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Original Research Article.

Role of Magnetic Resonance Imaging in Evaluation of Cerebellopontine Angle Schwannomas

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ABSTRACT

Objectives: The study was designed to evaluate the role of Magnetic Resonance Imaging (MRI) to localize and characterize the MR imaging features of cerebellopontine angle (CPA) schwannomas and to compare with surgical/histopathological findings.

Methodology: Thirty eight patients of clinically suspected & MRI diagnosis cases of CPA Schwannoms were selected in this cross sectional study in different places of Bangladesh {Mymensingh Medical College Hospital Mymensigh, Sher-E-Bangla Medical College Hospital, Barisal, Popular Diagnostic Centre Gazipur & Lab Aid diagnostic Centre Barisal. Surgery of all MR diagnosed cases were done in Dhaka Medial College Hospital & National Institute of Neuroscience Hospital, Dhaka} during the period from April 2008 to August 2019. All patients included in the study were subjected to detailed clinical history and physical examination following which MRI was carried out on 1.5 Tesla & 0.3 Tesla MR machine and the standard protocol consisted of T1WI, T2WI, DWI and FLAIR images in axial, sagittal and coronal planes.

Results: MRI was erroneous in giving provisional diagnosis of schwannoma in two cases, which on subsequent surgery and histopathology was found to be a meningiomas. The sensitivity of MRI for correctly diagnosing vestibular schwannoma was 100 % and specificity was 92.86 % with a positive predictive value of 94.12 % and accuracy of 96.67 %. MRI is considered as an excellent noninvasive investigation for CP angle schwannoma's. It can identify the site and extension of the lesions as well as the characteristic signal.

Keywords: Schwannoma, Vestibulocochlear Nerve, Magnetic Resonance Imaging.

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INTRODUCTION

A schwannoma is a tumor that arises from Schwann cells. Schwann cells are cells that are derived from a primitive structure known as the neural crest. Schwann cells, like the central nervous system's oligodendrocytes, lay down the myelin sheath. Theoretically, schwannomas can arise anywhere that a Schwann cell is found. However, in the brain and spinal cord, schwannomas tend to arise mainly at the root entry zones of the following[1]:

- The VIIIth (vestibulocochlear) cranial nerve–where they are referred to as vestibular Schwannomas (or acoustic "neuromas");
- The Vth (trigeminal) cranial nerve–where they are referred to as trigeminal Schwannomas;
- The lower cranial nerves (IX, X or XI–i.e. glossopharyngeal, vagus, or accessory) at the jugular foramen–where they are referred to as jugular foramen Schwannomas;
- The spinal cord's spinal nerve roots (especially sensory or "dorsal" nerve roots)–where they are referred to as spinal Schwannomas.

Lesions of the cerebellopontine angle (CPA) are frequent and represent 6–10 % of all intracranial tumors.[2] Acoustic neuromas, which are also called vestibular schwannomas, and meningiomas are the two most frequent lesions and account for approximately 85–90 % of all CPA tumors.[3]

CT and MRI are widely used radiological methods for CPA imaging. The main radiological diagnostic goal is the description of the relation of the tumor to internal acoustic meatus (IAM), the brain stem and cerebellar hemispheres. The second line basic information is if the lesion is extra- or intracerebral.[4] Since the introduction of Magnetic Resonance (MR), malformations of the brain have been found with greater frequency than previously suspected. This is especially true for any lesions in the cerebellopontine angle, where the sensitivity and specificity of MR imaging with its multidimensional imaging capabilities are far superior to that of CT. The high contrast resolution and multi planar capabilities of MR helps to delineate shape and margins, extent, mass effect, intensity at MR imaging, enhancement and adjacent bone reaction.[5] The MR imaging technique described is simple and non-invasive. Therefore MRI excellent modalities in evaluation of cerebellopontine angle schwannomas.

