocular muscles, namely, superior, medial and inferior recti and inferior oblique muscles and levator palpebrae superioris. Clinical presentation of patient's with schwannoma in the third cranial nerve [Figures 3 and 4] includes diplopia, unable to elevate the upper eyelid resulting in ptosis and lack of coordination of extraocular muscles for vision tracking and fixation. Autonomic parasympathetic component of the third cranial nerve innervates the ciliary muscle and sphincter pupillae, lesions in the nerve may result in pupillary dilatation and unresponsiveness. Differential diagnoses of the third cranial nerve schwannoma are meningioma, the perineural spread of malignancy, aneurysm and lymphoma.

### Trochlear Nerve

The trochlear nerve is the only cranial nerve that exits from the dorsal midbrain and it has the longest intracranial course.<sup>[11]</sup> After exiting from the midbrain, the nerve passes anteriorly, along with the ambient cistern and runs alongside

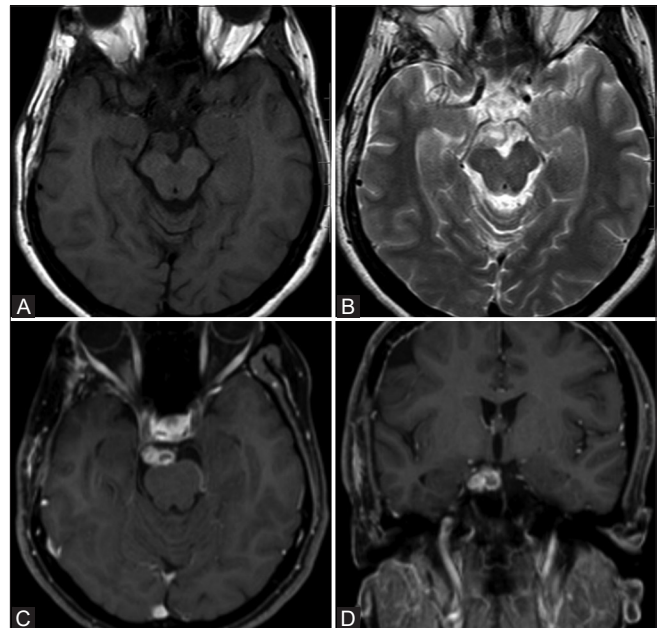


**Figure 2 (A and B):** Optic nerve schwannoma. Coronal T2 fat-suppressed (A) and axial post-contrast T1-weighted (B) images show a well-defined heterointense mass in the intraconal compartment of the left orbit involving the left optic nerve with inhomogeneous enhancement. This patient is a case of NF2 with multiple intracranial schwannomas. No biopsy was done. Symptomatic lesions were treated with radiosurgery

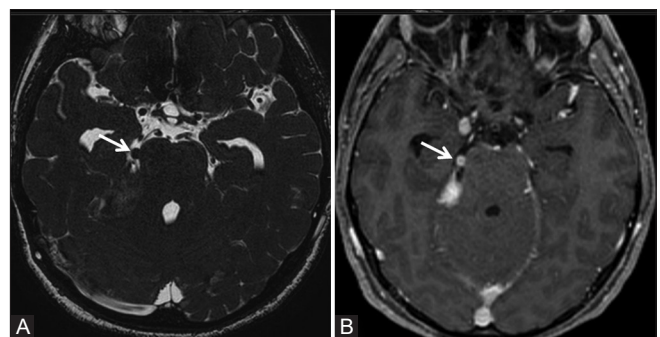


**Figure 4 (A and B):** Another oculomotor nerve schwannoma. Axial B-FFE (A) and (B) post-contrast T1-weighted images show a well-defined nodular lesion (arrow) arising from the left oculomotor nerve with significant enhancement. This 61-year-old woman presented with left eye ptosis and underwent cyberknife surgery. No surgery was done

the 3<sup>rd</sup> cranial nerve. The nerve pierces the dura between the attached and free borders of the tentorium. The nerve runs in the lateral wall of the cavernous sinus with third, sixth, ophthalmic and maxillary division of 5<sup>th</sup> nerves before entering the orbit via superior orbital fissure. Fibres from the nucleus cross the midline before exiting the midbrain, so the nerve fibres innervate the opposite side superior oblique muscle, which is the only muscle innervated by trochlear nerve. Schwannoma in trochlear nerve [Figure 5] clinically present as vertical diplopia, exacerbated by looking down and in activities such as climbing the stairs and reading.

