



## Migraine and Neurophysiology

### Introduction

- Neurophysiological techniques allow us to study the current activity of the nervous system. In daily clinical practice, these recordings are very helpful in the diagnosis of neurological diseases such as epilepsy or neuropathies.
- Migraine is a *primary* headache, i.e., there is not an underlying macroscopic structural lesion, but a dysfunction of the central nervous system (CNS) at several levels. Like other primary headaches, migraine is characterized by ictal (during the headache), peri-ictal (before the headache), and interictal (between headaches) periods. Migraine is the generic term used to define a headache with certain specific symptoms, but it is actually a complex and heterogeneous disorder.
- In the case of migraine, the contribution of neurophysiology to *diagnosis* is limited, with few exceptions. However, the techniques can be useful in the assessment of CNS dysfunction, i.e., in understanding the *pathophysiology* of the disease. Neurophysiology can also be used to understand the effect of migraine *treatments*. Therefore, neurophysiology is mainly dedicated to clinical research in migraine.

### Main Neurophysiological Tools

Neurophysiological tools used in migraine research are noninvasive, and most of them are portable devices that are accessible at a relatively low cost. The main techniques are electroencephalography (EEG and more recently magneto-EEG or MEG, a recording of spontaneous cerebral activity), evoked potentials (EPs, i.e., cerebral activity recorded in response to a visual, auditory, or painful stimulus), and the nociception-specific blink reflex (nsBR, an evaluation of trigeminal nociception). Another important tool is transcranial magnetic stimulation (TMS), which can modify brain excitability.

### Short Summary of Neurophysiological Findings in Migraine

On average, most interictal recordings have disclosed two main findings:

- 1) A *decreased preactivation* level of the brain, which can be normalized by repetitive TMS and might be due to a reduced activity of connections between the thalamus, a subcortical structure, and the ipsilateral cortex.
- 2) A *reduced habituation* to various repetitive stimuli. Habituation is a physiological mechanism and a form of learning in which there is a decreased response to a stimulus after repeated exposure to that stimulus over time. This phenomenon appears to be defective in migraineurs.
  - These brain abnormalities of migraineurs were found at both cortical and subcortical levels and were normalized during the headache and in the peri-ictal period.
  - Contradictory results were found by some authors (increased excitability, no lack of habituation) or in particular subtypes of migraine (greater habituation in familial hemiplegic migraine). These results underscore the heterogeneity and complexity of the disease.
  - It is important to mention that these results are the statistical conclusions of group analyses and cannot be applied to individual patients.

### Take-Home Message

- Neurophysiological recordings cannot be used for migraine diagnosis as their outcomes result from group analyses.
- Between attacks, the brain of migraineurs is characterized on average by a reduced preactivation level and an impaired habituation to repeated stimuli. These phenomena could play a role in migraine genesis

## References

- [1] Bohotin V, Fumal A, Vandenneede M, Gérard P, Bohotin C, Maertens de Noordhout A, Schoenen J. Effects of repetitive transcranial magnetic stimulation on visual evoked potentials in migraine. *Brain* 2002;125:912–22.
- [2] Coppola G, Ambrosini A, Di Clemente L, Magis D, Fumal A, Gérard P, Pierelli F, Schoenen J. Interictal abnormalities of gamma band activity in visual evoked responses in migraine: an indication of thalamocortical dysrhythmia? *Cephalalgia* 2007;27:1360–7.
- [3] Magis D, Ambrosini A, Bendtsen L, Ertas M, Kaube H, Schoenen J; EUROHEAD Project. Evaluation and proposal for optimization of neurophysiological tests in migraine: part 1: electrophysiological tests. *Cephalalgia* 2007;27:1323–38.