A COMPARATIVE STUDY OF RECENT NEUROIMAGING TECHNIQUES IN PATHOPHYSIOLOGY OF FOCAL EPILEPSY

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Abstracts: Cross-sectional imaging studies are known to play a significant role in the evaluation of epilepsy patients. However no single technique of neuroimaging is free of drawbacks to diagnose epilepsy and ascertain the pathophysiological basis. Comparative studies on these techniques have remained largely inconclusive with no clear differentiation between these in terms of pathophysiological basis and diagnostic or prognostic specificity with conflicting reports on their individual superiority. So it is important to find out the relative sensitivity of different techniques with regard to non-invasive detection and localization of epileptogenic lesions having organic basis such as vascular abnormalities, tumours, and infarcts that would be amenable to surgical treatment. Here, we compared the different imaging modalities and their specific role in patients with epilepsy. In this study it was concluded that PET is superior in detecting epileptic lesions as compared to then EEG ,CT,MRI, and MRS. At the same time MRS is superior to PET in its ability to detect bilateral abnormalities.

Key Words: EEG, electroencephalography; PET, Positron emission tomography; CT, computed tomography; MRI, Magnetic resonance imaging; MRS, MRspectroscopy.

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Introduction:

Epilepsy is a chronic disease characterized by recurrent seizures affecting 2% of the population. Prior to the advent of cross-sectional imaging, evaluation and classification of seizure patients was based on electroencephalography (EEG) data and clinical findings which was the only means to document epilepsy Modern neuroimaging techniques are useful to diagnose the pathology underlying the epilepsy. Both structural and functional neuroimaging play an essential role in noninvasive localisation of epileptogenic foci. Structural brain imaging (CT,MRI) reveals morphologic lesions of the brain such as localized atrophy, tumors, vascular malformations and cortical developmental abnormalities. Functional brain imaging produces images reflecting tissue biochemistry, metabolism, perfusion or receptor density. SPECT, MRS and PET are tools used to produce 'functional images' 1.(Pillai JJ et al.2002 Neuroimaging is even more important for those patients who have medically intractable seizures[1] .. Having replaced computed tomography (CT) in many situations, MRI, single-photon emission CT/positron emission tomography and electromagnetic source imaging with magneto encephalography are provide new insights into the pathophysiology of epilepsy. Magnetic resonance (MR) imaging has become the technique of choice for high-resolution structural imaging in epilepsy, due to multiple advantage like lack of ionising radiation, superior soft tissue contrast, multiplanar imaging capability, and lack of beam-hardening artifacts allowing visualisation of epileptogenic substrates with greater sensitivity and accuracy. However 15% of patients with epilepsy, structural lesions can remain undetected. Localisation of the exact epileptic foci is crucial for therapy planning for patients with focal epilepsy[2]

Overall diagnostic accuracy can be improved by using other neuroimaging techniques that provide additional information on the location of the seizure focus. This can help in achieving a successful, seizure-free surgical outcome[3]. Clinical PET with fluorodeoxyglucose (FDG) provides a measure of glucose uptake and thus metabolism.

The present study compares available imaging modalities, their specific role in patients with focal epilepsy and practical applications of imaging data in the management of patients with focal epilepsy.

Material and Methods:
MATERIALS

Ethical approval

This study approved from the Ethical & Research Committee,
Study Design
Prospective observational study including 20 screened patients of epilepsy.
Consent for inclusion obtained from the patients in writing after explaining the whole procedure of the study and its utility before the procedure though the study was totally non invasive.. A detailed history recorded and detailed general and CNS examination done. After primary screening through EEG for one hour duration in awake state with hyperventilation and photic stimulation during interictal phase the patient would be subjected for neuroimaging of the brain in order to find epileptogenic focus, associated morphological changes in relation to EEG findings during interictal phases of epilepsy.

2. **Inclusion Criteria:**
i. focal epilepsy patient attending neurology OPD & referred by neurophysicians(under treatment)
ii. Age groups
iii. Male and Female
iv. Focal epilepsy

3. Exclusion Criteria:
1. Pregnancy.
2. Breast feeding. Mothers should interrupt breast feeding for 24 h if PET is indicated.
3. Lack of cooperation, or inability to cooperate, with the procedure.

4. EQUIPMENT

PET-CT Machine: PET-Scan Discovery STE-8(GE Medical systems) with an 8 slice CT-Scan. The dye being used in the machine is F-l 8 FDG (Fluoro-Deoxy Glucose)

MRI Machine: Siemens 1.5 T with plain and spectroscopy study protocol data fused with help of cortex ID protocol on ADW 4.2 work station

METHOD

1) Twenty (Ref), known patients (age : 5 - 65 yrs.) of either sex or suspected for symptomatically or clinically for epilepsy with different age group, sex and weight.
2) Parameter recorded
   a) Physical
      - Age (years)
      - Height (cm)
      - Weight (kg)
   b) Recording procedure

PET SCAN with all above criteria we have done CT scan, MRI , MR spectroscopy and PET scan.

