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Original article

Prognostic Value of Auditory Brainstem Evoked Response in Patients with Idiopathic Sudden Sensorineural hearing loss.

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Abstract:

Background: A hearing loss of at least 30 decibels over three successive frequencies in less than 72 hours is referred to as idiopathic sudden sensorineural hearing loss (ISSNHL). Auditory brainstem response may serve as a potential prognostic indication in patients with ISSNHL, according to several studies. Low serum thyroid hormone levels can contribute to hearing loss since they are strongly tied to the cochlea's proper functioning. **Aim:** To investigate the prognostic value of ABR and the association between its results and the thyroid hormone serum levels in ISSNHL patients. **Methods:** Observational prospective study was conducted on thirty patients with ISSNHL that occurred within the last 72 h with 30 dB hearing loss at three sequential frequencies. Pure tone audiometry, word discriminationscores, immittencemetry and auditory brain stem response were performed on the day of admission then again on the third day after admission and one month later. Thyroid

hormone serum level were assessed after admission. **Result:** Hearing recovery was observed in 21 patients (70%). The absolute latencies of waves I, III, and V latencies were statistically significantly delayed in the affected ears compared with the unaffected ears. There was a statistically significant correlation between hearing outcome and wave I latency. Wave V latency was statistically significantly negatively correlated with free T4. **Conclusion:** Auditory brainstem response is an important prognostic factor in ISSNHL but caution shouldbe considered when adopting ABR testing without assessing thyroid hormone levels.

1. Introduction:

Idiopathic sudden sensorineural hearing loss (ISSNHL) is considered a common complaint.[1] ISSNHL patients resemble 5 to 60.9 per 100,000 people annually, and the rate is increasing.[2,5] It may associated with ear fullness ,tinnitus , vertigo and abdominal upset. It refers to suddensensorineural hearing loss that occur in72 hours, affecting at least two adjacent frequencies with hearing loss more than 20 dBHL.[2] In spite there was any clear pathogensis of ISSNHL but theories may suspect viral infection,circulatory causes ,autoimmune disorders , and neoplasm as causes.[3] Many studies have described prognosting factors for ISSNHL to be considered in the following of thesecases like the timing of initial therapy, hearing loss duration, pure toneaudiometry configurations and accompanied symptoms.[1] Auditory brainstem response (ABR)is an electrophysiological test used indetecting the integrity of the auditorypathway and explore the retrocochlearlesions. Previous researches havestated that ABR may act as aprognostic tool in these patients withISSNHL. [3]

The thyroid gland is considered as oneof the most important organ of the human body. Thyroid hormones have important roles in cochlear maturation and development of normal hearing.Abnormal thyroid function can influence hearing like changes in auditory brainstem response (ABR) latencies and amplitudes , abnormalities in hearing thresholds and otoacoustic emission results.[4] About 25 % of patients demonstrateddifferent types and degrees ofhearing loss ,associated with congenital thyroid abnormalities.[3] Among the patients with ISSHL, the prognostic value of ABR and theassociation between its results and thethyroid hormone

serum levels (TSH, T3, and free T4) were assessed.

2. Aim of The Work:

To investigate the the prognostic value of ABR and the association between itsresults and the thyroid hormone serum levels in ISSNHL patients.

3. Patients And Methods:

3.1. Patients

After approval of Ethical committee,Faculty of medicine, Beni Suef University was obtained with approval number: FMBSUREC/04102020/Abd- Elfattah, this prospective study took place during the period from November 2020 to November 2021. Cases were collected from Audiology unit, faculty of medicine Beni Suef University hospital, diagnosed as ISSNHL. Approval of All patients who were diagnosed as ISSNHL based on the initial PTA results within 72 hours with 30 dB hearing loss at three consecutive frequencies.[5]

Patients who have any infectious ear disorders (acute and chronic otitis media), eardrum abnormalities, previous SSNHL history, Meniere's disease, acute acoustic trauma, previous history of ear surgery in the affected ear, fluctuating or recurrent hearing loss or vestibular schwannoma, were excluded from the study. Patients with profound hearing loss were notincluded in the ABR analysis.

