MIRROR FOCUS: HOW CAN IT BE MONITORED?

D. Debatisse, S. de Ribaupierre, E. Pralong, J. G. Villemure
Neurosurgery Department, CHUV, Lausanne, July 2005

FUNCTIONAL HEMISPHERECTOMY

Functional hemispherectomy (FH) is indicated in severe refractive epilepsies (e.g., Rasmussen encephalitis, Sturge-Weber disease, porencephaly) (Villemure). Indeed, it consists of a resection of the central region, combined with the disconnection of the frontal and parieto-occipital lobes, which are left in place, from the thalamo-cortical and base-ganglo-cortical connections. That is, FH allows to obtain recordings from frontal and parieto-occipital lobes that are free from all ascending (or reverberating) subcortical influence, but in whom the cortico-cortical connectivity is left intact.

MIRROR FOCUS EPILEPSY

The classical understanding of epileptogenic focus is a cortical region whose neurons are undergoing an abnormal, intransient or permanent, electrical and biochemical activity, with or without clinical repercussion. There are structural alterations (such as hippocampal sclerosis, brain neuma and cerebral edema) responsible for these perturbations. Neurons localized in such an epileptic activity have the capacity to generate a paroxysmal depolarization shift by hyperthronization of all neurons concerned, with or without external input. This activity can be observed by means of electroencephalography (EEG), electrocorticography (ECoG), intracranial EEG, and modern techniques such as magnetoencephalography (MEG), positron emission tomography (PET), single photon emission computed tomography (SPECT), functional magnetic resonance imaging (fMRI), and positron emission tomography angiography (PET-angiography).

The modern theories are based on the concept that cortex above can generate an epileptic crisis, even in generalized epilepsy (Jules Robert, 1964). The mirror focus, or secondary epileptogenic focus, arise in the contralateral homotopic area within days or weeks of the original epileptic focus. These two phases of development are the dependent and the independent stage. During the initial dependent stage the secondary focus has two phases, the primary focus activity which reflects the synchronous synaptic discharges coming through calosal connections from the original focus (therefore the “mirror focus” name). For a dependent focus to become independent, there is a need for cortico-thalamic network integrity. In epilepsy surgery the phase of the secondary epileptic focus is important as we might think that a dependent focus will vanish after resection of the epileptic source, while an independent focus will be affected by resection of the primary focus. Of course, the mirror focus is not either dependent or independent but might be in between the two stages.

A new METHODOLOGY for neuromonitoring during epilepsy surgery

We have not encountered in the literature any methodology that would enable us to prove that mirror focus does exist and that surgery can be a way to cure it. Furthermore, even if intra-operative neuromonitoring has been done (spikes chasing during epilepsy surgery has been done for a long time), there were no intra-operative methods described to show that functional hemispherectomy or even lesionectomy has an impact on mirror focus epilepsy. We studied and documented multifocal epilepsy, with dipole analysis and continuous neuromonitoring, in three children while they underwent a functional hemispherectomy and in one during lesionectomy for medically intractable epilepsy. They all benefited from a preoperative and postoperative EEG. The supplement was intra-operative monitoring with continuous contralateral EEG and « snap shot » ipsi-lateral corticography which was done at different moments during the surgery. All the data was then interpreted with dipolar analysis. This new methodology enabled us to have a visual follow-up of the epileptic activity, continuously for the contralateral hemisphere and at different operating times, in order to follow the epileptic phenomenon on the ipsi-lateral hemisphere.

POPULATION

Case 1 : 5-year-old boy suffering from a prenatal vascular lesion (left ponsopahlial cavity) resulting in a mild hemiparesis associated with developmental delay. FH was decided on the basis of a secondary severe regression with refractive epilepsy (electrical status epilepticus during sleep and wakefulness: ESES).

Case 2 : 7-year-old boy suffering from a prenatal/lesseremic ischemic lesion with an important atrophy. Clinically, he had a mild hemiparesis. FH was justified by an important developmental delay associated with a refractive epilepsy (ESS).

Case 3 : 17-month-old girl with a T1 neonatal encephalopathy and a suspicion of a Sturge-Weber disease. She rapidly developed a severe encephalopathy resulting in an important left hemiparesis associated with developmental arrest and severe refractory epilepsy. Her background EEG showed a very low-amplitude signal on the left side and diffuse epileptic activity in the right, contralateral hemisphere.

Case 4 : 4-year-old girl who developed epilepsy at the age of 3½ years on an epilepsy at left polar frontal lesion. A first operation with partial resection of the lesion did not improve her epilepsy. The EEG showed spike and wave epileptic discharges on the left frontal lobe (17) and sometimes generalized epileptic activity predominantly on frontal regions.

DISCUSSION and conclusion:

We propose here a new methodology in neuromonitoring consisting of intra-operative contralateral continuous EEG associated with « snap shots » ipsi-lateral corticography (CoEEG) in order to study mirror focus epilepsy.

Cette méthode nous a permis une meilleure compréhension des mécanismes intervenants dans ces epilepsies dramatiques, pourrait être d’une aide dans les algorithmes décisionnels à la chirurgie ainsi que pour les stratégies opératoires.

The consistent study of multifocal epilepsy might help us in a better understanding of electrogeneis and pathophysiology in mirror focus epilepsy, in providing arguments for early surgical intervention in such problems and maybe in the planning of operations in assessing the degree of independence of the secondary foci.