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Prevalence Of Electroencephalogram Changes In Brain Tumor Patients

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Abstract:
Background: *Brain tumor is inherently serious and life threatening disease. It builds the intracranial pressure in the brain, by shifting the brain or pushing against the skull and also damaging nerves and healthy brain tissues. The intracranial pressure affects and interferes with normal brain functionally which results in generation of abnormal electrical activities from brain. With recent development in the medical engineering and instruments, EEG instrument are able to record the brain electric activities with high accuracy.EEG is reliable in localizing lesions involving superficial portions of the cerebral hemisphere.The present study is therefore planned to access the prevalence of EEG changes in brain tumor patients attending at neurosurgery OPD of Agartala Govornment Medical College and Hospital.*
Objectives: *To estimate the proportion of EEG changes in patients of brain tumor attending OPD of a tertiary care hospital & to find out EEG changes in different types of brain tumor.*
Materials and Methods*: A hospital based cross sectional study was conducted among 46 brain tumor patients of all age group attending neurosurgery OPD of AGMC and GBPH.EEG was done in the Department of Physiology of AGMC and GBPH. Sensors called electrodes are attached to the head (usually with glue or paste) and connect to an EEG recording machine after obtaining informed consent. EEG was reviewed for any abnormal background or interictal epileptiform discharges.*
Results*: Among 46 diagnosed brain tumor patients participating in the study, 9 of them are having slow wave discharges in the EEG tracing.*
Conclusion*:In the present study it is definite that presence of slow wave discharges in EEG can be a sign of brain tumor but not always.The degree of change on an EEG depends on the site, size and rate of growth of the lesion.*
Key Words: *Electroencephalogram, Brain-tumor, Interictalepileptiform discharges, Slow wave discharges, Abnormal EEG.*

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I. Introduction

Brain tumor is inherently serious and life threatening disease. Brain tumor builds the intracranial pressure in the brain, by shifting the brain or pushing against the skull and also damaging nerves and healthy brain tissues. The intracranial pressure affects and interferes with normal brain functionally which results in generation of abnormal electrical activities from brain. With recent development in the medical engineering and instruments, EEG instrument are able to record the brain electric activities with high accuracy.[1]

EEG in humans started in 1920s. In 1936, Walter who introduced the term “delta waves” first identified the association between localized slow waves on EEG and tumors of the cerebral hemispheres. Delta is the frequency of EEG that is less than 4 hertz (hz), whereas the normal alpha frequency is between 8 and 12 hertz (hz).

Experience has shown EEG to be reliable in localizing lesions involving superficial portions of the cerebral hemispheres though it is of limited value in deep seated lesions, especially posterior fossa tumors..[2]EEG abnormalities in brain tumors depend on the stage at which the patient presents for evaluation.Brain tumors may be associated with various EEG findings. The following may be seen at the time of diagnosis:

- Focal slow activity

- Focal attenuation of background activity
- Asymmetric beta activity
- Disturbance of the alpha rhythm
- Interictal epileptiform discharges (spikes and sharp waves)
- Normal EEG

Activation procedures are usually of limited value in patients with tumors, although hyperventilation occasionally can accentuate focal slowing. Asymmetries of photic driving can be useful at times, although they also can be misleading.A normal EEG occurs only in about 5% of hemispheric tumors but in 25% in deeper tumors.

EEG Changes in Tumors by Location

Supratentorial tumors

- Frontal lobe tumors,Temporal gliomas,Parietal tumors,occipital gliomas,occipital meningiomas characteristically cause focal PDA(Polymorphic delta activity), which localizes the lesion.
- In centroparietal tumors, sensory motor cortical rhythm may be attenuated ipsilaterally, but occasionally may be more persistent and of higher amplitude.

Deep hemispheric tumors

The typical EEG finding is IRDA(Intermittent rhythmic delta activity). Infratentorial tumors

In brainstem and cerebellar tumors, EEG is more often abnormal in children than in adults. IRDA may be observed, possibly more so if hydrocephalus is present.

