Brainmapping and seizure disorders

Because it is unusual for routine EEG recording to coincide with the ictal seizure, so, it is there for necessary to depend on the interseizure EEG pattern for diagnostic assistance in cases of epilepsy. The EEG interseizure pattern might take the form of spike, polyspikes or sharp wave discharge, either alone or in association with slow waves. These epileptic activity might be focal or polyfocal symmetrical or asymmetrical, synchronous or asynchronous.

Unfortunately, 20-30% of epileptic patients show normal recording while 40% of epileptic patients show nonspecific abnormality. Metwally 1986 also reported that 20 - 45% of epileptic patients had a normal tracing.

To further complicate the problem, epileptiform activity is an occasional finding in individual who has never experienced a seizure, so its presence must not be taken as establishing in the diagnosis of epilepsy. Diagnosis of epilepsy should therefore depend on the clinical picture and the EEG should be interpreted in conjunction with the clinical picture.

If the clinical picture is typical of a grand mal fit or a petit mal fit, then the EEG when abnormal should confirm the diagnosis, but occasionally the clinical picture is atypical especially in patients with partial complex seizure where the ictal phenomenon might take the form of anger, anxiety or depression or ictal violence.

**Basic concept of brainmapping**

I have been working in the field of conventional EEG, and brainmapping for over 20 years. My master degree thesis was about brainmapping and quantitative EEG and its application in the field of neurological and psychiatric disorders. I have mapped till now over 4000 patients and over 1000 normal individual. Although many might not understand the basic concept of brain mapping and probably underestimate its significance in clinical practice and research work, however brainmapping is nothing but a quantification, objective analysis and description of what is qualitatively described by conventional EEG.

In fact conventional EEG has fallen short of expectation not because it contains too little informations but because it contains too much informations to be handled by the unaided visual analysis.

In brain mapping the following is done

1-**Spectral analysis:** where the various EEG frequencies (delta, theta, alpha, beta) are separated from each other.

2-**Quantification:** The percentage activity in each frequency band during a specific time rage is calculated.

3-**Topographic display:** The percentage activity in each frequency band is drawn forming a surface image comparable to both CT scan and MRI.

Thus the subjective, qualitative and impressionistic description of conventional EEG is transformed into an objective, and quantitative description of the same data (the brain electrical activity).

Alpha map in the eye closed awake state. Notice the following:

1-The maximum percentage alpha activity is around 70%

2-The middle line distribution of the alpha maximum. With maximum activity at O1,O2, F3,F4 electrodes

3-The topographic display of the alpha activity (alpha map) allows analysis of the alpha activity by just one look

In the same way we can analyze other frequency bands

http://brainmapping.yassermetwally.com is a section of my web site dealing with the issue of brainmapping.

The author,
Professor Yasser Metwally

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The alpha map

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Although spikes and/or polyspikes constitute the most important epileptic interseizure EEG pattern, there has been no precise mathematical definition of an EEG spike. Various authors and committees have tried to define formally what constitute an EEG spike, these attempts were either qualitative, depending on the impressionistic visual inspection or even when quantitative were lacking in parameters which describe the phenomena exactly. In fact until now little progress has been made towards formulating a precise definition of an EEG spike. Although a trained person can detect spikes in the EEG through extensive definitions, but limitation of such impressionistic and idiosyncratic evaluation of the EEG data clearly exist. In this respect, Metwally, 1986 commented that the potentialities of the clinical and research EEG can not be realized until such impressions are replaced by numbers and until subjective descriptions are replaced with mathematically derived characteristics.

The clinical evaluation of the EEG, consists of visual inspection and has two parallel objectives, the first is to determine the presence or absence of discrete, often diagnostic, discontinuities such as the spike, and wave of epilepsy. In this endeavor, the visual inspection has proved successfully as transients often stands in clear contrast with the background of the EEG. In fact, visual inspection in this respect was found superior to C.EEG in detecting epileptic transients. The second objective is to screen the EEG for underlying background abnormalities, a complex process in which the EEG estimates the amount, spatial distribution, and temporal stability of the various EEG frequency bands, in this respect computer assisted power spectral analysis, where the amount of energy in all frequency bands is quantified, was found clearly superior to visual inspection.

Based on the idea that the EEGs of the epileptic patients more often than not contain very useful though subtle information, even when reported by visual inspection to be within normal some investigators have utilized the technique of power spectral analysis in order to detect these subtle abnormalities.

The introduction of power spectral analysis and subsequent brain electrical activity mapping (BEAM spectral studies) has further extended the clinical utility of the classical EEG as an investigatory tool in epileptology. BEAM spectral studies is now considered as an important contribution towards localization and characterization of epileptic foci, especially when the standard EEG is considered as within normal or showing non specific changes. In this respect, BEAM was capable of uncovering cases of covert epilepsy and of detecting subclinical epileptogenic foci. Using the technique of brain electrical activity mapping (BEAM spectral study) while investigating a group of epileptic patients. Metwally, 1986, 1998 found that focal increase of the spectral energy in all frequency bands signals epileptogenic cortex. The author reported that the increased spectral energy might involve the whole power spectrum, or it might be localized to the beta band. Occasionally, the focal increased energy in the beta band might be associated with decreased energy in the Delta, theta and alpha bands either at the site of the beta focus or in the nearby cortex.

Focal beta hyperactivity (Focal increase of the beta spectral energy) is a manifestation of a seizure focus. In less irritable foci, the power increase is limited to the beta band while more excitable epileptogenic foci show a BEAM spectral profile characterized by focal increase of the spectral energy in all frequency bands (Delta - theta, alpha as well as beta bands). In patients where the enhanced beta focus is associated with power reduction in the alpha theta and delta bands, a pattern of diminished and augmented activity in close proximity, might suggest a region of atrophy and gliosis surrounded by epileptogenic cortex. The diminished power in the delta band might, in this respect, indicates functionally destructive cortex.

The author, Professor Yasser Metwally

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Two example of alpha and theta percentage activity maps, Notice the central & bitemporal topographic location of the theta maximum activity and the occipital & Bifrontal maximum alpha activity. In general the alpha percentage activity has a middle line maximum while delta percentage activity has an anterior bifrontal maximum. Absolute power in all frequency ranges has an occipital maximum. Numerical values for the theta percentage activity is shown in the table above. The theta maximum is localised at electrodes T5,T6,T3,T4, while the numerical values for the

To be cont on page 3
Alpha percentage activity is shown in the table below.

Maximal alpha activity occurred at O2, O2 and F3, F4 and FZ electrodes.

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<thead>
<tr>
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<th>FP1</th>
<th>FP2</th>
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<tbody>
<tr>
<td>31.8/14.1</td>
<td>37.9/10 (F3)</td>
<td>67.7/7.1 (O1)</td>
</tr>
<tr>
<td>29.5/7.5</td>
<td>37.7/9.7 (FZ)</td>
<td>32.2/8.6 (C3)</td>
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<tr>
<td>26/7.9</td>
<td>37.9/10.1 (F8)</td>
<td>57.18/11.5 (PZ)</td>
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<tr>
<td>21.7/16.3 (T5)</td>
<td>21.9/10.5 (T6)</td>
<td>66.5/4.5 (O2)</td>
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</table>

%Delta activity map showing the frontal maximum

Maximal alpha activity occurred at O2, O2 and F3, F4 and FZ electrodes.