Original Article

IMAGING OF INTRA CRANIAL SPACE OCCUPYING LESIONS THROUGH MAGNETIC RESONANCE

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Abstract

"Imaging of intracranial space occupying lesion has been given new depth with the advent of CT and MRI scanning, allowing for exquisite anatomical detail in the axial, sagittal, and coronal planes and allowing for the characterisation of tumour tissue. The development of MR angiography has allowed for the noninvasive creation of a three-dimensional virtual vascular map of tumour blood supply, which has aided in the early diagnosis and localization of the SOL and, in conjunction with cutting-edge neurosurgical techniques, has improved the prognosis of mass lesions." [2]

"When combined with MR angiography, these techniques provide the neurosurgeon with a virtual road map that helps determine whether or not surgery is even possible, and how it should be approached if it is. [3] CT, on the other hand, is an easily accessible, cost-effective alternative. Acute bleeding, calcification, and bone degeneration are also improved." [1]

"MRI is preferable to CT because it provides more information about the lesion, including whether it is diffuse or localised, if there is any remaining tumour or if it has returned, where many lesions are located, and how they relate to and affect the spinal column. MRI's other strengths—multi-planar imaging and MR angiography—make it a valuable diagnostic tool as well.".[4]

Key words: angiography, feasibility, lesions, modalities, calcification, spine, MRI

Introduction

"There is a wide variety of tumours that may inhabit brain tissue. Early identification is essential for planning the action necessary to avoid Intracranial Space Occupying Lesions and their associated greater morbidity and death." [1]

"A handy umbrella phrase for localised intracranial lesions of neoplastic, vascular, or chronic/acute inflammatory origin that cause increased intracranial pressure is "space occupying lesions of brain." Because the skull can only hold a certain amount of tissue, any additions to that tissue within the skull will result in increased intracranial pressure". [5]

"There are many causes of intracranial space occupying lesions, thus it's crucial to evaluate the patient clinically and distinguish between the neoplastic and non-neoplastic nature of the lesion seen by neuro-imaging (CT scan, MRI scan, etc.)".

In the present study, "those cases were included which were either clinically suspected cases brain space

occupying lesions or already diagnosed cases of brain space occupying lesions on cross sectional imaging of MRI."

Aim and Objectives

Aim of Study

- To study the role of magnetic resonance imaging in evaluation of spaceoccupying lesions of brain.

Objectives of the Study

1. To study the number and distribution of various intracranial spaceoccupying lesions (SOL) and its impact on surrounding structures.

2. To study MRI features of different intracranial space occupying lesions.

Review of Literature

The term "intracranial space occupying lesions" is defined as "any neoplasm, benign or malignant, primary or secondary, as well as any inflammatory or parasitic mass lying within the cranial cavity. It also includes haematomas, different types of cysts, & vascular malformations. [6] Different authors have reported that majority of patients of ICSOL had neoplasms followed by infective & traumatic etiology. [7,8] Gliomas are more common followed bymeningiomas, abscesses, pituitary tumors &tuberculoma." [9]

The term intracranial space occupying lesion is "generally used to identify any lesion, whether vascular or neoplastic or inflammatory in origin which increases the volume of intracranial contents and leads to a rise in the intracranial pressure". [10]

Table 1: Classification of intra cranial space occupying lesions :

1. Congenital	"Dermoid, Epidermoid, Teratoma."	
2. Traumatic	"Subarachnoid hemorrhage, Subdural and Extradural hemorrhage, Hemorrhagic contusion"	
3. Inflammatory	"Multiple sclerosis and its variants ,Neuromyeltis Optica spectrum, Acute disseminated Encephalomyelitis, Acute Hemorrhagic Leucoencephalitis, Neurosarcoidosis"	
4. Infective	"Abscess, Tuberculoma, Syphilitic Gumma, Fungalgranulomas"	
5. Parasitic	"Cysticercosis, Hydratid cyst, Amebic abscess,Schistosoma japonicum."	
	Neuronal Tumors	"Gliomas – astrocytoma, ependymoma, oligodendroglioma, germinoma, medulloblastoma."

