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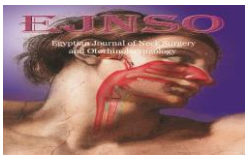

Effect of obstructive sleep apnea on complex auditory brain stem response

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Abstract:

Objective: Investigate the impact of obstructive sleep apnea (OSA) on complex auditory brainstem response (C-ABR).Also, the evaluation C-ABR affection degree corresponded with the severity of OSAS.

Patients and methods: C-ABR has been employed in a prospective study on 30 individuals with obstructive sleep apnea. Results were compared to those of normal people.

Results: All participants had the seven C-ABR waves. In the waves of the filter element (transients) wave V (onset), wave C (transition), offset peak O, there was a significant statistical difference between the control and study, indicating that OSAS patients had abnormal neural synchrony affecting the filter element. However, there was no statistically significant difference in C-ABR latencies in the waves on the source elements (D, E, F).

Conclusion: OSAS patients had aberrant neuronal synchronization that affected the filter elements (transients) and waves (V, C, O), but not the source elements.

Key words: Obstructive sleep apnea (OSA), Click evoked auditory brain stem response (click-ABR), Complex –auditory brain stem response (C-ABR), Apnea hypopnea index (AHI),Polysomnography.

Introduction

Obstructive sleep apnea syndrome (OSAS) is characterized by nocturnal sleep snoring. It is an apnea and hypopnea brought on by collapsing of the airway in its upper part at some stage in sleep. A considerable risk of disability was found in some cases of severe OSAS that resulted in functional damage to vital organs 1,2

Patients with OSAS experience a variety of symptoms, including daytime sleepiness, apathy, and lethargy, loss of memory, and cognitive impairments, which could indicate that the neurological system has suffered functional damage. 3 Generally speaking, early OSAS-related hypoxemia is reversible but persistent hypoxemia may result in irreversible functional impairment. 4 This energy consumption is heavily reliant on blood O2 since it occurs during the signal transmission process at the multiple tiers of the cochlea and central nucleus transduction. Hence, OSAS patients may experience auditory difficulties as a result of prolonged hypoxemia. Severe OSAS patients displayed abnormalities during standard audiometry testing, including pure-tone audiometry (PTA), otoacoustic emissions distortion product (DPOAEs) and auditory evoked

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brainstem response (ABR) which might also indicate that auditory system has some functional impairments. 3

Mild and moderate OSAS, there is still lack of relevant research that examines the auditory function. According to Casale et al. (2012) and Seo (2018), the ABR test is typically used in clinics to determine the health of the auditory neural circuit. An effective method for examining the functional integrity of OSAS is the ABR, which mimics the synaptic activity of auditory brainstem neurons. 5,6 In several investigations, OSAS patients' (click evoked-ABR) showed prolonged absolute peak latencies and interpeak latencies (wave I-V and wave III-V). The pathophysiologic process may be explained by abnormalities in neurotransmitter synthesis and aberrant nerve impulse conduction in the auditory pathway, both of which are brought on by hyperlipidemia caused by respiratory problems. 6

Some investigations, on the other hand, stated that recurrent hypoxemia in OSAS doesn’t cause any acute or chronic harm to the auditory brainstem proved by click evoked-ABR 7. These contradictory results highlight the need for novel approaches and in-depth research in this area.

Complex -ABR, has emerged as a novel method of ABR in the last years. According to Purcellet et al., 2004, the transitory components of speech-ABR caused significant problems for many people, including those with persistent developmental stuttering (PDS) and learning problem children (LPC). The click-ABR in these patients is normal. According to these results, complex ABR may be a more accurate technique than click-ABR for identifying auditory function 8 .

As a result, complex-ABR may contribute to the study of the auditory system's neurological condition and could serve as a useful tool in detecting very early neurological function abnormalities in OSAS patients. Based on this principle, we tested the auditory system of a selected sample of OSAS patients with mild to severe symptoms and a control group of individuals with normal hearing. Because hemispheric dominance is related to handedness, the right ears of participant who are right-handed were recorded and analyzed.

Patients and methods:

The protocol of the study was approved by the medical research ethics Committee of faculty of medicine SOHAG University of (Soh-Med-22-08-20)

Our study included 60 individuals who were separated into two groups. Group (A): From January 2021 to May 2021, 30 patients with obstructive sleep apnea with age range from20-50. The patients underwent overnight polysomnogram monitoring at the Sleep Centre of Sohag University Hospital's ENT department. The apnea hypopnea index (AHI) and lowest oxygen saturation (SaO2) were used to diagnose OSAS, and its severity was graded as mild, moderate, or severe. 9-11 OSAS severity was identified with AHI score, mild OSA between five and fifteen events /h, moderate OSA between fifteen and thirty events/h and sever OSA>= thirty events/h. Patients with mild, moderate and severe OSAS and mild hypoxemia are included in the OSAS group.