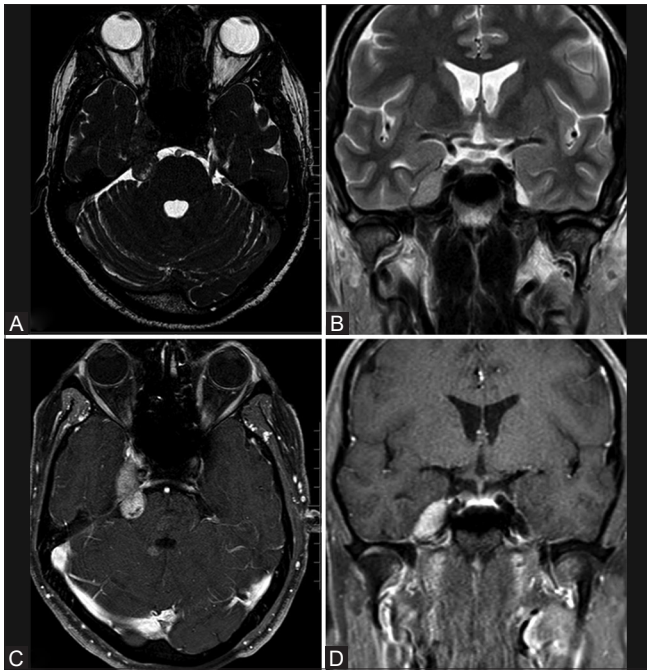


**Figure 3 (A-D):** Oculomotor nerve schwannoma. Axial T1-weighted (A) and T2-weighted (B) images show a heterointense lesion in interpeduncular cistern arising from the right oculomotor nerve. Axial (C) and coronal (D) post-contrast T1-weighted images show heterogeneous enhancement with non-enhancing foci of necrosis. No surgery was done. The lesion was treated with cyberknife therapy

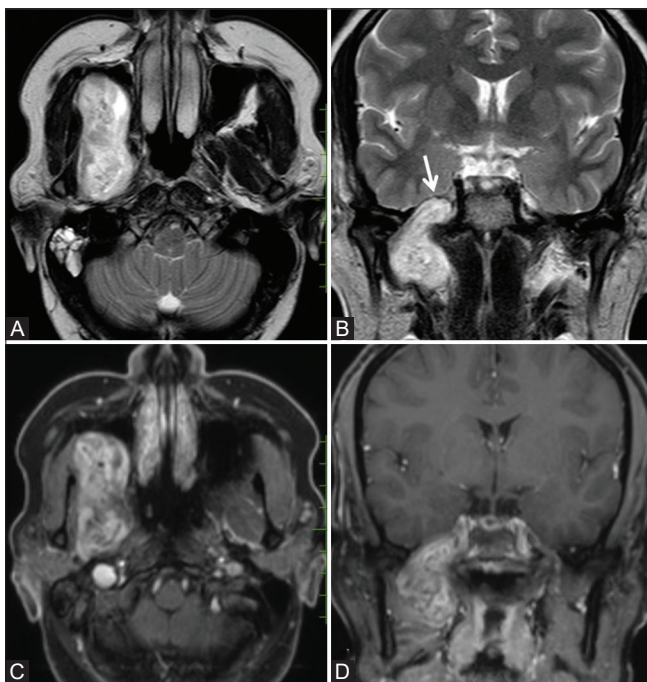


**Figure 5 (A and B):** Trochlear nerve schwannoma in a 53-year-old man with neurofibromatosis 2. Axial B-FFE (A) and post-contrast T1-weighted (B) images show well-defined nodule (arrow) arising from a trochlear nerve in the right ambient cistern. The nodule shows homogeneous enhancement on contrast imaging. Enhancing lesions are also seen in the right cerebellopontine cistern and para sellar regions, are part of vestibular and trigeminal schwannomas. No biopsy of trochlear nerve schwannoma was done. The lesion has been included in cyberknife therapy of vestibular schwannoma





**Figure 6 (A-D):** Trigeminal schwannoma. Axial B-FFE (A) and T2-weighted (B) images show a hyperintense oval-shaped mass in the cisternal segment of the right trigeminal nerve and right Meckel's cave. Axial (C) and coronal (D) post-contrast T1-weighted images show contrast enhancement. No biopsy was done. The lesion was treated with cyberknife radiosurgery

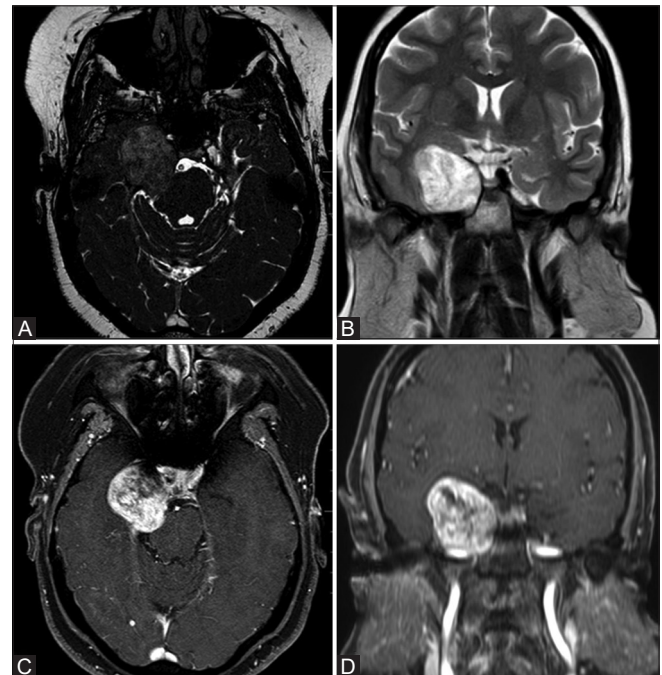


**Figure 8 (A-D):** Schwannoma from the mandibular division of the trigeminal nerve. Axial (A) and coronal (B) T2-weighted images show well-defined dumb-bell shaped heterointense mass in right pterygoid space and infratemporal fossa extending along the postganglionic segment of the mandibular division of right trigeminal nerve. Axial (C) and coronal (D) post-contrast T1-weighted images show heterogeneous enhancement. The lesion widens and fills the foramen ovale (arrow in b). Total excision of the lesion was done and histopathology confirmed schwannoma

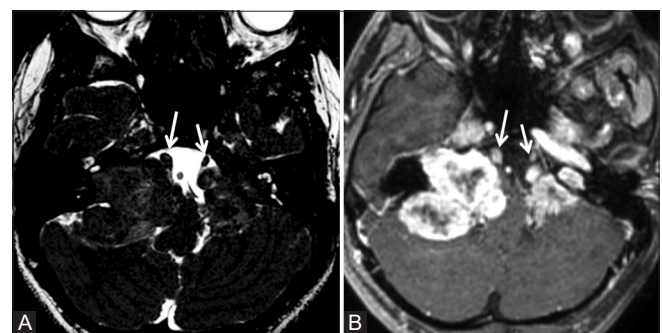
Differential diagnosis includes aneurysm and perineural spread of neoplasm.