Clinical Evaluation

The most common symptoms associated with vestibular schwannomas are those caused by pressure on the cochlear and vestibular divisions of the eighth cranial nerve, namely, sensorineural hearing loss, tinnitus, and dysequilibrium.[6] Frequently, patients with vestibular schwannomas have difficulty understanding speech in the affected ear. The symptoms are usually slowly progressive, evolving over months or years. Some authors have noted only tinnitus as a presenting symptom. Facial nerve manifestations such as twitching or weakness are relatively uncommon.[7] Instead, larger tumors are more likely to cause trigeminal manifestations such as facial numbness and loss of the corneal reflex. Still larger tumors may cause deficits of the lower cranial nerves, cerebellar signs and symptoms, or signs and symptoms of hydrocephalus.[8]

MATERIALS AND METHODS

This multicentre prospective study was conducted in 38 patients of all age groups over a period of 11 years, during the period from April 2008 to August 2019, who presented with signs and symptoms of any lesion in the CP angle & referred to radiology department for radiodiagnosis. Informed consent was taken from all patients undergoing this study. MRI was performed in all patients, among them who were diagnosed as schwannomas by MRI, after surgery histopathology was done. Histopathological reports were collected and correlated with MRI findings. Patients excluded from the study were;

- Those with contraindications to MRI
- History of previous surgical intervention
- Patient refused to surgery after MRI diagnosed as CPA mass.
- Those with histopathological reports were not available.

However in 2 cases, histopathological reports were not available. Two patients refused surgery after enrolling into the study. Finally histopathology reports were collected from 34 patients and they were considered as study sample. Histopathological diagnosis was considered as gold standard of diagnostic criteria.

MR Technique

MR scan in all cases included in the present study was carried out on 1.5 & 0.3 Tesla unit.

MR Imaging Protocol

The standard protocol consisted of T1WI, T2WI, DWI and FLAIR images in axial, sagittal and coronal planes. Gadolinium 0.1 mmol/kg was used as contrast wherever required. Each MR image was analyzed for specific features that were relevant to the evaluation of cerebellopontine angle schwannoma.

Table 1: Age incidence

Age group in years	n	%
≤20	2	5.3
21–30	16	42.1
31–40	8	21.1
41–50	4	10.5
51–60	4	10.5
>60	4	10.5
Total	38	100

Table 2: Sex incidence

Sex	n	%
Male	16	42.1
Female	22	57.9
Total	38	100

Table 3: Presenting complaints in patients with CP angle lesions

Symptoms	n	%
Vertigo	14	36.8
Tinnitus	16	42.1
Hearing abnormalities	32	84.2
Headache	22	57.9
Vomiting	2	5.3
Facial nerve palsy	2	5.3

Table 4: Cranial nerve examination

Involvement of cranial nerves	n	%
Trigeminal nerve (CN V)	22	57.9
Facial nerve (CN VII)	6	15.8
Vestibulocochlear nerve (CN VIII)	34	89.4

Table 5: Distribution of lesions according to type of lesion

Lesions	Solid (n = 16)	Cystic (n = 0)	Mixed (n = 3)
Vestibular schwannoma	30	0	4
Trigeminal schwannoma	2	0	2
Total	32	0	6
Percentage (%)	84.21	0	15.79

RESULTS

In our multicentre prospective study, “Role of MRI in evaluation of cerebellopontine angle schwannoma”, a total of 38 patients of all age groups presenting with signs and symptoms of any lesion in the CP angle, attending outdoor patients department / admitted to any one of the following hospital/ diagnostic centre. The hospital/ diagnostic centre are Mymensingh Medical College Hospital, Mymensigh, Sher-E-Bangla Medical College Hospital, Barisal, Popular Diagnostic Centre Gazipur & Lab Aid diagnostic Centre Barisal and referred to the respective Radiology Department for Radiodiagnosis and all the imaging were included in our study. Surgery of all MR diagnosed cases were done in Dhaka Medial College Hospital, Dhaka & National Institute of Neuroscience, Dhaka. After taking relevant history and thorough clinical examination, MRI was done. The observations of this study are as follows:

In the present study, maximum number of patients were in the age group of 21–40 years (Table 1) constituting 68.4 % of patients out of which there were 16 male and 22 female patients (Table 2). Hearing loss was the chief complaint in 84.2 % of patients of vestibular schwannoma (Table 3). Vestibulocochlear nerve was involved in 89.4 % of the cases of vestibular schwannomas (Table 4). Table 5 show the distribution of the type of lesions whether solid, cystic or mixed. 84.21 % of the lesions were solid and rest 17.59 % of the lesions show mixed (solid + cystic) characteristics.

In the present study, all cases of schwannoma were hypointense to brain parenchyma on T1WI (Table 6).

