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Research Report

Auditory brainstem responses (ABR) in normal hearing adult subjects with Down's syndrome

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ABSTRACT

Background: Auditory brainstem responses (ABRs) have been previously investigated in subjects with Down's syndrome (DS), but the published data are generally from children with hearing loss. The aim of this study was to evaluate the hearing pathway in normal hearing adult DS patients. *Methods*: We used ABRs to analyze absolute and interpeak latencies in 19 adult DS patients aged 18–45 years whose pure tone audiometry (PTA) test results indicated thresholds within normal limits, and 19 normal controls. *Results*: The DS sample showed statistically significant gender-related differences in interpeak interval III–V ($p = 0.015$). The latencies of waves III and V, and interpeak intervals III–V and I–V, were significantly shortened in the DS patients than in the controls. *Conclusions*: Our findings may be due to the smaller brain sizes and simpler afferent auditory pathways of DS subjects.

1. Introduction

Auditory brainstem responses (ABRs) represent a widely used objective audiometric test for the diagnosis of deafness. They can also be used to make an accurate and non-invasive functional assessment of the major parts of the auditory system. It is also possible to derive useful information on the central nervous system. In particular, wave V is the most constant and most prominent of the brainstem responses, and the most useful diagnostically for audiometry. It has been demonstrated that the analysis of this wave can identify a pathological process in the brainstem (Beagley and Sheldrake, 1978).

ABRs can be affected by gender, age and hearing loss. It has been reported that females have shorter conduction times than age-matched males (Allison et al., 1983; Beagley and Sheldrake, 1978; McClelland and McCrea, 1979; Mitchell et al., 1989; Schwartz et al., 1994), which Allison et al. (1983) attributed to differences in body size and proportions. Many authors have reported increased latency with age (Allison et al., 1983; Asselman et al., 1975; Stockard et al., 1979), and decreased conduction velocity in older patients. Allison et al. (1984) and Dorfman and Bosley (1979) explained this as being due to age-related decreases in the peripheral and central conduction velocity. Other authors have suggested that this may be due to axonal dystrophy (Dolman et al., 1980), a preferential loss of larger myelinated fibres (Morrison et al.,

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1959), demyelination (Wisniewski and Terry, 1976), neurotransmitter alterations (Giacobini et al., 1982), or vascular and biochemical changes (Samuel et al., 1983). Finally, it is known that hearing loss has a major effect on ABRs (Bauch and Olsen, 1986; Mair and Laukli, 1986; Rosenhall et al., 1986), and Mair and Laukli (1986) have reported that threshold preservation in the 4–8 kHz frequency band is necessary for the generation of a normal auditory brainstem response at suprathreshold stimulus levels.

A number of published studies have investigated ABR latencies in subjects with Down's syndrome (DS) (Ferri et al., 1995; Folsom et al., 1983; Kaga and Marsh, 1986; Sersen et al., 1990), but these studies have generally only considered children (Folsom et al., 1983; Kaga and Marsh, 1986) or young people (Ferri et al., 1995; Sersen et al., 1990). It has been reported that nerve stimulation conduction times are shorter in Down's Syndrome patients than in normal subjects, but the reasons for this are still unclear. Squires et al. (1986) suggested that DS subjects may have a shorter pathway from the cochlea to the cochlear nucleus. Diaz and Zuron (1995) attributed it to alterations in the cochlea or in the auditory pathway, such as an alteration of the high-frequency region of the cochlea, a shortening of the extra-cephalic auditory pathways, or a simplification of the pathway. Ferri et al. (1995) claimed that the most important factor was the evidently impaired inhibition, or increased excitability of the central nervous system. Finally, Kakigi and Kuroda (1992) suggested three hypotheses: faster nerve fibre conduction velocity, a small brainstem, and cochlear hearing deficit.

Only Ferri et al. (1995) investigated the possible influence of gender and age on brainstem auditory evoked potentials (BAEPs) in adult DS subjects.

The aims of this study were to compare latencies in normal hearing adult DS patients and normal controls (because ABRs are often influenced by overlapping pathologic mechanisms with DS) and to evaluate the effect of gender and age on ABRs in DS patients. To the best of our knowledge, this is the first study among normal hearing adult DS subjects.

2. Results

All ABR patterns showed good morphology, synchronism and repeatability. The peak complexes were well identified.

Table 1 shows the mean values (±standard deviation) of the peak and interpeak latencies in each group (DS males, DS females, control males, control females). Fig. 1 displays these results in six box-plots that show the different results in each wave or interpeak by groups. The Kruskal–Wallis test showed that there were statistically significant differences among the 4 groups for each wave and interpeak, except for peak I and interpeak I–III. Table 1 also reports the values of the test statistics and the p-value. No latency results correlated with age.

As observed in the control group, the DS sample also showed slight differences by gender indicating that the females had shorter latencies than the males, but not all of these differences were statistically significant. Between DS males and females, only the latencies of the interpeak III–V were significantly different ($p=0.015$) and between control males and females the significant differences were observed for the latencies of the wave V ($p=0.029$) and interpeak I–V ($p=0.037$).

There was no statistically significant difference between the DS and control groups overall, but significant differences were observed when the data were stratified by gender. The differences in latencies between DS males and control males – as those between DS females and control females – were statistically significant for every peak and interpeak except for peak I and interpeak I–III. In particular, the DS males reported mean latencies shorter than control males. In DS male, the mean latencies of peak III and peak V were shorter (0.5 and

Table 1 – Latencies and interpeak intervals in the samples

	DS males	DS females	Control males	Control females	Kruskal–Wallis Test		Mann–Whitney Test							
							DS males vs DS females		Control males vs Control females		DS males vs Control males		DS females vs Control females	
					χ^2	p	U	p	U	p	U	p	U	p
Peak latencies (ms)														
I	1.67±0.098	1.64±0.09	1.67±0.084	1.69±0.208	1.054	ns								
III	3.41±0.301	3.59±0.145	3.91±0.235	3.77±0.182	14.137	0.003	31.5	ns	19.5	ns	9.0	0.002	14.0	0.049
V	5.41±0.149	5.38±0.137	5.74±0.184	5.54±0.120	16.834	0.001	42.5	ns	11.0	0.029	9.0	0.002	9.0	0.015
Interpeak latencies (ms)														
I–III	2.13±0.174	1.97±0.116	2.08±0.105	2.05±0.091	7.391	ns								
III–V	1.77±0.075	1.68±0.062	1.88±0.113	1.81±0.107	12.753	0.005	16.0	0.015	21.00	ns	19.5	0.036	10.0	0.021
I–V	3.78±0.182	3.74±0.087	3.96±0.084	3.86±0.111	12.922	0.005	35.0	ns	14.5	0.037	16.0	0.016	11.5	0.035

The latencies of waves I, III and V, and their interpeak intervals, in DS subjects and controls by gender: mean±SD, results (chi-square χ^2 and p-value) of Kruskal–Wallis analysis of variance was used to compare the 4 groups by gender (DS males, DS females, control males, control females). If the p-value of the Kruskal–Wallis test was <0.05, then the Mann–Whitney post-hoc test was performed and the values of U and p were reported. (vs=versus).