Evaluation of Supratentorial Brain Neoplasms - A Cross Sectional Study from a Tertiary Care Hospital, Surendranagar, Gujarat

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ABSTRACT

BACKGROUND

Brain tumours represents 1.7 % of all cancers and contributes 1.8 % of all cancer deaths. Of all the brain tumours, 80 % are supratentorial.[1] Magnetic resonance imaging (MRI) is an important modality, having higher sensitivity for detecting intracranial pathology. Multiplanar imaging is possible with MRI which helps in detection, localization and characterization of the lesion. MRI examination has helped in early diagnosis, accurate localization of the tumour, with prompt initiation of appropriate medical or surgical therapy. Recent advances like magnetic resonance (MR) spectroscopy, MR fluoroscopy with stereotactic guided biopsy have revolutionized the role of MRI in study of intracranial tumours.

METHODS

A cross sectional study of 75 patients was done by Siemens Essenza 1.5T MRI from June 2018 to June 2020 using dedicated head coil.

RESULTS

In our study, most of the patients were between 31 - 60 years of age (39 % of all patients) with the largest group between 31 - 40 years (20 % of all patients). Out of 75 cases of supratentorial neoplasms, 47 (72 %) were intra-axial lesions, 15 (23 %) were extra-axial lesions and 3 (5 %) were intra ventricular lesions. In this study, 69 % of the lesions were solitary and 31 % were multiple. Most of patients (89 %) showed some enhancement, most common being heterogeneous/inhomogeneous enhancement. Commonest type of supratentorial neoplasms were metastases comprising 29 % of this study.

CONCLUSIONS

Magnetic resonance imaging is an important modality, having higher sensitivity for detecting intracranial pathology. Multiplanar imaging is possible with MRI which helps in early detection, localization and characterization of the lesion. Metastasis is the most common supratentorial tumour in this study followed by meningioma. Intra-axial tumours are more common than extra-axial tumours in this study.

KEYWORDS

MRI, Metastasis, Glioma, Meningioma

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BACKGROUND

The designation "brain tumours" is commonly applied to a wide variety of intracranial mass lesions that are distinct in their location, biology, treatment, and prognosis. Since many of these lesions do not arise from brain parenchyma, the more appropriate term would be "intracranial tumours." Majority of these tumours present with non-specific complaints such as headache, stroke, like syndromes, or seizures.

Often diagnosis is made or suggested initially by the findings on imaging studies. However, prognosis of these patients has improved considerably due to recent advances in diagnostic techniques, microsurgery, and radiotherapy. Clinical evaluation, radiology and pathology plays a big role in deciding the long-term prognosis.[1] 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. Infra**-**tentorial means below the tentorium and applies to tumours arising in the posterior fossa. In adults, two-thirds of primary brain tumours arise from structures above the tentorium (supratentorial). Supratentorial tumours occur in several locations which include the skull, meninges, sellar, suprasellar, cerebro spinal fluid (CSF) spaces, pineal gland and intraparenchymal.

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 central nervous system (CNS) to characterize tumour types and determine treatment options. Recent advances in imaging techniques have exploded into the horizon of using many different modalities such as magnetic resonance imaging and computed tomography (CT) perfusion, positron emission tomography, and single photon emission CT. These imaging modalities have revolutionized the diagnosis and management of brain tumors.[2]

MRI has earned recognition as the optimal screening technique for the detection of the most intracranial neoplasms. MRI using spin echo, gradient echo, and combination spin echo and gradient echo pulsing sequences before and after intravenous administration of paramagnetic contrast agents provides inherently greater contrast resolution between structural abnormalities and adjacent brain parenchyma and has proved to be more sensitive in the detection of focal lesions of the brain. Moreover, the multiplanar capability of MRI is very helpful to determine the anatomic site of origin of lesions and to demarcate extension into adjacent compartments and brain structures.[3] MRI is a powerful instrument for evaluating patients with primary brain tumours. Among all the imaging modalities, MRI is the most sensitive for detection of the brain tumours.