6. Neoplasms	Tumors arising from appendages	"Meningioma, schwannoma, chondroma, osteoma."
	Pituitary lesions	"Pituitary adenoma, Craniopharyngioma."
	Vascular lesions	"Angioma, Hemangioblastoma, Papilloma of choroid plexus."
	SecondaryNeoplasms	Metastasis

Brain Tumours:

The term "brain tumours" refers to a "mixed group of neoplasms originating from intracranial tissues and the meninges with degrees of malignancy ranging from benign to aggressive. Each type of tumour has its own biology, treatment, and prognosis and each is likely to be caused by different risk factors. Even "benign" tumours can be lethal due to their site in the brain, their ability to infiltrate locally, and their propensity to transform to malignancy. This makes the classification of brain tumours difficult sand creates problems in describing the epidemiology of these conditions." [11]

"Mwang studied the frequency, mode of presentation and outcome following treatment of gliomas in patients treated at the Kenyatta National Hospital in Nairobi. Two hundred and fourteen histologically confirmed intracranial tumours were included. Ninety seven (45.8%) of these were gliomas of which eighty one were astrocytomas, ten ependymomas and six Oligodendroglioma. Meningiomas were the next common tumours (34.4%). Gliomas affected the young age group most, with the peak in the first decade of life. Males were most affected with a male to female ratio of 1.4:1. Features of increased intracranial pressure were the commonest mode of clinical presentation. The parietal region was the commonest site of intracranial gliomas (37.5%)". [18]

In India, "Desai reported that 102 patients under the age of 12 years with cerebellar astrocytomas were retrospectively analyzed. The clinical features were predominantly related to increase intracranial pressure and the location of the tumour. Twenty-six tumors were located in the vermis and 76 in the cerebellar hemisphere. The brain stem was involved in 20 patients. All 102 patients had a preoperative contrast-enhanced CT scan. Midline vermian tumors were predominantly solid and enhancing, whilst the hemispheric tumors were cystic and nonenhancing." [19]

Immune factors: Viruses, Allergies & Infections:

"In experimental animal models brain tumours can be induced by a number of viruses, including retroviruses, papovaviruses, and adenoviruses but there is little epidemiological support for this occurring in humans. At one time it was thought that live polio vaccines contaminated with SV40 might increase the risk of brain tumours, but this was not supported by more detailed powerful studies. Direct examination of brain tumour tissue for evidence of a viralcause has shown the presence of different viral DNA sequences in some cases within separate pathological series. However, the mechanisms of how a virus might initiate malignant transformation remain unknown." [19]

"In utero infections with influenza and chicken pox (varicella) have been cited as a risk factor but the case for this is not strong. Some recent epidemiological work on a series of patients from the north west of England diagnosed with brain tumours has shown geographical distributions which are suggestive of an infectious aetiology for some of the tumour types". [20]

Chemicals:

"N-nitroso compounds are found in the environment but the most common source of human exposure is through

foods, with vegetables and cured meats being major sources. Alkylating agents, such as methyl nitrosurea, are known transplacental carcinogens, particularly for brain tumours in rats". [19]

Head trauma and injury:

"Patients with brain tumours inevitably recall occurrences of trauma or injury to the head, and studies of patients' reports are therefore subject to "recall bias". Some epidemiological investigations of the relation between head trauma/injury and the subsequent development of a tumour have attempted to overcome this by examining medical records, but these mainly fail to demonstrate any relation." [20]

Tumour types:

"Molecular cytogenetic techniques have helped to understand that brain tumours arise from genetic disruptions in cells, causing the cells to become neoplastic, but the causes of genetic disruption remain unclear. Brain tumours in the same family members are extremely rare. Furthermore, brain tumours can occur anywhere in the intracranial space. [21] The tumour is named according to the cellular origin and the microscopic appearance. Most childhood brain tumours arise in the supporting cells of the brain (glia) and are called gliomas. The most common is the astrocytoma, derived from astrocytes, which are major supportive cells. Astrocytes constitute nearly 40% of the total CNS cell population and are widely spread throughout the central nervous system including the optic nerves. [21] Tumours are classified histologically from grade I through grade IV. Grade I and II are histologically benign, but grade III and grade IV are malignant, hence glioblastoma. Other tumours are ependymomas, gangliogliomas, choroid plexus papillomas, and oligodendrogliomas. Other common brain tumours in childhood arise in the primitive nerve cells, and are much more common in children than in adults. When they occur in the cerebrum, they are called ―primitive neuroectodermal tumour (PNET). In the infratentorial location they are called medulloblastomas, while those in the pineal gland are called pineoblastomas. They are malignant, grow rapidly, and tend to spread through the CSF". [22]

"A third type of childhood brain tumour arises in the non-neuronal embryonal cells. They are germ cell tumours, craniopharyngiomas, or dermoids. Tumours arising in the meninges, nerve sheaths, or pituitary gland have an expansible nature with little or no infiltration to the brain or spinal cord. They are meningiomas, neurinomas, and pituitary adenomas respectively. Theyusually occur in adults, but can appear in children". [23]

