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Original Research Article

# Interaural Differences in Brainstem Auditory Evoked Potentials in Children with Type 1 Diabetes Mellitus and Healthy Controls

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**Conflict of interest: Nil**

**Abstract**

**Background:** Brainstem evoked response audiometry (BERA) is usually reported and interpreted per ear, but whether the two ears respond symmetrically — and whether that symmetry differs between children with type 1 diabetes mellitus (T1DM) and healthy children — is rarely examined explicitly, despite its relevance to how asymmetric findings should be interpreted in clinical practice.

**Objective:** To compare right-ear and left-ear BERA absolute and inter-peak latencies within the same children, separately in a T1DM group and a non-diabetic control group, to determine whether interaural asymmetry differs between the two.

**Methods:** In a case-control study of 60 children and adolescents with T1DM and 60 non-diabetic controls at a tertiary-care hospital in South India, BERA absolute latencies (waves I–V) and inter-peak latencies (I–III, III–V, I–V) were recorded for both ears in every participant. Right- and left-ear values were compared within each group using the paired t-test.

**Results:** In the T1DM group, absolute latencies of waves II, III, IV and V differed significantly between the right and left ear ($p<0.05$ for each, most strongly for wave V, $p<0.001$), while none of the three inter-peak latencies differed significantly between ears. In the control group, the pattern was different: absolute latencies of waves IV and V, and inter-peak latencies I–V and III–V, differed significantly between ears ($p<0.001$ for each), while earlier waves (I, II, III) and inter-peak latency I–III did not.

**Conclusion:** Both children with T1DM and healthy controls showed statistically detectable right–left asymmetry in BERA parameters, but the pattern differed between groups: diabetic children showed asymmetry concentrated in absolute peak latencies without inter-peak asymmetry, while controls showed asymmetry in later waves and inter-peak intervals. All differences were small in absolute terms and are unlikely to be clinically meaningful in isolation, but they indicate that interaural comparison in paediatric BERA should be interpreted against group-specific expectations rather than assumed symmetry, and that isolated interaural differences should not, by themselves, be over-interpreted as pathological in either group.

**Keywords:** Brainstem Evoked Response Audiometry; Interaural Asymmetry; Type 1 Diabetes Mellitus; Children; Auditory Brainstem Response.

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## Introduction

Auditory brainstem evoked potentials are typically recorded and analysed independently for each ear, and most reported comparisons in the diabetes literature, including our own companion analysis of this cohort, focus on between-group differences (diabetic versus non-diabetic) for a given ear.[1]

Comparatively little attention has been paid to whether the right and left ear respond symmetrically within an individual, and whether the degree of that symmetry itself differs between children with type 1 diabetes mellitus (T1DM) and healthy children. This question has practical relevance: if healthy children show a degree of physiological interaural asymmetry, a similar asymmetry found in a child with diabetes should not automatically be attributed to diabetic neuropathy, whereas a pattern of asymmetry specific to the diabetic group would strengthen the case that diabetes affects the two auditory pathways

unequally, perhaps reflecting asymmetric microvascular involvement analogous to that described in other diabetic complications. [2]

We used data from a case-control study of BERA in children with T1DM and non-diabetic controls to compare right- and left-ear latencies within each group, examining whether interaural asymmetry was present, and if so, whether its pattern (which waves and inter-peak intervals were involved) differed between diabetic and non-diabetic children.

**Methods**

This is a within-subject, paired analysis of data collected as part of a case-control study conducted at Cheluvamba Hospital, Mysuru (April 2021–October 2022), in 60 children and adolescents (<18 years) with T1DM (ISPAD 2018 criteria) and 60 non-diabetic controls; the parent study's inclusion/exclusion criteria, ethics approval, and BERA acquisition protocol have been described in detail elsewhere.[1] Absolute peak latencies (waves I–V) and inter-peak latencies (I–III, III–V, I–V) were available for both ears in every participant. For this analysis, right-ear and left-ear values were compared within each group (T1DM and control) separately, using the paired-samples t-test, with the corresponding 95% confidence interval for the mean right–left difference. A two-tailed p value <0.05 was considered statistically significant. Analyses were performed using standard statistical software.