Tumor Type and EEG

- EEG patterns are not specific for tumor pathology, but some general correlations exist.
- Slowly growing extra-axial tumors, such as meningiomas , produce the mildest EEG disturbances, whereas rapidly growing intra-axial tumors, such as glioblastomas, cause the most marked abnormalities.
- Benign intra-axial tumors, such as astrocytomas or oligodendrogliomas, are intermediate in their effects on the EEG.
- Interictal discharges most commonly are observed initially in slowly growing tumors and often are observed later in the course of higher-grade lesions.
- Location is important in the EEG findings because the temporal lobe is one of the more epileptogenic zones.
- Rationale of study
- The character and distribution of EEG changes produced by tumors depend primarily on lesion size, rate of growth, distance from the cortical surface, and specific structures involved.
- In general, the following are true:
- PDA(Polymorphic delta activity),is the hallmark of tumor localisation
- Both metastatic tumors and gliomas commonly cause delta activity, changes are more marked with aggressive gliomas.
- Deep tumors are more likely to cause widespread hemispheric or bilateral slowing, often rhythmic (IRDA).
- Small deep tumors may cause no abnormalities, especially if the thalamus is not involved.
- When the tumor is growing rapidly and involves cortex, localized loss of background activity may occur.
- Spikes, sharp waves, or spike-wave discharges often are observed at the time of diagnosis in slowly growing tumors.With more malignant neoplasms, both seizures and epileptiform discharges occur later. Location of discharges does not always correlate with tumor location

Despite advances in neuroimaging, EEG still offers a unique view of physiologic changes over time in patients with brain tumors, especially in regard to seizures[2]

As there is alarming rise in proportion of patient having brain tumor in Northeast India in all age group including younger population this study is conducted to access the prevalence of EEG abnormalities in brain tumor patients attending at neurosurgery OPD of Agartala Government Medical College and Hospital.

II. Objectives

- To estimate the proportion of EEG changes in patients of brain tumor attending OPD of a tertiary care hospital &
- To find out EEG changes in different types of brain tumor

III. Materials & Methods

- **Study Type:** Observational study
- **Study Design:** Hospital based cross sectional study
- **Study Duration:** 6 months
- **Study Area/Location:** Department of Physiology in collaboration with Department of Neurosurgery and Neurology,Agartala Government Medical College
- **Study Population:** 46 newly diagnosed brain tumor patients attending at neurosurgery OPD of Agartala Government Medical College and Hospital.

Inclusion criteria for cases

- Newly diagnosed brain tumor cases.
- Patient of all age group.
- Patient of all gender
- Those who are willing to participate

Exclusion criteria for cases

- Old diagnosed and treated cases of brain tumor
- Post operative brain tumor cases
- Patient of Glassgow Coma Scale less than 13
- Those who are not willing to participate in the study

Sampling Technique: All the patients attending Neurosurgery Unit are selected maintaining the inclusion and exclusion criteria.

Study Tools:

1) EEG Machine: EEG maximus 24 containing 16 recording channels
2) Case Record Format

Data Collection: All the study subjects were selected consecutively during the study period following the inclusion and exclusion criteria. The data were collected from all the brain tumor cases attending neurosurgery opd of AGMC and GBPH, within 6 months.

Data Management: After completion of the data collection the obtained data were coded and entered into Microsoft excel worksheet and were subjected for statistical analysis using statistical package for social sciences [spss 25] software for windows. Quantitative data were expressed by mean, SD and qualitative data were expressed by frequency and proportion. Inferential test like T test and Chi Square Test will be used as appropoate. A P value less than 0.05 will be considered as statistically significant.All EEG details will be noted in a Case Record Form (CRF).

Ethical Consideration: Permission was sought from the institutional ethics committee (EC).The nature and purpose of the study will be explained to the participants. Informed consent were taken from every patient and information thus collected were dealt with strict confidentiality and were used for research purpose only.

IV. Procedure

Sensors called electrodes are attached to the head (usually with glue or paste) and connect to an EEG recording machine after obtaining informed consent.
EEG was reviewed for any abnormal background or interictal epileptiform discharges.

V. Results

- Among 46 diagnosed brain tumor patients participating in the study, 9 of them are having slow wave discharges in the EEG tracing.
- In 20% of the brain tumor patients slow wave discharges and spiked waves are present and in 80% of them it is absent.