We wanted to study the distribution of various supratentorial neoplasms in the form of location, age and sex. We also wanted to identify various imaging characteristics of tumour in various sequences of MRI.

METHODS

A cross sectional study of 75 patients was done by MRI from June 2018 to June 2020 by convenient sampling technique. Patients who were referred to the Radiology Department of C. U. Shah Medical College and Hospital by physicians with complains of headache, seizures, paralysis, paraesthesia were evaluated by MRI. Patients with supratentorial lesions due to infective aetiology, congenital malformations, trauma or stroke were excluded from the study.

The study was performed on Siemens (Magnetom Essenza) 1.5 Tesla MRI machine with dedicated head coil. The conventional protocol included T1W (TE 8.0 ms, TR 480 ms), T2W (TE 102.9 ms, TR 4780 ms), and FLAIR (TE 92.2 ms, TR 8002 ms) sequences in axial, sagittal and coronal planes. Contrast medium was administered intravenously to all cases using Gd-DTPA, 0.1 mmol/Kg, given manually by a slow intravenous injection. Post contrast T1 weighted axial, coronal and sagittal sequences were performed.

MRI brain findings were noted and recorded. The present study included 75 cases of patients with supratentorial brain neoplasms. Following observations were made according to age, sex, presenting symptoms and MRI appearances of the various lesions and the study data was analyzed.

Statistical Analysis

Data was entered and analysed by using Microsoft excel 2013 & appropriated statistical analysis was done.

RESULTS

Age Distribution

In our study, most of the patients were between 31 - 60 years of age (39 % of all patients) with largest group between 31 - 40 years (20 % of all patients). The youngest patient was 2-year-old with low grade glioma and the oldest patients were 4 in number, each being 85 years old; three of them having metastasis and one having meningioma.

Sex Distribution

In this study there were 33 male and 38 female patients out of total 75 patients with intracranial supratentorial brain neoplasms.

Distribution According to the Location of the Lesions

Out of 75 cases of supratentorial neoplasms, 47 (72 %) were intra-axial lesions, 15 (23 %) were extra-axial lesions and 3 (5 %) were intra ventricular lesions.

Distribution According to the Part Involved

The parietal lobe was most commonly involved part of brain in 34 patients. Many of these patients had simultaneous involvement of cerebral lobes and ventricles. Next most

common site of neoplasms was the temporal lobe (in 29 patients). Decreasing order after it was frontal – 27 patients, others (e.g. basal ganglia and deep peri-ventricular white matter) – 11 patients and occipital lobe – 7 patients and lateral ventricles – 3 patients.

Distribution According to the Number of the Lesions

In this study, 69 % of the lesions were solitary and 31 % were multiple. Majority of multiple lesions were seen in cases of metastases and a few cases of meningioma. In the present study on T1WI most of the tumours were predominantly hypointense (44 patients - 68 %). The heterogeneity of signal was attributed to presence of haemorrhage (mostly subacute) or calcification. Then followed isointense signal on T1WI which is seen mostly in cases of meningioma. Most of the lesions demonstrated predominantly hyperintense (50 patients – 76 %) signal on T2WI. The heterogeneity on T2WI was most probably due to necrotic or cystic components. Then followed hypointense and isointense lesions. Most of the lesions were non-suppressed on flair images (37 patients - 57 %). The lesions which showed suppression were chiefly lesions with cystic components.

Signal Intensity on Advanced MRI Sequences

24 patients (37 %) of present study showed diffusion restriction on diffusion weighted imaging (DWI) and 30 patients (46 %) showed blooming on gradient images.

Enhancement

In my study, most of the patients (89 %) showed some enhancement, most common being heterogeneous/inhomogeneous enhancement. 7 patients (11 %) didn't show any enhancement which included mainly low-grade neoplasms. Most common tumour to show intense homogenous enhancement was meningioma.

Necrosis, Oedema and Mass Effect

In this study, 44 patients showed perilesional oedema and 42 patients showed mass effect. 37 % of the neoplasms (24 patients) showed necrotic components within the lesion probably due to high grade of tumour in many. They included metastasis, gliomas of higher grade.

