Magnetic Resonance Imaging Evaluation of Extra Axial Cerebellopontine Angle Tumours

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ABSTRACT

BACKGROUND

Cerebello-Pontine Angle (CPA) tumours are classified into extra-axial, intra-axial, extradural and petrous axis tumours and are usually benign. Depending on the origin of tumour and neurovascular structures displacement, CPA tumours can be asymptomatic or may present with tinnitus, vertigo or unilateral hearing loss. We wanted to study the magnetic resonance imaging (MRI) characteristics of extra axial CPA tumours and assess the incidence of extra axial CPA tumours.

METHODS

Patients with signs and symptoms of CPA tumours and diagnosed with CPA tumour on computed tomography were analysed and MRI was performed with contrast study.

RESULTS

Tumours of CPA are not uncommon and represent 6 - 10 % of intracranial tumours. In extra axial CPA tumours, schwannoma (50 %), meningioma (30 %) are the most common; less common are arachnoid cyst (12.5 %) and epidermoid cyst (7.5 %). Schwannomas are the most common extra axial CPA tumours followed by meningioma. Schwannomas are enhancing masses most commonly arising from the vestibular nerve, usually round in shape with associated extension into internal auditory canal showing intense heterogeneous enhancement; meningiomas are hemispherical or oval shaped lesions with a broad attachment to the tentorium or dura mater usually shows intense homogeneous enhancement. Epidermoid cysts and arachnoid cysts appear with CSF signal intensity on all the MRI sequences; epidermoid cyst shows restriction on DWI but arachnoid cyst does not show restriction on DWI and is suppressed on FLAIR sequences. CISS image clearly demonstrates the epidermoid cyst.

CONCLUSIONS

MRI is the most sensitive non-invasive modality to evaluate extra axial CPA tumours. MRI helps to detect the location and describes the extension of the lesions based on their signal characteristics and contrast enhancement patterns.

KEYWORDS

Cerebellopontine Angle Tumours, Schwannomas, Meningioma, Epidermoid Cyst

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BACKGROUND

Cerebello-Pontine Angle (CPA) tumours account for 10 % of all intracranial tumours.[1] Extra-axial tumours comprise of schwannoma, meningioma, epidermoid cysts and arachnoid cysts. Schwannomas account for 70 - 80 % of all CPA lesions, whereas meningiomas and arachnoid cyst both account for 10 - 15 % and epidermoid cyst is seen in 5 % of CPA lesions.[2-4] CPA lesions may present with various signs and symptoms including headache, hearing impairment, and hemiplegia. These clinical symptoms cannot differentiate the pathology or the extent of CPA lesions, hence the need for advanced neurological imaging to assess the extent and type of the lesion allows proper treatment.[5]

Computerized tomography (CT) and magnetic resonance imaging (MRI) are the primary modalities for diagnosis of cerebellopontine lesions. MRI is superior in characterizing the different types of CPA masses. Knowledge about the signal characteristics which are typical and more specific features such as oval shape or ice-cream cone shape, surrounding hyperostosis, a dural tail, extension into skull base foramina and enlargement of the internal auditory canal (IAC) helps in limiting the differentials considered. MR advanced techniques that include diffusion-weighted imaging (DWI), MR spectroscopy, and MR perfusion can help provide a more specific diagnosis.

We wanted to study the MRI characteristics of various extra-axial cerebellopontine angle tumours.

METHODS

This cross-sectional descriptive study was carried out during the period November 2018 - February 2019 in the Department of Radiodiagnosis, Bangalore Medical College and Research Institute, Victoria Hospital, Bangalore, Karnataka. In present study, 40 patients are analysed who were referred by neurologists to department of radio-diagnosis with signs and symptoms of CPA tumour. Patient demographics such as name, age, sex, signs and symptoms were documented. MRI was performed using Siemens Magnetom Avanto model B5 1.5 Tesla MRI machine.

MRI brain study is performed in supine position. The MRI system used zero helium boil-off technology. T2 - weighted image (T2WI) axial, sagittal and coronal planes, T1 - weighted image (T1WI) axial and sagittal plane, and constructive interference in steady state (CISS) axial images were taken, post gadolinium T1WI in axial, coronal and sagittal plane were also obtained whenever needed. DWI was performed as and when necessary. Signal intensity pattern of tumours in different MRI sequences and contrast enhancement pattern was collected.

Inclusion Criteria

All age group patients with signs and symptoms of CPA tumour and with diagnosis of CPA tumour on computed tomography.

