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Magnetic Resonance Imaging in Evaluation of Supratentorial Extra-Axial Brain Tumors

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Abstract: ***Magnetic Resonance Imaging has higher sensitivity and specificity for detecting, localization and characterization of intracranial brain tumours. Of all the brain tumours, 80% are supratentorial, of which 40% are extra-axial. The objective of our study is to assess diagnostic ability of MRI in characterizing various supratentorial extra-axial tumours using T1, T2 weighted images, Diffusion-weighted imaging (DWI), Susceptibility weighted imaging (SWI) and contrast-enhanced image. It is a prospective study conducted in the Department of Radio-diagnosis, Narayana Medical College and Hospital, Nellore, Andhra Pradesh from June 2018 - February 2019 using 3Tesla whole-body MR system. In the present study, the majority of the patients belonged to the age group of 40-50 years, 26 patients were males, and 24 were females. In male's majority had a meningioma, in female's majority had pituitary adenoma. Meningiomas are the most common brain tumours (44%), followed by pituitary adenomas (20%). Headache and vomiting are the most common symptoms.***

Keywords: MRI, Supratentorial, extra-axial, Meningioma, Pituitary adenoma

1. Introduction

Brain tumours in adults comprise a diverse group of neoplasms that vary depending on factors such as the cell of origin, site of occurrence, morphology and pattern of spread. The annual incidence of primary intracranial tumours is increasing in frequency [1]. However, the prognosis of these patients improved considerably due to recent advances in diagnostic techniques. The clinical management of primary brain tumours is typically conducted by a team of health care providers, including, radiologists, neurologists, neurosurgeons, medical oncologists, radiation oncologists, and pathologists. Most of these specialities depend on diagnostic imaging of the CNS to characterize tumour types and determine treatment options. MRI is a powerful instrument for evaluating patients with primary brain tumours.

The tentorium is an extension of the dura mater that covers the cerebellum and separates the cerebellum from the inferior occipital lobes. Supra-tentorial means above the tentorium and applies to tumours arising above the tentorium [1].

Infra-tentorial means below the tentorium and applies to tumours arising in the posterior fossa. Brain stem tumours also come under infratentorial compartment.

In adults, two-thirds of primary brain tumours arise from structures above the tentorium (supratentorial), whereas in children, two-thirds of brain tumours arise from structures below the tentorium (infratentorial) [15]. Supratentorial tumours occur in several locations which include the skull, meninges, sellar, suprasellar, CSF spaces, pineal gland and intraparenchymal.

Extra-axial tumours are those that originate from the meninges, nerve sheaths, calvarium and the cell rests. MRI features which are suggestive of extra-axial findings are 1. Displacement of the brain from the skull with consequent widening of the subarachnoid cisterns, subdural and epidural space.2. Peripherally, broad-based along the calvarium with associated overlying bone changes. 3.Enhancement of adjacent meninges.

Definitive findings for extra-axial tumours are -1.CSF cleft, vessels between brain and lesion, 2. Cortex between mass and oedematous white matter,3. Dura (meninges) between (epidural) mass and brain [1].

2. Objective

The objective of our study is to assess diagnostic ability of MRI in characterizing various supratentorial extra-axial tumours using T1, T2 weighted images, Diffusion-weighted imaging (DWI), Susceptibility weighted imaging (SWI) and contrast-enhanced T1 images

3. Material and Methods

It is a prospective study conducted in the Department of Radio-diagnosis, Narayana Medical College and Hospital, Nellore, Andhra Pradesh from June 2018 - February 2019 using 3Tesla whole-body MR system**.**

Fifty cases of supratentorial extra-axial brain tumours are included.

3.1 Inclusion criteria:

Cases referred for MRI with clinical suspicion of supratentorial extra-axial brain tumours.

3.2 Exclusion criteria:

All patients are having cardiac pacemakers, metallic implants and prosthetic heart valves.

3.3 Follow up:

All patients followed up in surgery and on HPE compared with MRI findings, final outcome of the disease recorded.