3.2. Methods

All patients were treated with the same protocol, they visited the Department of Otorhinolaryngology unit, and were diagnosed through physical examination, basic audiologicalevaluation, and thoughtful review ofpast medical history. All patients underwent blood sampling and ABRtests on the day of admission.

- Basic audiological evaluation

{1}- Pure tone audiometry for frequencies ranging from 250Hz to 8 kHz

{2}- Speech audiometry including speech reception threshold and word discrimination scores

{3}- Immittencemetry includingtympanometry (single frequency tympanometry) and acoustic reflex threshold

- Auditory Brain Stem Response

The reference electrodes placed on the right (A2) and left (Al) mastoids; the active is on the scalp at the vertex. Electrode impedances were less than 5 kΩ, and inter-electrode impedances were less than 2 kΩ. Click presented at a rate of 21.1 stimuli per second in rarefaction polarity at intensity of 80 dBHL.Averaged potentials to 1200 clicks obtained. Two recordings obtained to ensure the replicability of the waveforms. The latencies of waves I, III, and V will be studied with BAEPs.

Pure-tone audiometry, speech audiometry and ABR testing were performed on the day of admission then performed again on the third day after admission and 1 month after the onset of ISSHL. Evaluations of audiological

improvement were performed using pure-tone average (PTA) thresholds at four frequencies (0.5, 1.0, 2.0, and 4.0 kHz). Their outcomes were classified as follows:

(1) complete recovery, (2) partial recovery, and (3) no recovery.

- Laboratory investigations including TSH, serum free T3 & serum free T4. The normal reference range is asfollows: serum free T3= 2.76-6.30pmol/L, serum free T4= 10.42-24.32 pmol/L, TSH= 0.35-5.50 mU/L.

Accordingly, patients were classified into thyroid function normal group and thyroid function abnormal group.

3.3. Statistical analysis

The data collected were tabulated and analyzed by SPSS (statistical package for social science) version 25(Armonk, NY: IBM Corp). The data was tested for normality using Kolmogorov–Smirnov test, Shapiro– Wilk tests then two types of statistics were done:

Descriptive statistics: According to the type of data qualitative ,data was represented as frequency and percentage, quantitative data was represented by mean ± SD.Analytical statistics:Independent sample t-test was used forcomparison between two groups ANOVA (f) test: is a test of significance used for comparison between three or more groups having quantitative variables.

Person's rank correlation coefficient: used to study correlation between two variables having normally distributeddata.

P-value of < 0.05 was considered statistically significant & <0.001 for high significant results for two tailed tests.

4. Results:

A total of 30 patients with newly coded ISSNHL who met the criteria for inclusion in our study, among which majorities were 20 males (66.67%) and10 females (33.33%). The mean age was 52.40 ± 6.07 years. In concerns of comorbidities, DM was noted in 9 (30%) patients, in contrast to HTN, which was present in 10 (33.33 %) patients. According to the initial PTA,patients were divided according to hearing loss degree to mild, moderate, moderately severe, and severe groups, that consisted of 5 (16.7%), 12 (40%),4 (13.3%), and 9 (30%) patients, respectively. The initial ABR resultsfollowing the initial PTA tests are presented in Table (1) . The latencies of the wave I showed a statistical significance increased with the severity of hearing loss.

Table (1): ABR latencies in relation to the degree of initial hearing loss.