30 cases of vestibular schwannomas (88.2 %) showed hyperintense signal on T2WI. Only 4 cases (11.8 %) showed mixed signal intensity on T2WI. Two case of trigeminal schwannoma was hyperintense on T2WI and other two mixed signal intensity on T2WI (Table 7); (Fig. 1).

All the cases showed hyperintesne signal on FLAIR images with no restriction on diffusion-weighted images. (Table 8). None of the lesions showed restricted diffusion (Table 9).

Out of 34 cases of vestibular schwannoma, 22 showed marked enhancement and 12 showed moderate enhancement.

Four cases of trigeminal schwannoma showed marked inhomogenous enhancement (Table 10).

Final diagnosis was made by surgery/histopathology in 38 patients. MRI was erroneous in giving provisional diagnosis of schwannoma in 2 case, which on subsequent surgery and histopathology were found to be a meningiomas. (Tables 11 & 12)

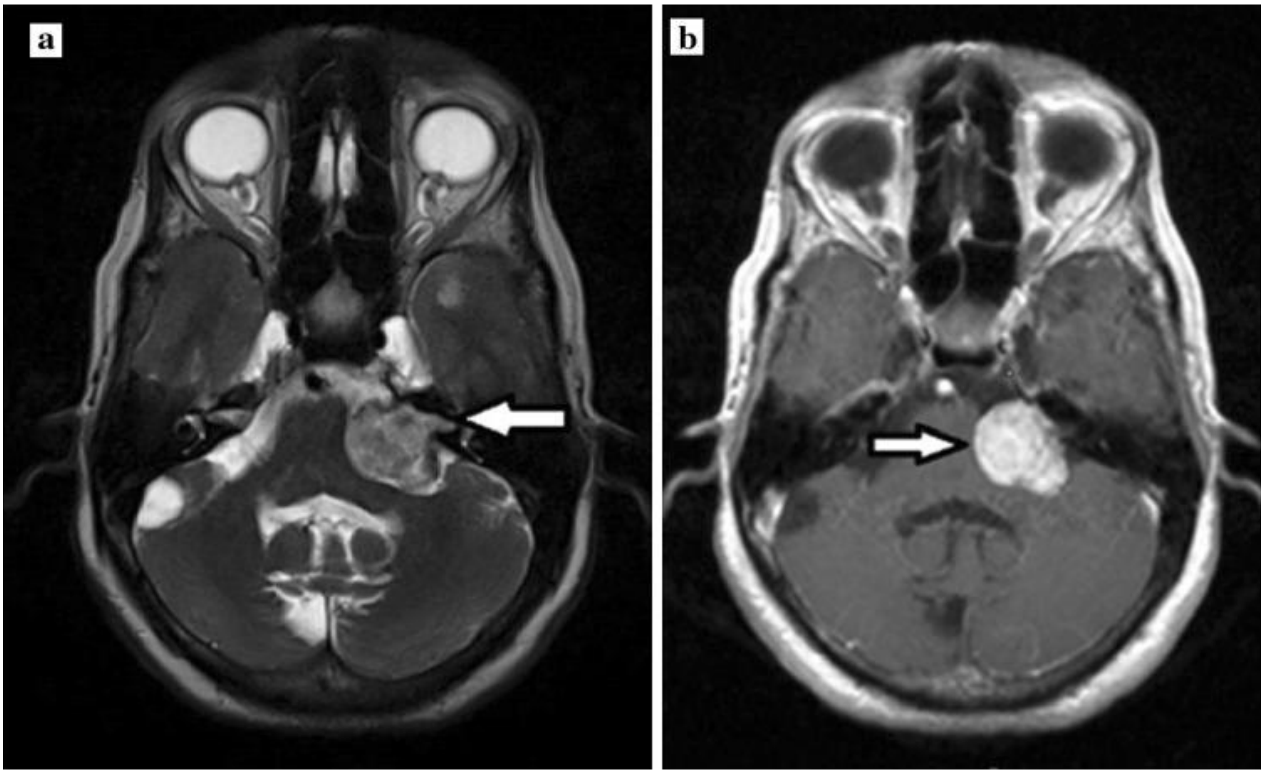

Fig. 1: Axial T2W1 image (a) shows a hyperintense mass lesion (arrow) in left CP angle cistern extending into left IAC and axial T1W1 post contrast image (b) shows marked enhancement of the CP angle lesion