Fig.1: Change in EEG among study participants

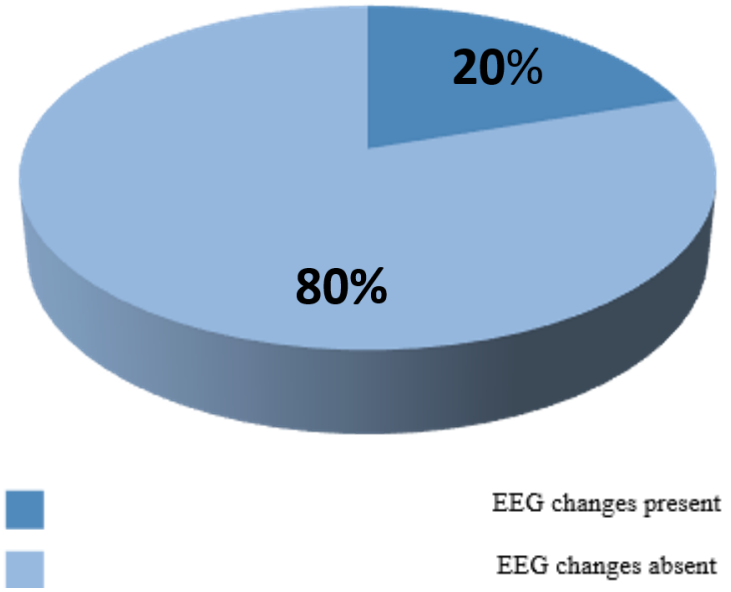
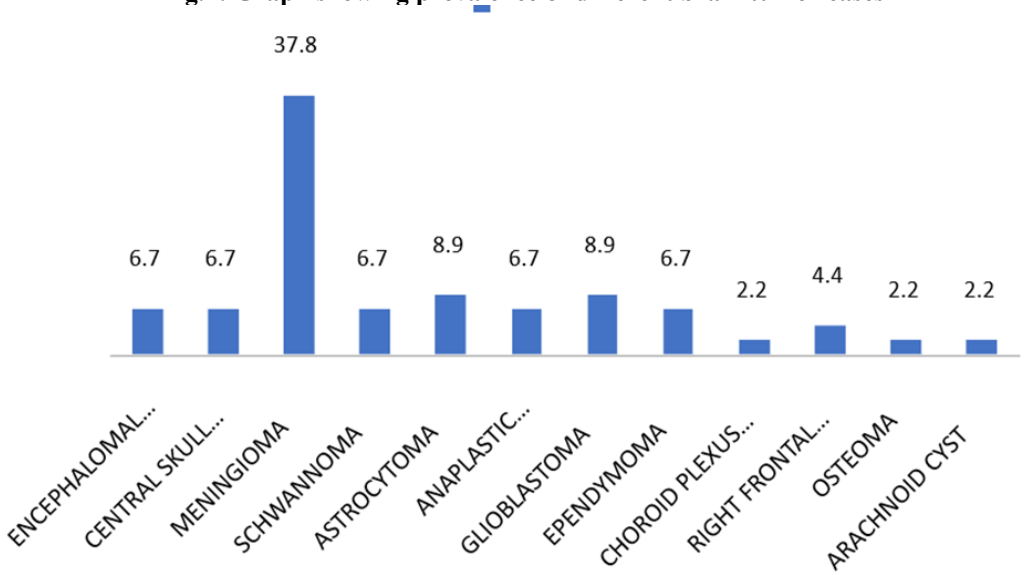
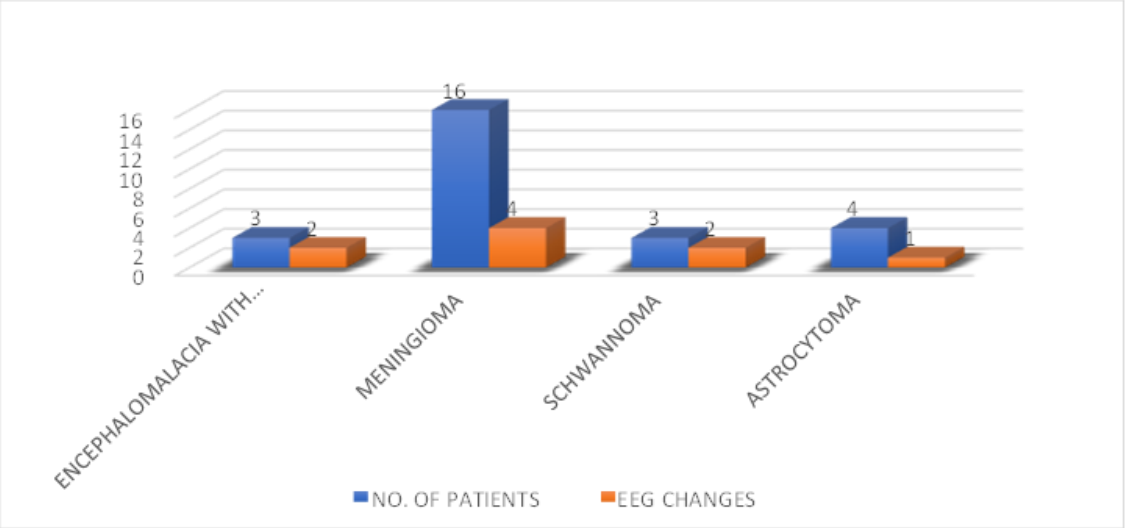