No. of cases	N=5			N=12			N=4			N=9			
Initial PTA average	36.64	±	3.60	51.19	±	4.84	64.25	±	5.37	74.05	±	2.53	<0.001**
SDS of ear	94.4%	±	2.2%	83.0%	±	5.7%	64.0%	±	8.6%	48.4%	±	7.1%	<0.001**
Absolute latency (ms)													
Wave I	1.57	±	0.02	1.47	±	0.16	1.71	±	0.15	1.78	±	0.09	<0.001**
Wave III	3.71	±	0.42	3.83	±	0.25	3.77	±	0.34	3.72	±	0.37	0.851
Wave V	5.42	±	0.30	5.40	±	0.20	5.66	±	0.28	5.52	±	0.33	0.377
Interpeak latency (ms)													
I-III	2.14	±	0.44	2.38	±	0.33	2.07	±	0.19	1.94	±	0.41	0.069
I-V	3.82	±	0.35	3.90	±	0.25	4.04	±	0.22	3.98	±	0.40	0.711
Wave I Amplitude	0.55	±	0.22	0.51	±	0.26	0.45	±	0.24	0.47	±	0.16	00.877

The comparison of ABR metrics between the affected and unaffected ears in all patients shows that the absolute latencies of wave I, wave III, and wave V were significantly prolonged in the affected ears compared with the unaffected ears. The amplitude of wave I, was significantly lower in the affected ears compared with the unaffected ears. The inter-peak latencies of wave I, wave III, and wave V were not significant in the affected ears compared with the unaffected ears.Table (2)

Table (2): Comparison of Initial PTA average, SDS%, and ABR metrics between the affected and unaffected ears in all patients with ISSNHL before treatment.

	Affected ear			**Unaffected ear**			**P value**
Initial PTA average	57.36	±	14.08	19.07	±	3.94	0.001*
SDS of ear	72.0%	±	18.8%	100%	±	0.0%	0.001*
Absolute latency (ms)							
Wave I	1.61	±	0.18	1.45	±	0.17	<0.001**
Wave III	3.77	±	0.32	3.55	±	0.21	0.002*
Wave V	5.47	±	0.27	5.31	±	0.22	0.011*
Interpeak latency (ms)							
I-III	2.17	±	0.40	2.13	±	0.28	0.657
I-V	3.93	±	0.31	4.04	±	0.35	0.185
Wave I Amplitude	0.20	±	0.22	0.27	±	0.29	0.001*

A comparison of ABR metrics between the affected ears in all patients before and after treatment shows that the absolute latencies of wave I and wave III were not significant, only wave V was significantly prolonged in the affected ears beforetreatment compared with after treatment Table (3) .

Table (3): Comparison of Initial PTA average, SDS%, and ABR metrics of theaffected ears in all patients with ISSNHL before and after treatment

	Affected ear (Before treatment)			Affected ear (After treatment)			P value
Initial PTA average	57.36	±	14.08	42.80	±	23.63	0.001*
SDS of ear	72.0%	±	18.8%	80.5%	±	22.9%	0.001*
Absolute latency (ms)							
Wave I	1.61	±	0.18	1.57	±	0.26	0.235
Wave III	3.77	±	0.32	3.82	±	0.53	0.611
Wave V	5.47	±	0.27	5.70	±	0.24	0.002*

Among cases, one patient (3.3%) had preexisting hypothyroidism, and 4 patients (13.33 %) had preexisting hyperthyroidism while 25 patients had normal thyroid functions Table (4) .

Table (4): Preexisting thyroid disease distribution and means of TSH, free T3, andfreeT4.

Thyroid functions	No.	%	TSH	Free T3	Free T4
Normal	25	83.3	2.43 ± 1.38	3.92 ± 0.79	15.50 ± 3.07
Hyperthyroidism	4	13.3	0.19 ± 0.03	7.95 ± 0.54	33.88 ± 2.27
Hypothyroidism	1	3.3	7.30	1.52	8.40
Total	30	100.0	2.29 ± 1.75	4.37 ± 1.66	17.71 ± 7.18

There was significant correlation between absolute latency wave I and hearing outcomes in all patients with ISSNHL Table (5)

According to Person's rank correlation coefficient analysis, initial PTA average at 500Hz was statistically significantly positively correlated with free T3, and at 1 kHz,2 kHz, 4 kHz, and 8 kHz was statistically significantly positively correlated with free T3 and free T4. Wave V latency was statistically significantly negatively correlatedwith free T4. Table (6).