STATISTICAL ANALYSIS

Data collected by prospective observational study entered in MS office Excel spread sheet. Statistical analysis done using NET based graph pad calculator. Correlation of findings between different neuroimaging modalities done using Chi Square test

Result:
Table showing site of lesion by different neuroimaging techniques. Out of 20 focal epilepsy patients unilateral lesion was detected in 4cases by CT scan ,6cases by MRI, 7by MRS and 17 cases by PET scan. Among bilateral lesion was detected by CT ocal and scan,1case was diagnose by MRI, 4 by MRS and 2 by PET scan. As the table shows that most of the cases of unilateral lesions were undetected by CT,MRI,MRS while 85% o cases were detected by PET scan showing that this imaging technique has much greater sensitivity over other imaging techniques. However MRS showing more sensitivity than PET scan in scanning bilateral lesions and in these 4 patient the chemical abnormalities were more on rt side as compared to left.PET also showed the lesion on right side in same paient .No bilateral lesion were detected by CT scan. One case was normal (no lesion) in CT, MRI, and PET scan but was positive in MRI.

Site of Lesion by Different Neuroimaging Technique

Parameter	Unilateral (N=20)	Bilateral (N=20)	Total focal patient
CT	4 (20%)	0 (0%)	4 (20%)
MRI	6 (30%)	1 (5%)	7 (35%)
MRS	7 (35%)	4 (20% more on right side)	11 (55%)
PET	17 (85%)	2 (10%)	19 (95%)

Discussion:

So far, no single technique appears clearly superior overall to any of the others.. The neuroimaging techniques measure different aspects of the epileptic process; that is, structure (MR imaging), metabolism (PET), and perfusion (SPECT). MR imaging depicts only gross anatomic alterations associated with focal epilepsy. Anatomicopathologic definition of the organic lesion is the most obvious on MR images. PET has the unique ability to image cerebral metabolism but is virtually limited to the interictal state, because it takes approximately 1 hour for the radiotracer to enter the cells to be metabolized and to be distributed throughout the brain tissue. A PET scan obtained 60 minutes after injection of the radiotracer during the seizure mostly reflects the postictal or interictal state.

Clear focus localization, is still a difficult task in which extensive video EEG monitoring is successful in 60%–90% of cases[4,5,6,7] .MR imaging remains without pathologic findings in up to 30% [8].

For both (temporal and extra temporal) 1(5%) by CT, 2(10%) MRI &MRS and 6(30%) by PET scan. Lesion which are shown in both and all hemisphere they were maximum in PET scan but in MRI & MRS lesion which are shown in PET in both temporal and extra temporal, only shown either in temporal or extra temporal ,escape one or more hemisphere so we can say that efficiency of PET scan is maximum compared to CT,MRI,MRS.

In study also PET showed the highest sensitivity for both temporal and extratemporal lesions[9]..In patients with normal MR imaging findings, PET was superior to MRS in lateralizing the lesion (95% versus 60%). The discrepancy in sensitivity of MR imaging between the previous studies and our study might reflect the fact that the previous studies were published during a time of technical maturation of MR imaging. If we had used the results of retrospective, blinded reinterpretations of the images instead of the original reports, the concordance rate and sensitivity would have been higher than the current results, as there would be an intraindividual learning curve that would make current interpretation more effective.

In the case of bilateral affection, multiple imaging approaches seem to be more reliable in detecting widespread pathology in both hemispheres than single MR imaging, in which bilateral affection is less evident. Our study and previously published data show that ^{1}H-MR spectroscopy able to demonstrate bilateral changes, not only in the patient group already classified as bilateral by EEG but also in patients with TLE classified as unilateral by EEG monitoring. predicting postoperative outcome in patients with TLE who remain refractory to conservative treatment. Pathologic findings in multimodal imaging that are located contralaterally to EEG focus or affect both hemispheres are considered predictors for a bad postoperative outcome in patients with unilateral TLE [10,11,12,13,14,15]. In our result It is noteworthy that our results give further evidence addressing this matter because 5% of patients with lesional findings in MR imaging in the right temporal lobe demonstrated bitemporal metabolite alterations in ^{1}H-MR spectroscopy. For bilateral detection of lesion MRS Is even more sensitive then PET

In the present study, PET showed hypometabolism on the lesion side in 19(95%) of 20patients. Some studies reported comparable findings in a comparative study of MRS and PET for lateralization of refractory temporal lobe epilepsy In their study, MRS and PET lateralized the seizure focus in 76% and 76% of the patients, respectively, when EEG findings were regarded as the standard of reference. The reasons why PET showed higher rates of correct lateralization in our study are uncertain. Several factors, including a different subject population, different imaging techniques, and a different standard of reference, might account for this discrepancy.

The discrepancies among the different imaging techniques may be explained by the fact that they measure different aspects of the epileptic process; that is, MR imaging depicts only gross anatomic alterations associated with epilepsy whereas PET has the unique ability to image cerebral metabolism and MRS measures the metabolites of cellular chemical components associated with epilepsy. MR imaging and PET have an advantage over MRS in visualizing the whole brain; they not only depict the lesion in the medial temporal lobe but can also show abnormalities in other regions.

Our results indicate that PET is superior in detecting epileptic lesion then CT,MRI, and MRS but MRS is superior to PET in its ability to detect bilateral abnormalities. Further studies are required for patients in whom lateralization of the seizure focus is inconclusive

Conclusion:

Present study indicate that PET is superior in detecting focal epileptic lesion than CT,MRI, and MRS but MRS is superior to PET in its ability to detect bilateral abnormalities, also further studies are required for lateralization of the seizure focus.

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