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Electroencephalographic (EEG) Changes In Preoperative Glioma Patients-A Cross Sectional Study

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Abstract:
Background:
Gliomas are inherently serious and potentially life-threatening conditions. They increase intracranial pressure through mass effect, shifting of brain structures, compression against the skull, and infiltration or destruction of healthy neural tissue. This rise in intracranial pressure, disrupts normal cerebral function, often leading to the emergence of abnormal electrical activity in the brain. Gliomas, as the predominant primary brain tumors, frequently disrupt neural activity, leading to detectable changes in electroencephalography (EEG). Seizures are the most common presentation of brain tumors. Although any type of brain tumor can cause seizure, neuroglial tumors and gliomas are the most common ones. 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.
Objectives*:*
To identify and characterize EEG changes in preoperative glioma patients.
Materials and Methods*:*
A hospital based cross sectional study was conducted among 30 pre diagnosed glioma 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 known brain tumor cases participating in the study, 30 patients are pre diagnosed glioma and 5 of those glioma patients 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 glial cell tumor(glioma) 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, Braintumor, Glioma, Interictalepileptiform discharges, Slow wave discharges, Abnormal EEG

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I. Introduction

Gliomas are inherently serious and potentially life-threatening conditions. They increase intracranial pressure through mass effect, shifting of brain structures, compression against the skull, and infiltration or destruction of healthy neural tissue. This rise in intracranial pressure, disrupts normal cerebral function, often leading to the emergence of abnormal electrical activity in the brain. With recent advancements in medical technology, electroencephalography (EEG) has become an increasingly accurate and non-invasive tool for recording and evaluating cerebral electrical activity [1].

Seizures are among the most frequent initial manifestations of brain tumors. Although any brain tumor may present with seizure activity, neuroglial tumors—particularly gliomas—are the most commonly implicated due to their propensity to involve cortical areas and irritate surrounding brain tissue [2].

The clinical use of EEG in humans began in the 1920s. In 1936, Walter introduced the term "delta waves" after observing an association between localized slow-wave activity on EEG and tumors of the cerebral hemispheres. Delta waves are defined as EEG frequencies below 4 Hz, in contrast to normal alpha rhythms, which range between 8 and 12 Hz [3].

EEG has shown particular reliability in localizing lesions involving the superficial cortical regions of the cerebral hemispheres. However, its diagnostic utility is limited for deep-seated lesions, especially those in the posterior fossa [3]. The EEG abnormalities associated with brain tumors depend on several factors, including the tumor's size, location, and the stage at which the patient presents for evaluation. Common findings at the time of diagnosis include:

✓ Focal slowing of background activity
✓ Focal attenuation of background rhythms
✓ Asymmetric beta activity
✓ Disturbance or asymmetry of alpha rhythm
✓ Interictal epileptiform discharges (spikes and sharp waves)
✓ Occasionally, a normal EEG [3]

EEG Changes by Tumor Location

I. Supratentorial tumors, such as frontal lobe tumors, temporal gliomas, parietal tumors, occipital gliomas, and occipital meningiomas, typically produce focal polymorphic delta activity (PDA), which assists in anatomical localization.
II. Centroparietal tumors may attenuate the sensory-motor cortical rhythm ipsilaterally, though this rhythm may also appear more persistent and of higher amplitude.
III. Deep hemispheric tumors are characteristically associated with intermittent rhythmic delta activity (IRDA) on EEG.
IV. Infratentorial tumors, particularly those involving the brainstem and cerebellum, are more likely to produce abnormal EEG findings in pediatric patients, particularly when hydrocephalus is present [3].

Given the alarming rise in the incidence of brain tumors across all age groups—including the younger population—in Northeast India, there is a growing need for early and accessible diagnostic tools. This study was therefore undertaken to assess the prevalence and patterns of EEG abnormalities in glioma patients attending the Neurosurgery Outpatient Department of Agartala Government Medical College and Hospital. The findings aim to enhance our understanding of the electrophysiological manifestations of gliomas and to contribute valuable data from this region to the broader field of neuro-physiology.

II. Objectives

To identify and characterize EEG changes in pre operative glioma patients.

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: 30 pre diagnosed glioma patients among 46 known brain tumor cases, attending at neurosurgery OPD of Agartala Government Medical College and Hospital

Inclusion criteria for cases

- Prediagnosed glioma cases.
- Patient of all age group.
- Patient of all gender
- Those who are willing to participate

Exclusion criteria for cases
- Post operative glioma cases
- Patient of Glassgow Coma Scale less than 13
- Those who are not willing to participate in the study

Sampling Technique: Convenient sampling. All the prediagnosed cases of glioma attending Neurosurgery opd 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 glioma 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 were 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 31 pre diagnosed glioma patients participating in the study, 5 of them were having slow wave discharges in the EEG tracing.
- Gliomas cause delta activity, often localized to the tumor site and neighboring zone.changes are more marked with aggressive gliomas.
- Small deep gliomas may cause no abnormalities.
- In all the glioma patients participating in the study seizure was present.