Exclusion Criteria

Patients in whom MRI is contraindicated or with previous surgical intervention and with intra-axial CPA tumour.

Statistical Analysis

SPSS (Version 10.0) was used for statistical analysis. Percentage and proportion were used to express the distribution of CPA tumour in total study subjects.

RESULTS

40 patients belonging to the age group of 10 - 70 years were evaluated. Maximum incidence of extra-axial CPA tumours found between 40 to 50-year age group constituting of about 30 % of cases (Table 1) and less incidence seen between 10 to 20-year group constituting of about 5 %.

Out of 40 patients of extra axial CPA tumours, 26 patients are female (65 %) and 14 patients are males (35 %) with female preponderance. Majority of the patients shows symptoms of headache and tinnitus (Table 2).

In present study, out of 40 patients, 20 patients had schwannomas, 12 had meningioma, 5 patients had arachnoid cyst and 3 patients had epidermoid cyst that constitutes about schwannomas (50 %), meningioma (30 %), arachnoid cyst (12.5 %) and epidermoid cyst (7.5 %) (Table 3). Most common extra-axial CPA tumours are schwannomas; second most frequent tumours are meningiomas. Epidermoid cyst and arachnoid cysts are less common CPA tumours.

Schwannoma in 20 patients with maximum of 6 cases in 4th and 5th decade each, 3 cases in 6th decade, 1 case in 2nd decade, 2 cases in 3rd and 7th decades each. Meningioma in 12 cases with maximum of 5 cases in 6th decade. (Table 1).

Age of Incidence (Years)	Schwan-noma	Meningioma	Arachnoid Cyst	Epidermoid Cyst
10 - 20	1	0	1	0
20 - 30	2	1	0	0
30 - 40	6	1	1	1
40 - 50	6	2	2	2
50 - 60	3	5	1	0
60 - 70	2	3	0	0
Total	**20**	**12**	**5**	**3**

Table 1. Incidence of Extra Axial CPA Tumours in Different Age Groups

Symptoms	Schwan-noma	Meningioma	Arachnoid Cyst	Epidermoid Cyst
Tinnitus	13	4	2	1
Hearing loss	8	2	0	0
Dizziness	4	4	5	3
Headache	11	5	4	4
Diplopia	2	1	0	0
Facial Swelling	2	0	0	0

Table 2. Number of Patients with Different Symptoms in Various CPA Tumours

Schwannoma, 14 patients were females and 6 patients were males, meningioma, 9 patients were females and 3 patients were males. Out of 5 patients with arachnoid cysts,

3 were males and 2 were females. Out of 3 patients of epidermoid cysts, 2 were male and 1 was female. Most of the patients with schwannoma presented with tinnitus, headache, hearing loss and dizziness (Table 2).

Out of 20 patients of Schwannoma, 9 showed homogenous enhancement (45 %) and 11 cases showed heterogeneous enhancement (55 %) on contrast (Figure 1). Out of 12 patients of meningioma, 10 showed homogenous enhancement (83.3 %) (Figure 3) and 2 showed heterogeneous enhancement (16.7 %) on contrast. 5 patients of arachnoid cyst and 3 patients of epidermoid cyst showed CSF signal intensity on T1, T2 and FLAIR (Fluid-Attenuated Inversion Recovery). Diffusion restriction noted in patients with epidermoid cyst (Figure 4c), no restriction in all patients with arachnoid cysts (Figure 3c).

MRI Diagnosis	Number of Cases	Percentage (%)
Schwannoma	20	50
Meningioma	12	30
Arachnoid Cyst	5	12.5
Epidermoid Cyst	3	7.5
Total	**40**	**100**

Table 3. Distribution of Various CPA Tumours

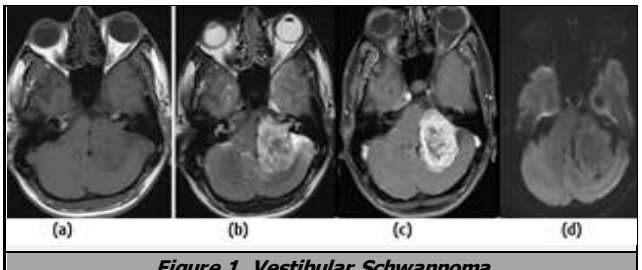

Figure 1. Vestibular Schwannoma

(a, b) Axial T1 and T2 images demonstrating a well-defined lesion in the left CPA showing T1 isointensity and T2 hyperintensity with extension and associated widening of the left CP angle. (c) postcontrast T1 axial image showing intense heterogeneous enhancement. (d) No obvious diffusion restriction in the DWI axial image.