### Trigeminal Nerve

The trigeminal nerve is the largest intracranial nerve.<sup>[12]</sup> The nerve arises from the lateral surface of mid pons. It has a larger sensory root which is laterally placed to the thinner

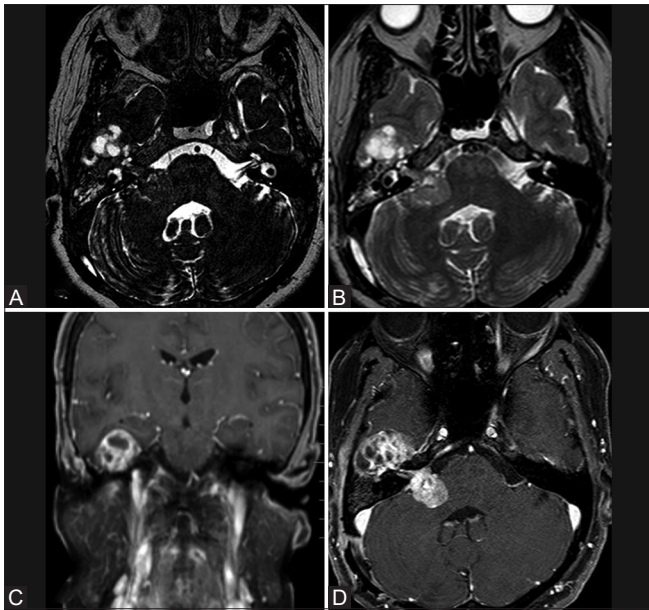


**Figure 7 (A-D):** Another case of trigeminal schwannoma with cavernous sinus extension. Axial B-FFE (A) and T2-weighted (B) images show a mass arising from the cisternal segment of right trigeminal nerve and Meckel's cave extending to the right cavernous sinus. There is mass effect over the ventral pons. Axial (C) and coronal (D) post-contrast T1-weighted images show heterogeneous enhancement. The lesion was biopsied, histopathology revealed schwannoma and the patient underwent cyberknife therapy

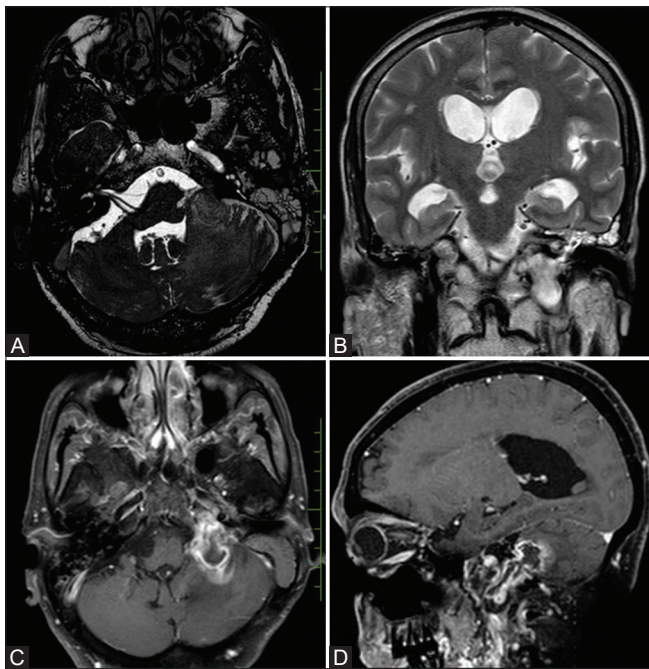


**Figure 9 (A and B):** Bilateral abducens nerve schwannoma in a patient with NF2. Axial B-FFE (A) and T2-weighted (B) images show two well-defined enhancing nodules arising from bilateral abducens nerves in prepontine cistern before the nerves enter the Dorello's canal. This patient also had bilateral vestibular schwannomas in cerebellopontine cisterns with mass effect over the brainstem. Abducens nerve schwannomas were not biopsied or operated. Surgery has been done for right vestibular schwannoma due to mass effect over the brainstem. Histopathology confirmed schwannoma