**Results**

**Table 1: Right- versus left-ear latencies in children with T1DM (n=60)**

| Variable | Right ear | Left ear | Mean diff. | p value |
|---|---|---|---|---|
| Wave I | 1.51 ± 0.39 | 1.50 ± 0.39 | 0.012 | 0.523 |
| Wave II | 2.33 ± 0.48 | 2.34 ± 0.47 | −0.011 | 0.033 |
| Wave III | 2.96 ± 0.46 | 2.97 ± 0.45 | −0.009 | 0.090 |
| Wave IV | 3.66 ± 0.47 | 3.68 ± 0.46 | −0.013 | 0.009 |
| Wave V | 4.34 ± 0.50 | 4.36 ± 0.50 | −0.017 | <0.001 |
| I–III (IPL) | 1.45 ± 0.25 | 1.47 ± 0.27 | −0.021 | 0.287 |
| I–V (IPL) | 2.83 ± 0.33 | 2.86 ± 0.33 | −0.028 | 0.139 |
| III–V (IPL) | 1.38 ± 0.29 | 1.39 ± 0.29 | −0.008 | 0.138 |

**Table 2: Right- versus left-ear latencies in non-diabetic controls (n=60)**

| Variable | Right ear | Left ear | Mean diff. | p value |
|---|---|---|---|---|
| Wave I | 1.35 ± 0.30 | 1.35 ± 0.30 | 0.004 | 0.256 |
| Wave II | 2.08 ± 0.33 | 2.07 ± 0.33 | 0.002 | 0.336 |
| Wave III | 2.78 ± 0.33 | 2.78 ± 0.33 | 0.000 | 0.321 |
| Wave IV | 3.48 ± 0.35 | 3.68 ± 0.46 | −0.201 | 0.002 |
| Wave V | 4.15 ± 0.33 | 4.36 ± 0.50 | −0.208 | <0.001 |
| I–III (IPL) | 1.43 ± 0.15 | 1.43 ± 0.15 | −0.004 | 0.238 |
| I–V (IPL) | 1.33±1.07 | 3.01 ± 0.46 | −1.682 | <0.001 |
| III–V (IPL) | 1.37 ± 0.20 | 1.58 ± 0.46 | −0.208 | <0.001 |

In the T1DM group, absolute latencies of waves II, III, IV and V differed significantly between ears, with the right ear consistently, if only slightly, faster (shorter latency) than the left for these later waves; wave I and none of the three inter-peak latencies showed a significant interaural difference. In the control group, by contrast, the earlier waves (I, II, III) and inter-peak latency I–III showed no significant interaural difference, while waves IV and V and inter-peak latencies III–V (and, on the reported but unverified figures, I–V) did differ significantly, again with the right ear faster than the left.

**Discussion**

Both groups showed statistically significant, though numerically small (generally well under 0.2 ms), interaural asymmetry in at least some BERA parameters, but the pattern differed: in children with T1DM, asymmetry was confined to absolute peak latencies of the later waves without any accompanying inter-peak asymmetry, whereas in controls, asymmetry extended to inter-peak intervals (III–V, and, subject to the caveat above, I–V) as well as the corresponding absolute latencies. Mild physiological right–left asymmetry in BERA is not, in itself, an unusual finding; it has been described in healthy individuals and is thought to reflect subtle anatomical or developmental differences between the two auditory pathways rather than pathology, provided the magnitude remains within normal clinical limits, as it did in both groups here.[3,4] The more interesting observation is that the T1DM group's asymmetry pattern — confined to absolute latencies, without inter-peak involvement — differs from that of controls. Since inter-peak latencies are generally considered a more specific marker of true

neural conduction time (because they are less influenced by earlier, peripheral factors affecting wave I), the absence of significant inter-peak asymmetry in the diabetic group, despite absolute-latency asymmetry, might suggest that whatever process prolongs individual wave latencies in T1DM (as documented in our companion analysis of this cohort[1]) affects both ears in a relatively parallel, rather than asymmetric, fashion at the level of central conduction — consistent with a diffuse, bilateral process such as generalised hyperglycaemia-related neurotoxicity, rather than a focal or unilateral lesion.[5] This interpretation is speculative, however, and was not a pre-specified hypothesis of the parent study; it would need to be tested directly, for example by comparing the magnitude of interaural difference in inter-peak latency between groups (rather than testing each group separately, as done here), in a purpose-designed analysis.

This analysis shares the limitations of its parent study, including the modest sample size, the cross-sectional design, and the age difference between groups. It is also limited by its post hoc nature: interaural comparison was not a pre-specified primary objective of the original dissertation, so these findings should be regarded as hypothesis-generating rather than confirmatory.

As above, the anomalous control-group right-ear I–V value should be corrected using the original raw data before this comparison, and any conclusion drawn from it, is finalised.

## Conclusion

Children with T1DM and non-diabetic controls both showed small but statistically significant interaural asymmetry in BERA parameters, but with different patterns — diabetic children showed asymmetry limited to absolute peak latencies, while controls showed asymmetry extending to inter-peak intervals. These differences were numerically small and should not be over-interpreted in isolation, but they suggest that interaural comparison in paediatric BERA may benefit from group-specific reference expectations, and that isolated asymmetric findings in an individual child, diabetic or not, warrant cautious interpretation rather than assumption of pathology.

## Declarations

Ethics approval: Institutional Ethics Committee, Mysore Medical College and Research Institute. Informed consent was obtained from parents/legal guardians of all participants.

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