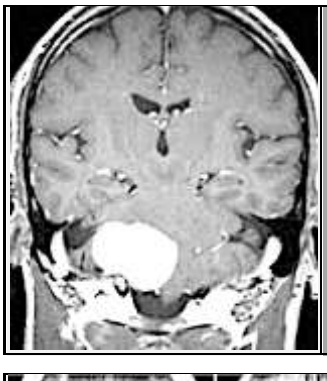

Figure 2. Meningioma Coronal Post Contrast T1 Image Showing Intensely Enhancing Lesion in the Right CP Angle

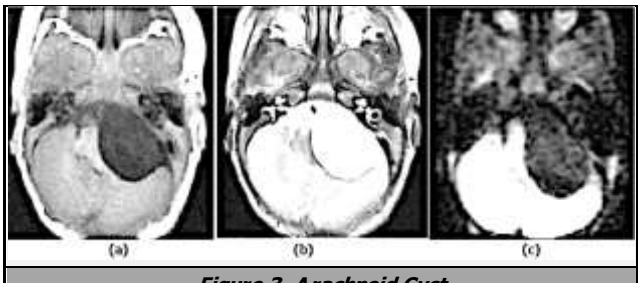

Figure 3. Arachnoid Cyst

(a, b) Axial sequences showing T1 hypointensity and T2 hyperintensity lesion similar to CSF in the left CPA. (c) Axial DWI image showing no diffusion restriction.

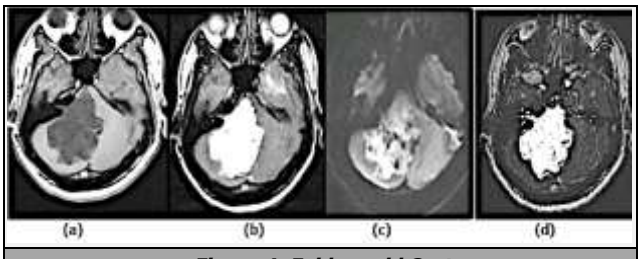

Figure 4. Epidermoid Cyst

(a, b) Axial sequences showing T1 hypointensity and T2 hyperintensity lobulated lesion in the right CPA.
(c) Axial DWI image showing areas of diffusion restriction within the lesion.
(d) CISS axial image showing hyperintense lesion.

DISCUSSION

Normal Anatomy of Cerebellopontine Angle

CPA is the space bound by the cerebellum, pons and temporal bone. The space is bounded by the temporal bone anteriorly and the ventral surface of the cerebellum, posteriorly. Pons and cerebellar peduncle form the medial border and cerebellar tonsil forms the inferior border.[6] It contains facial nerve (CN7), vestibulocochlear nerve (CN8) and loop of anterior inferior cerebellar artery (AICA). The facial and vestibulocochlear nerves pass superiorly and laterally towards the IAC within the space. Superiorly, the trigeminal nerve is visible and inferiorly the glossopharyngeal, vagus, and spinal accessory nerves are located. Glial tissue surrounds the facial and vestibulocochlear nerves throughout their intracranial course. In the IAC, Schwann cells encase these nerves. The vestibular ganglion (Scarpa's ganglion) is located near the mid portion of the IAC.[6] The vestibulocochlear nerve is divided into vestibular and cochlear segments, which happens in the subarachnoid space or in the medial part of the IAC. In the posterior half of IAC, vestibular segment of the vestibulocochlear nerve divided into superior and inferior vestibular nerves.

Vestibular Schwannoma

Schwannomas are benign (World Health Organization [WHO] Grade I) slow growing encapsulated tumours that are composed entirely of well-differentiated Schwann cells. Schwann cells are derived from precursor cells in the embryonic neural crest. 5 – 10 % of primary intracranial neoplasms are schwannomas and nearly 30 % are intraspinal tumours.[7,8] Vestibular schwannomas represent 80 - 85 % of the CPA tumours. Intracranial schwannomas occur in all the age groups, but the peak incidence is in the fourth to seventh decades of life.[4] There is a distinct sex predilection with a female-to-male ratio of 2 : 1.[6,7]

In our study, out of forty patients 20 were diagnosed with schwannomas, male 6 cases and females 14 cases. Female to male ratio was 2.3:1. More number of cases was found between 30 - 50 years of age corresponding to 60 % of the cases. Vestibular component of VIII cranial nerve was commonly involved than facial and trigeminal nerves.