Group (B) 30 healthy and age matched individuals, with age range from 25 to 50 years, (normal had the following: AHI less than 5, SaO 2 more than 90%) were recruited. Every one of control had, normal hearing, sleeping habits of good quality, no visual impairment, no nervous system or psychiatric disorder, and no recent use

of medicines known to impair sleep or cause daytime sleepiness.

Every participant was told in writing about the goals of the experiment and cooperated. The protocol was in accordance with the Helsinki Declaration. All PSG studies were scored by licensed and registered PSG technologists, and reviewed by experienced sleep medicine specialists. Overnight PSG was performed on all individuals using established technique and criteria for sleep stages (EEG and submentalis EMG), leg movements (anterior tibialis EMG), and arousals from sleep. Pulse oximetry was used to monitor arterial ox hemoglobin saturation, and a measure airflow was performed by nasal pressure cannula. Thoraco-abdominal movements were used to measure respiratory effort (respiratory inductance plethysmography). All PSG investigations were evaluated and reviewed by licensed and certified PSG technicians was used to and experienced sleep medicine professionals

ABR tests

The ABR test was performed in an electromagnetically protected and acoustically attenuated environment using a (Intelligent Hearing System) Smart EP System. Elicited by clicking to validate the presence of wave V, an auditory brain stem response was performed. Stimulus settings included the following: kind of stimulus: click type, intensity: 90dBnHL, presentation rate: 13.1p/s, polarity: alternating, and mode of delivery: monaurally to the right ear using an ER3A- insert phone. Parameters for recording: electrode assemblage; the active electrode is high fontal, the ground electrode is on low frontal, the negative electrode is on the right, and the reference electrode is on the left. The number of sweeps is 1024, the filter is 100-1500 Hz band passes, and the analysis period is from 0 to12 ms.

7 .**Complex Auditory Brainstem Response (C-ABR):**

Stimulation parameters: The syllable /da/ has duration of 40 milliseconds. There is an initial noise burst followed by a formant transition between a consonant and a steady-state vowel in the first 10 ms. Intelligent Hearing System Company created the stimulus, which was then placed in spoken auditory brain response software. The intensity was set to 80 dBSPL, the polarity alternated, the presentation rate was 11p/s, and the administration mode was delivered monaurally to the right ear via an ER3A-insert phone. Electrode montage: high frontal electrode Fz (active) , low frontal FPz (the ground) ,left side (reference),and negative electrode on right.

Because complex ABR (C-ABR) has no ear differences, the recordings were collected entirely from the right ear. All electrodes were attached to the Smart EP equipment's pre-amplifier. 4000 sweeps, 100-1500 Hz band passes, 75 ms analysis time (including pre-stimulus recording of 15 ms). The reaction was described by the existence of 7 waves (V, A, C, D, E, F, O), with wave V comparable to wave V induced via click stimuli and immediately followed by a negative wave (wave A). Following the initial reaction, FFR is represented by a succession of peaks (C-F). The offset reaction is represented by Wave O. the absolute latencies of the waves and their amplitude were measured

Equipment:

Room that is Sound treated: IAC model 1602.Pure tone audiogram: model interacoustic AD 629, Immittancemetry: model GSI 39, Evoked potentials system SMART intelligent hearing system (HIS), and

Philips RespironicsALICE5 PSG Polysomnography.

Statistical analysis

For the statistical analysis, SPSS ver. 13.0 (SPSS Inc., Chicago, IL, USA) was used. P< 0.05 (two-tailed) was set as the significance level. To investigate group differences, the independent sample t-test was used. Link among AHI with complex ABRs was investigated using bivariate correlation analysis.

Results

Demographic data

This study was done on 30 patients suffering from obstructive sleep apnea (study group) with age range from 20-50 and male to female ratio 14\ 16 and control group composed of also 30 volunteers with age range from 25-50 and male to female ratio13\17. (Table1)

Sleep data:

The AHI distribution of the 30 patients suffering from OSA participants in table2; 12 of them have mild degree of severity, 9 have moderate degree and the rest complaining of severe degree.

Complex ABR data:

Table (3) displays the C- ABR waves for both groups. All of the marked peaks were audibly evoked in the order specified. We discovered that OSAs patients had longer latency values than the control group for all peaks by comparing these waves' latency. In the complex ABR transients, OASA patients showed substantially longer delay values than the control group for the peaks V, C, and O (P 0.001). Peaks A, D, E, and F all suffered negligible delays.

To determine if the brain stem timing of C-ABR is connected to the severity of OSA, there was no significant association was found between the degree of OSA severity and complex ABR. (Table:4)

Table (1): Demographic data; age and gender distribution between study and control group

	Age		Gender(male\female)	
	Range	Mean	Number	Percentage
Study group	20-50	34.47	14\16	46.67%\53.33%
Control group	25-50	41.33	13\17	43.33%\56.67%

Table (2): degree of severity in study group:

	number	AHI
Mild	12	9.1+-2.5
Moderate	9	21.9 +-4.3
Severe	9	54.4=-17.9

Table (3): complex ABR latencies in the control and study groups:

	Control group		Study group		P value
	Mean	SD	Mean	SD	
V	5.79	.12	6.13	.36	<0.001
A	7.4	.12	7.58	.55	0.16
C	17.18	.09	18.10	.64	<0.001
D	23.37	.19	23.05	.98	0.17
E	31.38	.19	31.33	.59	0.77
F	39.97	.46	40.19	.82	0.37
O	47.22	.43	49.45	1.03	<0.001

Table (4) correlation between C-ABR latencies and degree of severity:

	C - ABR latencies	mean	SD	P value
Degree of severity	V	6.13	.36	0.16
	A	7.58	.55	0.04
	C	18.10	.64	0.99
	D	23.05	.98	0.05
	E	31.33	.59	0.42
	F	40.19	.82	0.022
	O	49.45	1.03	0.57

Discussion:

OSAS raises the risk of cardiovascular system disorders such as disease of coronary arteries and hypertension, in addition to clinical symptoms such as daytime sleepiness, morning headaches, and memory and concentration loss as well as the risk of CNS disorders such as stroke [12,13]. Many scholars have previously conducted tests to investigate how OSAS affects the auditory system. According to these studies, which used ABR, OAE, and audiometry, hearing loss can be more severe in people with moderate to severe OSAS 6, 13, 14.

While the typical complex -ABR waveforms in this study are morphologically identical for both groups, OSAS patients' peak V, C, and O latencies are considerably longer (Table 3), suggesting that the transient complex-ABR components of their participants' complex-ABR may be aberrant. This finding is consistent with cases of PDS 14 and LPC 15, 16 patients in complex-ABR trials.

Complex-ABRs are potentials that auditory evoked and they reflect the harmonized neuronal activity in the

auditory brainstem, but they could respond differently to stimuli. Variations in the neuronal populations used for speech syllable encoding offer a possible explanation. In contrast to simple sounds, complex sounds may be processed by a distinct system in the auditory brainstem 17.

In the area of abnormal speech-ABR performance in LPC populations, certain researches supported this hypothesis 15. Speech syllables have tones, which are primarily reflected in the sound of the F0, timbre, which is primarily reflected by harmonics, timing, which is primarily reflected in the beginning, end, and transitions between phonemes, and other acoustic characteristics related to meaningful language. The auditory mechanisms involved in speech syllable coding may be more sophisticated than those involved in clicking sound stimuli because the auditory brainstem may need to mobilize more neurons or alter their functioning for the speech stimulus. Furthermore, the reverse masking effect makes coding speech sounds more challenging for the auditory system 18. According to this study, complex-ABR has better application potential since it could give extra information on the auditory brainstem center to more accurately mimic auditory function 17.

The irregularity in the transient components of OSAS patients (Table 3) is thought to represent filter information, which is coupled to temporal and formant information as coding with the "where" circuit. The periodic complex-ABR components, which represent sound source information connected to F0 or pitch as coding with the "what" pathway, showed no significant differences. The auditory what where functional pathways may be supported by the delay in the latencies of the transient components' peaks V, C, and O and have independent functions19.

These abnormal complex-ABR performances could be the result of temporal information encoded in the auditory brainstem interfering 14, 15, 20-22. Peak V might be a highly synchronised neuronal response to the stimulus's commencement; peak C could be a response to the beginning of voice that happens after the stimulus's onset; and peak O could be a response to sound cessation because it coincides temporally to the stimulus's offset 14, 15. These transitory peaks in complex -ABR may be caused by octopus cell activity in brainstem nuclei that transmit speech timing information 23. Auditory neurons may be particularly sensitive to hypoxemia-related damage because they produce burst responses that burn a lot of energy or more oxygen 7, 23. These neurons may be more vulnerable to hypoxemia-related dysfunction. Transient auditory neurons are more prone to negative influences than auditory neurons that produce periodic components of complex ABR. This concept was supported by other study in noisy surroundings 24 as well as among the elderly 25.

According to study, an OSAS patient's SaO2 decreases in direct proportion to their AHI. As a result, severe OSAS should have a greater chance of impairing the affected neurons' temporal coding capacities. Despite the fact that OSAS patients have modest hypoxemia, a greater AHI indicates prolonged apnea and hypopnea durations or more frequent hypoxia, which affects auditory function due to a lack of blood flow in the brainstem 26.

According to Fu et al (2018), there were considerable positive associations among the latencies of peaks (V, C, and O) with AHI, implying that the damage might be exacerbated by the severity of the OSAS. 27 On the other hand we discovered no significant link between

degree of severity and speech ABR abnormalities in this investigation of OSAS patients, which may have contributed to the limited study group size.

Conclusion:

Patients with obstructive sleep apnea may have abnormal c-ABR in the form of abnormal neural synchrony affecting the filter elements (waves V, C, O), but there was no effect on the source elements. While changes in the click-evoked auditory brain stem response are not discernible. BecauseThese elements correspond to th e coding of temporal information in spee ch syllables. this discovery implies that OSA may be to blame for the temporal information processing deficits that C-ABR can reveal. As a result, C-ABR has the potential to be used as a biomarker in OSA.

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Conflicts of interest: No

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