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**Dr. Naveen S Maralihalli**  
Professor and Head,  
Department of Radiodiagnosis,  
Basaveshwara Medical College,  
Chitradurga, Karnataka, India

**Dr. Siddaroodha Sajjan**  
Assistant Professor,  
Department of Radiodiagnosis,  
Basaveshwara Medical College,  
Chitradurga, Karnataka, India

## A study on various patterns of cranial metastases on MRI

**Dr. Naveen S Maralihalli and Dr. Siddaroodha Sajjan**

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### Abstract

**Introduction:** The radiological imaging plays a primary role to detect, localize, and diagnose the lesion. Various modalities which can be used are radiography, Computed imaging, Magnetic resonance imaging, Nuclear medicine and angiography. Except MRI, all other modalities involve exposure to radiation.

**Methodology:** Fifty (n = 50) patients, who underwent surgery with histopathological diagnosis were included in the study. Written informed consent was obtained from all the patients for the study. Detailed clinical history was taken in all the patients.

**Results:** Intraaxial was the most common compared to the extra axial location. Supra tentorial was most common than infra tentorial. Skull vault involvement was seen in 10% cases and dural metastases were seen in 18% cases.

**Conclusion:** Brain metastasis is common among patients with systemic cancer. Brain metastasis (MET) is thought to occur when the primary tumor acquires the ability to migrate away from the primary site and travels to the brain.

**Keywords:** Cranial Metastases, MRI, Histopathological diagnosis

### Introduction

Patients with cranial metastases may present with Headaches, Confusion or behavioural changes, Motor deficits, Seizures occur commonly in patients with intra cerebral or leptomeningeal metastasis and may be the initial clinical presentation.

Most of the remaining symptoms are specific to the location of the metastatic lesion. Thus, metastatic tumors can produce visual disturbances, vertigo, aphasia, and imbalance. Endocrine disorders develop if the tumor involves the hypothalamus, the pituitary gland or its stalk. Meningeal carcinomatosis is often manifested by cranial neuropathies <sup>[1]</sup>.

Brain metastases are one of the most feared complications of cancer, because even small tumors may cause incapacitating neurologic symptoms. Slight growth of a brain metastasis can kill patients by compressing normal brain against a nonexpansible skull, herniating the intracranial contents across compartmental precincts.

Lung cancer was universally the most common primary tumor, causing brain metastases in 18% to 64% of cases studied. The next most common cancers in descending order were breast (2%-21%), melanoma (4%–16%), and colorectal cancers (2%– 11%). When included, the hematologic malignancies caused approximately 10% of cerebral metastases, primarily to the leptomeninges <sup>[2]</sup>. The radiological imaging plays a primary role to detect, localize, and diagnose the lesion. Various modalities which can be used are radiography, Computed imaging, Magnetic resonance imaging, Nuclear medicine and angiography. Except MRI, all other modalities involve exposure to radiation.

Although contrast enhanced CT is faster than MRI, however Gadolinium-enhanced MRI is superior to contrast-enhanced CT in the diagnosis of brain metastases. Gadolinium-enhanced MRI has the following advantages <sup>[3, 4]</sup>.

- Provides better soft tissue contrast.
- Provides relatively stronger enhancement with paramagnetic contrast agents.
- No bone artifacts in the images.
- Provides less partial-volume effects, particularly for lesions adjacent to bones.
- Provides direct multiplanar imaging.
- Intracranial metastatic lesions arise from number of sites and through various routes so they can involve any part of the central nervous system and their imaging appearances vary.
- Magnetic resonance imaging (MRI) plays a key role in lesion detection, lesion delineation, and differentiation of metastases from other intracranial disease processes.

**Correspondence**  
**Dr. Siddaroodha Sajjan**  
Assistant Professor,  
Department of Radiodiagnosis,  
Basaveshwara Medical College,  
Chitradurga, Karnataka, India

## Methodology

**Type of study:** Prospective study

### Study population

The patients selected for the study were referred from Neurosurgery/Neurology OPD or Emergency department at our hospital, who were clinically suspected to have a space occupying lesion or having history suggestive of metastases. The patients presented with symptoms like headache, motor weakness, diminished vision, double vision, seizure. All patients were seen by appointment, except for the emergency cases. Relevant history of illness and significant clinical findings of all patients were recorded. Previous investigations were reviewed. Most of the patients were taken for examination without any pre-medication. In uncooperative patients MRI was performed under sedation with supervision of anaesthetist.

Fifty (n = 50) patients, who underwent surgery with histopathological diagnosis were included in the study. Written informed consent was obtained from all the patients for the study. Detailed clinical history was taken in all the patients.

1. All cases with clinical symptoms or suspected cases of cranial metastases who were referred to Radiodiagnosis department for Magnetic Resonance Imaging.
2. All age groups and both male and female patients
3. All patients who had positive histopathological diagnosis.

### Exclusion criteria

Patients contraindicated for MRI.

- Pregnant female
- Claustrophobia
- Patients with MR non-compatible devices like aneurysmal clips, cochlear implants, etc.