Clinical Features:

"A part from those related to subarachnoid haemorrhage due to rupture of aneurysm, it may present with features of space occupying lesion. In non- thrombosed giant aneurysm, CT shows a homogenous, primarily hyper-dense space occupying lesion with enhancement. The partially thrombosed giant aneurysms appear hyper-dense with hypodense or iso-dense portion in the plain CT scan. CT scan diagnosis is possible in every case of partially or non- thrombosed aneurysm, but cerebral angiography remains the definitive study to detect the lesion." [57]

Materials and Methods

"The study was conducted in the MRI SECTION OF Department of Radio- diagnosis at Krishna Hospital after obtaining ethical committee clearance. Thepatients included in the study were referred from the various clinical departments of Krishna Hospital**."**

STUDY DESIGN- Observational Study.

SAMPLE SIZE- 90 patients

SAMPLING TECHNIQUE-Convenience Sampling **STUDY DURATION** – November 2017 to November 2019**INCLUSION CRITERIA:**

- Patients of adult age group (age>18years) and both sexes willing togive consent for examination.
- Clinically suspected cases of intracranial SOL which were confirmed onCT.

EXCLUSION CRITERIA:

- Patients with contraindications to MR Imaging: patients with ferromagnetic implants, cochlear implants, etc.
- Critically ill patients who are on life support.
- Patients with claustrophobia.
- Patients with known allergy to contrast agent.

Methodology

Informed consent was taken from the patient/attendant/legally acceptable representative for inclusion in the study as per the proforma attached.

Computed Tomography:

CT was performed on 16 slice Multi-detector CT Siemens Somatom Emotion machine in our institute or done outside with high suspicion of intracranial space occupying lesion and were found positive.

Those cases were sent to MRI section of department of Radio-diagnosis.

Clinical evaluation:

A detailed history was taken with complete physical and systemic examination of thepatient. Relevant biochemical investigations were done wherever required.

Magnetic Resonance Imaging:

MRI was performed on **MAGNETOM AVANTO 1.5 –TA Tim+Dot MR System (SIEMENS).** Patients were positioned in the gantry with all precautionary measures. Scout images in axial, sagittal and coronal planes were taken. Basic sequences for brain,e.g.,T1W,T2W,FLAIR,DWI,ADC& HEMO were taken in different planes. Additional sequences,e.g., SWI,Mag,PHASE,T1FS pre and post contrast images, CISS and MRS were taken as per the requirement of the study . The contrast used was Gadolinium based (i.e. gadobenetedimeglumine 0.5M solution-10ml vial).The dose given was 0.2mmol/kg.Dynamic contrast imaging was also done wherever needed.

Acquired images were analysed and then entered in the masterchart.

Observations and Results

The present study was carried out in the MRI section of Department of Radio- diagnosis, Krishna Hospital, Karad, among a total of 90 cases suspected of having ICSOL on the basis of history and/or suspected on CT.

Demographic Characteristics

In our study, we observed cases with suspected ICSOL belonged to different adult age group and both genders. Hence, in order to study their age and gender wise distribution, we assessed their demographic characteristics.

Age distribution:

The mean age observed in our study was 48.37 ± 14.64 years. Most common age group decade was 41-50 years with 27 patients (30%), followed by 51 — 60 years with 16 patients (17.78%) and 41-50 years with 16 patients(17.78%).

Table 2: Distribution of patients according to their age group

Age	Number	%
18-20	4	4.44
21-30	8	8.88
31-40	16	17.78
41-50	27	30.00
51-60	16	17.78
61-70	14	15.56
71-80	5	5.56
Total	90	100

Sex:

There were 54 females (60%) and 36 males (40%) in our study. Male tofemale ratio was 0.67: 1.

Table 3: Gender wise distribution of patients

Gender	Frequency	%
FEMALE	54	60
MALE	36	40

TOTAL	90	100

Symptoms:

Most common symptom was seizures seen in 44 patients (48.88%), followed by headaches in 32 patients (35.56%), motor neuro-deficit in 20 patients(22.22%), giddiness in 11 patients (12.22%), vomiting in 5 patients (5.56%), fever in 4 patients (4.44%) & h/o TB in one patient (1.11%).