Fig.2: Graph showing prevalence of different brain tumor cases



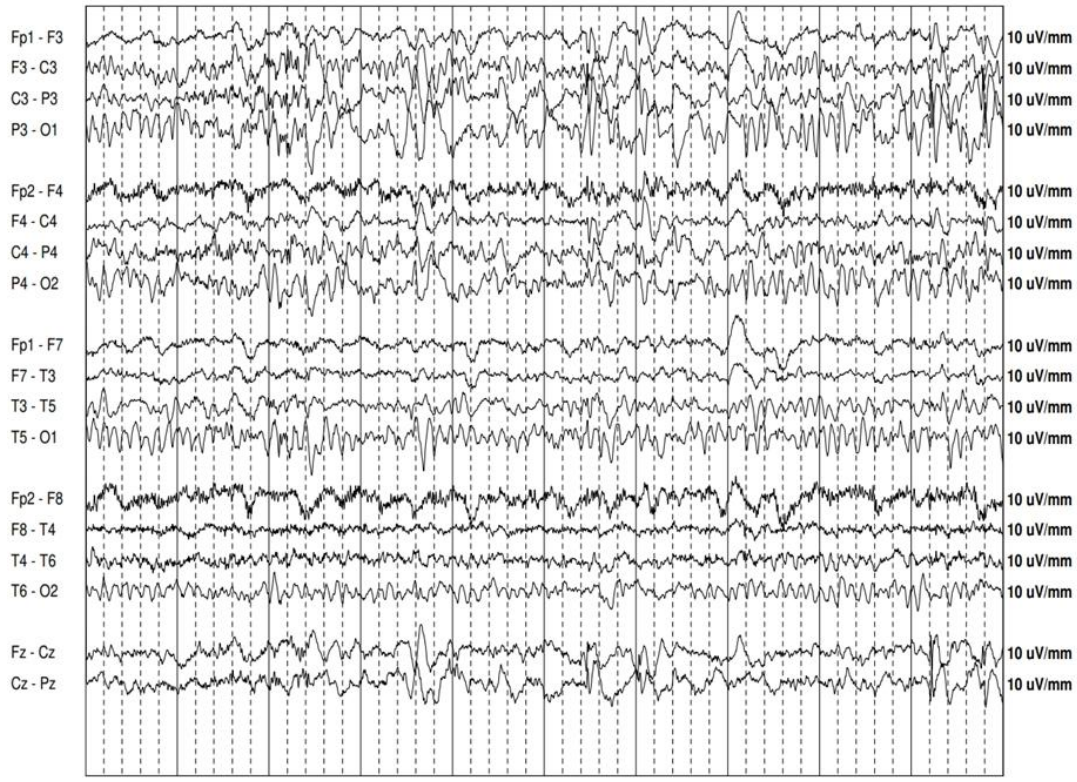
- 6.7% encephalomalacia with gliosis
- 6.7% of central skull base tumor
- 37.8% meningioma
- 6.7% schwannoma
- 8.9% astrocytoma
- 6.7% anaplastic oligodendroglioma
- 8.9% glioblastoma
- 6.7% ependymoma
- 2.2% choroid plexus
- 4.4% right frontal neoplasm
- 2.2% osteoma
- 2.2% arachnoid cyst

Fig.3 graph showing prevalence of EEG abnormalities in the patients of brain tumor having same diagnosis but different EEG changes



- Among 16 meningioma patients only 4 are having EEG changes
- Among 3 gliosis patient 2 are having EEG changes
- Among 3 schwannoma patients 2 are having EEG changes
- Among 4 astrocytoma patients only 1 have showed EEG changes

Fig 4:EEG of a patient with glioma showing abnormal electrical epileptiform discharges with spiked waves