Table (5): Comparison between ABR parameters as regards hearing recoveryoutcomes in ISSNHL patients after treatment.

	No Recovery	Partial Recovery	Complete Recovery	F	P value
No. of cases	9	6	15		
Initial PTAaverage	71.46 ± 5.03	52.92 ± 15.14	21.55 ± 2.16	141	<0.001**
SDS of ear	0.52 ± 0.08	0.75 ± 0.17	1.00 ± 0.00	97	<0.001**
Absolute latency (ms)					
Wave I	1.71 ± 0.16	1.72 ± 0.38	1.43 ± 0.17	6.35	0.005*
Wave III	3.81 ± 0.91	3.79 ± 0.12	3.85 ± 0.31	0.027	0.973
Wave V	5.78 ± 0.24	5.65 ± 0.31	5.67 ± 0.21	0.705	0.503

F: ANOVA test, **:P value <0.05 is significant, ** P value <0.001 is highlysignificant*

Table (6): Correlation between serum thyroid hormone levels, initial PTA average and ABR parameters.

ABR parameters	TSH		Free T3		Free T4	
	r	p-value	r	p-value	r	p-value
Initial PTA averages						
250Hz	-0.039	0.840	0.307	0.099	0.193	0.307
500Hz	-0.145	0.444	0.454	0.012*	0.347	0.060
1kHz	-0.142	0.455	0.487	0.006*	0.439	0.015*
2kHz	-0.182	0.336	0.567	0.001*	0.494	0.006*
4kHz	-0.117	0.536	0.501	0.005*	0.495	0.005*
8kHz	-0.208	0.270	0.505	0.004*	0.459	0.011*
ABR parameters						
Wave I latency	0.203	0.282	-0.011	0.953	-0.190	0.316
Wave III latency	-0.072	0.704	0.195	0.302	0.055	0.771
wave V latency	0.216	0.253	-0.270	0.148	-0.407	0.026*
IPL I–III	-0.211	0.262	0.253	0.178	0.147	0.439
IPL I–V	-0.258	0.169	0.172	0.363	0.231	0.218
IPL III–V	-0.039	0.840	0.307	0.099	0.193	0.307

*r: Person's correlation, P value>0.05 insignificant, * P- value≤0.05 significant, **P- value ≤0.001 highly significant*

5. Discussion:

This study was aiming to study the effect of idiopathic sudden sensorineural hearing loss on auditory brainstem response latencies and to assess the relationship between thyroid hormone levels and the quantitative data of ABR tests in ISSNHL individuals. The amplitude or latencyof wave I or the lack of wave V were examined in the earlier research [3,4] as potential related factors with hearing outcomes in individuals with ISSNHL. We looked at the absolute and inter-peak latencies as potential determinants of variation among treatment outcome groups.

In our study we found that the mean latencies of the wave I increased with initial severity of hearing loss. The mean SDS and threshold in dBHL also increased with initial severity of hearing loss. That was in agreementwith Heo et al. in 2019**,** who stated thatthe mean latencies of the wave V and waves I–V intervals increased with initial severity of hearing loss [4]

The absolute latencies of wave I, wave III, and wave V were significantly prolonged in the affected ears compared with the unaffected ears.

The inter-peak latencies were not significant in the affected ears compared with the unaffected ears.

In accordance with our results, the study of Bang et al. in 2019**,** as they reported that the mean latency of ABR wave I was significantly longer in the affected ear than in the unaffected ear [6].

In our study we found statistically significant difference in wave I amplitude between affected andunaffected ears. These results came in accordance with Seo and his colleagues, 2022. They suggested that the decrease in amplitude of the ABR wave I in ears that have completely recovered from SSNHL suggests that cochlear synaptopathy may be involved in the pathogenesis of SSNHL.[7] In contrast Bang et al. in 2019**,** reported that the mean amplitudes of wave and wave V did not differ between the groups.[6]

As regard the absolute latencies of wave I and wave III were not significant, only wave V was significantly prolonged in the affected ears before treatment compared withafter treatment.