Table 6: Distribution of lesions according To T1W1

Lesions	Hypointense		Isointense		Total
	No	%	No	%	
Vestibular schwannoma	34	100	0	0	34
Trigeminal schwannoma	4	100	0	0	4

Table 7: Distribution of lesions on T2WI

Lesions	Hyperintense		Isointense		Mixed		Total
	No	%	No	%	No	%	
Vestibular schwannoma	30	88.2	0	0	4	11.8	34
Trigeminal schwannoma	2	50	0	0	2	50	4

Table 8: Distribution of lesions on flair

Lesions	Hyperintense		Hypointense		Mixed		Total
	No	%	No	%	No	%	
Vestibular schwannoma	32	94.1	0	0	2	5.9	34
Trigeminal schwannoma	2	50	0	0	2	50	4

Table 9: Distribution of lesions on DW1

Lesions	Restriction				Total
	Absent		Present		
	No	%	No	%	
Vestibular schwannoma	34	100	0	0	34
Trigeminal schwannoma	4	100	0	0	4

Table 10: Distribution of lesions according to gadolinium enhancement

Lesions	Non-enhancing	Moderate	Marked	Homogenous	Inhomogenous
Vestibular schwannoma	0	12	22	18	16
Trigeminal schwannom	0	0	4	0	4

Table 11: Distribution of cases on MRI diagnosis

MRI diagnosis	n	%
Vestibular schwannoma	34	89.5
Trigeminal schwannoma	4	10.5

Table 12: Final diagnosis based on surgical/ histopathological findings

Final diagnosis	n	%
Vestibular schwannoma	32	84.21
Trigeminal schwannoma	4	10.5
Meningioma	2	5.29

DISCUSSION

Schwannomas arise from the vestibulocochlear nerve much more often than from any other cranial nerve, and the vestibular division is far more commonly involved than the cochlear division. Hence, for these lesions in the internal auditory canal (IAC) region, vestibular schwannoma has become the preferred and most accurate term.[9,10] In our study, the most common lesion was vestibular schwannoma, which constituted 53.3 % of the total number of cases. The studies[11,12] reported that vestibular schwannomas account for approximately 8 to 10 % of all intracranial tumors and approximately 60–90 % of all CPA tumors which is consistent with our study.

In the present study most of the vestibular schwannoma's were hypointense relative to pons on T1-weighted images and hyperintense to pons on T2-weighted images. The studies[13-16] reported that on T1-weighted images, schwannomas are usually isointense or mildly hypointense relative to the pons and are hyperintense to cerebrospinal fluid (CSF). On T2-weighted images they are mildly hyperintense to the pons and isointense to hypointense to CSF, which is consistent with the present study. Intratumoral hemorrhage, at various stages of hemoglobin breakdown, may also be detected on MR imaging.[17]

One study[18] reported that Vestibular schwannomas enhance intensely after intravenous administration of a gadolinium contrast agent on T1-weighted images. The sensitivity of contrast-enhanced, T1-weighted, MR imaging can approach 100 % in detecting schwannomas, especially with a small voxel size.[19] In the present study, all of the cases with vestibular schwannoma showed marked to moderate enhancement after administration of gadolinum and most of the cases showed homogenous enhancement which was consistent with the above study.

One study[20] found that as a group, vestibular schwannomas enhance substantially more than meningiomas, neurofibromas, or paragangliomas on contrast-enhanced T1-weighted imaging. However, enhancement varies greatly within tumors of the same type and overlaps between different tumor types. Similar results were seen in the present study.

Vestibular schwannoma epicentered upon internal auditory canal and extended within the canal in 20 out of 34 lesions in the present study. This consistent with the study[21] in his study of acoustic schwannoma: MR findings in 84 tumors who concluded that this feature strongly suggests the diagnosis of acoustic schwannoma. Vestibular schwannomas, however, do not extend antero-superiorly above the dorsum, and extremely rarely herniate into the middle cranial fossa. None of the vestibular schwannomas in the present study extended into the middle cranial fossa.