Many past studies report states that most common place for origin of schwannoma is vestibulocochlear nerve, then the other cranial nerve and the vestibular division of the vestibulocochlear nerve is more commonly associated than the cochlear division.[9,10]

Studies conducted by Press GA, Hesselink JR,[11] Tali ET et al,[12] Valvassori GE et al,[13] and Daniels DL et al,[14] reported that schwannomas are usually isointense or mildly hypointense compared to the pons and hyperintense compared to cerebrospinal fluid on T1 - weighted images. They appear hyperintense compared to pons and isointense to hypointense compared to CSF on T2 weighed images.

Curati WL et al,[15] demonstrated that on T1 images vestibular schwannomas enhance intensely after contrast. The sensitivity of identifying schwannomas from the contrast enhanced study with small voxel size T1 - weighted MR imaging may reach up to 100 %. In the present study vestibular schwannomas showed moderate enhancement (Figure 1d) after gadolinium contrast administration and homogenous enhancement was seen in nearly half of the cases, was similar with the above study.

Breger RK et al,[16] reported that on contrast enhanced T1 imaging, vestibular schwannomas may enhance considerably more than meningiomas, neurofibromas and paragangliomas. Anterosuperiorly, vestibular schwannomas do not extend above the temporal bone, and very rarely enter into the middle cranial fossa. In the present study, none of the vestibular schwannomas herniate into the middle cranial fossa. The results in the present study were similar and reliable with the literature described.

In the present study, one of the tumours had both solid and cystic components which showed marked enhancement on post contrast study. Consistent with the findings described by Goldberg R et al.[17]

Meningioma

Meningiomas are well-circumscribed, solid and slow growing tumour that are composed of neoplastic meningothelial cells arising from the arachnoid layer of the meninges with a broad attachment to the adjacent dura. With annual incidence of about 4.5 / 100,000 population, meningiomas are seen in 30 % of all primary brain tumours.[18] Next to schwannoma second most frequent is meningiomas constituting 10 - 15 % cases of CPA tumours. Peak incidence is seen throughout fifth to seventh decades of life with more predilection in female. Neurofibromatosis-2 is one of the most common hereditary tumour syndromes that is associated with meningioma which generally seen in younger age group patients and do not have any gender predilection.[19]

In the present study, out of 12 patients with meningioma, 8 show iso-intensity (66.6 %), 2 show hypo-intensity (16.6 %), 2 show mixed intensity (16.6 %) on T1 - weighted images. Out of 12 patients with meningioma, 10 show hyperintense (83.3 %), 1 show isointense (8.3 %) 1 show mixed intensity (8.3 %) to the cortical grey matter on the T2 - weighted images.

In present study, after contrast administration, enhancement is seen in all meningiomas. Out of 12 patients with meningioma, 9 shows homogenous enhancement (Figure 2) (75 %), 3 shows heterogeneous enhancement (25 %) on contrast.

Approximately 20 % of the patients with meningiomas demonstrate cystic foci, haemorrhage and calcifications.[20] In our study, cystic components were seen in 25 %, foci of calcification in 12 % and haemorrhage in 10 % of the patients.

Meningiomas is frequently associated with brain oedema.[20] On T2 - weighted images the tumour location, size, signal intensity and brain-tumour interface for invasive pattern were linked to the existence of edema with meningioma patients. But the histological variations not associated with this finding.[21,22] In our study, 75 % of the patients with meningioma had brain edema, which was discrete.

Nakau et al.[23] included nine cases of meningioma with dural tail sign to study the correlation of the MR imaging and histopathological findings. During surgical resection of tumours it was mandatory to respect the surrounding dura-mater as it appeared that tumour cells nests in the surrounding dura-mater of the meningioma. On post-contrast T1 - weighted images, approximately 35 % of the patients may present the dural tail signal. In the present study dural tail sign was seen frequently, detected in 50 % of the meningioma patients.

Arachnoid Cyst

Arachnoid cysts are congenital, benign, intra arachnoidal space-occupying lesions constituting 1 % of all intracranial masses.[20] They have CSF as its contents and do not have ventricular communication. Supratentorial region is the most common intracranial location. middle cranial fossa constitutes 50 - 60 % of the intracranial tumours. Other locations include the posterior fossa and suprasellar cistern (10 %). Rare locations are interhemispheric space or in the choroidal fissure, quadrigeminal cistern and cistern magna.[24,25]

Several theories are proposed about the origin. Arising secondary to spilt in arachnoid mater or a development of the arachnoid diverticulum. Temporal fetal meninges fails to completely fuse as the sylvian fissure appears, is the newer concept of origin of middle cranial fossa arachnoid cyst. Others might include secretion of fluid from cystic walls, CSF pulsations causing distention of the space, or one-way ball-valve mechanism of CSF flow.[26] Similar aetiology is linked to trauma associated lesions, mastoid infection, meningitis, and subarachnoid bleed.[25] Arachnoid cysts are most of the time asymptomatic it can give symptoms when they enlarge resulting the mass effect. Arachnoid cyst at CPA when large can compress the vestibulocochlear nerve and present with tinnitus or hearing loss, when it compresses pons it can present vertigo.