Diagnosis and Frequency of Distribution

Commonest type of supratentorial neoplasms were metastases comprising 29 % of this study. Next most common type of neoplasms in this study was meningeal neoplasms having approximately 25 % of cases, which was comprised mostly by meningioma (12 cases) & other 4 cases showed atypical meningioma pattern. The next most common types were glial neoplasms having approximately 39 % patients. Among 25 cases of glial neoplasms on MRI, approximately 14 cases were diagnosed with higher grade of neoplasms (majority of them were glioblastoma multiforme). Other 11 cases were diagnosed as low-grade glial neoplasms. Other miscellaneous types were neuronal & mixed glioneuronal neoplasms (4.6 %), hematopoietic neoplasm and mesenchymal neoplasm 1.5 % each.

Sequences	Signal	No. of Patients	Percentage
T1	Hypointense	44	67.69
	Hyperintense	0	-
	Isointense	21	32.30
T2	Hypointense	11	16.92
	Hyperintense	50	76.92
	Isointense	4	6.15
FLAIR	Non-suppressed	37	56.92
	Suppressed	28	43.07
DWI	Restriction	24	36.92
	No restriction	41	63.08
GRE	Blooming	30	46.15
Enhancement	Heterogeneous	34	52.30
	Homogeneous	13	20
	Rim	11	16.92
	No enhancement	7	10.76

Table 1. Characterization of Tumours on MRI in This Study

Metastasis

The images shown below are of a 62-year-old male patient presenting with single episode of seizure before 3 weeks.

Meningioma

A 40-year-old female patient came for MRI of brain with complaint of progressive increase in contralateral upper and lower limb hemiparesis since last 2 months. MRI of brain showed large extra axial lesion involving left perisylvian fronto-temporo-parietal region. The lesion showed intense post contrast enhancement with enhancing dural tail along its antero-superior aspect.

DISCUSSION

Metastases

In our study, metastases turned out to be the most common supratentorial neoplasm with age varying from 40 years to 85 years and a male: female ratio of 12 : 7. The overall mean age of presentation was 63.32 years whereas it was 64.83 years for male and 60.71 years for females. In our study, metastatic lesions of brain showed most frequent sites involved were the parietal region followed by equal involvement of frontal and temporal region. Majority of the cases showed multiple lesions within the brain. The lesions were predominantly hypointense on T1WI and hyperintense on T2WI. On post-contrast study, most lesions showed some enhancement with 9 patients each showing heterogeneous and peripheral rim like enhancement in respectively. On DWI, only 6 lesions demonstrated restriction of diffusion with low apparent diffusion co-efficient (ADC) values.