Fig.1: Change in EEG among glioma patients participating in the study

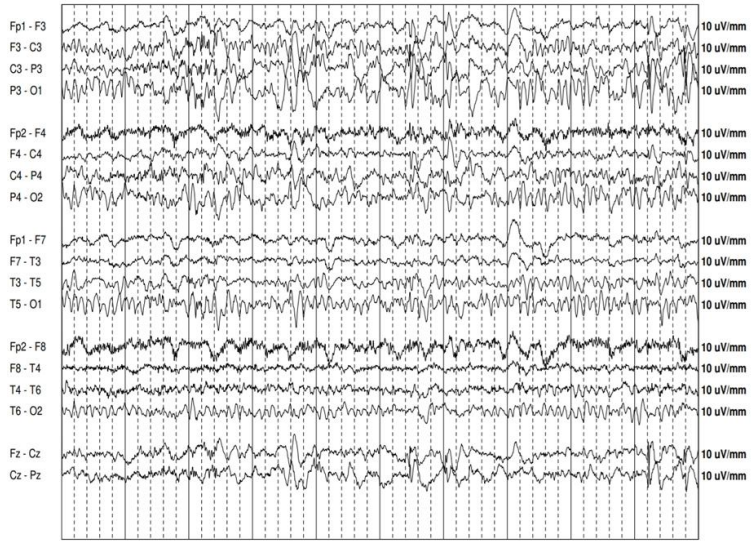


Fig.2: Change in EEG among glioma patients participating in the study

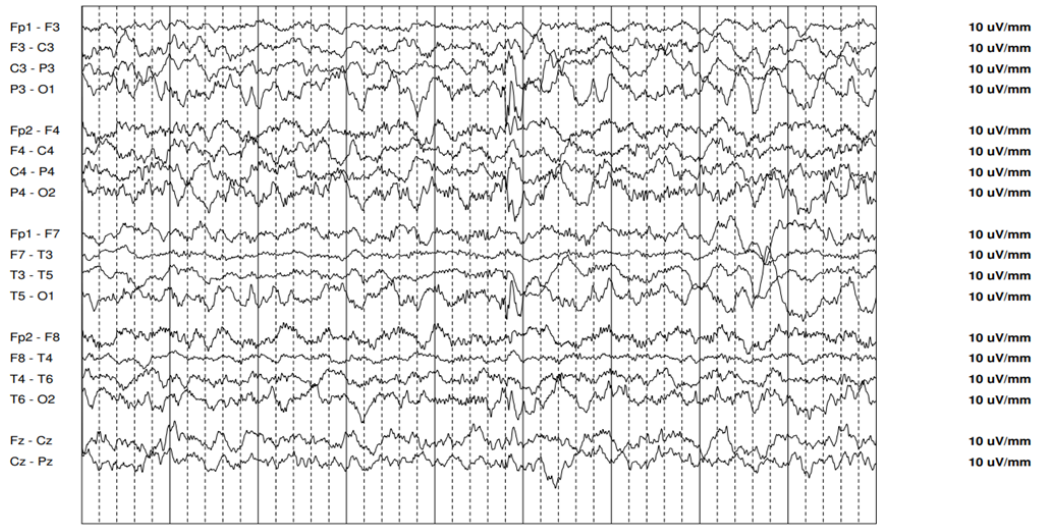
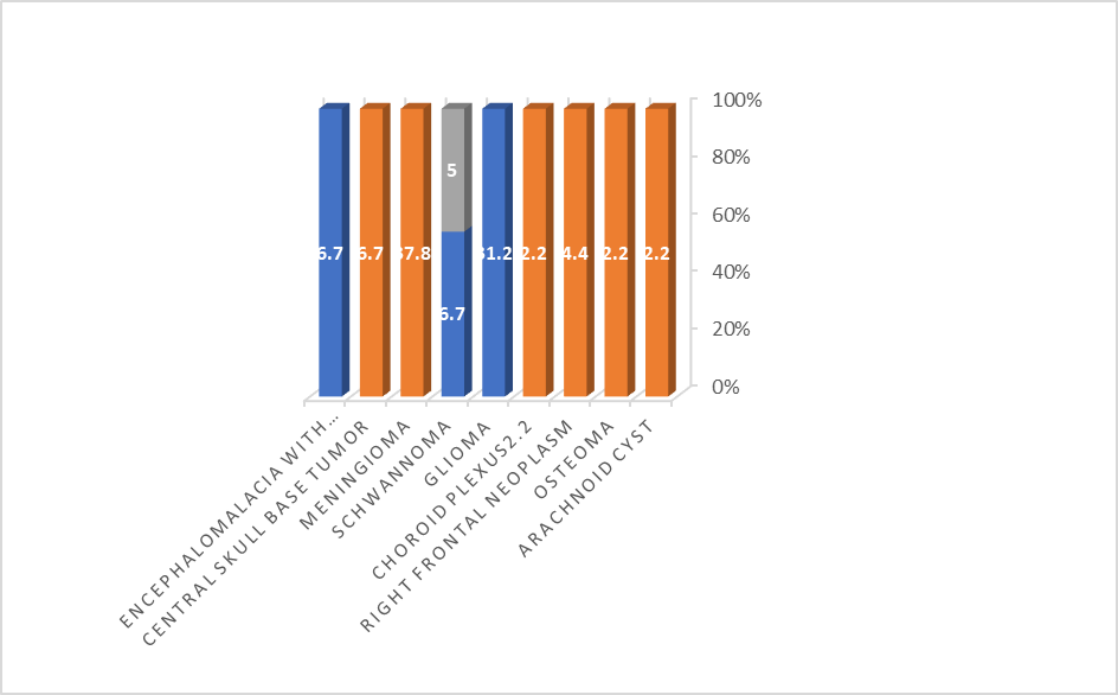