4. Results

Majority of the patients (19) in present study belonged to the age group of 40-50 years. Among the others age ranged from 50-60 years (12), 60-70 years (14), above 70 years (3). In present study, there 27 were males and 23 were females. In males, majority (13) of the patients had meningioma, whereas in females, majority (10) had pituitary adenoma.

In this study, higher incidences of meningiomas (44%) were noted.

Table 1: Overall incidence of supratentorial extra-axial brain tumours

Tumour	No. of cases	Percentage
Meningioma	22	44%
Pituitary adenoma	10	20%
Craniopharyngioma	3	6%
Arachnoid cyst	5	10%
Colloid cyst	2	4%
Hemangiopericytoma	1	2%
Choroid plexus papilloma	1	2%
Dermoid cyst	1	2%
Epidermoid cyst	1	2%
Dural metastasis	1	2%
Ependymoma	1	2%
Schwannoma	1	2%
A-V malformation	1	2%

Table 2: Sex wise distribution of various tumours

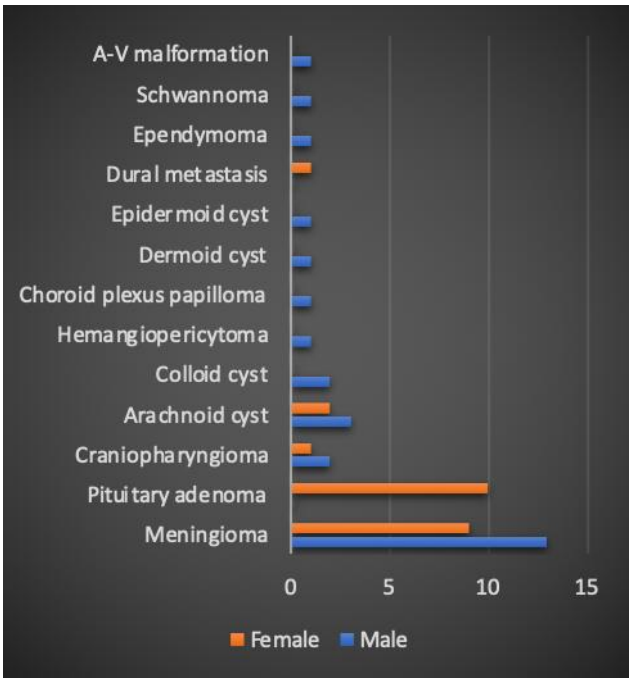

Table 3: Patient symptoms in various tumours

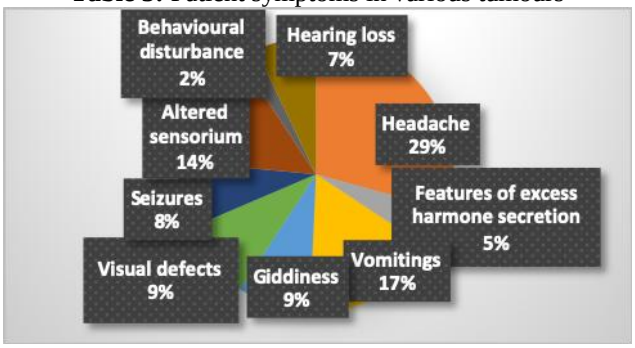

Table 4: MR imaging characteristics of supratentorial extra-axial tumours

Tumour	No. Of cases	T1 signal intensity				T2 signal intensity				Contrast enhancement		
		Iso	Hypo	Hyper	Hetero genous	Iso	Hypo	Hyper	Hetero genous	Homo genous	Hetero genous	No
Meningioma	22	16	0	2	4	0	0	18	4	10	12	0
Pituitary adenoma	10	0	7	0	3	0	0	7	3	7	3	0
Arachnoid cyst	5	0	5	0	0	0	0	5	0	0	0	5
Craniopharyngioma	3	0	2	0	1	0	0	2	1	0	3	0
Colloid cyst	2	0	0	2	0	0	2	0	0	0	0	2
Hemangiopericytoma	1	0	0	0	1	0	0	0	1	0	1	0
Choroid plexus papilloma	1	1	0	0	0	0	0	1	0	1	0	0
Dermoid cyst	1	0	0	0	1	0	0	0	1	0	0	1
Epidermoid cyst	1	1	0	0	0	0	0	1	0	0	0	1
Duran metastasis	1	1	0	0	0	0	0	1	0	0	1	0
Ependymoma	1	1	0	0	0	0	0	1	0	0	1	0
Schwannoma	1	1	0	0	0	0	0	1	0	0	1	0
A-V Malformation	1	0	0	0	1	0	0	0	1	0	1	0

