INTRODUCTION

Mental disorders and brain abnormalities are always the main challenge for physicians as such dysfunctions have permanent adverse effects on the patient. To yield better outcomes, robust and objective information are needed for all sorts of diseases in this field. Using recent advances in the diagnostic tools and protocols, supplementary information help researchers to manifest more detailed studies through signs and symptoms of psychosomatic abnormalities. Efficient management of neuropsychiatric disorders requires great effort and exact long-term follow-up for better convalescence. Here, we discuss about the number of brain disorders and treatment techniques. This study was aimed to comprehensively review recent advances in diagnostic and therapeutic techniques based on electrophysiological signals for chronic headaches, particularly migraine. The associations between electrophysiological signals and cognitive impairments of abnormal brain functions, particularly chronic headache are discussed. Our focus is on the new neuromodulation and neural self-regulation techniques such as neurofeedback along with biosignal processing in the both diagnosis and treatment of the disorders.

Cognitive functions of the brain

Analysis and determining the correlation of electrophysiological data with brain pathophysiological states, has a long precedent in diagnostic procedures. Most of the brain cognitive functions originate from the coordination interactions of so many neurons, which are distributed in specialized brain zones. The process of segregation and integration of neural activity essentially must be occurred at different spatial and temporal scales. Moreover, these scales should be dynamically adjusted and the circumstance which the adjustment takes place upon, depends on the nature of the respective cognitive tasks. Based on the distributed organization of the sensory system, integration of responses across various regions of the cortex, has a fundamental role in the representation of sensory objects[1].
Brain cognitive dysfunctions

Cognitive disorders are attributed to the category of mental abnormalities which affect memory, learning and perception in the early stages and involve amnesia, dementia and delirium. The main risk factors of cognitive disorders can be classified into tumours, strokes, closed-head injuries, infection, and exposure to neurotoxins, genetic factors, and disease. However, as a critical item, the physician must distinguish between history, risk factors, and treatment methods of each problem; as the prognosis of the cognitive disorders is directly dependent upon the right primary diagnosis. Throughout the above implication, several cognitive symptoms may be found, which indicate the need of an advanced examination; some of the more common symptoms are confusion, rapid changes in mental states, poor short-term memory, problem with critical thinking, planning, organization and attention, decrease awareness of self or surrounding (delirium contains both cognitive and consciousness abnormalities), and slowed processing speech. Generally, the symptoms of cognitive disorders vary depending on specific type but the clinical findings, introduce “problems with the brain’s ability to process information or recall”, as the most common symptom.

Migraine headaches

Soon by the progression of the industrial life and the accelerating phase of stress and anxiety in the most of the people life style, migraine headaches come up to see with the considerable number of human beings. Migraine as a neurological disorder is followed by a primary neuronal dysfunction (primary CNS), which subsequently results in intracranial and extracranial changes; characterized by paroxysmal attacks, which are symptom-free intervals between them. Meanwhile, special systemic signs will be appeared due to the central mechanisms; including: nausea, vomiting, drowsiness, diplopia and respiratory problems. Besides, the clinicians know migraine as a debilitating disorder in various levels of brain impairment and systemic effects, it may impose on numerous sections like economic costs on society, employment, household work, and so many other related problems may possibly be burdened on sufferers. Thereby in the first step, the most crucial goal comprised in the capacity of vital standards is focusing on differential diagnosis simultaneously with an exact evaluation of the detailed classic features of each specific disorder. Several diseases are associated with cranial cavity, and several other structures in the body can mimic signs and symptoms of migraine. Therefore, the exaggerated significance of conclusive diagnostic techniques such as electroencephalography and close monitoring of the patient, can be seen. Therefore, all the above-mentioned conditions should be taken into account when choosing an effective treatment for migraine.

In general, headache syndromes can be associated with focal neurological symptoms. Overall, long lasting headaches with the duration more than weeks or months are known as neurological disorders, which are frequently caused by structural brain lesions. Throughout the recent researches, we can sub classify the headaches of which the neurological symptoms occur prior to the headache attacks, in the group of benign abnormalities. In the cases are mostly seen due to the structural lesions of the brain, clinical symptoms will be appeared during headache and in the post headache phase (Fig. 1). Nevertheless, hemiplegic migraine onset and preceding phase are a little different; after migraine accompany with aura, the most common headaches in relation with focal neurological signs are cluster ones associated trigeminal autonomic cephalalgia. However, a perfect evaluation

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**Fig. 1** Headaches with focal neurological signs and symptoms.
Migraine headache theranostics

Electroencephalography and chronic migraine

During the recent years, a line of research has been devoted to identification and developing diagnostic criteria using biosignal and physiological data for the early diagnosis of different disorders. EEG-based measures because of good temporal and spatial resolution of EEG, are good candidates for developing such databases. In this regard, EEG-based indices have been the first option for developing diagnostic criteria for migraine. In case-by-case evaluation of patients afflicted by migraine, unspecific EEG rhythms were detected subsequent to the drowsiness and hyperventilation. However, the prevalence of definitely abnormal EEG detection in patients is not high. Several controlled and blinded trials have shown specific features such as slow waves, suppression of background activity amplitude during visual aura. In this regard, the most certain abnormal EEGs have been found with unilateral or bilateral data activity, which recorded in interictal phases of hemiplegic migraine and those cases with disturbed consciousness as well. This survey may sometimes lead to misdiagnosis because it may be difficult or somehow impossible to clarify the differences among migraine and epilepsies headaches.