Definitive diagnostic tool is MRI for arachnoid cysts evaluation and to confirm extra-axial situation. On T2 weighted images shows homogeneous hyper intense signal of the cyst same as that of CSF. Similar feature of CSF can be confirmed using FLAIR sequences. Similar characteristics on T1W and T2WIs, and shows no enhancement with

gadolinium is seen in both arachnoid cyst and epidermoid cyst. Arachnoid cysts show similar signal as that of CSF signals on every sequence, particularly on the FLAIR sequence, unlike epidermoid cysts which shows minimal suppression. DWI sequence allows easier differentiation as epidermoid cysts show restricted diffusion. Phase contrast study can be employed not only to determine if the cyst communicates with the subarachnoid space, but also to find the location of this communication. In the preoperative evaluation, it is important to differentiate whether the arachnoid cyst has communication with the CSF space or not. CSF flow patterns is specific in each system and Phase-contrast study may help in separating between communicating and non-communicating arachnoid cysts.[27]

Eslick et al.[28] documented a patient with an CPA arachnoid cyst that give rise to diplopia secondary to compression on the cranial nerve VI. When arachnoid cysts compress the brainstem, patients may become symptomatic.

To differentiate arachnoid cyst from another cyst MRI is helpful. In patient with unilateral hearing loss and tinnitus. If suspicious of retrocochlear pathology, MRI must be performed to look for cerebellopontine angle.

In our study 5 cases of arachnoid cysts were evaluated. 3 male cases and 2 female cases, in 4 cases cyst was noted in the right side and left side in one case. All followed CSF signal intensity in all sequences.

Epidermoid Cyst

Epidermoid cysts are congenital intradural tumours, occurring from the ectodermal epithelium inclusion elements at the time of closure of neural tube.[29] After acoustic schwannomas and meningiomas, the third most common CPA masses are epidermoid cysts. Intracranial epidermoid tumours most commonly occurs in the CPA which constitutes of 5 % of CPA tumours.[30] They comprise 1 % of all the intracranial tumours. Pituitary gland and in the posterior fossa along the cerebellum and brainstem are other most common location. Epidermoid cysts typically have wavy margins and take the shape of the CPA. Tendency of insinuating itself around the surrounding nerves and blood vessels in the CPA and engulf the cranial nerves and vessels is seen specially in the epidermoid cyst. Usually they have irregular or scalloped margins. On contrast study they do not usually enhance with gadolinium and do not contain haemorrhage. On computed tomography (CT), epidermoid cysts have decreased attenuation. Differentiation from arachnoid cysts is difficult on CT scans as epidermoid cyst usually show attenuation similar to that of CSF, but MRI helps to differentiate easily. On T1 images, cysts are usually slightly hyper or iso-intense to the gray matter. T1 signal characteristic varies with lipid content, when there is more of lipid content the signal intensity also increases.[31]

In primary intracranial tumours, epidermoid cyst constitutes 0.2 to 1.4 %. Intracranial epidermoid cyst, 40 % is seen in the CPA and epidermoid cyst constitute 5 % of all CPA tumours.

In present study, epidermoid cysts were detected using CISS image. On T1 - weighted image epidermoid cysts show hyperintense signal compared to CSF, on CISS sequences cysts show hyperintensity (Figure 4). CISS sequence helps to detect the tiny lesion in the Meckel's cave and delineate the extension of the lesion.

In present study 3 patients were detected with epidermoid cysts, two cases in male and one in female. On T1 and T2 images, epidermoid cyst shows signal intensity similar to CSF signal intensity but on FLAIR sequence no complete suppression, with restricted diffusion on DWI sequence.

CONCLUSIONS

MRI is the most useful method to improve the sensitivity of detecting extra axial CPA tumours. MRI is the most sensitive modality to differentiate the lesions by the anatomical location of origin, shape, signal intensity, and enhancement pattern after contrast administration. In some cases, a complementary advanced MRI technique such as diffusion-weighted image may be needed.

Data sharing statement provided by the authors is available with the full text of this article at jebmh.com.

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