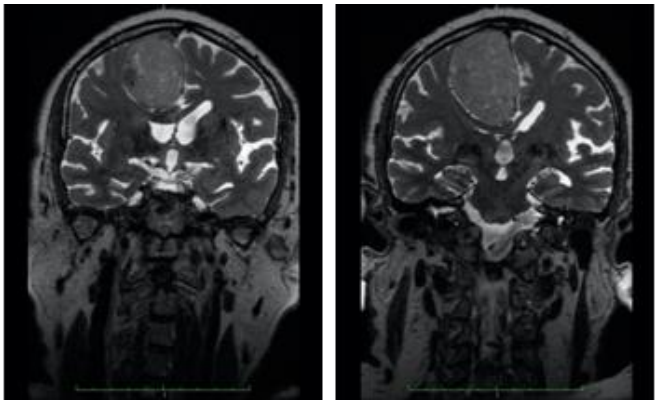

Fig. 1: Coronal T2 CUBE images showing cortical buckling and CSF cleft sign in parafalcine meningioma

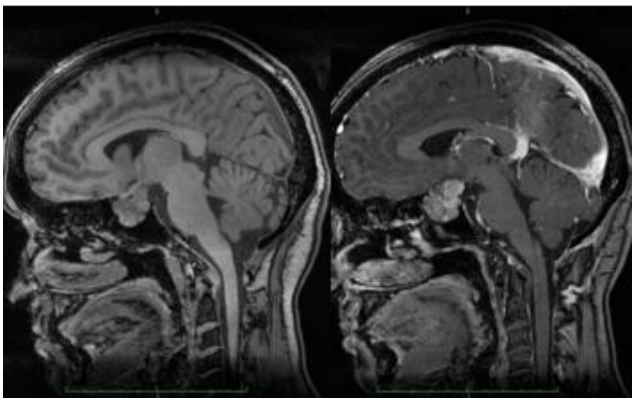

Fig. 2: Sagittal T2 and Contrast enhanced T1 images showing lobulated cystic lesion with enhancing solid component with epicentre in suprasellar cistern, suggestive of craniopharyngioma

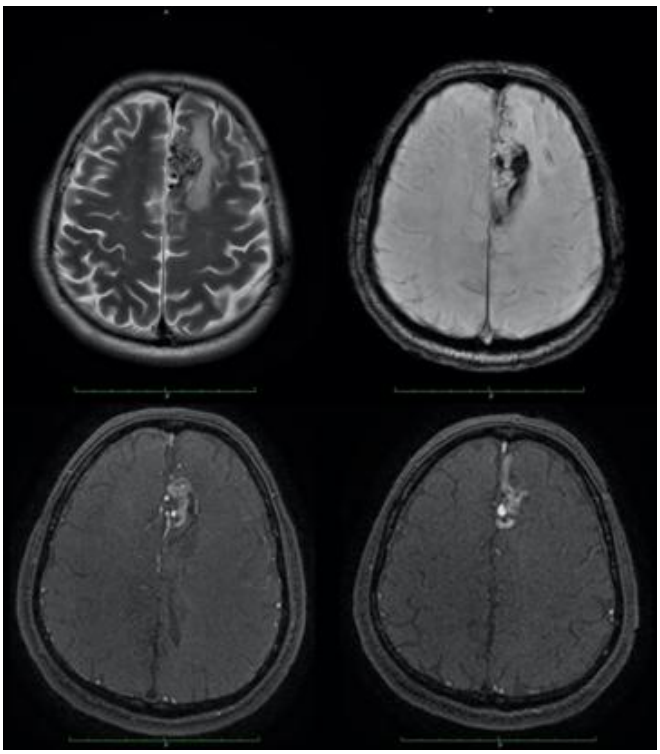

Fig. 3: Axial T2 weighted, SWAN, MR brain angio images showing an ill-defined heterogenous lesion on T2WI with blooming on SWAN images and enlarged feeders arising from ACA and draining into superior sagittal sinus noted on MR brain angiogram, suggestive of A-V malformation

