NEUROPHYSIOLOGIC BASIS OF CONSCIOUSNESS. ROLE OF THE RETICULAR ACTIVATING SYSTEM

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Neurophysiologic basis of consciousness is still "terra incognita". The crucial discovery of the importance of reticular activating system (RAS) in maintenance of consciousness is done by Moruzzi and Magoun (1). This experiment done in cats has been essential for our understanding of RAS in the maintenance of consciousness and its disorders caused by its damage.

So far we still do not have reliable methods to evaluate dysfunctions of RAS. We are facing this problem in everyday practice dealing with the comatose patients suffering from cerebral hypoxia/ischemia.

So far imaging techniques can give us only limited information about dysfunction of RAS, while neurophysiologic testing can give us more information. It is still not sufficient enough to quantify RAS damage as well as to predict recovery, especially if the patient is in the vegetative state or minimal conscious state as a paradigm of major dysfunction of RAS.

Even we do not know the exact mechanism of consciousness and its disorders, using DBS of main RAS thalamic nuclei, as a therapeutic method in patients with VS/MCS has given us promising results. It has been shown that DBS could have significant therapeutic impact for those pathologies (2).

Using a similar approach we tried DBS in 2 MCS patients suffering from hypoxic encephalopathy caused by cardiac fibrillation. The results were very good and both patients regained full consciousness with recovery of high cortical functions after being stimulated intermittently for 2 months. Pre implantation testing by multimodal neurophysiologic methods in both patients showed: bursting of beta activity in 12 hours continuous processed EEG, presence of cortical somatosensory evoked potentials (SEPs) from upper and low extremities, motor evoked potentials (MEP) from upper and low extremities, and brain stem auditory evoked potentials (BAEP). Imaging technique (MRI) showed moderate cerebral atrophy, while positron emission tomography (PET) showed hypometabolism of glucose in the motor cortex and subcortical grey matter.

In an attempt to explain the very good recovery of those two patients, we speculate that certain ischemic encephalopathy caused by cardiac fibrillation produce reversible damage of the thalamic grey matter (RAS nuclei) while not affecting cerebral cortex. Support for this hypothesis is neurophysiologic and neuroimaging evaluation, showing functional integrity of the cerebral cortex, corresponding to the good clinical recovery. It is highly probable that DBS restores function in hipoxic/ishemic lesion of the RAS.

References:

1. Moruzzi G, Magoun HW. Briain stem reticular formation and activation of the EEG. EEG Clin Neurophysiol 1: 455, 1949
2. Tsubokawa T, Yamamoto T, Katayama Y, Hirayama T, Maejima S, Moriya T. (1990) Deep brain stimulation in a persistent vegetative state: follow up results and criteria for selection of candidates Brain Inj 4: 315-27.