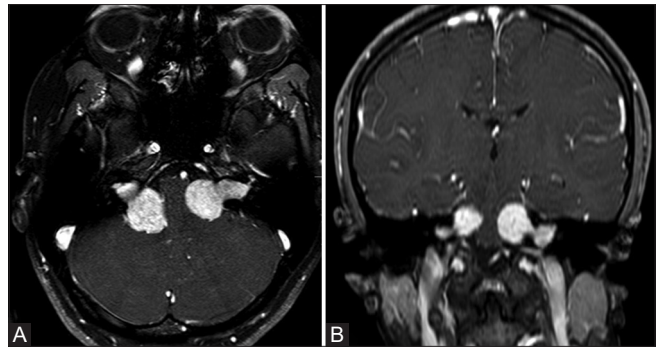




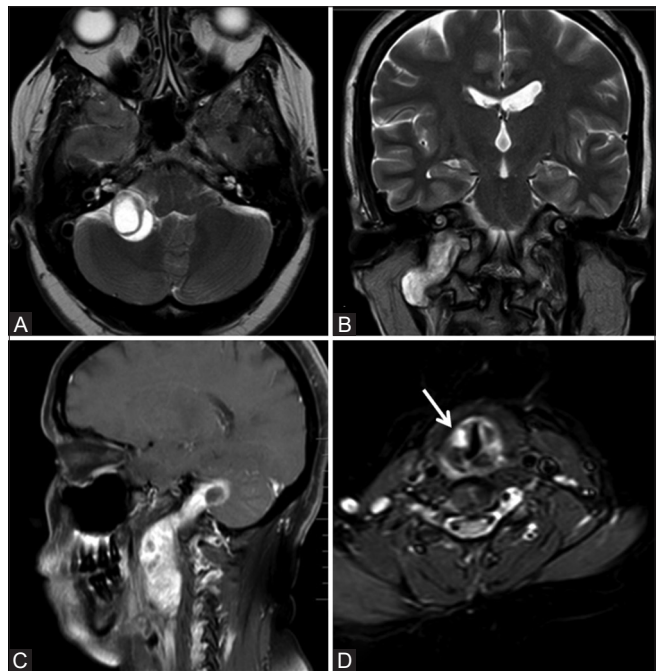
**Figure 10 (A-D):** Facial nerve schwannoma. Axial B-FFE (A) and T2-weighted (B) images show well-defined mixed intensity lesion with a solid and cystic component in the right cerebellopontine cistern. Axial (C) and coronal (D) post-contrast T1-weighted images show heterogeneous enhancement and the lesion extends along with cisternal, canalicular and labyrinthine segments of 7<sup>th</sup> nerve. Mass effect is seen over the right side of the pons and middle cerebellar peduncle. The patient underwent surgery followed by radiotherapy. Histopathology confirmed schwannoma



**Figure 12 (A-D):** Recurrent left glossopharyngeal nerve schwannoma. A 42-year-old male operated for glossopharyngeal nerve schwannoma 7 years ago. Axial B-FFE (A) and coronal T2-weighted (B) images show a recurrent mass in the inferior aspect of left cerebellopontine angle cistern, extending into the jugular foramen and continuing along with the jugular bulb. Axial (C) and sagittal (D) post-contrast T1-weighted images show intense peripheral enhancement. Centre of the lesion is cystic and show no enhancement. As this patient is a recurrent biopsy-proven case of glossopharyngeal schwannoma, further radiotherapy was given

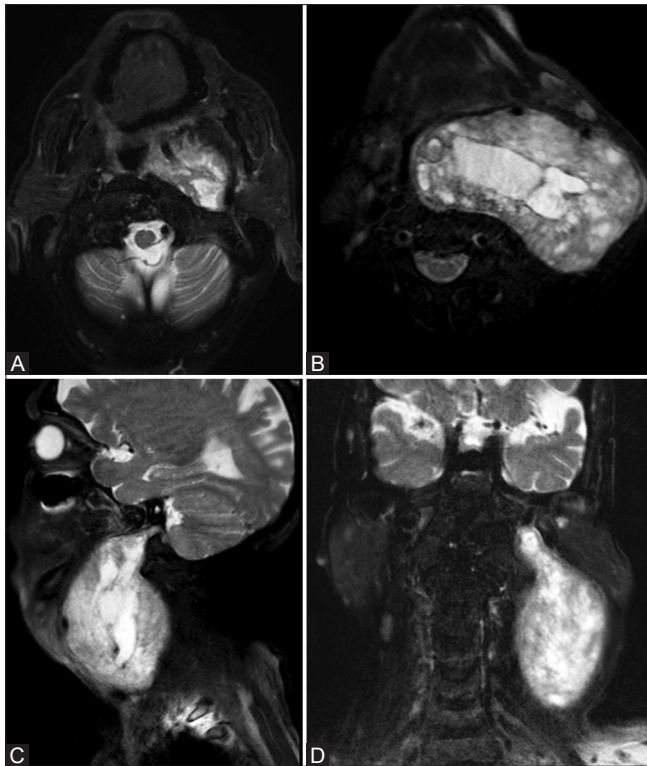


**Figure 11 (A and B):** Bilateral vestibular nerve schwannoma: Post-contrast administration axial (A) and coronal (B) MR images at the level of cerebellopontine angle cisterns reveal intensely enhancing 'ice-cream cone' shaped masses in bilateral cerebellopontine cisterns with intra canalicular extension. No biopsy was done. The patient underwent cyberknife radiosurgery



**Figure 13 (A-D):** Vagus nerve schwannoma. Axial (A) and coronal (B) T2-weighted images show well-defined extra-axial mixed solid and cystic mass in the right cerebello-medullary, cerebellopontine angle cisterns extending to the right jugular foramen. The jugular foramen is widened with loss of normal signal void of the right jugular bulb. The lesion is extending inferiorly to suprahyoid carotid space. Sagittal post-contrast T1-weighted image (C) shows inhomogeneous enhancement. Axial STIR image (D) shows increased signal intensity in right true vocal cord, due to denervation injury. Total excision of the lesion was done and histopathology confirmed schwannoma

motor root. The nerve traverses the prepontine cistern anterolaterally and pierces the dura to enter the Meckel's cave, which is a CSF containing space, placed posterolaterally to the cavernous sinus. In an anterior aspect of the Meckel's cave, the trigeminal ganglion is enclosed which then divides into 3 subdivisions, namely, ophthalmic (V1), maxillary (V2) and mandibular (V3) branches. Ophthalmic and maxillary divisions contain sensory fibres which enter the lateral aspect

