Cortical localization in petit mal absences: a Brain mapping study

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Abstract

The paper presents the results of the analysis of typical petit mal absences with the application of brain mapping topography. A selective group of twenty five children between the ages of 5 -12 years with clinical and electrophysiological petit mal absences were studied.

The analysis of the classic 3c/sec spike wave pattern by brain mapping revealed that the maximum power of the discharges was in the antero-medial areas of the frontal regions in twenty two children with right hemispheric predominance in thirteen children while three children had more than one focus: bifrontal and right temporal. The involvement of the frontal lobes and the right hemispheric predominance in the pathophysiology of petit mal absences needs further evaluation.

Introduction Petit mal absences are one of the main forms of primary generalized seizures and their pathophysiologic mechanisms are still incompletely understood. The paroxysmal EEG activity of 3 c / sec spike- wave is a typical sign of petit mal absences.

Explanation of the phenomenon is given by two classical hypotheses: Gibbs et al. (1936) who first described the EEG pattern favored a cortical dysfunction as a cause of the seizures, while Penfield and Jasper (1954) proposed that activity from a centrencephalic pacemaker, which included structures of the brain stem and the thalamus, radiating up on the cortex, gave rise to the bilaterally synchronous spike-wave activity.

Petsche (1962) concluded that although subcortical structures may have some influence, the spike-wave pattern itself is formed in the cortex.

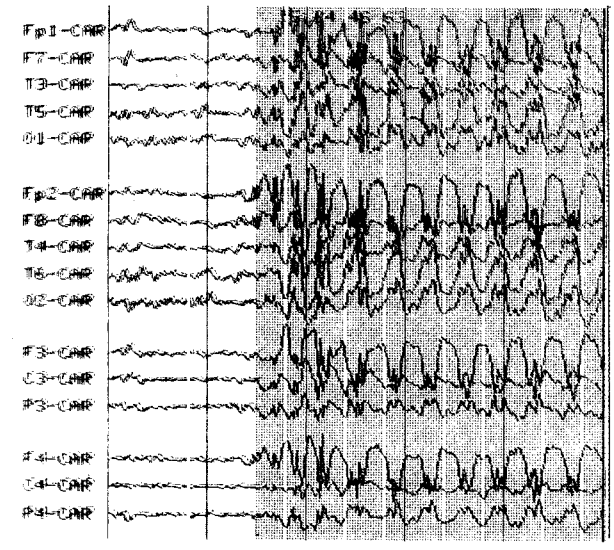
Today the generally accepted explanation derives from the work of Gloor (1984). It proposes a cortical neuronal hyperexcitability, which gives rise to spike and wave bursts reflect oscillations between excitation (spike) and inhibition (wave) in connected thalamo-cortical neurones. Thus this theory involves both thalamus and cortex in the origin and maintenance of spike wave activity and is a combination of the two classical hypotheses.

Aird et al. (1989) consider absence seizure not to be categorized as a generalized form of seizures along with generalized tonic- clonic seizures (GTCS), since absence seizures arise from a much more limited involvement of CNS (cortico-thalamic and cortico reticular systems) rather than the entire brain as seen in GTCS.

Materials and Methods A selective group of twenty five children with age range between 5-12 years (fifteen males and ten females) with typical petit mal absences as defined by the Commission on the Classification and Terminology of the International League Against Epilepsy (1989) were studied. All children had normal mental and neurological status. Children with neurological deficits, mixed types of seizures or atypical EEG records were excluded.

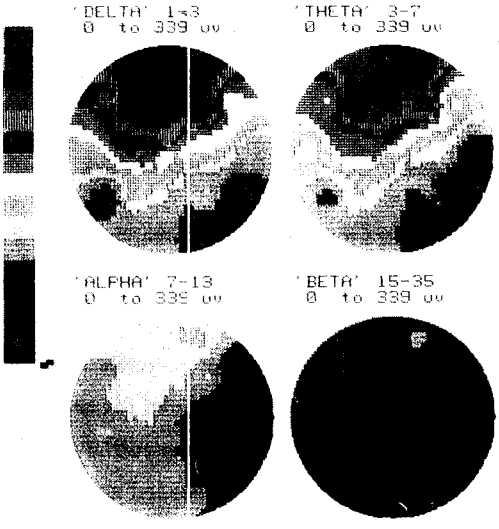
All children had topographic EEG mapping using 16 channels Neuroscope-Dantec-machine, where 16 scalp electrodes were applied according to the 10-20 system with earlobes reference to collect 16 channels EEG data. Five minutes of EEG data were collected for each of the eyes closed, eyes open and hyperventilation. The segments free of artifacts were recorded and stored on magnetic disc for subsequent evaluation and analysis. Spike-wave complexes were analyzed by the system which allows visual inspection of EEG traces on a color monitor and selected segments were summated and different color maps representing voltage levels were reconstructed. All children had normal EEG background activity. The duration of the primary bilateral synchrony of 3 c/s spike-wave varied from 3-5 sec. to 10 sec. None of the patients had interdischarge focal EEG abnormalities.