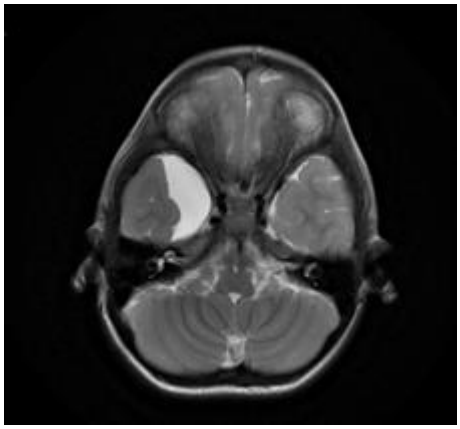

Fig. 4: Axial T2 weighted image showing extra-axial CSF signal intensity lesion noted in right basi temporal lobe, suggestive of arachnoid cyst

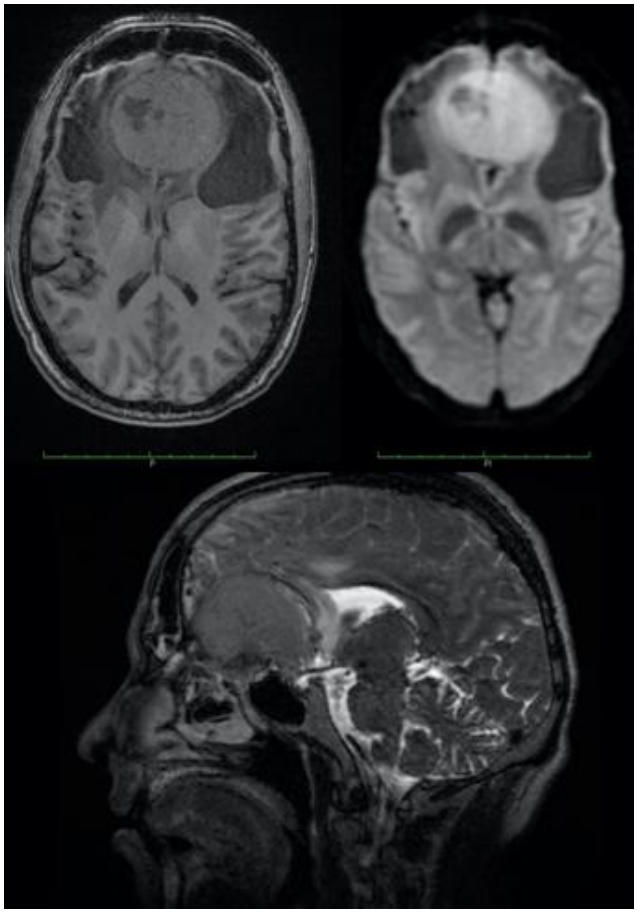

Fig. 5: Axial T1, DWI and Sagittal T2 CUBE images showing a large well-defined extra-axial heterogeneously hypointense to grey matter on T1 WI, T2 WI, with diffusion restriction and few necrotic areas within. Broad base of the lesion noted towards planum sphenoidale. Cortical buckling and CSF cleft sign noted. Moderate perilesional oedema with cystic encephalomalacic changes are noted in bilateral frontal lobes. Mass effect noted in form of compression of genu and rostrum of corpus collosum, Suggestive of planum sphenoidale meningioma.