VI. Discussion

- Edward V. Spudis et al. (1975) conducted a seminal study which highlighted that large neoplasms may be located superficially within the brain, potentially giving rise to acute or chronic clinical manifestations without producing discernible alterations in electrical activity. This observation underscores the complexity of neurophysiological responses to intracranial tumors.In concordance with these findings, our present study

demonstrates that while electroencephalographic (EEG) changes can serve as indicative markers of underlying brain neoplasms, such alterations are not universally present. The variability in EEG patterns suggests that the presence of a tumor does not invariably correlate with detectable electrical disturbances, particularly in cases where the lesion does not impinge upon cortical structures directly involved in generating measurable EEG signals.These findings emphasize the importance of a multimodal diagnostic approach in the evaluation of suspected brain tumors. While EEG remains a valuable tool in the neurological assessment, its limitations in sensitivity, especially in cases of deeply situated or slowly growing tumors, must be acknowledged. Therefore, reliance solely on EEG may lead to underdiagnosis or delayed detection, reinforcing the need for comprehensive neuroimaging and clinical correlation in the diagnostic workup.

- M. Sharanreddy and P.K. Kulkarni (2013) emphasized the clinical utility of electroencephalography (EEG) as a cost-effective and reliable diagnostic modality, particularly in the evaluation of glioma series. Their study highlighted EEG's value as an accessible and non-invasive tool capable of detecting functional disturbances associated with intracranial tumors.Our present findings are in alignment with these observations. EEG continues to stand out as a low-cost, non-invasive diagnostic technique that can effectively identify aberrant electrical activity within the brain, often reflective of underlying neoplastic processes. Notably, our study further supports the premise that the magnitude of EEG abnormalities tends to correlate with tumor size; larger lesions are more likely to produce prominent deviations in EEG tracings, potentially due to increased mass effect or cortical involvement.These results reinforce the relevance of EEG as an adjunctive tool in the initial assessment and monitoring of brain tumors. While it may not replace advanced neuroimaging techniques, its affordability, safety profile, and ability to provide real-time functional insights make it a valuable component in the diagnostic armamentarium, especially in resource-limited settings.
- In a study conducted by Ko David Y., M.D., et al. in December 2022, it was concluded that both metastatic brain tumors and gliomas frequently induce delta wave activity on EEG, often localized to the site of the lesion and its adjacent cortical areas. The extent and nature of these EEG changes were found to be more pronounced in cases involving high-grade gliomas. Furthermore, the study noted that deep-seated tumors are more likely to result in diffuse hemispheric or even bilateral slowing, whereas small, deep lesions—particularly those sparing the thalamus—may produce minimal or no detectable abnormalities. In contrast, rapidly growing tumors that invade the cortex may manifest as a localized attenuation or loss of background activity on EEG.Our present findings are in concordance with these observations. We observed that larger tumors tend to exhibit more prominent and aggressive EEG alterations, likely due to greater cortical involvement or increased mass effect. Moreover, EEG abnormalities demonstrated a distinct correlation with the anatomical location of the tumor. For instance, neoplasms located in the frontal lobe predominantly produced pathological changes in the frontal EEG leads, thereby supporting the concept of topographic correlation between tumor site and EEG findings.These results underscore the diagnostic value of EEG not only in detecting the presence of cerebral neoplasms but also in providing functional localization. Although EEG may not detect all deep-seated or small tumors, especially in subcortical regions, it remains a valuable adjunct in the neurodiagnostic framework, particularly when used in conjunction with neuroimaging and clinical evaluation.

VII. Conclusion

- In the present study it is definite that presence of slow wave discharges in EEG can be a sign of brain tumor but not always.
- EEG abnormalities co relate with the tumor location(e.g.,Frontal lobe tumors show frontal EEG changes).
- Larger tumors tends to show more extensive EEG abnormalities

VIII. Limitations

This study demonstrated limited accuracy in localizing brain tumors, particularly those located in deep-seated or subcortical regions, due to the attenuation and dispersion of electrical signals through brain tissue.

In this study,the recordings obtained via EEG were sometimes contaminated by external influences such as muscle activity (electromyographic artifacts), ambient electrical noise, and patient movement. These artifacts were obscuring true cerebral activity, thereby reducing diagnostic reliability.

This study was unable to distinguish between different tumor histologies—such as gliomas, meningiomas, or metastatic lesions—as the electrical patterns generated are non-specific and often overlap among various tumor types.

Due to its limited spatial resolution,this study does not provide the precise anatomical detail required for neurosurgical planning, especially in cases requiring exact lesion localization

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