## Results

### Patient population

A total of 50 patients who met the inclusion criteria were enrolled in the study. The age of patients in the study ranged from 13 to 67 years with a mean age  $\pm$  SD:  $49.04 \pm 13.76$  years.

### Age wise distribution

Among the patients, youngest patients was 15 years old and oldest patients was 70 years, 51-60 years was the single largest group followed by 61-70, 41-50, 31-40, 21-30 and less than 60.

**Table 1:** Age wise distribution

Age in years	Gender		Total
	Female	Male	
<20	0(0%)	2(5.9%)	2(4%)
21-30	1(6.3%)	3(8.8%)	4(8%)
31-40	5(31.3%)	2(5.9%)	7(14%)
41-50	5(31.3%)	5(14.7%)	10(20%)
51-60	3(18.8%)	14(41.2%)	17(34%)
61-70	2(12.5%)	8(23.5%)	10(20%)
Total	16(100%)	34(100%)	50(100%)

**Table 2:** Gender distribution

Gender	No. of patients	%
Female	16	32.0
Male	34	68.0
Total	50	100.0

Based on duration of symptoms, the onset of symptoms was classified as <1 Month, 1-3 month, 3-6 month, 6-12 month and more than 12 months. 62% of patients presented with symptoms duration 1-3 months, 14% with < 1 month, 12% with 3-6 months, 4% with 6-12 months and 8% of patients had symptoms with duration of more than 12 months.

**Table 3:** Duration of symptoms

Duration	No. of patients	%
<1 month	7	14.0
1-3 months	31	62.0
3-6 months	6	12.0
6-12 months	2	4.0
>12 months	4	8.0
Total	50	100.0

The various symptoms with which these patients presented were headache (68%), motor weakness (66%) followed by visual disturbance (38%), vomiting (36%), speech disturbance and seizure (28%).

**Table 4:** Clinical features

Clinical History	No. of patients (n=50)	%
Headache	34	68.0
Seizures	14	28.0
Loss of consciousness	2	4.0
Vomiting	18	36.0
Motor weakness	33	66.0
Speech disturbance	16	32.0
Visual disturbance	19	38.0

Intraaxial was the most common compared to the extra axial location. Supra tentorial was most common than infra tentorial. Skull vault involvement was seen in 10% cases and dural metastases were seen in 18% cases.

**Table 5:** Location of metastases

Location	No. of patients (n=50)	%
Intra/Extra axial		
Intraaxial	39	78.0
Extraaxial	10	20.0
Both	1	2.0
Supra/infratentorial		
Supratentorial	36	72.0
Both	7	14.0
Infratentorial	7	14.0
Skull vault		
Negative	45	90.0
Positive	5	10.0
Dural/Meningial based lesion		
Negative	41	82.0
Positive	9	18.0

**Table 6:** Pattern of appearances of metastatic lesions from different site.

Type of pattern n=50	Lung(n=30)	Unknown primary(n=5)	Breast (n=3)	Kidney (n=3)	Melanoma(n=3)	Thyroid (n=2)	Brain (n=2)	Uterus (n=1)	Cervix (n=1)
Solitary	17	5	3	3	2	2	0(0%)	0(0%)	1
Multiple	13	0	0	0	1	0	2	1	0
Mixed (Cystic and solid)	11	2	1	3	2	1	1	0	0
Cystic	13	0	2	0	0	0	0	1	1
Solid	6	3	0	0	1	1	1	0	0
Necrosis	22	3	3	1	1	0	0	0	1
Bleed	13	3	0	0	0	0	0	0	1
Calcifications	2	1	0	1	0	0	0	0	0
Pattern of contrast enhancement									
Heterogeneous	11	2	1	3	3	1	2	0	1
Ring	18	2	2	0	0	0	0	1	0
Homogeneous	1	1	0	0	0	1	0	0	0
Restriction diffusion on DWI	10	1	0	1	0	0	1	0	0

In 30 Cases of primary being in the lung, 17 cases were solitary and 13 were multiple. Among 30 cases 13 cases were cystic, 11 were mixed solid cystic and 6 were solid lesions.

In 30 cases from the lung 22 showed necrosis, 13 showed bleed and two cases were having calcifications.

18 cases showed ring enhancement, 11 cases showed heterogeneous enhancement and 1 case was showing homogeneous enhancement and restriction diffusion was seen in 10 out of 30 cases.

In 5 cases of unknown primary 3 were solid and 2 were mixed lesions, necrosis was seen in 3 cases, bleed was seen in 3 cases and calcification in one case.

2 were showing heterogeneous enhancement, 2 cases showed ring enhancing lesions and 1 case was showing solid enhancement pattern on post contrast images. Restriction diffusion was seen in 1 case among 5 cases.

In 3 cases metastases to the brain were from the breast, 2 cases were cystic, 1 was mixed. All 3 cases showed necrosis. 2 cases were ring enhancing and 1 case was showing heterogeneous enhancement.

3 cases were in renal origin, all were solitary lesions, all were mixed lesions, 1 case showed necrosis, 1 case was having bleed within, 1 case showed calcifications within and 1 case showed restriction diffusion on DWI images.