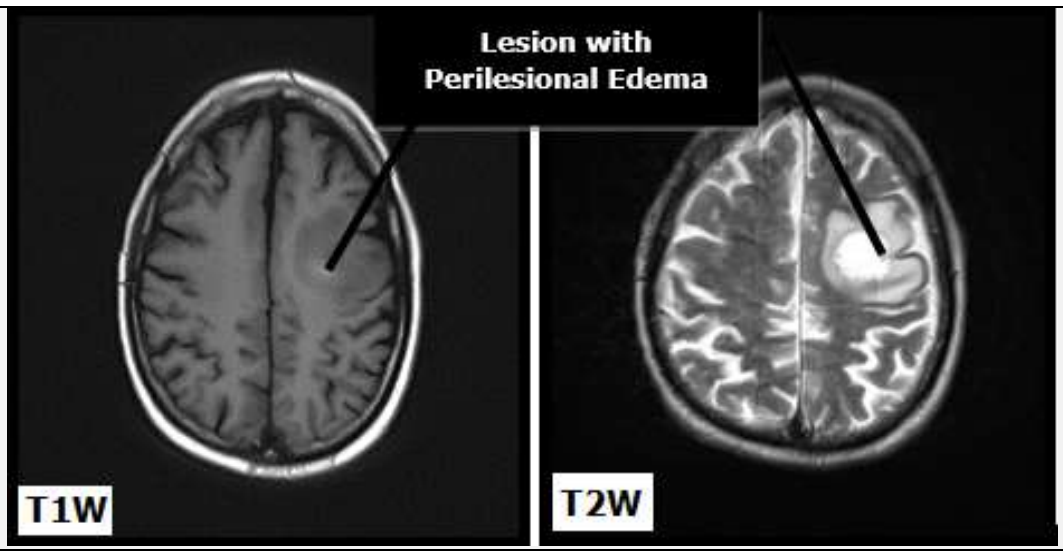

Figure 1. Left Frontal Lobe Lesion is Hypointense on T1WI and Hyperintense on T2WI with Adjacent Oedema

Figure 2. The Lesion Shows Peripheral Enhancement on Post Contrast Study

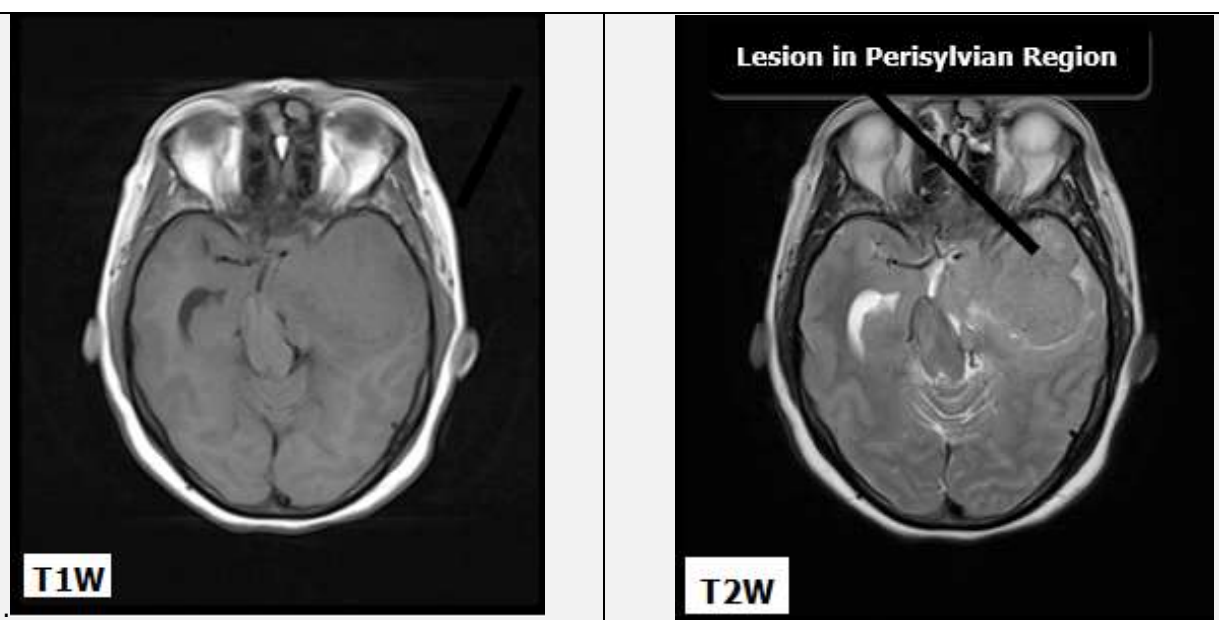

Figure 3. Large Extra Axial Lesion in Left Perisylvian Region. The Lesion is Hypointense on T1WI and Hyperintense on T2WI