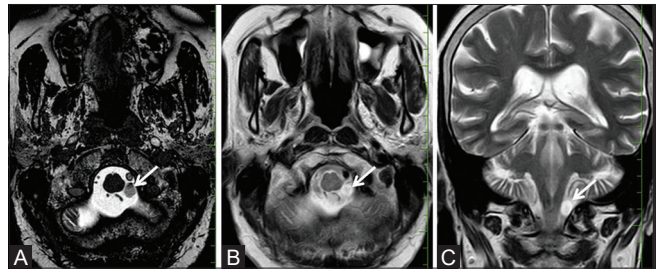


**Figure 14 (A-D):** Another case of vagal schwannoma. Axial (A and B), sagittal (C) and coronal (D) T2-weighted images show well-defined encapsulated heterointense mass in left carotid space. Multiple cystic areas are seen within the mass. Superiorly the mass involves jugular foramen, inferiorly extends to infra hyoid carotid space significantly narrowing the suprahyoid and glottic airway. Histopathology evaluation confirmed schwannoma

of the cavernous sinus and exit the skull via the superior orbital fissure and foramen rotundum, respectively. The mandibular division which has motor fibres for muscles of mastication exits inferiorly via the foramen of ovale.<sup>[13]</sup> Trigeminal schwannomas are the second most common intracranial schwannomas. Schwannoma of the trigeminal nerve can involve the preganglionic segment which is cisternal, the ganglionic segment which is in Meckel's cave [Figure 6] or postganglionic which is in cavernous sinus [Figure 7] or foraminal [Figure 8]. Schwannoma involving both preganglionic and ganglionic segment has a typical dumb-bell appearance. Clinical presentations include facial numbness, pain and tingling sensation. Denervation changes can be seen in muscles of mastication if the lesion involves the mandibular division. Differential diagnoses include cerebellopontine angle meningioma, large vestibular schwannoma, ependymoma, the perineural spread of metastasis, atypical pituitary macroadenoma, internal carotid artery aneurysm and skull base lesions such as chondrosarcoma and chordoma.

### Abducens Nerve

Abducens nerve arises from the abducens nucleus which is placed anterior to the fourth ventricle in dorsal pons. The



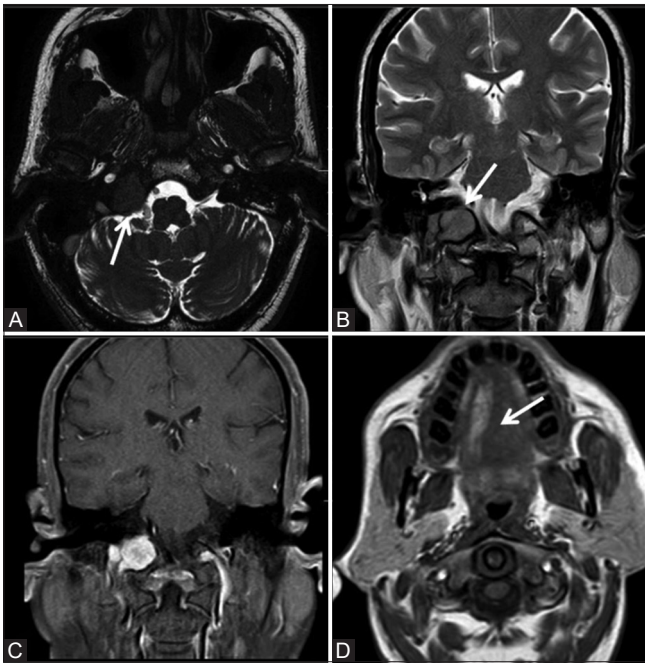
**Figure 15 (A-C):** Accessory nerve schwannoma. Axial B-FFE (A), axial (B) and coronal (C) T2-weighted images show well-defined extra-axial lesion (arrow) arising from cranial nerve root of left accessory nerve involving left cervico-medullary cistern at the level of cervico-medullary junction. The lesion is hyperintense on T2 images. The left vertebral artery is seen anterior to the lesion. No biopsy was done

nerve courses anteriorly and exits from the pontomedullary junction then traverses the prepontine cistern from posterior to the anterior direction and enters the Dorello's canal by piercing the dura near the posterior aspect of the clivus.<sup>[14]</sup> Successively the nerve runs along the central portion of the cavernous sinus and enters the orbit through the superior orbital fissure to innervate the lateral rectus muscle. Schwannoma of abducens nerve can be seen anywhere along its course in prepontine cistern [Figure 9], Dorello's canal, cavernous sinus or superior orbital fissure. The clinical presentation would be diplopia due to lateral rectus palsy. Secondary denervation injury of lateral rectus will be seen as the increased signal intensity of muscle on T2-weighted images or atrophy with fatty change. Differential diagnosis includes meningioma, the perineural spread of malignancy, lymphoma and cavernous haemangioma.