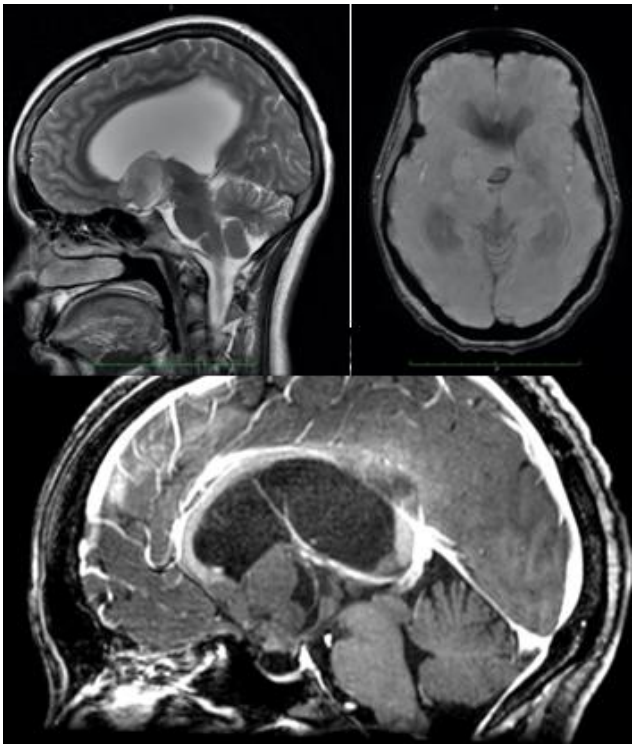

Fig. 6: A well-defined lesion T2 hyperintense to lesion with few areas of blooming on SWAN, representing calcifications and minimal heterogenous enhancement on post contrast images, noted with epicentre in the foramen of monro and anterior part of 3rd ventricle. Mass effect noted in form of upstream hydrocephalus, compression over thalamus and optic chiasm, suggestive of intraventricular ependymoma.

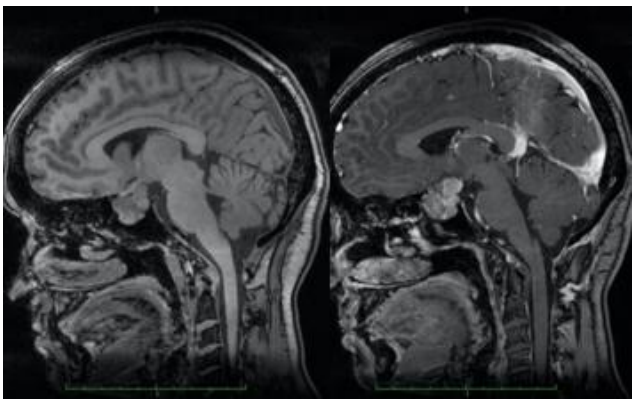

Fig. 7: Sagittal T1 and T1 post contrast images showing well defined T1 heterogenous signal intensity lesion showing moderate enhancement on post contrast images with epicentre in Sella, suggestive of pituitary adenoma

5. Discussion

Intracranial masses are commonly divided into extra-axial and intra-axial. The term extra-axial means off the axis; applied to intracranial lesions that do not arise from the brain parenchyma itself. The differential diagnosis of intracranial lesions begins with an accurate assessment of the extra-axial Location.

Another classification of supratentorial and infratentorial based upon the tentorium.

MRI enables more accurate localization and evaluation of these tumours. This superiority is due to the visualization of the tumours in all the three dimensions and lack of beam hardening artefacts at the base of the brain with MR.

In our study 50 cases of supratentorial extra-axial tumours were evaluated, meningiomas were the most common diagnosis (22 cases, i.e. 44%) others include pituitary adenoma, craniopharyngioma, hemangiopericytoma, colloid cyst, arachnoid cyst, choroid plexus tumour, dermoid, epidermoid, metastasis, ependymoma, schwannoma and AV malformations.

5.1 Age Distribution:

The age group ranges from 40-76 years, peak incidence of neoplasms was seen in the fourth to fifth decade.

5.2 Sex Distribution:

Female and male patients were 23 and 27.

5.3 Clinical Features:

In our study, 80% of patients came with headache. Vomiting, seizures, giddiness, visual disturbances and hormonal imbalance were the other common symptoms.

