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# Efficacy of computed tomography in diagnostic evaluation of supratentorial tumors

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## Abstract

**Background:** Computed tomography, with it's wider availability, lesser cost and higher efficacy in differentiating calcification/ hemorrhage can play a vital role in the diagnosis of supratentorial tumors mostly in resource poor settings.

**Objectives**

1. To study the distribution of various supratentorial neoplasms.
2. To study CT features of supratentorial neoplasms.
3. To localize and assess the extent of supratentorial neoplasms.

**Methods:** This was a prospective observational study of 80 patients with supratentorial brain tumors reporting to radiology department for CT brain, in a tertiary care teaching hospital in Bangalore.

**Inclusion Criteria**

- All age groups with supratentorial tumors were included.

**Exclusion Criteria**

- All cases with supratentorial pathology and Symptomatology due to infections, congenital malformations, trauma or cerebrovascular accidents etiology were excluded.

**Results:** Glioma (42.5%) were the most common tumors followed by extra-axial tumors (40%). High grade gliomas were more common in females above 50 years of age (26.9%) in the study, Low grade gliomas were common in males above 50 years of age (33%). Among extra axial tumors, meningiomas were most common (56.3%) which were common in females above 50 years of age (34%). Low grade gliomas, high grade gliomas and oligodendrogliomas were commonly found in frontal lobe (55%) while frequent sites of origin of meningiomas included the frontal and parietal convexities (50%). Our study showed 31.25% hypodense, 32.5% isodense and 33.75% hyperdense lesions. About 62.4% of the gliomas showed marked amount of enhancement while only 15% showed slight

enhancement. Other features observed were calcifications, necrosis, edema and Extension.

**Conclusion:** In this study most of the cases presented with non-specific symptoms like headache, seizures and were reported across all the age groups. Gliomas were the most common followed by meningiomas. CT imaging played a significant role in determining the characteristic features of different supratentorial tumors in the study which helped in arriving to a diagnosis.

**Keywords:** CNS neopalsms, Computed tomography, Glioma, Menigioma, Supratentorial tumor, Calcification, Necrosis

## Introduction

Primary brain tumors are the sixth to eighth most frequent types of neoplasms in adults, while they are the second most prevalent kind of malignancy in children.[1,2] Primary intracranial neoplasms are estimated to affect 12.3 people out of every 100,000 people annually, and their frequency is rising.[3]

CNS neoplasms can be categorised in a number of ways. Depending on the location (such as supratentorial or infratentorial), or as extra or intra-axial. Location of the tumor as well as histology have significant roles in determining clinical presentation and prognosis.[4]

Since the majority of those with brain tumors present with vague symptoms such headaches, stroke-like syndromes, or seizures, a diagnosis is frequently made based on the results of imaging techniques.[3]

A wide range of imaging modalities, including MRI, CT perfusion, PET, and SPECT, are now possible because of the explosion in imaging technology. Due to its greater accessibility and cheaper cost, computed tomography is still the most often utilised type of neuroimaging for the diagnosis of brain tumors. Due to recent advancements in diagnostic methods and microsurgery, many individuals' prognoses have significantly improved.[5] Our study discussed role of Computed tomography imaging and its features in supratentorial brain tumors extensively.

## Objectives

1. To study the distribution of various supratentorial neoplasms.
2. To study CT features of supratentorial neoplasms.
3. To localize and assess the extent of supratentorial neoplasms.

## Materials and Methods

This study was conducted in Radiology Department of Rajarajeshwari Medical College and Hospital during the period July 2022 to July 2023.

### Study design and study subjects

A prospective observational study was conducted among 80 patients with supratentorial tumors reporting to Radiology department of Rajarajeshwari Medical College and Hospital, Bangalore, Karnataka for Computed tomography scan. These patients were referred to department of Radio-diagnosis after suspected to have brain tumors by clinicians and were subjected to radiological evaluation by CT scan. Ethical committee approval was obtained. Informed consent, thorough clinical history and clinical examination was done on patients before CT examination.

### Inclusion Criteria

- All age groups with supratentorial tumours were included.