### Facial Nerve

The facial nerve has one motor, one secretomotor and one sensory nucleus in dorsal pons.<sup>[15]</sup> The nerve emerges from the posterolateral aspect of the pons and the cisternal segment runs anterolaterally towards the porus acusticus. A canalicular segment of the facial nerve is placed anterosuperior. A labyrinthine segment of the nerve extends from the internal auditory canal to geniculate ganglion. The tympanic segment starts from the geniculate ganglion runs to the pyramidal eminence. In the tympanic cavity, the facial nerve runs superolateral to the oval window. The mastoid segment runs from the pyramidal eminence to stylomastoid foramen. An extratemporal segment of facial nerve enters the parotid gland and divides into five main branches namely frontal, zygomatic, buccal, mandibular and cervical.<sup>[16]</sup> Facial nerve schwannoma [Figure 10] can involve any of these segments among which geniculate ganglion is the most common location.<sup>[17]</sup> Clinical presentation is via facial nerve paresis. Differential diagnoses include cerebellopontine angle meningioma, schwannoma of other lower cranial nerves, epidermoid and the perineural spread of metastases. The differential diagnosis for a temporal segment of facial nerve schwannoma includes





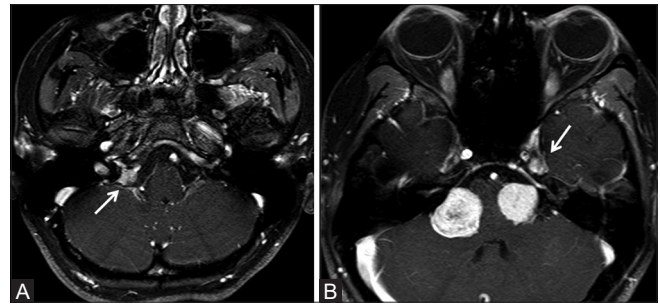
**Figure 16 (A-D):** Hypoglossal nerve schwannoma. Axial B-FFE (A) and T2-weighted (B) images show well-defined heterointense mass in right hypoglossal canal arising from hypoglossal nerve and extending into the cerebello-medullary cistern. Post-contrast axial T1-weighted image (C) shows intense enhancement in the mass. The right half of the tongue shows fatty replacement of the intrinsic muscles and appears hyperintense on T1-weighted image (D). No biopsy was done. The patient underwent cyberknife radiosurgery

cholesteatoma, myeloma, metastases and perineural spread of parotid malignancy like adenoid cystic carcinoma or mucoepidermoid carcinoma.

### Vestibulo Cochlear Nerve

The vestibulocochlear nerve emerges from the lateral aspect of the pons and has cisternal and canicular course similar to the facial nerve. The two nerves may have a close association with the anterior inferior cerebellar artery. In internal acoustic meatus, the vestibulocochlear nerve divides into 3 major divisions, namely, cochlear, superior and inferior vestibular nerves and each one of them are separated by falciform crest and bill's bar. The facial nerve is placed anterosuperiorly and the cochlear nerve is placed anteroinferiorly. Superior and inferior vestibular nerves are in the posterior aspect of the acoustic meatus.<sup>[18]</sup> The vestibulocochlear nerve is the most common intracranial nerve for schwannoma involvement. Patients with vestibular schwannoma clinically present with vertigo or sensory neural hearing loss. Schwannoma can involve cerebellopontine angle cistern, internal acoustic meatus, vestibule and cochlea. Differential diagnoses for lesions in cisternal and canicular segments are similar to the facial nerve.

Vestibular schwannomas involving cisternal and canicular segments have a typical 'ice-cream cone'



**Figure 17 (A and B):** Neurofibromatosis 2: Post-contrast administration axial MR images show right jugular foramen (A), bilateral vestibular (B) and left Meckel's cave (B) schwannoma. No biopsy was done. The patient underwent cyberknife radiotherapy

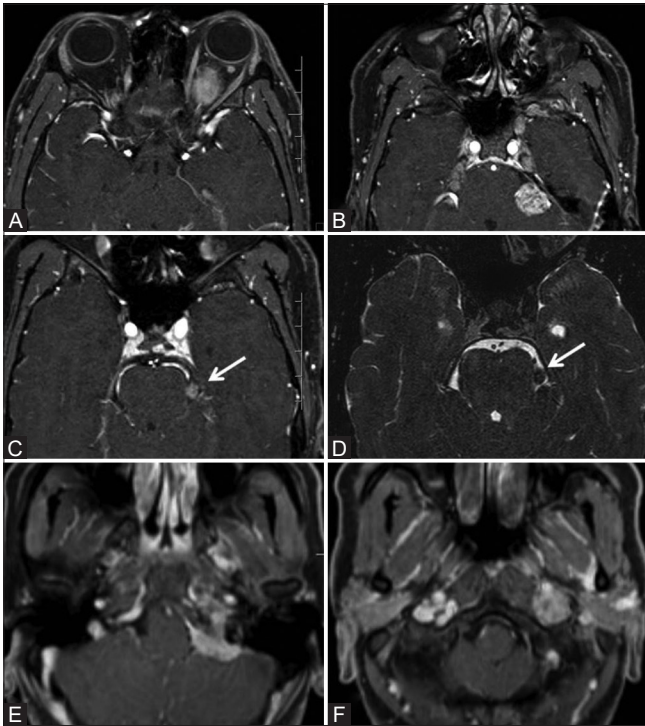
appearance [Figure 11]. Smooth expansion of acoustic meatus and internal auditory canal can be seen on CT and MR imaging. The focus of enhancement is seen in vestibule and cochlea in a rare type of intra labyrinthine schwannomas. Assessing the extension of enhancement and expansion of geniculate ganglion or labyrinthine segment will help to identify 7<sup>th</sup> or 8<sup>th</sup> nerve origin of the lesion.