Meningiomas

The incidence of meningiomas in our study is 44%, which is higher than the incidence reported in the literature (20% by Peter MB) [2].

In our study, meningiomas were more common in males than in females. In our study, 10 cases of meningiomas are present between the age group of 60-70yrs.In the present study, meningiomas were located predominantly in parasagittal, parafalcine, olfactory groove, sphenoid ridge, tentorial, planum sphenoidale and parasellar regions.

In our study, 40% of cases were isointense on T1, and 36% were hyperintense on T2W1. Forty cases of meningiomas were studied by Allen D Elster et al [4] and reported isointense signal intensity on T1 in 62% of cases.

A study conducted by Marie V Spagnoli et al. [20] report that on T1WI, 56% of tumours were isointense, and 36% were hypointense, and on T2WI 52% were isointense while 44% were hyperintense. Contrast enhancement was demonstrated in all our cases, which relates to literature. Calcification was seen as areas of low signal intensity in all the sequences and blooming on SWAN sequence. Most of the meningiomas are showing diffusion restriction. In our study on the post contrast tumours show strong but heterogeneous enhancement in 60% of cases because of calcifications and cysts.

Features of an extra-axial mass lesion like “Dural tail” was seen in 60% of cases. Enhancement of the dura was demonstrated in 72% of cases in a study by Shigeki Aoki et al [3].

In our study, A case of right tentorial meningioma noted with arterial supply from marginal tentorial artery (of Bernaconi-cassinari)

Pituitary adenoma:

In the present study, 10 cases (20%) of pituitary adenomas were evaluated by MRI, out of which six were microadenomas, and four cases were macroadenoma. Daniel G Schwartzberg. Et al. [5] reports microadenomas are more common than macroadenomas.

In the present study, 80% of cases were females, and 20% were males. Peak age incidence was seen in the fourth to fifth decade. In our study, on MR, 70% of the adenomas were hypointense on T1, and all 10 cases appear hyperintense on T2W1. A study by Walter Kucharczyck et al. [6] reports hypointense signal intensity on T1 in 82% of cases.

In our study, on post-contrast, 70% of cases show homogenous enhancement and 30% of cases show heterogeneous enhancement because of cysts and haemorrhage.

Arachnoid cyst:

In our study, 5 cases of the arachnoid cyst are evaluated. Male preponderance was seen (3 cases), 2 cases were females. A study by Knut Wester et al. [7] reports that middle cranial fossa arachnoid cysts occur more commonly in males. Headache is the most common symptom in these cases Location wise they are more common in supratentorial, i.e. middle cranial fossa (50-60%). They are CSF containing cysts and follow CSF signal intensity on T1, T2 W imaging and doesn't show enhancement on post-contrast images [8].

Craniopharyngioma:

These tumours arise from the epithelial cell rests along the involuted hypophyseal-Rathke's duct. Out of 50 cases of supratentorial extra-axial tumours three cases were craniopharyngiomas. Craniopharyngiomas account for 3% of all tumours in all age group-Fitz RC et al [11]. In our study, it accounted for 6%. There is no sex predilection. 40% of craniopharyngiomas in children occur between 5-15years and a second smaller peak at 40-60yrs [10]. In our study of 3 cases, two cases occurred between 40-50 years and another case in 56yrs female. In our study, 2 cases are hypointense on T1, 1 case shows variable signal intensity of T1 and all 3 cases show hyperintense signal intensity on T2. All three cases show heterogenous enhancement with one of the showing nodular patterns of enhancement.

Colloid cyst:

Two cases of the colloid cyst are evaluated in our study, which was located at the foramen of Monro.

George Morrison et al. [19] studied 73 cases of intra-ventricular mass lesions. They found that colloid cysts are the second most common intra-ventricular tumours, which was exclusively confined to the third ventricle at the foramen of Monro.

In our case, the colloid cysts were well defined, spherical which is hyperintense on T1, the hypointense signal on T2W1 and showing no enhancement on post-contrast. In the literature, several studies report a variable appearance of colloid cysts on MRI.