### Exclusion Criteria

- All cases with supratentorial pathology and Symptomatology due to infections, congenital malformations, trauma or cerebrovascular accidents etiology were excluded.

**The Computed Tomography (CT) Machine**

All the cases were studied on a Siemens Somatom AR. Computed tomography system which is a modified third generation machine. Factors of 130 KV and 70 MA were a constant feature for all cases.

**Technique**[6]

Routine axial scans were performed in all 80 cases, taking orbito-meatal line as the baseline.5mm slice thickness with 5mm table increment for the posterior fossa and 10 mm slice thickness with 10 mm table increment for the supratentorial region were employed routinely, with a scan time of 3 seconds per slice. Thin contiguous slices of 2 mm or 3 mm were done where ever necessary.

Multiple coronal and sagittal reformatted images were frequently used to further analyse the lesions detected on axial scans.

Direct prone coronal sections at $90^0$ to orbito-meatal line were obtained in cases where axial and reformatted images could not be conclusive in localization and extent of the tumor. For contrast enhancement bolus injection of Diatrizoate meglumine and Diatrizoate sodium (Trazograf 76% or Urograffin 76%) in a dose of 300 mg of iodine / kg body weight was used and given just before the contrast enhanced CT was to be performed.

The magnification mode was commonly employed, and the scans were reviewed on a direct display console at multiple window levels and width to examine the wide variation of tissue density in the fore brain and al so to look for osseous involvement.

The pre and post contrast attenuation values, the size, location of the lesions were reviewed by a panel of radiologists.

**Ethical statement**

Ethical approval for the study was sought and obtained from the health research and ethics committee of Rajarajeswari Medical College and Hospital. The data obtained was treated with utmost confidentiality.

**Statistical Analysis**

Data collected was entered into Microsoft excel sheet and was analysed using SPSS software version 26. Descriptive data was expressed in frequency and percentages.

