Simultaneous Recordings of Human Auditory Potentials: Transtympanic Electrocochleography (ECoG) and Brainstem-evoked Responses (BER)

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Summary. The simultaneous recording of the electrocochleography (ECoG) and the brainstem-evoked responses (BER) enables the I-V interval to be known easily and thus increases the reliability and prognostic value of electrophysiologic measurements of the auditory system.

The correlation between the first negative peak of the action potential (N1 in ECoG) and the wave I (BER) is evident.

Simultaneous recording of the ECoG and the BER objectifies other correlations, especially N2 and wave II.

Wave I, like Wave II, would result from the summation of the cochlear nerve responses and those of the cochlear nuclei. Wave I would be the early cochlear responses and wave II the late cochlear responses corresponding to the high and low responses, as described in ECoG.

Key words: Electrocochleography — Brainstem-evoked responses

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Introduction

Electrocochleography (ECoG) analyses the first bioelectric potentials evoked by acoustic stimulation, produced from the organ of Corti and the cochlear nerve. These are, on the one hand, sensorial responses — cochlear microphonic potential (CM) and summating potential (SP) — and on the other hand the action potentials (AP) of the cochlear nerve fibres.

In clinical audiology, two types of AP are studied:
1. whole-nerve action potential (WNAP) obtained by wide-band click stimulating virtually the entire basilar membrane;
2. compound action potential (CAP) resulting from more limited stimulation of the cochlea by more specific acoustic stimuli (e.g., tone bursts).

The WNAP is characterized at high intensity (e.g., 100 dB H.L.) by a first negative peak (N1) followed by a second, less ample, negative peak (N2) (Fig. 1). On decrease in the intensity of the acoustic stimulus, the N1 amplitude decreases while that of N2 increases. Towards 50 dB HL, the AP may take the shape of a “W”. At very low intensity, it is often only N2 that is discernible [1]. As amplitude decreases, latency time increases.

Study of the derived action potentials [2, 3] and the results obtained in the case of recruitment lead one to think that (a) the early components of AP (N1) correspond to the nerve responses originating from the basal turn of the cochlea and are preponderant at high intensity and (b) the late components (N2) correspond to those from the second turn of the cochlea and are preponderant at low intensity.

The normal electrocochleogram has therefore a twofold response: (1) early, corresponding to N1 and the basal cochlear turn known as the High or H-response [4], and (2) later, corresponding to N2 and the second cochlear turn, known as the low or L-response.

The brainstem-evoked (or electrical) responses (BER) are those from the evoked auditory potentials of the cochlea and brainstem recorded by surface electrodes. The normal early evoked response shows seven successive positive waves with respect to vertex (Fig. 1). For each wave there would appear to be several generators, even bilateral generators. Classically [5], the simplified neurophysiologic correlation is the following: acoustic nerve (wave I), cochlear nuclei (II), superior olivary complex (III), lateral lemniscus (IV), inferior colliculus (V), medial geniculate body (VI), and auditory radiations (VII). Each wave is the summation of several neuronic groups that come into activity during one and the same space of time [6].

In otoneurology, the aim is to establish the latency times of the three most readily identifiable waves: I, III, and V. The interval of time between two waves (I–III, III–V, and I–V) is of major importance since it represents the time of conduction between two nerve relays.

From a diagnostic point of view, the interaural latency differences (IT) have the highest value, chiefly the IT V and IT I–V. Their mean value is nil in the normal subject [6]. Study of IT is the best test for the diagnosis of retrocochlear auditory pathology.