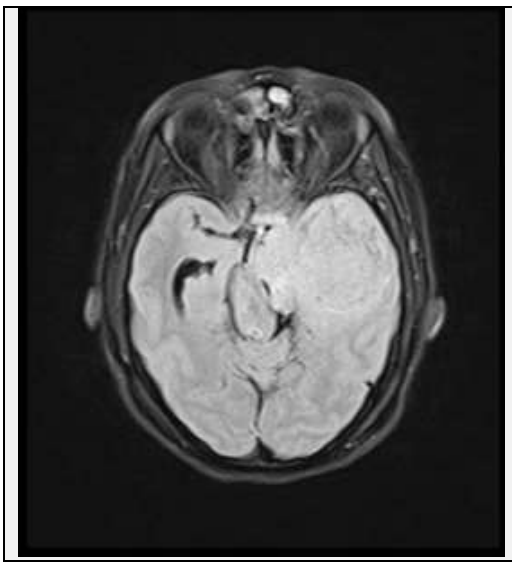

Figure 4a. Flair

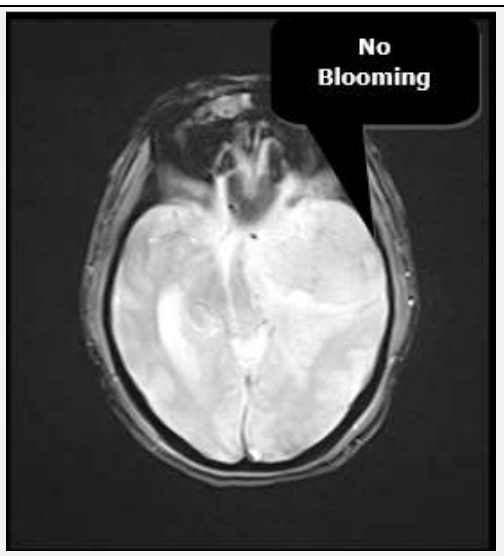

Figure 4b. GRE

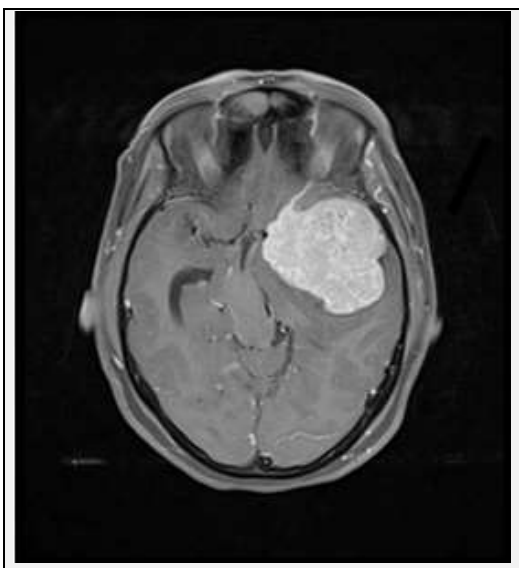

Figure 5a. T1 Axial (Post Contrast)

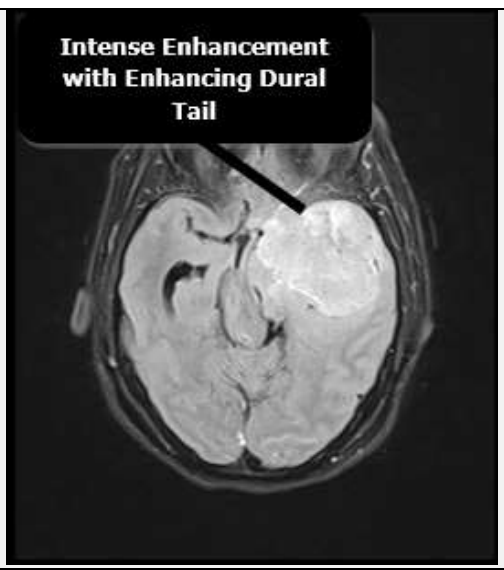

Figure 5b. T2 Flair Axial (Post Contrast)

Brain metastases occurs in 15 - 40 % of patients with cancer.[4,5] Certain malignancies are often associated with brain metastases, including cancers of the lung, breast, skin, colon, pancreas, testes, ovary, cervix, renal cell carcinoma, and melanoma.[4,5] Although many case reports of intracranial metastatic disease from various other cancers exist.