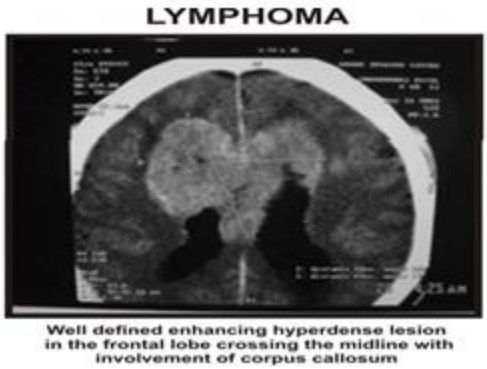


Figure 1: Lymphoma

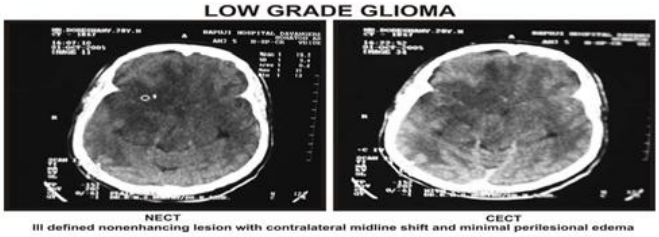


Figure 2: Low grade glioma

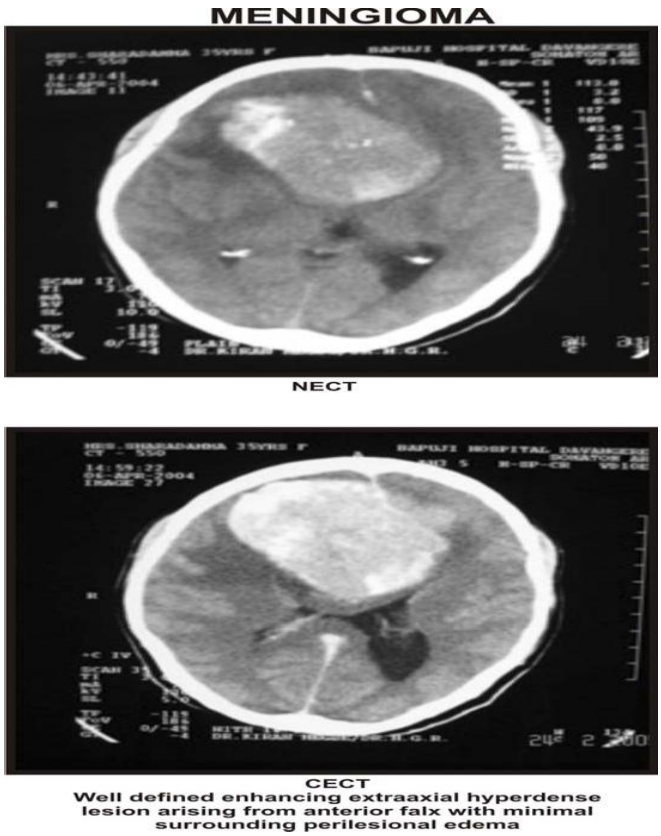


Figure 3: Meningioma

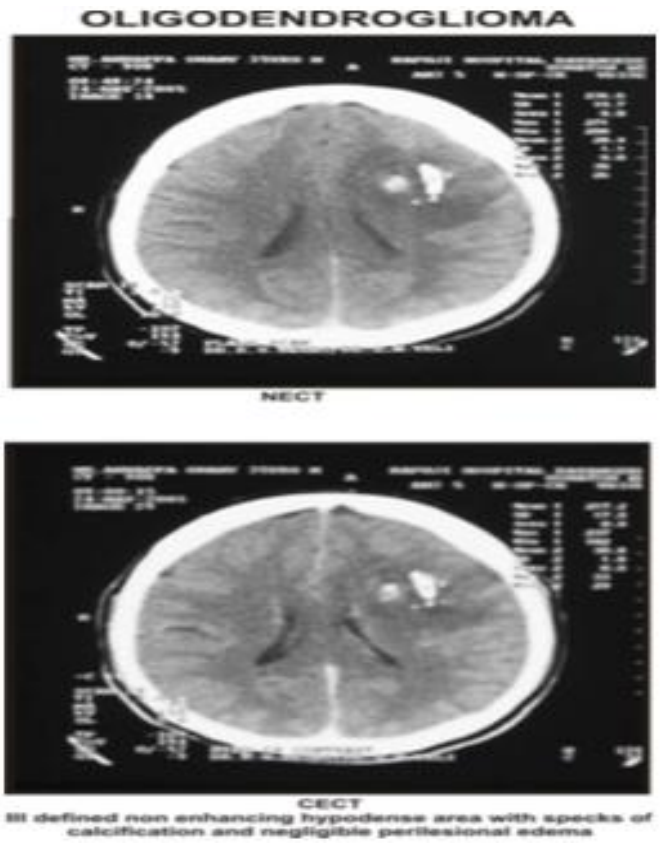


Figure 4: Oligodendroma

**Results**

Among total 80 cases included in the study, majority of the cases i.e., 48 (60%) presented with intra-axial tumors and the remaining 32 (40%) presented with extra axial tumors. (Graph 1)Primary cerebral gliomas are the largest group of all intracranial tumors. In this study34 (42.5%) cases of gliomas were encompassed which included majority of high-grade gliomas i.e., 19 (55.8%) of all the gliomas. High grade gliomas were more common in females above 50 years of age (26.9%) in the study. Low grade gliomas constituted 26.4% of all the gliomas which were common in males above 50 years of age (33%). [Table 1] Among other intra-axial tumors (17.5% of all the gliomas), lymphoma was the commonest which was diagnosed in 6 cases and all were males above 50 years age. This was followed by 3 cases of metastasis and 2 cases of PNET which were seen in males below 25 years of age. [Table 1]