Out of 34 cases of vestibular schwannoma, two cases were diagnosed as meningioma after surgery and subsequent histopathology. The study[22] reported that signal intensity of the masses on MR images will not contribute to the accurate radiographic diagnosis of the intracanalicular meningioma. Both lesions are isointense to hypointense on T1-weighted MR images and are of variable signal intensity on T2-weighted MR images. They will also both brightly enhance after administration of contrast medium. Although it is very difficult to differentiate a meningioma from a vestibular schwannoma if an entirely intracanalicular type is encountered, other extension patterns may provide some information leading to the correct diagnosis (Fig. 2).

Hence, in the present study, MRI had a sensitivity of 100 % and specificity of 92.86 % with a positive predictive value of 94.12 % and accuracy of 96.67 % in the diagnosis of vestibular schwannoma. The study[23] of role of MRI in the evaluation of acoustic schwannoma and its comparison to histopathological findings in 2011 found that the overall sensitivity of MRI to diagnose Acoustic Schwannoma was 96 % with specificity of 88.2 %, positive predictive value of 92.31 % and accuracy of 92.86 % which is consistent with the above study.

Four cases of trigeminal schwannoma were encountered in this study. On clinical examination there was involvement of the cranial nerve V which was also seen in the study[12] where reported that trigeminal nerve schwannomas tend to involve the ganglion, the nerve root, or both. Therefore symptoms of nerve V tend to dominate over dysfunction of nerve VIII and the patients present with facial pain or numbness.

In the present study, two lesions were solid in nature and the others showed both solid and cystic components. On MR imaging, the lesions appeared hypointense on T1-weighted images and showed hyperintense to mixed signal intensity on T2-weighted and FLAIR images with no restriction on DWI. Both the lesions showed marked enhancement on post contrast sequences. Similar findings were described by the studies[11,24]; (Fig. 3).