The current study showed that based on hearing recovery, Hearing recovery

was reported in 21 (70%) of 30 cases, including full recovery in 15(50%) cases, partial recovery in 6 (20 %) cases, and no recovery in 9 (30 %) cases.

There were statistically significant correlation between Initial PTA average, and SDS of affected ears and treatment outcomes. There was significant correlation between absolute latency wave I and hearing outcomes while there was non- significant correlation between other ABR parameters and hearing results in all patients with ISSNHL.

Our results were in agreement with study of Lin

et al. in 2017, as they reported the significant association between wave I latency and hearing outcomes in the affected ears with a prolonged pattern from the complete hearing recovery group to the slight hearing recovery group. These findingsdemonstrated that better hearing outcomes were associated with shorter wave I latency in the affected ear.[8]

In the study of Zarandy and his colleagues in 2017, they stated that the chance of responsiveness in patients with profound hearing loss whoresponded to medical therapy and had at least wave V ABR was correlated with the presence of ABR .[9]

Furthermore, Heo in 2019 revealed that the comparison of the ABR outcomes between the one-month successful recovery and poor recovery groups were showed whereas The mean latencies of all ABR metrics were not significantly different between the two groups.[3]

The present study showed that among cases, one patient (3.3%) had preexisting hypothyroidism, and 4 patients (13.33 %) had preexistinghyperthyroidism while 25 patients had normal thyroid functions. Our results showed that initial PTA average at 500Hz was statistically significantly positively correlated with free T3, and at 1kHz, 2kHz, 4kHz, and 8kHz was statistically significantly positively correlated with both free T3 and free T4. Wave V latency was statistically significantly negatively correlated withfree T4.

Our results were supported by study of Heo et al. in 2019 as they revealed that wave V latency was negatively associated with serum T3 levels. The waves III–V intervals and the waves I–V intervals were negatively associated with serum T3 levels.[3]

Chandrasekhar in 2011, reported delay of absolute latency of wave III and wave V in hypothyroid patientscompared to wave III and wave V of control group.[10] Whereas Anjana in 2006, showed that the latency of wave III was prolonged from in control to in hypothyroidism patients.[11]

Regardless of the outcome of thehearing test, our findings showed that T4 levels were inversely correlated with wave V latency in ABR testing. This outcome contrasts with other research that suggested the ABR mightserve as a prognostic indication in ISSNHL patients.[9]This difference inthe study's findings suggests that using ABR testing without first determining thyroid hormone levels should be donewith caution.

It is still unclear exactly how thyroid hormone levels affect pathophysiology. Segmental demyelination of Schwann cells isthought to be influenced by hormone imbalance, according to one pathophysiological theory for the dysfunction of the nerves in hypothyroidism. Additionally, according to other researchers, low thyroid hormone levels impair microcirculation, which in turn affects the metabolism and oxygenation of cells as well as the creation of energyin cells. The central auditory pathwayis known to be regulated by

thyroidhormones in terms of protein synthesis and myelin formation. T4 also functions in the central nervous system as a neurotransmitter. Thus, it is conceivable that the cochlea, central auditory pathway, and retrocochlear area could be impacted by decreased thyroid hormone levels.[12]

This research has several restrictions. First off, patients with hearing thresholds above 90 dBnHL cannot undergo the ABR exam. Second, the study's sample size was too small to conclusively identify a connection between thyroid hormone levels and the results of the ABR.

In conclusion, this study is the studied ABR in patients with ISSNHL and the role of thyroid hormones in adopting it as a prognostic factor. The findings show that clinical caution should be exercised when adopting ABR testing without assessing thyroid hormone levels. Further evaluation is needed to confirm the relationship between initial ABR results in patients with ISSNHL and levels of thyroid hormones before we adopt the ABR results as a prognostic factor in ISSNHL patients.

6. Conclusion:

Auditory brainstem response is an important prognostic factor in ISSNHL but caution should be considered when adopting ABR testing without assessing thyroidhormone levels.

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