Among extra-axial tumors, meningiomas were most common in the study which constituted 56.3% of extra axial tumors. These were common in females above 50 years of age (34%). Pituitary adenomas constituted of 28% all the extra-axial tumors and were common in males between 25-50 years age group and Craniopharyngiomas accounted to 15.6% of all the extra-axial tumors and were common among males above 50 years of age. [Table 1] Majority of the subjects in the study presented with headache (34, 42.5%) and convulsions (27.5%). [Graph 2]Low grade gliomas, high grade gliomas and oligodendrogliomas were commonly found in frontal lobe (55%). Majority of the ependymomas were seen in per ventricular region and all sub ependymomas were seen in 3rd ventricular region. 50% of the lymphomas were seen in frontal and other 50% in parietal region. All the PNET cases, all

germinoma cases and all metastasis cases were seen in parietal, frontal and lateral ventricular region respectively. [Table 2] 50% of the meningiomas were seen in frontal and parietal convexities (Graph 3) Majority of the gliomas i.e., 59.5% presented as hypodense lesions, 28% as isodense lesions. 43% of the intra axial tumors presented as isodense lesions, 72% of the meningiomas presented as hyperdense lesions 44.4% of the pituitary adenomas presented as hyperdense lesions and other 44.4% as isodense lesions. 40% of the Craniopharyngiomas presented as hyperdense and other 40% as isodense lesions. Majority i.e., 62.4% of the gliomas, 61.4% of the meningiomas, 89% if the pituitary adenomas and 60% of the Craniopharyngiomas showed marked enhancement on CT scan. Other features observed were calcifications in 50% of the meningiomas, 44.4% of the pituitary adenomas; necrosis in 43.8% of gliomas, 55.6% of pituitary adenomas, edema in 53% of the gliomas and in 50% of the other intra axial tumors. Extension was observed in 15.6% of the gliomas and 21% of other intra-axial tumors.[table 3]