These cysts don't show diffusion restriction. It was associated with dilatation of the lateral ventricles.

Hemangiopericytoma:

One case of hemangiopericytoma is reported in our study. They are usually supratentorial with the mean age group of 40-50yrs [14]. In our study lesion appears as T1, T2 mixed signal intensity showing heterogenous enhancement on post-contrast and mild diffusion restriction. No foci of blooming noted in the SWAN indicating no haemorrhage/calcific foci within.

Choroid plexus papilloma:

Choroid plexus papilloma is considered tumours of neuroepithelial tissue and comprises an important subgroup of the non-astrocytic gliomas [1]. They are mostly benign neoplasms. Most common location is lateral ventricle followed by fourth ventricle.

In our study, one case of choroid plexus papilloma is reported with a mean age of the patient 50-60yrs noted arising from the right lateral ventricle.

The tumour appears isointense on T1 and hyperintense on T2 with few foci of blooming on SWAN (calcification, haemorrhage). There is no diffusion restriction.

Epidermoid:

They arise from the embryonic ectodermal elements. Over 90% of intracranial epidermoid cysts are intradural and almost always extra-axial. They represent 0.2-1.8% of intracranial tumours [1,13]. In the present study, they constitute 2% of tumours. In our study, it is located in the middle cranial fossa (Sylvian fissure), which is the second most common site. The age group of the patient ranges from 40-50years.

Dermoid:

It is benign cystic mass with mature squamous epithelium, keratinous material and adnexal structures (hair, follicles and sebaceous and sweat gland.). Dermoid cysts are usually extra-axial lesions most often found in the midline [1,15]. In our study, it is located in the suprasellar cistern, which is the most common site of dermoid.

It appears heterogeneously hyperintense on T1, T2 showing no enhancement on post-contrast images.

The lesion is showing few foci of blooming on SWAN (calcification)with mild diffusion restriction. **Metastasis:**

One case of carcinoma breast who had multiple metastases both in the supra- and infratentorial regions with surrounding oedema and mass effect in our study.

In the reported literature, carcinoma breast was the second most common malignancy to metastasize to the brain [15].

Ependymoma:

In our study, one case of supratentorial ependymoma is noted, which is abutting the third ventricle. The lesion appears isointense on T1, hyperintense on T2 with foci of blooming on SWAN representing calcification and showing restricted diffusion. Heterogenous enhancement is noted on post-contrast. Elizabeth A Healey. reported irregular contrast enhancement in three out of four cases. Mark K Lyons et al. in his study says that contrast enhancement was seen in 62%, hydrocephalus in 66% and calcification in 28%.

Schwannoma:

Schwannomas are benign slow growing encapsulated tumours that are composed entirely of well-differentiated Schwann cells [1,16]. One case of schwannoma is reported in our study, which is arising from the trigeminal nerve. It is located in the meckel's cave. The mean age group of the patient in our study is 40-50yrs. It appears isointense on T1, hyperintense on T2 showing diffusion restriction without any foci of blooming on SWAN. Although macroscopic intratumoral hemorrhage is rare SWI reveals foci of blooming if present.

AV malformation:
Dural arteriovenous malformations comprise approximately 10-15% of all intracranial arteriovenous malformations. Most of them are located in the posterior fossa or in the region of the cavernous sinus. Other sites include the regions of the superior sagittal sinus, anterior cranial fossa, and the cranio-cervical junction [19]. One case dural AV malformation is reported in our study.

6. Conclusion

Magnetic resonance imaging scan of brain was performed in 50 patients with supratentorial extra-axial tumours.

The commonest supratentorial extra-axial tumour was meningioma.

Multiplanar capability of MRI was helpful in identifying the precise anatomic location and the exact extent of the tumours.

On post contrast images there was a clear definition of the size, margins, and nature of the tumour and it also improved the differentiation between the tumour and surrounding oedema.

SWI sequence is useful for identifying the foci and calcification and haemorrhage within the tumour.

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Author Profile

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