### Glossopharyngeal Nerve

The glossopharyngeal nerve emerges from the lateral surface of medulla between the inferior olivary nucleus and inferior cerebellar peduncle, at the level of retro olivary groove. The nerve traverses the cerebello medullary cistern in close association with flocculus of the cerebellum and anterior and superior to the vagus nerve.<sup>[19]</sup> The nerve exits the cranium via the pars nervosa which is anterior aspect of the jugular foramen, enters the carotid space, lies between the internal carotid artery and internal jugular vein and then it descends in front of the internal carotid artery.<sup>[19]</sup> Glossopharyngeal nerve schwannoma [Figure 12] can involve the cerebello-medullary cistern, jugular foramen or suprahyoid carotid space. Schwannoma in cerebello medullary cistern can arise from any among 9–11<sup>th</sup> cranial nerve. Clinical presentation varies from dysphonia, dysphagia and dysarthria to change of taste sensation in the posterior tongue. Differential diagnoses include schwannoma of 10, 11<sup>th</sup> cranial nerves and paragangliomas of jugular foramen and suprahyoid carotid spaces.

### Vagus Nerve

Vagus nerve has intracranial course similar to glossopharyngeal nerve, it exits from the lateral aspect of the medulla at the level of retro olivary groove posterior to glossopharyngeal nerve, traverses the cerebello medullary cistern and enters the pars vascularis which is the posterior part of jugular foramen and lies between the glossopharyngeal and spinal accessory nerves.<sup>[20]</sup> After exiting the skull, the nerve reaches the carotid space traverses posterior and in between the carotid and internal jugular



**Figure 18 (A-F):** Another patient with neurofibromatosis 2: Post-contrast administration axial T1 (A-F) and Axial B-FFE (d) images show left optic nerve (A), bilateral vestibular (B) and trigeminal (B) schwannomas. Left trochlear nerve (C and D), bilateral jugular foramen schwannomas (F) and meningioma in left cerebello medullary cistern (E) are also seen. No biopsy was done.

veins. Inferiorly the nerve traverses the thorax and reaches the abdominal cavity via oesophageal hiatus.<sup>[21]</sup> Vagus nerve schwannomas can involve the cerebello-medullary cistern, jugular foramen, suprahyoid [Figure 13] or infrahyoid carotid spaces and splay the carotid bifurcation, carotid arteries and internal jugular vein [Figure 14]. Clinical presentation varies between no symptoms to vocal cord paresis and clinical features of other lower cranial nerve paresis may present due to compression. Differential diagnoses are similar to glossopharyngeal nerve schwannoma which include schwannoma of 9, 11<sup>th</sup> cranial nerves and paragangliomas of the jugular foramen, supra and infra hyoid carotid spaces.

### Spinal Accessory Nerve

Spinal accessory nerve has cranial and spinal rootlets. Cranial rootlets arise from the lateral aspect of medulla below the vagus nerve. Spinal rootlets arise from ventral horn cells of the upper (C1–C5) segment of the cervical spinal cord. These rootlets join together to form a single trunk and pass towards the foramen magnum. In cerebello-medullary cistern, spinal and cranial rootlets join together and traverse towards the pars vascularis of the jugular foramen. The nerve passes posterior to the glossopharyngeal and vagus nerves in the jugular foramen and exits the skull.<sup>[22]</sup> Spinal accessory nerve schwannomas

can involve the cerebello-medullary cistern [Figure 15], jugular foramen and suprahyoid carotid space. Clinical presentation includes difficulty in shrugging the shoulder and inability to rotate the neck secondary to denervation injury of sternomastoid and trapezius muscles, respectively. Differential diagnosis includes schwannoma of 9, 10<sup>th</sup> cranial nerves and paragangliomas of jugular foramen and suprahyoid carotid space.

### Hypoglossal Nerve

The hypoglossal nerve is a pure motor nerve which supplies the intrinsic and extrinsic muscles of the tongue. The nucleus is located in front of the fourth ventricle, the nerve fibres traverse the medulla in paramedian location and exits as multiple rootlets in the ventrolateral aspect between the pyramid and olivary nucleus. The nerve traverses the cerebello medullary cistern anterolaterally and enters the bony hypoglossal canal. While passing through the cerebello medullary cistern the nerve is posterior to the vertebral artery and anterior to the posterior inferior cerebellar artery. In the neck, the nerve traverses medial to 9<sup>th</sup> to 11<sup>th</sup> cranial nerves, then lies deep to digastric muscle and supply the muscles of the tongue.<sup>[23]</sup> Clinical presentation includes dysarthria, difficulty in moving the tongue, deviation of the tongue to one side and hemiatrophy. Hypoglossal schwannoma [Figure 16] can involve cerebello medullary cistern, hypoglossal canal, suprahyoid neck and floor of the mouth. Hemiatrophy and fat intensity of one half of the tongue on MRI [Figure 16D] will clinch the diagnosis of hypoglossal schwannoma. Differential diagnoses are paraganglioma of carotid space, squamous cell carcinoma and salivary gland tumours involving lingual space and floor of the mouth.