Graph 1: Distribution of supratentorial tumors

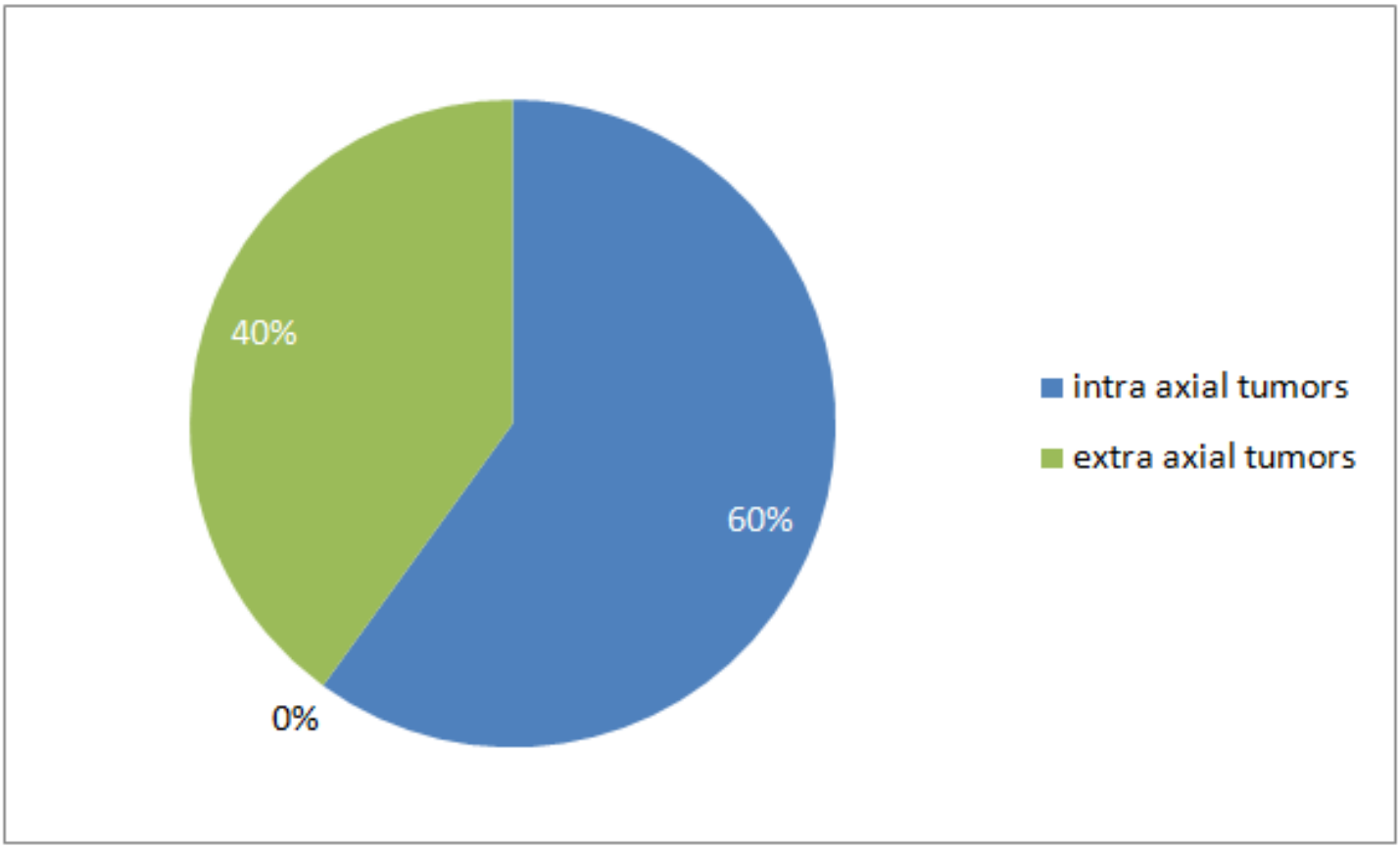


Table 1: Age and gender wise distribution of Supratentorial tumors on CT

| Type of tumor | | <25 years | | 25-50 years | | >50 years | | Total |
|---|---|---|---|---|---|---|---|---|
| | | M | F | M | F | M | F | |
| | Low grade glioma | 1(11) | 0 | 2(22.5) | 1(11) | 3(33) | 2(22.5) | 9 |
| | High grade glioma | 3(15.7) | 1(5) | 4(21) | 3(15.7) | 3(15.7) | 5(26.9) | 19 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Gliomas (intra axial) | Oligodendrogliomas | 0(0) | 0(0) | 0(0) | 0(0) | 1(100) | 0(0) | 1 |
| | Ependymoma | 0(0) | 0(0) | 1(25) | 0(0) | 2(50) | 1(25) | 4 |
| | Subependymoma | 0(0) | 0(0) | 0(0) | 0(0) | 1(100) | 0(0) | 1 |
| Others (intra axial) | Lymphoma | 0(0) | 0(0) | 0(0) | 0(0) | 6(100) | 0(0) | 6 |
| | PNET | 3(100) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 3 |
| | Germinoma | 2(100) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 2 |
| | Metastasis | 0(0) | 0(0) | 0(0) | 0(0) | 3(100) | 0(0) | 3 |
| Extra axial | Meningioma | 2(11) | 3(17) | 1(5) | 4(22) | 2(11) | 6(34) | 18 |
| | Pituitary adenoma | 1(11) | 1(11) | 3(33) | 1(11) | 2(22) | 1(12) | 9 |
| | Craniopharyngiomas | 1(20) | 1(20) | 0(0) | 1(20) | 2(40) | 0(0) | 5 |

