Auditory Evoked Potential in Patients with Tinnitus

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Percieving sounds in the absence of stimulus from an external sound source is referred to as tinnitus [1-3]. Unlike auditory hallucinations, tinnitus is generally an indication of damage to the auditory system, which may be accompanied by hearing loss and vertigo. Tinnitus may result from acoustic trauma and has even been reported among patients with depression. Research has shown that tinnitus occurs in approximately 10-25% of the world's population; however, only 0.5%-1.6% seeks medical assistance [1,4]. In some cases, the symptoms may be severe enough to affect sleep and everyday activities. Patients with tinnitus may be prone to emotional exhaustion, anxiety, and poor concentration.

Opinions differ as to the causes of tinnitus. Until 1980, it was believed that tinnitus originated in the hair cells of the cochlea [3]. Even today, the physiological mechanisms underlying tinnitus are still not completely understood. Several scholars have advocated that tinnitus stems from cochlear lesions; however, opinions differ regarding whether tinnitus is caused by the activation or suppression of auditory nerves in the cochlea. Evans et al. claimed that auditory nerves in the cochlea of tinnitus patients are suppressed [5]. However, recent research has revealed that the peripheral auditory system is not the only source of tinnitus [6]. In fact, the pathways from the cochlea to the auditory cortex have been implicated in this condition. There is even the possibility that psychological factors play a role, and researchers have noted a correlation between tinnitus and exposure to high-stress environments for prolonged periods of time [1]. Studies have shown a correlation between tinnitus and abnormal cognitive function [2]. This would indicate that the causes of tinnitus extend beyond the auditory system to higher-order cognitive processing.

Numerous researchers are looking into event-related potentials and their link to tinnitus. It appears that tinnitus patients are more susceptible than normal individuals to cognitive processing issues, in terms of information recognition and the analysis of auditory endogenous sounds. Overall, the causes of tinnitus extend beyond the auditory system to cognitive processing, psychological factors, and even emotional stress [7].

The human auditory system consists of the outer ear, the middle ear, and the inner ear. The outer ear includes the auricle and ear canal. The middle ear cavity houses the ossicular chain through which sounds are amplified and transmitted into the inner ear. The inner ear comprises the cochlea and auditory nerves. Sound waves received by the ear undergo a series of transductions, from sound waves into mechanical energy, which is then converted into electric signals by the cochlea in the form of nerve impulses. No sounds are perceived until these nerve impulses are processed by the brain. Electrical signals from the nervous system can be detected by epidural and intra-epidermal electrodes. The signals produced by the nervous system in response to specific stimulation are referred to as evoked potentials. In cases where the stimulation source is a sound signal, the responses are called auditory evoked potentials. Based on a specific time frame, these potentials can be further classified as short, middle, or long latency potentials. Short latency potentials can be recorded using the following methods: electrocochleography, auditory steady-state response, and auditory brainstem response. Middle latency potentials include the auditory middle latency response. Long latency potentials include long latency response, P300, and mismatch negativity [8,9].

Tinnitus is not caused merely by the peripheral auditory system. It is possible that the central auditory system also plays a significant role, which means that tinnitus may also be associated with cognitive processing abnormalities or attention deficit disorders. Auditory evoked potentials provide a non-invasive means by which to record the electrical signals of neural activities from the scalp, thus provide a useful tool for the evaluation of auditory disorder, such as tinnitus and hearing loss [10].

ARTICLE INFORMATION

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