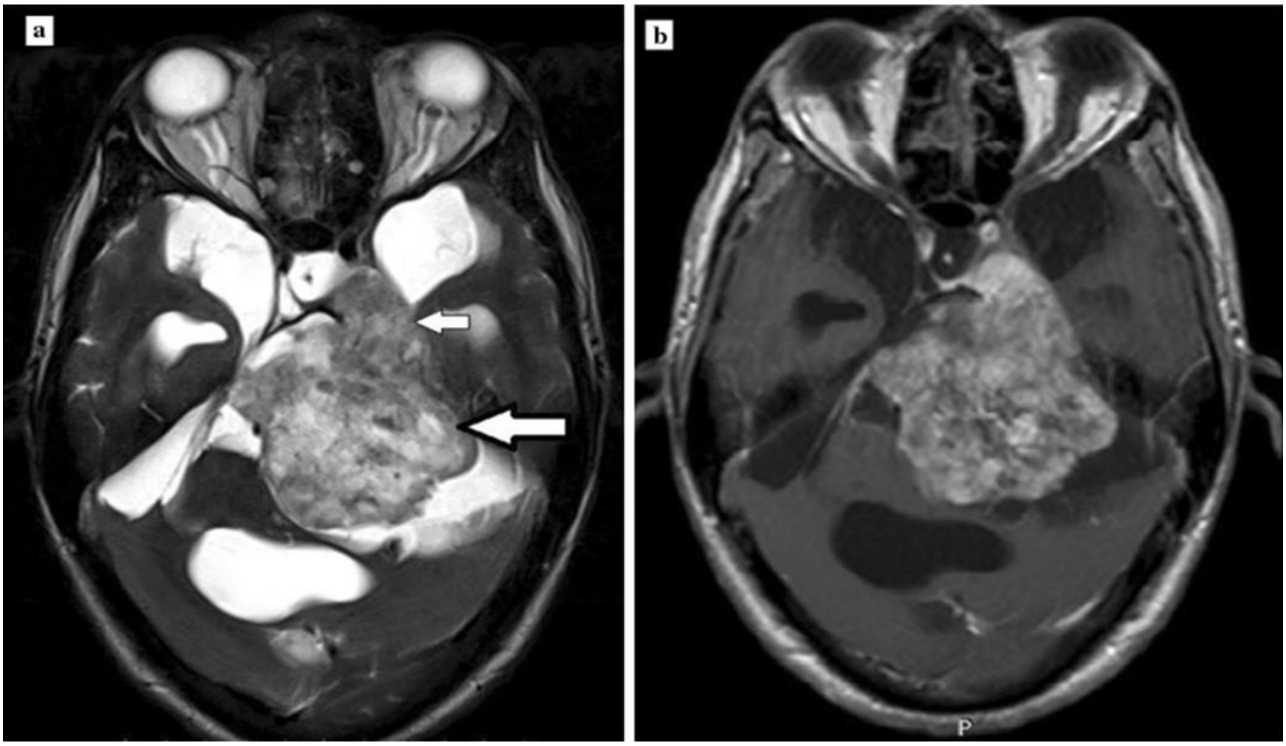

Fig. 2: Axial T2W image (a) shows a large, lobulated, well-defined mass in the left CP angle cistern (*arrow*) appearing hyperintense. It is crossing the midline in the prepontine cistern towards the *right side*. There is no extension into either of the internal auditory canals. There is marked compression of the brainstem, cerebellum and left thalamus with severe obstruction of the cerebral aqueduct and posterior third ventricle. Post contrast T1W axial image (b) shows diffuse inhomogeneous enhancement of the lesion.

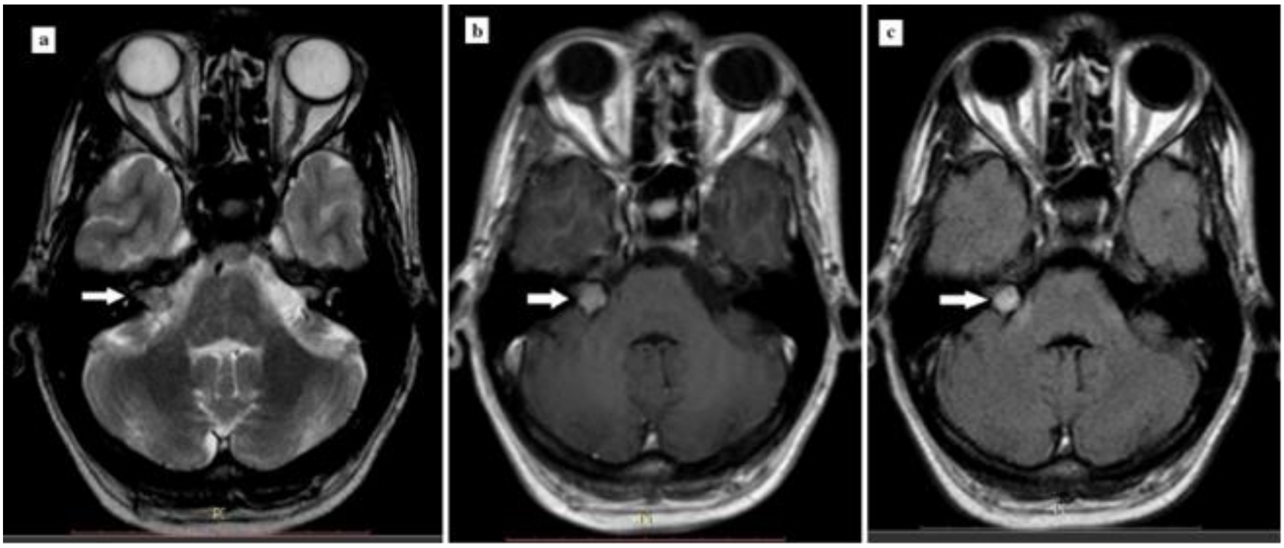

Fig. 3: Axial T2W image (a) and FLAIR image (b) shows a hyperintense well defined rounded lesion in the right CP angle cistern (*arrow*), adjacent to the right IAC. Post contrast T1W axial image (c) shows marked homogenous enhancement of the lesion

Trigeminal schwannomas in this study harbored the Meckel's cave. The studies[25,26] described dumb-bells configuration of trigeminal schwannomas due to involvement of CPA and Meckel's cave. In two patient in the present study, the trigeminal schwannoma extended through the foramen ovale as was reported by the study.[27]

CONCLUSIONS

A spectrum of usual and unusual lesions exist in the CP angle and is primarily based on the site of origin of the masses. Signal intensity at MR imaging, enhancement, shape and margins, extent, mass effect, and adjacent bone reaction are also helpful in establishing the diagnosis. MRI is considered as an excellent noninvasive investigation of the CPA lesions. It can identify the site and extension of the lesions as well as the characteristic signal. Apart from diagnosing, MR imaging plays an important role in stratifying patients into appropriate treatment options.

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