M-male F-female

Graph 2: Presenting symptoms among study subjects

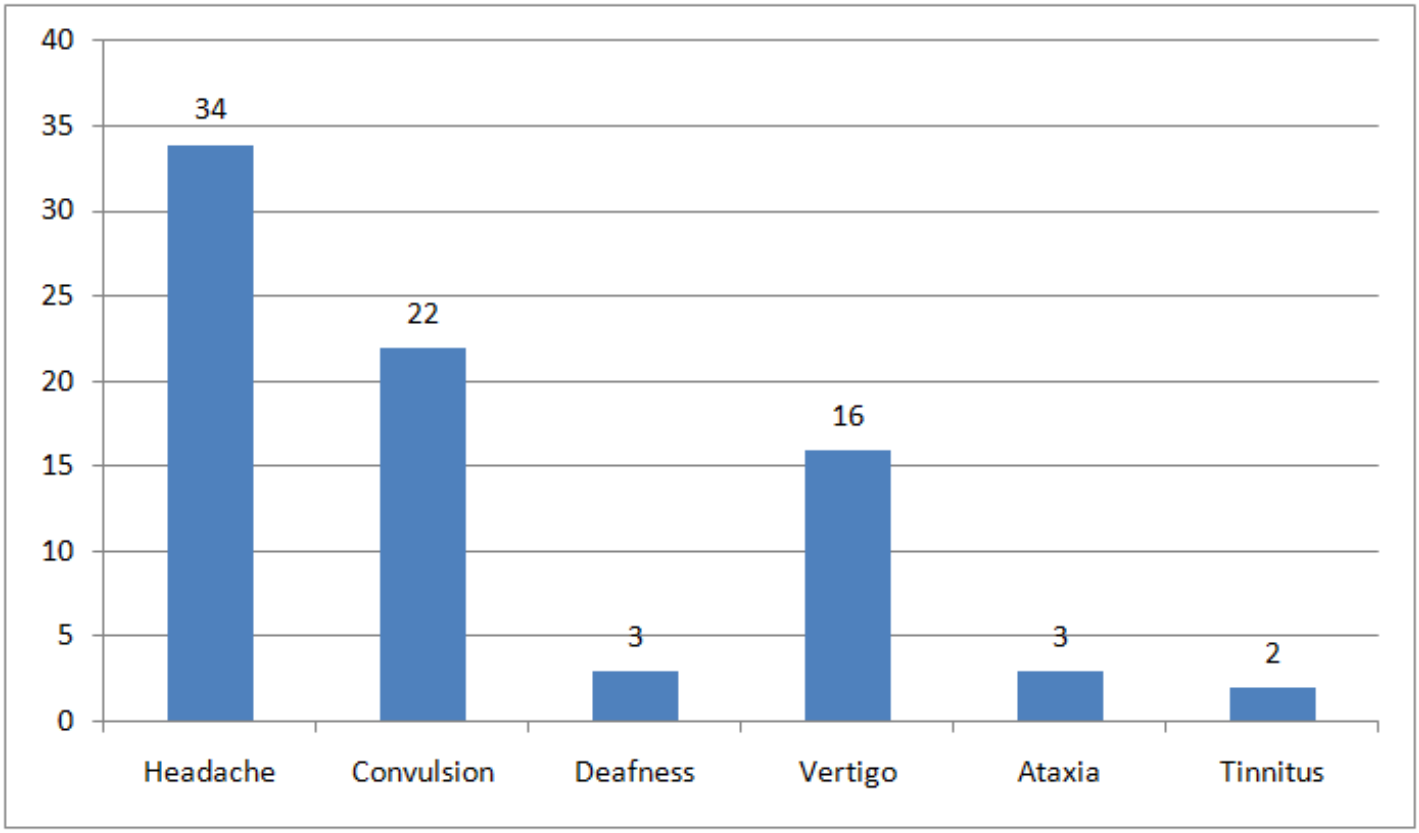


Table 2: Location of Supra tentorial tumors

| Type of tumor | | F | p | T | O | LV | 3rd V | PV | Total |
|---|---|---|---|---|---|---|---|---|---|
| Gliomas (intra | Low grade glioma | 5(55) | 0(0) | 3(33) | 1(12) | 0(0) | 0(0) | 0(0) | 9 |
| | High grade glioma | 9(47) | 4(21) | 3(16) | 3(16) | 0(0) | 0(0) | 0(0) | 19 |
| | Oligodendrogliomas | 1(100) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 1 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| axial) | Ependymoma | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 1(25) | 3(75) | 4 |
| | Subependymoma | 0(0) | 0(0) | 0(0) | 0(0) | 1(100) | 0(0) | 0(0) | 1 |
| Others (intra axial) | Lymphoma | 3(50) | 3(50) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 6 |
| | PNET | 0(0) | 3(100 | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 3 |
| | Germinoma | 2(100) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 2 |
| | Metastasis | 0(0) | 0(0) | 0(0) | 0(0) | 3(100) | 0(0) | 0(0) | 3 |

F-frontal, P-parietal, T-temporal, O-occipital, LV-lateral ventricle, 3rd V-3rd Ventricle, PV-peri ventricle

Table 3: Location of Meningiomas

| Site | No. of cases | Percentage |
|---|---|---|
| Convexity | 9 | 50.0 |
| Parasagittal | 6 | 33.3 |
| Sphenoid ridge | 3 | 16.7 |