3 cases were melanoma metastases, 2 were solitary, and 1 case was with multiple lesions. Among 3 cases 2 were mixed lesions and 1 was solid lesion. 1 case showed necrosis and all case presented with bleed and showed heterogeneous enhancement.

2 cases from thyroid, both were solitary, 1 case was solid, and 1 case was mixed. 1 case showed heterogeneous enhancement and other showed homogeneous enhancement on post contrast images.

2 Cases were brain metastatic lesion, both were having multiple lesions, 1 was mixed and other was with solid lesions. Both were showing heterogeneous enhancement and 1 was showing restriction diffusion on DWI images.

## Discussion

Brain metastasis is common among patients with systemic cancer. Brain metastasis (MET) is thought to occur when the primary tumor acquires the ability to migrate away from the primary site and travels to the brain. Metastasis often causes severe neurological symptoms that significantly impair quality of life. Improvements in diagnostic imaging and improved systemic cancer control there is increase

patient survival rate. The clinical symptoms are often nonspecific such as headache, vomiting, seizures, blurring of vision, diplopia etc. So for arriving at correct diagnosis Imaging is the most important diagnostic modality for brain metastasis.

Our study includes a group of 50 patients presented with above mentioned symptoms which are evaluated with MRI. The lesions characterized by MRI as metastases are correlated with histopathological study.

In our study group of 50 patients, 34 were males (78%) and 16 were females (32%) with mean age of presentation was 49 years. (Mean  $\pm$ SD 13.7) commonly presented in the age group of 51-60 years (17%). In a study done by Koul R *et al*<sup>5</sup> at Cancer Care Manitoba between 2004 and 2007 of 51 patients radiologically diagnosed as brain metastasis, 30 were male, 21 were female with median age 60 years. In our study most common presenting symptom was headache (68%) followed by motor weakness and visual disturbance (38%).

In a study done by Andrew B. Lassman *et al.*<sup>[6]</sup> most common presenting symptoms were Cognitive or mental status change, headache.

In a study done by Teri Nguyen *et al.*<sup>[7]</sup> most common presenting symptoms were Cognitive or mental status change, Headache, Weakness.

In a study done by Fink KR *et al.*<sup>[8]</sup> Metastatic symptoms may include headache, seizure, syncope, focal neurological deficit, or papilledema.

In a study done by Chi A, Komaki R *et al.*<sup>[9]</sup> most common presenting symptoms in cases of metastases were Headache (49%) Mental problems (32%) Focal weakness (30%).

In a study done by Prabhash K *et al.*<sup>[10]</sup> symptoms of metastases include headache (49%), focal weakness (30%), mental disturbances (32%), gait ataxia (21%), seizures (18%), speech difficulty (12%), visual disturbance (6%), sensory disturbance (6%), and limb ataxia (6%).

In our study intra axial (80%) metastatic lesions were common than extra axial (18%) metastatic lesions and supratentorial (36%) lesions were common than infratentorial (7%).

In a study done by Koul R *et al.*<sup>[5]</sup> metastases were located mainly in the cerebrum (76%).

In a study done by Teri Nguyen *et al.*<sup>[11]</sup> Intracranial metastasis includes brain, dural, and leptomeningeal lesions, with brain metastases accounting for 75% of these lesions.

In a study done by Norden AD *et al.*<sup>[12]</sup> about 80% of metastases are located in the cerebral hemispheres, 15% in

the cerebellum, and 5% in the brainstem.

In our study dural metastases were seen in 18% cases. In a study done by Nayak L *et al.* [13] intracranial dural metastases (IDM) occur in up to 9% to 10% of all patients with systemic cancer. In our study out of 50 cases 34 cases were single metastases and 16 were multiple metastatic lesions. In a study done by Gerrard GE *et al.* [14] although multiplicity is the hallmark of metastatic disease, almost half of patients have a solitary metastases at the time of diagnosis in some series. In a study done by Fink KR *et al.* [8] Brain metastases are solitary approximately 50% of the time; 20% of the time there are two lesions, and 30% of the time, three or more lesions are identified. In our study out of 50 cases 10 cases were iso intense and 20 were hypo intense on T1W images. 24 cases were hyper intense on T2W images. In a study done by Fink KR *et al.* [8] Metastases are usually iso- or hypointense on T1W, hyperintense on T2W images. In a study done by Prabhaskar K *et al.* [10] Metastatic lesions are isointense to mildly hypointense on T1- weighted images, hyperintense on T2- weighted images or with FLAIR. Surrounding edema is relatively hypointense on FLAIR and T1- weighted images and hyperintense on T2- weighted images.

### Conclusion

- 50 patients were studied for cranial metastatic lesions using 1.5 Tesla MRI machine.
- Incidence of cranial metastatic lesions was higher in the 51-60 years age group followed by 61-70 years.
- Cranial metastatic lesions were more common in males.
- Most common complaint of patients of cranial metastatic lesions was headache followed by motor weakness.
- Most commonly patient's presented with symptoms of 1-3 months duration.
- Supra tentorial, Intra axial metastases is the most common site involved

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