### Conclusion

Knowledge about the anatomy of cranial nerves, clinical presentation, characteristic clinching imaging features of each one of the cranial nerve schwannomas like ‘ice cream cone’ appearance of vestibular schwannoma, an extension of enhancement to the geniculate ganglion in facial nerve schwannomas, the involvement of foramen ovale and extracranial extension of the mandibular division of trigeminal schwannomas, infrahyoid carotid space extension of vagal schwannomas, syndromic association of multiple cranio- spinal schwannomas like neurofibromatosis 2 [Figures 17-19] and secondary imaging features like denervation injury of end organs will aid the radiologist in establishing the diagnosis and thereby treatment planning of intracranial schwannomas.

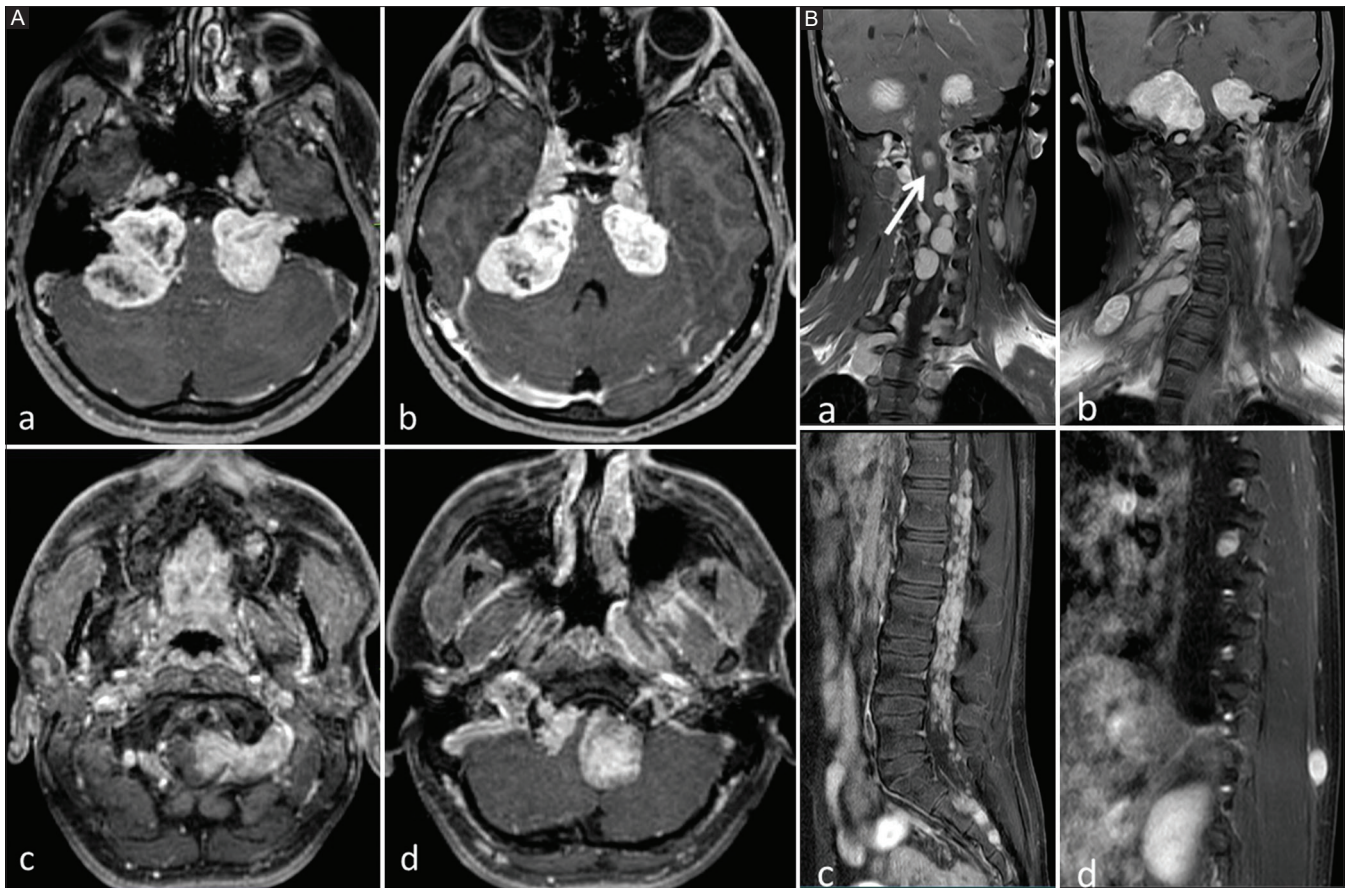
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### Conflicts of interest

There are no conflicts of interest.





**Figure 19 (A and B):** (A) One another patient of NF2: Bilateral vestibular schwannomas (a and b), bilateral trigeminal nerve schwannomas extending to cavernous sinuses (a and b), right hypoglossal nerve (d) and left upper cervical (c) schwannomas are seen. No biopsy is done. Symptomatic lesions treated with radiosurgery. (B) Same patient with NF2: Numerous spinal nerve root schwannomas are seen in the cervical, dorsal and lumbosacral spine. Schwannoma is also seen in the subcutaneous plane of the posterior lower chest wall (d). Intra medullary ependymoma (arrow in a) is also seen in the cervical cord at C1 level. No biopsy was done. Symptomatic lesions were treated with radiosurgery

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