The detection of brain metastases is important for initial staging of patients with systemic malignancy. In some cases, Silvestri et al.[6] reported that the presence of brain metastases comes to clinical attention through new neurological signs and symptoms, and imaging is therefore indicated in such patients and symptoms may include headache, seizure, syncope, focal neurological deficit, or papilloedema. Metastatic disease can involve different compartments of the central nervous system. The most common, metastatic disease affects the skull and/or brain parenchyma. Metastases can also involve the leptomeninges and pachymeninges. 6 MRI is a sensitive screening test for brain metastasis. It is also useful to further evaluate mass lesions found on non-enhanced computed tomography (NECT) to refine the differential diagnosis. On MRI, Chen et al. reported that metastases are usually isointense or hypointense on T1, hyperintense on T2, and exhibit avid enhancement.

Some metastases, such as melanoma, are T1 hyperintense due to the paramagnetic effects of melanin. Haemorrhagic metastases may also demonstrate T1 signal hyperintensity, depending on the age of haemorrhage. DWI usually demonstrates facilitated diffusion (i.e., bright on apparent diffusion coefficient map), rather than diffusion restriction. This is comparable to the present study. Vasogenic oedema can be substantial, and is unrelated to lesion size. Hakyemez et al. [7] found a significantly increased ratio of vasogenic oedema to contrast enhancing lesion size in metastases compared with high grade primary brain tumours, although metastases may display little or no vasogenic oedema. Small cortically based metastases may not demonstrate any visible oedema, and must therefore be looked for carefully. Gadolinium contrast enhancement is vital to detect small metastases. Balériaux and Healy et al.[8,9] have documented the utility of contrast in the detection of additional lesions compared with noncontract studies. In these studies, contrast administration improved diagnostic confidence. Contrast administration is also important to

distinguish non-neoplastic white matter disease from metastases.

Meningeal Neoplasms

In present study, meningioma is the second most common primary neoplasm representing approximately 35 % of all primary brain neoplasm with an age range of 37 - 85 years and a mean age of 56.43 years whereas it was 68.17 years for male and 49.40 years for females. Most of the tumours were isointense (87.5 %) on T1WI and hypointense (50 %) on T2WI. Majority of the tumours didn't show any suppression on FLAIR images and didn't show any restriction of diffusion on DWI. On post contrast study, 10 patients (62.5 %) showed homogenous enhancement of the lesions with 6 patients (37.5 %) showing heterogenous enhancement due to necrosis & calcification. The degree of enhancement is dependent both on tumour vascularity and extracellular accumulation of contrast.

Verheggen and Mahmood et al.[10,11] reported that meningiomas constitute approximately 20 % of all intracranial tumours and are easily diagnosed using routine MRI imaging. Furthermore Mahmood et al.[11] reported that malignant and atypical meningiomas, although relatively uncommon and accounting for approximately 7.2 % and 2.4 % of all meningiomas, respectively,[10,11] were associated with less favourable clinical outcomes because they are more prone to recurrence and aggressive growth.[12] In the present study, we did not observe any malignant meningioma among the studied patients.

According to the world health organization (WHO) classification of meningiomas, those meningiomas with low-risk of recurrence and aggressive growth are classified as WHO grade I.[12] The grade I classification includes the most common types of meningioma (fibrous or fibroblastic, transitional or mixed, and meningothelial) and the following benign subtypes: Psammomatous, angiomatous, microcystic, secretory, lymphoplasmacytic, and metaplastic.[12]

Gliomas

Primary cerebral gliomas are the single largest group of all intracranial tumours. In our study, gliomas represented 38.46 % of all supratentorial neoplasms and 54.34 % of all primary tumours in the supratentorial region.