PETIT MAL EPILEPSY



PRIMARY BILATERAL SYNCRONY

PETIT MAL EPILEPSY



Results Twenty two children (22/25) showed maximum power of the discharges in the antero-medial areas of the frontal regions with right hemispheric predominance in thirteen children.

Three children (3/25) had more than one focus: bifrontal and right anterior temporal. Five children had jerking of the eyelids consistently associated with the discharges during hyperventilation.

Discussion Brain mapping topography showed that even the most typical 3 c/s spike-wave complexes were neither truly generalized nor bilaterally symmetrical or synchronous. In this study brain mapping EEG was applied to twenty five children with typical petit-mal absences in an attempt to delineate the origin of the classic 3 c/s spike-wave complexes, where they occur initially and how they involve neighbouring areas during their development. The results of this study revealed that twenty two children showed maximum power of the discharges in the frontal regions, a finding in agreement with the data previously presented. The frontal maximum which has been known to exist since the original description of the pattern by Gibbs (1936) involves, however, not only the lateral but also the medial surfaces of the hemispheres.

Niedermeyer (1982) has suggested that the supplementary motor areas are the structures responsible for frontal midline maximum and that the cingulate gyrus may contribute to a considerable extent. The cingulate gyri are in close opposition that allow the rapid spread of the discharges through the corpus callosum without having to descend first to the diencephalic structures. Gloor (1984) proposed a cortical neuronal hyperexcitability which gives rise to spike and wave discharges. Many authors have suggested that the neuronal hyperexcitability could be due to increased activity in excitatory neurones or decreased activity in inhibitory neurones (*Meldrum, 1982; McNamara, 1984; Woodbury, 1984*).

Depaulis (1992) pointed to the existence of a system exerting inhibitory control over generalized tonic-clonic seizures and absence seizures involving the neurones from the substantia nigra, the GABAergic nigro-collicular pathway.

Warter et al. (1988) also have suggested failure of the arousal-mediating catecholaminergic neurotransmission controlling neocortical activity.

In this study, the finding of right hemispheric predominance may be considered surprising.

3 c/s spike-wave complexes in the anterior right paramedial frontal region.

To what extent the right hemisphere is involved in the pathogenesis of some of the field changes in petit mal absences, is at present an open question.

Three children had more than one focus:
Bifrontal and right anterior temporal foci, a finding that has been observed by other authors. However, Rodin et al. (1987) found that although the maximum electric fields were in the frontal areas, but successive spike-wave complexes within one seizure could show different origins and different spread of the field.

The findings suggest that several intracortical generators contribute to the formation of the spike and wave complexes. Thus the involvement of the temporal regions may result from rapid propagation of focus from the frontal lobe along preferential pathway such as the uncinate fasciculus and the cingulum which link the frontal lobe to the temporal region.

Conclusion The reported study is only one step in the light of confusion surrounding the pathophysiology of petit mal absences. The field of epileptology is growing and as a result there is more interest in the study of the basic mechanisms underlying the generation, propagation and control of seizures. Many questions remain unanswered and require additional experiments, neuro-imaging techniques and the involvement of more workers in the field.

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تحديد منشأ الموجات الصرعية الصغرى فى القشرة المخية باستخدام رسام المخ التوبوجرافى

هدف هذا البحث هو استخدام رسام المخ التوبوجرافى فى تحديد أصل الموجات الكهربية المميزة للنوبات الصرعية الصغرى والمكونة من مجمع شوكة وموجة يناب ثلاث مرات كل ثانية وكيفيه انتشارها الى ما يجاورها فى المناطق الأخرى. ويشمل البحث مجموعة مختارة من خمسة وعشرين طفلاً تتراوح أعمارهم بين ٥-١٢ عاماً ويعانون من نوبات صرعية صغرى ولم يظهر أحد منهم أعراضاً تدل على وجود أى مرض عصبى أو عقلى.

وبتحليل هذه الموجات الكهربية المميزة باستخدام رسام المخ التوبوجرافى أظهر اثنان وعشرون طفلاً أقصى قوة لهذه الموجات فى مقدمة الجانب الأمامى بينهم ثلاثة عشره طفلاً تسود فيهم نصف الكرة المخى الأيمن، بينما أظهر ثلاثة أطفال أكثر من بؤرة لكل منهم فى مقدمة الجانب الأمامى والفص الصدغى الأيمن.

وتمت مناقشه النتائج فى ضوء الأبحاث التى تناولت هذا الموضوع. وتدل نتائج البحث أن مقدمة الجانب الأمامى لها دور أساسى فى تكوين هذه الموجات الكهربية المميزة، كذلك توحى بوجود علاقة لنصف الكرة المخى الأيمن بنشأة هذه الموجات.