The emerging of neuroimaging techniques in line with more specific and detailed diagnostic techniques for the pathophysiology of diseases associated with the cranium and brain, has recently increased the accurate diagnosis of such disorders. Before neuroimaging era, the application of EEG as a frequent method, led the clinicians to the valuable information. For migraine data analysis of analogue EEG, several abnormal patterns were reported; including: focal slow activity, spike activity, posterior quadrant slow wave abnormality, generalized slow activity, low amplitude and distinct hyperventilation response (Fig. 2); it has been said that hyperventilation by the mechanism of increasing the repulsing of carbon dioxide, induces vasoconstriction to the brain blood vessels, which will be followed by different levels of low perfusion states for the brain structures.

Historically, EEG abnormalities in headache syndromes were described initially by Engel et al. "Dysrhythmic migraine" was the term attributed to the group of patients with the paroxysmal high voltage abnormal slow wave activity.

Neurophysiological features of paraclinical anxiety

Anxiety disorders are characterized by emotional states associated with behavioural impairment as well as somatic complications. From the very beginning, we should distinguish ben anxiety and fear; as fear is a normal response to a preserved threat due the "fight or flight responses".

There are currently several medications for the treatment of both anxiety and depression disorders. However, medications are associated with significant side effects. Biofeedback techniques are new and efficient approaches with the least side effects that have evoked the physicians to concentrate on non-pharmaceutical methods.

There are different types of biofeedback techniques, which are based on the physiological components of anxiety disorders, are demonstrated to have prolonged or to some degree persistent therapeutic effects. In between, panic and anxiety disorders have different manifestations in comparison with each other. Panic
disorder is known by brief periods of massive autonomic arousal which may be accompanied by a simple tachycardia, while generalized anxiety is associated with persistent worry. Under this circumstance, muscle tension and physiological consequences of the prolonged tension may be seen as headaches and muscle soreness. Several studies demonstrate that accompaniment of the biofeedback technique with psychotherapy and/or medication can be well efficient.

**Biofeedback and brain disorders**

Electromyography signal is the first biological signal used for biofeedback system where EMG signal usually provides auditory feedback—reflecting the electrical activity of the muscles. Therefore, it could be an indicator of muscular tone. By the early research, frontalis EMG feedback has been suggested. For this purpose, sensors should be placed on the forehead or frontal bone, the site with high sensitivity to the muscle tension induced by anxiety moreover is able to detect therapeutic alterations and the outcomes of the treatment. Several studies during early 1980s demonstrated the self-organizing principles of the brain, which was later known as neuroplasticity or brain plasticity. Based on this concept, another form of biofeedback known as electroencephalogram (EEG) biofeedback, neurotherapy or neurofeedback (NF) was proposed through which genetic and environmental tendencies are counterbalanced due to learning to alter brain wave patterns. NF is a biofeedback for the brain where the values of specific physiological variables or cognitive functions are voluntarily modified using the biosignals recorded from and feedbacked to the subject.

In an NF system, the EEG electrodes are placed on the scalp to convey the electrophysiological signals of the brain into a software package where these signals are converted into appropriate forms of visual, vibratory, or auditory and then transferred to a display based on the fluctuation of EEG signals. After initial preprocessing and artifact elimination, the signals are separated into three main frequency bands: slow (up to 7 Hz); medium (8–12 Hz); fast (13–21 Hz). Higher frequencies are associated with the higher level of arousal states and mental activities and physical state of the subject. Frequencies higher than 21 Hz are associated with excessive autonomic arousal from anxiety to anger, while very fast rhythms, above 40 Hz (gamma), fulfill functions beyond arousal. The feedback software gives a signal (auditory, visual, or vibratory) when the patient produces more normal brainwaves at least in 60–70% of the session.

The main procedure in NF is measuring brain waves to produce a signal, which acts as a feedback and can induce self-regulating function of the brain. Several preclinical and clinical trials have shown that EEG biofeedback is a promising therapeutic approach for several neuropsychiatric disorders and brain dysfunctions including anxiety, aggression, autism, depression, pain, insomnia, headaches, trauma, and epilepsy. In addition, several controlled studies have demonstrated the efficacy of NF for improving cognitive functions in healthy individuals, the outcomes which have been used in different fields to enhance the occupational performance of individuals in sport and different jobs with special cognitive capacities. The feedback signal depending on the approach, can be auditory, vibratory, or visual.

**Heart rate variability**

Heart rate variability has been initially applied to panic disorders where the mechanisms of tachycardia and autonomic activities are central. The HRV is generally associated with the level of autonomic activity. In this regard, if we pose upon the detailed interpretation, possibly we can gain more specialized information related to the action of SNS and PNS. Three fundamental components of HVR are as follows:

- Quick, high frequency (related to respiration is used as vagal tone index)
- Mild frequency (in relation to blood pressure and is influenced by sympathetic nervous system and the parasympathetic nervous system)
- Low frequency (associated with temperature, vasomotor, hormonal and metabolic regulation which is primarily regulated by means of SNS)

**CONCLUSION**

Brain abnormalities and mental impairment are such serious and pervasive illnesses, which require conclusive methods of diagnosis prior to a meticulous way of treatment. Throughout the above-mentioned basic information, the significance of biosignal analysis have been proved but yet there is a controversy in applying a combination of biofeedback technique with other routine methods like psychotherapy and medication.

**REFERENCES**