Low Grade Glioma

Our study encompassing 25 cases of supratentorial gliomas had 8 low grade gliomas i.e., 32 %. Our study of 8 patients of low-grade gliomas had 5 males and 3 females showing male : female ratio of 5 : 3 with age varying from 2 – 64 years. Mean age of patients with low grade gliomas was 32.38 years and median age was 35 years. In our study, most common presenting complaints were seizures (37.5 %) followed by headache and altered consciousness (25 % each) with majority of them having less than 3 weeks duration of symptoms. The lesions were most commonly located in the temporal region followed by equal involvement of frontal and parietal region. Majority of the cases showed single lesion within the brain. The lesions were invariably isointense to hypointense on T1WI and hyperintense on T2WI along with non-suppression on FLAIR images. On post-contrast study, 5 patients showed no enhancement along with heterogeneous enhancement in 3 patients. Salzman et al.[13] reported that these tumours are homogeneously hyperintense on FLAIR imaging and usually do not restrict on DWI. Peritumoral oedema and haemorrhage are rare and higher-grade lesions should be suspected if enhancement is noted.[13]

High Grade Glioma

In our study, among 25 cases of gliomas, 14 were high grade i.e., 56 %. Majority of high-grade gliomas were comprised of glioblastoma multiforme (GBM) with age varying from 14 - 82 years and a male : female ratio of 1 : 1. The mean age of presentation was 49.71 years. Patients' symptoms were mostly headache and seizure. This was in line with the previous findings of Sizoo et al. (2010).[14] The lesions were most commonly located in the temporal region followed by parietal, frontal, and occipital region respectively. The lesions were invariably isointense to hypointense on T1WI and hyperintense on T2WI along with non-suppression on FLAIR images. Timmons et al. (2018), reported similar findings in a review.[15] We found almost all cases of high-grade glioma showing a solitary lesion with no history of intra/extra cranial malignancy in our study. As per our study of 14 cases of high-grade glioma, all cases showed some contrast enhancement. Majority of them (12 patients) showed heterogeneous enhancement along with peripheral ring like enhancement in 2 patients. Contrast enhancement in the higher grade/malignant tumours is related to vascularity necrosis, pleomorphism and cellularity. Barker, Davis, Chang, and Prados (1996) and Liu et al. (2017) reported the same findings.[16,17] In our study, among 14 cases of high-grade gliomas, 78.57 % showed diffusion restriction with low ADC value.

Neuronal and Mixed Neuronal Glial Tumours

In present study, three patients of neuronal and mixed neuronal glial tumours were seen of age 40 years, 55 years and 23 years. 2 cases were females, and 1 case (of ganglioglioma) was male. All 3 patients came with complaints of seizures with invariably involving temporal lobe.

The lesions showed hypointense on signal T1WI and hyperintense signal on T2WI without any areas of diffusion restriction on DWI. Ganglioglioma showed few areas of blooming within the lesion whereas the other two did not show any blooming on gradient images. All lesions showed some contrast enhancement on post contrast study. Dysembryoplastic neuroepithelial tumour (DNET) was seen having homogeneous contrast enhancement while ganglioglioma and multinodular and vacuolating neuronal tumour (MVNT) showed heterogeneous contrast enhancement.

CONCLUSIONS

CT scan is less helpful in intracranial brain neoplasms because of beam hardening artefact. MRI showed magnificent sensitivity in detecting haemorrhage / calcification, necrosis, oedema as well as extension of the tumours to other adjacent sites and orbital region in case of acoustic schwannoma. Advanced MRI techniques like DWI and GRE have helped to diagnose all suspected malignant lesion non-invasively with fair accuracy which was not possible with CT scans.

The salient advantages of MRI are its ability to tissue characterize the lesion, detect haemorrhage / calcification, necrosis and oedema accurately, ability to differentiate malignant from benign lesions non-invasively and most importantly lack of ionizing radiation. The findings seen on MRI have highly correlated with the histopathological findings. Sometimes even in patients with reaction to iodinated contrast media in whom CT is contraindicated, MRI proves invaluable.

Thus, MRI assumes great diagnostic importance & it proves to be a valuable modality of imaging in evaluating the characteristics, distribution and assessing the extent of various intra-axial and extra-axial neoplasms in the supratentorial region.

Data sharing statement provided by the authors is available with the full text of this article at jebmh.com.
Financial or other competing interests: None.
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