Table 4: Distribution of patients according to their symptoms

	NUMBER	**%**
SEIZURES	**44**	**48.88**
HEADACHE	**32**	**35.56**
MOTOR NEURODEFICIT	**20**	**22.22**
GIDDINESS	**11**	**12.22**
VOMITING	**5**	**5.56**
FEVER	**4**	**4.44**
TB	**1**	**1.11**
OTHERS	**11**	**12.22**

Lesions:

There were 62 patients with single lesions (68.89%) and other 28 patients hadmultiple lesions (31.11%).

Table 5: Distribution of patients according to the number of lesions

LESIONS	**FREQUENCY**	**%**
MULTIPLE	28	31.11
SINGLE	62	68.89
TOTAL	90	100

Side of lesion

Majority of the lesions were unilateral lesions, seen in 45 patients (50.00%) , bilateral in 35 out of 90 cases (38.89%) while midline lesions were seen in 10 cases(11.11%).

Table 6: Distribution of patients according to the side of lesions

SIDE OF LESIONS	**FREQUENCY**	**%**

UNILATERAL	45	50.00
MIDLINE	10	11.11
BILATERAL	35	38.89
TOTAL	90	100

Intra/extra axial:

Majority were intra axial lesions seen in 51 out of 90 patients (56.67%), rest39 patients (43.33%) had extra axial lesions.

Table 7: Distribution of patients according to the location (intra-axial/extra-axial) of lesions

INTRA/ EXTRA AXIAL	FREQUENCY	%
EXTRA AXIAL	39	43.33
INTRA AXIAL	51	56.67
TOTAL	90	100

Solid / cystic lesions:

Majority of the lesions were solid seen in 64 patients (71.11%), some were solid- cystic in 14 patients (15.56%) and few were cystic in 12 patients (13.33%).

Table 8: Distribution of patients according to the component of lesions (solid/cystic/solid-cystic)

SOLID/CYSTIC	FREQUENCY	%
SOLID	64	71.1
CYSTIC	12	13.3
SOLID –CYSTIC	14	15.56
TOTAL	90	100

Calcification:

Calcification was seen in 18 patients (20%).

Table 9: Distribution of patients depending on the presence of calcification within the lesion

Calcification	FREQUENCY	%
PRESENT	18	20
ABSENT	72	80

TOTAL	90	100

Hemorrhage/necrosis:

Majority of the patients, 57 out of 90 (63.33%) were negative for hemorrhage / necrosis. 21 patients were positive for hemorrhage (23.33%), 7 patients were positive for hemorrhage /necrosis (7.78%) and 5 patients had necrosis only (5.56%).

Table 10: Distribution of patients depending on the presence ofhemorrhage /necrosis / both) within the lesion

HMG/NECROSIS-	FREQUENCY	%
HMG	21	3.33
HMG/NECROSIS	7	7.78
NECROSIS	5	5.56
ABSENT	57	63.33
TOTAL	90	100

Mass effect:

Out of 90 patients, mass effect was seen in 67.8% (61 cases) and was absentin 32.2% (29 cases).

Table 11: Distribution of patients depending on the presence of masseffect

	FREQUENCY	%
PRESENT	61	67.8
ABSENT	29	32.2
TOTAL	90	100

Edema:

Edema was present in 65 patients (72.22%) and absent in 25 patients(27.78%).

Table 12: Distribution of patients depending on the presence of edema

	FREQUENCY	%
PRESENT	65	72.2
ABSENT	25	27.8
TOTAL	90	100

Discussion

The mean age observed in our study was 48.37 ± 14.64 years. Most common age group decade was 41-50 years with 27 patients (30%), followed by 51 — 60 years with 16 patients (17.78%) and 41-50years with 16 patients (17.78%).

B Karpagam et al.[88]did a similar study in 50 cases of ICSOL in 2015, theyfound the highest prevalence in two decades, 21-30 years and 41 – 50 years(16% each), followed by 31 — 40 years and 61 -70 years age groups (14% each). 41- 50 years decade was also seen most common in our study.

Kaki RR et al. [89] in their prospective cohort study on 50 patients**,** found that the most common decade was 6th that is 50-60 years (28%), which was the second most common decade in our study.

Kaki RR et al. [89] found that out of 50 patients under their study, the main presenting symptoms was headache and the most common clinical signswere altered sensorium.

There were 62 patients with single lesions (68.89%) and other 28 patients hadmultiple lesions (31.11%).

B Karpagam et al. found that amongst 50 patients of ICSOL they studied, majority were low grade gliomas (24%) followed by high grade gliomas and meningiomas (16% each), other lesions were pituitary macroadenoma (12%), tuberculoma and metastasis (10% each), Medulloblastoma (4%) etc.