Table 4: CT features among study subjects

| CT feature | Type of tumor | | | | |
|---|---|---|---|---|---|
| | Gliomas | Other intra axial tumors | Meningioma | Pituitary adenoma | Craniopharyngiomas |
| Density | | | | | |
| Hyperdense | 4(12.5) | 4(28.5) | 13(72) | 4(44.4) | 2(40) |
| Isodense | 9(28) | 6(43) | 5(28) | 4(44.4) | 2(40) |
| Hypodense | 19(59.5) | 4(28.5) | 0(0) | 1(11.2) | 1(20) |
| Enhancement | | | | | |
| Slight | 5(15.6) | 4(28.6) | 3(16.6) | 0(0) | 0(0) |
| Moderate | 7(22) | 5(35.7) | 4(22) | 1(11) | 2(40) |
| Marked | 20(62.4) | 5(35.7) | 11(61.4) | 8(89) | 3(60) |
| Other features | | | | | |
| Calcifications | 6(18.8)) | 3(21) | 9(50) | 4(44.4) | 5(100) |
| Multiplications | 0(0) | 1(7) | 0(0) | 0(0) | 0(0) |
| Necrosis | 14(43.8) | 2(14) | 4(22) | 5(55.6) | 0(0) |
| Edema | 17(53) | 7(50) | 5(28) | 0(0) | 0(0) |
| Extension | 5(15.6) | 3(21) | 0(0) | 0(0) | 0(0) |

**Discussion**

The differential diagnosis of intracranial lesions begins with an accurate assessment of the lesion location. Intracranial masses are commonly divided into intra-axial and extra-axial locations.[7] Primary cerebral gliomas are the largest single group of all intracranial tumours.[8] In this study gliomas represented 42.5% of all intra-axial tumours in the supratentorial region which constituted the majority. This was in accordance to a study by Baker et al (1974-1977) which reported an incidence of 34%

for gliomas.[5]This study included majority of high-grade gliomas i.e., 19 (55.8%) of all the gliomas. According to Butler AR et al. [9] majority i.e., 76% were high grade gliomas which was similar to this study. High grade gliomas were more common in females above 50 years of age (26.9%) in the study.

According to Butler AR et al.[9] The mean age was 58 years with a male predominance which correlated well with our study, mean age being between [51-60] years with a male predominance. Low grade gliomas constituted 26.4% of all the gliomas which were common in males above 50 years of age (33%) suggesting male preponderance which was similar to a study done by Butler AR et al.[9] in which 64% of the males presented with low grade gliomas. This was also in concordance to a study by Leeds NE et al.[10] in which out of 100 cases of supratentorial gliomas, 29% were low grade gliomas. According to a study by Butler AR et al.[9] median age of patients with low gradeglioma was 38 years correlating with our study with age range lying between 21-40 years.

In this study, Oligodendroma accounted to 3% of all the gliomas. In a study done by Birjandi A et al.[11]oligodendrogliomaaccounted to 7% of total gliomas which was more compared to this study. According to Birjandi A et al.[11]oligodendrogliomas were common in males (77.1%) compared to females (22.9%) which was consistent with this study.

In this study Ependymoma constituted to 5% of all the tumors which was more compared to a study done by [45]in which it was 0.9%. According to Osborne AG et al.[12] ependymomas were found in 63% males and 37% females which was similar to this study (75% males and 25% females). In this study, meningiomas were the most common extra-axial tumors representing 22% of all primary brain tumors which was consistent with a study by Curnes JT et al.[13] in which they accounted for 15% of all the brain tumors. Zimmerman et al.[14] in a study of 2262 intracranial neoplasms reported an incidence of 27.3% for meningiomas which was similar to this study.[56] In this study, meningiomas were common in females and in >50 years age group which was similar to a study by Paul FJ et al which showed maximum incidence in the 6$^{th}$ and 7$^{th}$ decade.[15]

In this study, Craniopharyngiomas accounted for 6% of all the tumors which was more compared to Fitz RC et al.[16] in which it accounted for 3% of all tumours in all age groups. In this study, 40% of the occurred in <25 years of age similar to Osborne AG et al.[12] in which 40% of Craniopharyngiomas occurred n children between 8 and 12 years of age.