Fig.3: Graph showing prevalence of glioma compared to other brain tumor case



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

So total prevalence of glioma is 31.2

VI. Discussion

A cross-sectional study conducted by Sri Handayani et al. (2019) investigated EEG changes in patients with intracranial tumors presenting with seizures, aiming to assess the concordance between tumor location and corresponding EEG abnormalities. Over a one-year period, 35 patients were consecutively enrolled. Abnormal EEG findings were observed in 68.2% of patients with primary intracranial tumors and in 84.6% of those with metastatic tumors.In cases of primary intracranial tumors, the predominant EEG abnormality was focal slowing (60.0%), followed by epileptiform activity (20.0%) and a combination of focal slowing with epileptiform discharges (13.3%). In contrast, among patients with metastatic tumors, focal slowing accounted for 36.4%, epileptiform discharges were present in 18.2%, and 45.5% exhibited both deceleration and focal epileptiform activity. Interestingly, the anatomical correlation between EEG abnormalities and tumor location revealed that abnormalities were observed in the tumor region in 23.1% of cases, in non-tumor areas in 38.5%, and in both tumor and non-tumor areas in another 38.5%.These findings suggest that focal slowing was the most frequent EEG abnormality in patients with intracranial tumors, surpassing epileptiform activity. Furthermore, the frequent presence of EEG changes in non-tumor regions implies that seizures may often arise due to irritative effects of the lesion rather than the formation of a discrete epileptic focus.Consistent with these observations, our present study found that EEG abnormalities frequently corresponded to the anatomical location of the tumor; for instance, frontal lobe tumors typically exhibited frontal EEG alterations. However, small and deeply situated gliomas may remain electrophysiologically silent, as illustrated in our cohort where only 5 out of 30 glioma cases in advanced stages demonstrated interictal epileptiform discharges characterized by sharp waves and spike activity. This underscores the potential limitations of EEG in detecting abnormalities in certain tumor types and locations, particularly in early or deep-seated lesions.

Ko David Y, MD et al. (2022) conducted a comprehensive study examining EEG characteristics in patients with intracranial gliomas. The authors reported that gliomas frequently produce delta frequency activity, typically localized to the tumor site and adjacent cortical regions. These EEG changes tend to be more prominent in high-grade or aggressive gliomas. Deep-seated tumors, particularly those involving subcortical structures, were associated with more widespread hemispheric or even bilateral slowing. Notably, small, deep tumors—especially when the thalamus remains uninvolved—may yield normal EEG findings. In cases of rapidly expanding gliomas with cortical involvement, a localized attenuation of background activity may be observed. Furthermore, spikes, sharp waves, and spike-wave complexes are often evident at the time of diagnosis in patients with indolently growing gliomas. In contrast, in more malignant neoplasms, both clinical seizures and epileptiform discharges tend to emerge later in the disease course. Importantly, the anatomical location of epileptiform discharges does not always correlate precisely with the tumor site.In alignment with these findings, our present study also demonstrated that the majority of glioma patients exhibited abnormal EEG patterns, most notably focal slowing and interictal epileptiform discharges. Additionally, larger tumor size was generally associated with more extensive and widespread EEG abnormalities. This reinforces the notion that tumor aggressiveness and mass effect contribute significantly to the degree and distribution of electrophysiological disruptions observed on EEG.

VII. Conclusion

- In the present study it is definite that presence of slow wave discharges in EEG can be a sign of glioma 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. Gliomas cause delta activity, often localized to the tumor site and neighboring zone. Changes are more marked with aggressive gliomas.
- Small deep gliomas may cause no abnormalities.

VIII. Limitations Of The Study

This study has limited sensitivity for detecting small or deep-seated intracranial tumors, as EEG primarily reflects surface cortical activity.

This study is susceptible to contamination from muscle artifacts, electrical interference, and patient movement, which may obscure or mimic pathological findings.

This study does not differentiate between tumor types such as gliomas and meningiomas, as EEG reflects functional changes rather than histological characteristics.

This study may fail to detect tumors in early stages or those that generate minimal electrical disruption, limiting its diagnostic utility in subclinical cases.

This study does not reliably predict tumor prognosis or treatment response, and cannot be used to monitor disease progression accurately over time.

This study lacks the anatomical resolution required for precise localization in surgical planning, often necessitating correlation with imaging modalities.

This study frequently requires adjunctive diagnostic tools such as MRI or CT, as EEG findings alone are often non-specific or inconclusive.

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