ELECTROPHYSIOLOGICAL MEASUREMENTS AND SPEECH-CODING STRATEGIES

Perioperative, transtympanic electric ABR in paediatric cochlear implant candidates

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With patients aged one year and younger considered for cochlear implantation, it is important to assess the suitability of an ear for implantation by preoperatively determining its electrical excitability. In a previous publication (Kileny et al., 1994), we described a technique to preoperatively obtain electrically evoked auditory brainstem responses (EABR) with transtympanic stimulation. This procedure is typically carried out in the operating room under general anaesthesia and neuromuscular blockade. Stimuli are delivered by a needle electrode placed transtympanically on the cochlear promontory. A custom-designed battery-operated stimulator requiring a trigger pulse from an evoked potential system is used to deliver the signal. This stimulator is capable of delivering biphasic pulses with an output limit of 999 μA. Pulses have a typical duration of 200 μs per phase and the EABR is recorded with a contralateral ear reference. In our clinic, we perform pre/perioperative transtympanic EABR on all patients who meet the following criteria:

- confirmed temporal bone malformation
- uncertain preoperative audiometric threshold due to the patient's young age or developmental status
- preoperative audiometric thresholds exceeding the limits of audiometer.

The current study was designed to: (a) evaluate the effects of age on the latency of the EABR wave V; (b) define the relationship between EABR thresholds and preoperative pure tone average (PTA); and (c) investigate the effects of aetiology of hearing loss on the latency of the EABR wave V. Subjects consisted of 59 children who underwent EABR at the time of their implant surgery.

To evaluate the effects of age on the latency of EABR wave V, subjects were divided into two age groups. Group 1 consisted of 29 'young' children aged 10–36 months and group 2 consisted of 30 'old' children aged 37–60 months at the time of the perioperative EABR. The younger group demonstrated a mean wave V latency of 4.3 ms while the older group demonstrated a mean wave V latency of 4.4 ms. A t-test revealed that this difference was not statistically significant.

Figure 1 (below) illustrates EABR sequences obtained from three patients with congenital hearing loss aged 18 months, 14 months and 13 months at the time of EABR testing.

To analyse the relationship between EABR thresholds and PTA, EABR thresholds from the 59 subjects were divided into two categories: 'low' (600 μA or less, 42 subjects)

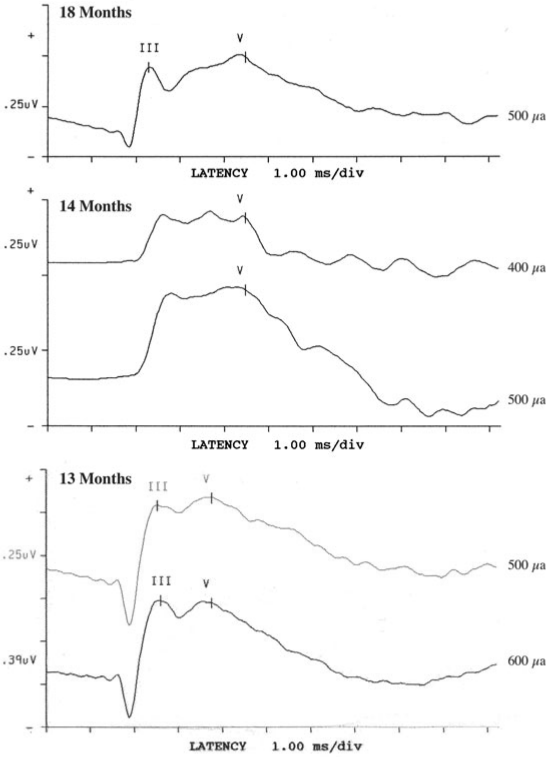

Figure 1: EABRs from three patients, aged 18, 14 and 13 months.

and 'high' (650 μA and above, 17 subjects). The 'high' EABR threshold group presented with a mean PTA value of 117 dB, HL (s.d. = 9.9). The 'low' EABR threshold group was associated with a mean PTA value of 109 dB, HL (s.d. = 10.1). This difference was determined to be statistically significant by an unpaired t-test ($t = -2.32$; $p = 0.014$).

The relationship between aetiology of hearing loss and EABR wave V latency was investigated by dividing the subjects into three groups based on their aetiology. For the subjects with congenital cochlear malformations ($n = 11$) mean wave V latency was 4.5 ms (s.d. = 0.71), and for those with unknown aetiologies ($n = 40$) it was of 4.3 ms (s.d. = 0.42). Subjects who lost their hearing following meningitis ($n = 8$) demonstrated the longest mean latency of 4.9 ms, with a standard deviation of 0.57. These differences did not reach statistical significance.

Our finding of similar wave V latencies for our 'younger' and 'older'" age groups may be explained by observations made by Jean K Moore, who reported that all structures associated with the generation of the ABR are formed by 29 weeks of gestation. From 30 weeks gestation to 6 to 12 months of age there are very small increments in neuronal size along the auditory pathway. Unlike acoustic stimulation, the mechanics of the basilar membrane (including inner and outer hair cell activation) is omitted when electrical stimulation is used to obtain an auditory brainstem response. The electrical signal is most likely transmitted directly to either dendrites, spiral ganglion cell bodies or cochlear nerve axons. Thus, the lack of a relationship between age and wave V latency may indicate that the well-known maturational changes seen with acoustic stimulation may be more peripheral than previously considered. The presence of an EABR in a congenitally deaf infant, coupled with the lack of significant changes in response configuration with age, may confirm the above-mentioned developmental principle.

In summary, this study found no relationship between the subjects' age and EABR wave V latency. EABR thresholds were related to preoperative PTA. Wave V latencies were prolonged in patients with meningitis.

Reference

Kileny PR, Zwolan TA, Zimmerman-Phillips S, Telian SA (1994) Electrically evoked auditory brain-stem responses in pediatric patients with cochlear implants. Archives of Otolaryngology Head and Neck Surgery 120: 1083–1090.

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Objective measurement (NRI) from intracochlear electric stimulation in Clarion CII adult implantees

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Objective

Cochlear implant fitting is particularly challenging in congenital and prelingually deafened children. It usually needs multiple careful and thorough sessions in order to better determine the starting level of electrical stimulation for the different speech-coding strategies adopted. In order to facilitate this task, intraoperative electrophysiological testing is most welcome. The advent, in most of the cochlear implant models, of specific software has allowed the measurement of neural action potential (AP) along the cochlear turns crossed by the electrode array (Thai-Van et al., 2001; Frank and Norton, 2001). This study has been designed to offer information regarding the utility of neural AP, when measured on an adult population, in comparison with previously utilized intraoperative tests.

Material and methods

Twenty-seven adult patients, between 16 and 79 years old (mean 43.4) were recruited for this study. According to the age of deafness they were divided in 20 postlingual, four perilingual and three prelingual. All of them have been implanted with a Clarion CII cochlear implant during the past two years. As far as coding strategy is concerned, 24 patients were using Hi Resolution (HR) and three patients CIS. In all of them, intraoperatively, the following procedures were carried out after placement of the implant:

- X-ray
- impedance measurement