Majority of the subjects in the study presented with headache (34, 42.5%) and convulsions (27.5%) similar to a study by Birjandi A et al.[11]

Seizures and headache were the most common presenting symptoms which were foundin57% cases Low grade gliomas, high grade gliomas and oligodendrogliomas were commonly found in frontal lobe (55%) which was similar to a study by Butler AR et al.[9] in which 71% of the tumors were located in frontal lobe. According to Birjandi A et al.[11] lesions involved frontal lobe in 57.12% patients which was similar to this study. In this study common site for ependymomas was per ventricular region which was similar to Osborn A Getal.[12] According to Jones RV et al.[17] most of the Subependymoma i.e., 60% occurred in the lateral ventricle which was similar to this study. In this study frequent sites of origin of meningiomas included the frontal and parietal convexities (50%), Parasagittal regions (33.3%) as well as the sphenoid wing (13.3%).

This was similar to a study by Nadich TP et al.[18] in which frequent sites of origin included the frontal and parietal convexities and Parasagittal regions (about 45%) as well as the sphenoid wing (15.20%).

Our study showed 31.25% hypodense, 32.5% isodense and 33.75% hyperdense lesions. Our study correlated well with the study done by Leeds NE et al.[10]In this study, about 62.4% of the gliomas showed marked amount of enhancement while only 15% showed slight enhancement which was contrary to a study done by Butler AR et al.[9] in which 37% of the gliomas showed slight enhancement but was similar to a study done by Leeds NE et al.[10]in which majority of the gliomas showed contrast enhancement.[42] In study done by Birjandi A. et al.[11]most of the tumors were isodense to hypodense and most did not show contrast enhancement which was contrary to this study.[44]

Leeds NE et al.[10] reported that important feature of grade I and II gliomas on NECT is the presence of well-demarcated lesions with moderately sharp borders and little/no edema and according to his study I.V. contrast enhancement occurred less frequently in gliomas (48%).The result found in this study was little different compared to present study. Most of the cases in this study had irregular borders with minimal edema.

According to Osborn AG et al.[12] 38% cases showed calcification and 56% showed edema similar to this study. In a study done by Leeds NE et al.[10] other features noted on NECT were calcification in 5.6% which was very less compared to this study (33.75%). In a study by Birjandi A et al.[11] calcifications were present in 71.4% which was more compared to this study. According to FitzRCetal.[16] nodular calcification was present in nearly all paediatric craniopharyngiomas and in 50% of adult cases which was similar to this study where all the cases showed calcification.

According to Sutton et al.[19] on NECT about 60% of meningiomas were hyperdense solid masses and calcification was seen in Upto 20% of the cases. In this study, 72% were hyperdense, 28% were isodense on pre-contrast scan and calcifications were seen in 50% of the cases. Our study correlated well with that of Suttonet al. According to Buetow MP et al.[20] calcification was seen in about 20-25% of meningiomas similar to this study. According to Kovac SK et al. pituitary adenomas are common lesions accounting for approximately 10-15% of all primary intracranial [21]In this study they constituted about 11.25% of all intracranial neoplasms and 28% of all extra-axial tumours which was consistent with Lovac SK et al. In this study, 89% cases showed marked enhancement and 44.4% cases showed calcification which correlated well with Rao Krishna VG et al.[22] in which calcification was noted in 20% of pituitary adenomas and almost all cases showed calcifications.

**Conclusion**

In this study most of the cases presented with non-specific symptoms like headache, seizures and were reported across all the age groups. Gliomas were the most common followed by meningiomas. Most common presenting site was frontal parietal lobes for most of the tumors. Most of the tumors in this study showed hyper density and marked enhancement on CT imaging. CT imaging played a significant role in determining the characteristic features like the site of tumor, pre contrast features like density of the lesion and post contrast features like enhancement of the lesion and other features like calcifications/haemorrhages/necrosis/edema which are specific to different supratentorial tumors in the study which helped in arriving to a diagnosis.

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