GB Mahal et al[90] studied various ICSOL in 50 patients, they found that congenital SOLs were 8%, infective lesions were 36%, tumors and tumor like lesions were 42%, mets 8%, vascular 14%.

RN Al Okailiet al[79] in their study of use of MRI in intraaxial brain tumorsfound that the lesions they diagnosed included primary neoplasms (high grade and low grade), secondary (metastatic) neoplasms, various abscesses, lymphoma, tumefactive demyelinating lesions, and encephalitis. Application ofa diagnostic algorithm that integrates advanced MR imaging features with conventional MR imaging findings may help the practicing radiologist make a more specific diagnosis for an intraaxial tumor.

Associations

There was no any significant association between the different categories of lesions and sex, age, presence of symptoms like fever, vomiting and neurodefecit (all $p > 0.05$).

Significant association is seen between the lesions being single or multiple & type of lesion. Primary neoplasms are found more to be single (44 of 45 — 97.78%) as compared to secondary neoplasms (5 of 22 – 22.73%) and other lesions. (13 of 23 – 56.52%).

Side of lesion and type of lesion showed significant association, where secondary neoplasms (17 out of 22 — 77.27%) and other lesions (14 out of 23-60.87%) are seen more on the midline or Bilaterally as compared to primary lesions which were more on the right (44.44%) and left side (24.44%)of the brain than midline (31.11%). There was significant association seen between the side of the lesions & type of lesion ($p < 0.0001$).

All the lesions were more solid in nature, but primary neoplastic lesions were also showing some lesions of solid- cystic lesions (10 out of 45 — 22.225) which were more compared to seen in secondary neoplasms (2 of 22 — 9.09%) and others (1 of 23 — 4.35%). This difference in the solid /cystic characteristic of lesions was significant ($p = 0.021$).

Calcification was seen in only primary neoplasms and other lesions, it wasabsent in secondary neoplasms. Primary neoplasms showed more calcification (34 out of 45 – 75.56%) as compared to other lesions (16 out of23 – 69.57%). There was significant difference between the different type oflesions and calcification ($p = 0.022$).

No significant difference was seen between the lesion types and HMG /Necrosis. ($p = 0.084$)

Mass effect was seen more in primary neoplasms (38 out of 45 – 84.44%) as compared to secondary neoplasms (13 out of 22 – 59.09%) or others (10 outof 23 – 43.48%). There was significant difference seen between the presence or absence of mass effect and the type of lesion (p = 0.002).

There was significant difference between the T1W appearance of the images seen on MRI of different lesions, all type of lesions were seen more Hypowhile primary neoplasms were also having to be seen as iso images (20 outof 45 — 44.44%) as compare to other types of lesions. (p = 0.002)

Summary

- We categorised patients into three parts, those who are having primary neoplasms seen in 45 patients (50.00%), those having secondary neoplasms in 22 patients (24.44%). Rest 23 patients had other diagnosis (25.56%), for analysis purpose.

- There was no any significant association between the different categories of lesions and sex, age, presence of symptoms like fever, vomiting and neurodefecit (all p > 0.05).

- Significant association is seen between the lesions being single or multiple & type of lesion. Primary neoplasms are found more to be single (44 of 45 – 97.78%) as compared to secondary neoplasms (5 of 22 – 22.73%) and other lesions. (13 of 23 – 56.52%).

- Side of lesion and type of lesion showed significant association, where secondary neoplasms (17 out of 22 — 77.27%) and other lesions (14 out of 23- 60.87%) are seen more bilaterally as compared to primary lesions which were more on the right (44.44%) and left side (24.44%)of the brain(i.e., unilateral) . There was significant association seen between the side of the lesions & type of lesion (p < 0.0001).

- All the lesions were more solid in nature, but primary neoplastic lesions were also showing some lesions of solid- cystic lesions (10 out of 45 —22.225) which were more compared to seen in secondary neoplasms (2 of 22 — 9.09%) and others (1 of 23 — 4.35%). This difference in thesolid /cystic characteristic of lesions was significant (p = 0.021).

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- No significant difference was seen between the lesion types and HMG /Necrosis. (p = 0.084)

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Conclusion

MRI has helped in the early and quick diagnosis and localisation of the ICSOL and in complement with advanced neurosurgical techniques have brightened the prognosis of mass lesions and their treatment.

For diagnosing and evaluation of intracranial space occupying lesion with a reasonable degree of the diagnostic accuracy, magnetic resonance imaging still remains the first line investigation along with the advancement of

newer modifications of MRI such as MR spectroscopy and the newer techniques like MR perfusion.

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