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ORIGINAL ARTICLE.

Complementary Role of Vestibular to Neurological Evaluation in Assessment of Dizzy Children

Youstina Adel Abdelmalak Attia[1], Ahmed Mohamed El-sayed Khater[1], Wafaa Samir Mohamed Hassan[2],Nahla Hassan Ahmed Gad[1]

[1]Audio-vestibular Medicine, E.N.T. Department, Faculty of medicine,Zagazig university, Zagazig, Egypt
[2]Neurology Department, Faculty of Medicine, Zagazig university,Egypt

Corresponding author:

Youstina Adel Abdelmalak Attia

Email address:

Youstinaadelabdelmalak@gmail.com

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ABSTRACT

Background: Vestibular disorders are common among the pediatric population, but these cases often go undiagnosed due to a lack of vestibular assessment. Accurate diagnosis can be achieved through a thorough combined assessment of vestibular and neurological functions.

Aim: The present work aims to 1) evaluate the vestibular findings and 2) detect the complementary role of vestibular to neurological assessment in dizzy children.

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Methods: This observational, case-control study involved 40 children: 20 healthy children and 20 children experiencing dizziness. All participants underwent full history taking, otological examination, basic audiological evaluation, neurological evaluation (clinical neurological examination, magnetic resonance imaging [MRI], and electroencephalography [EEG]), vestibular assessment (office tests and VNG), and the pediatric dizziness questionnaire.

Results: Clinical neurological assessment of dizzy children revealed normal findings. However, EEG exhibited two patients with epilepsy, while MRI displayed positive findings in one case. However, vestibular assessment revealed impaired vestibular functions in the study group. Using the VNG, showed higher latency and lower velocity of saccadic test in both directions in the study group compared to the control group. Additionally, the pediatric dizziness questionnaire showed a mean vestibular category score of 4.1 ± 2.51 and a mean neurological category score of 3.2 ± 2.19. The questionnaire revealed that 45% of cases had vestibular disorders, 35% had neurologic disorders, and 20% had a combination of both.

Conclusion: Neurological examinations alone may fail to diagnose dizziness in children. Despite the low prevalence of cases diagnosed with MRI and EEG, these investigations remain important for uncovering obscure conditions that were not revealed during clinical examinations and require urgent intervention. Additionally, vestibular assessment in dizzy children is a useful tool for diagnosing vestibular lesions. The pediatric dizziness questionnaire also complements the findings of vestibular and neurological assessments.

Keywords: Vestibular Evaluation; Neurological Evaluation; Dizzy Child

INTRODUCTION

Central neurological conditions can lead to imbalance and can be associated with vestibular disorders. The causes include head injury, brain tumors, other space-occupying lesions, ataxic and demyelination syndromes, epilepsy, metabolic brain conditions, vascular causes (bleeding and arterio-venous malformation), and post-infective and inflammatory causes (encephalomyelitis and meningitis). Therefore, a comprehensive vestibular evaluation besides the neurological assessment is essential [1].

The frequency of imbalance and vestibular dysfunction in children is estimated to be between 0.45% and 5.3%. This prevalence increases with age with a slightly higher incidence in females than males [2]. Children are frequently incapable of describing their vestibular problems, which may explain the relatively low prevalence. Vestibular abnormalities are often overlooked in children, with signs of disrupted bodily balance typically attributed to a lack of motor coordination or behavioral changes [3].

Balance in the body relies on the integration of the visual, vestibular, and somatosensory systems, which are controlled by the central nervous system via cortical and cerebellar activities. Although these systems develop anatomically before birth, full integration occurs only between the ages of 8 and 10 years old. Any disruption among these sensory systems can lead to vestibular discomfort [3].

The vestibular system consists of two otolith organs and three semicircular canals (posterior, anterior, and horizontal). The VIII cranial nerve's vestibular branch consists of two branches: inferior and superior. The inferior branch innervates the posterior canal and saccule. whereas the superior branch innervates the horizontal and anterior canals, as well as the utricle [2]. The peripheral vestibular system gives data regarding linear and angular accelerations. Three sets of paired semicircular canals detect angular acceleration. The otolithic organs detect vertical and horizontal linear acceleration. The somatosensory system uses mechanoreceptors in the skin and joints to convey data related to exteroception and proprioception. Vision offers information on spatial orientation [4].

A dizzy child may be diagnosed with a wide range of manifestations such as unsteadiness, frequent falls, aberrant gait, and lightheadedness. These symptoms can hinder the development of postural-motor control and result in recurring falls [5]. The most common causes of dizziness in adolescents and children include visual changes, vestibular neuritis, serous otitis media, benign paroxysmal vertigo of childhood, head trauma, infectious labyrinthitis, malformation of the inner ear, vestibular migraine, and tumors of the posterior fossa [3]. Additionally, certain groups, such as those with congenital infections (e.g. toxoplasma, rubella, cytomegalovirus, and herpes simplex), hearing loss, and/or prematurity, are known to be at elevated risk for vestibular dysfunctions [6]. In neurology clinics, many of these children with dizziness may go undiagnosed, a condition that requires further vestibular investigations.

Previous studies have analyzed a significant number of participants using a retrospective methodology [7,8,9]. These patients underwent multidisciplinary assessment; hence the studies involved a wide range of suspected causes of dizziness including vestibular, neurological, pediatric, ophthalmologic, and psychiatric causes in their participants. To improve the accuracy of

diagnoses in neurology clinics for children experiencing dizziness, it is essential to provide more specific information. Therefore, the present study was designed to evaluate the suspected vestibular and neurological causes of dizziness. The main objectives of this study were to assess vestibular findings in children with dizziness and determine the complementary role of vestibular assessment in pediatric neurology clinics.

METHODS

Participants

This observational, case-control study was conducted on 40 children at the Audio-Vestibular Medicine Unit, E.N.T and Neurology Departments, Faculty of Medicine, Zagazig University Hospitals during the period from March 2023 to November 2023. They were classified into two main groups: the control group; which included 20 healthy children and the study group; which included 20 children complaining of dizziness. Verbal and written informed consent were collected from the parents after an explanation of the procedure and medical research. The research was conducted under the World Medical Association's Code of Ethics (Helsinki Declaration) for human research. This study was carried out after the approval of the Institutional Review Board (IRB#10487/28-2-2023).

The study group included cases of both genders, aged 10 to 18 years, who complained of dizziness, including a sense of self-rotation, imbalance, or rotation of surroundings. Cases with a history of systemic conditions affecting the vestibular system (e.g., ototoxic drug intake, diabetes mellitus, renal diseases, etc.) were excluded based on the absence of medical complaints.

Procedure

All cases were subjected to 1) complete history taking involving vestibular, neurological, and medical history, 2) neurological assessment including comprehensive clinical neurological examinations, electroencephalogram (EEG), and neuro-imaging with the magnetic resonance imaging (MRI), 3) otological examination, 4) basic audiological evaluation including pure tone audiometry, speech audiometry [10,11], and immittancemetry, 5) Vestibular assessment with office tests and videonystagmography (VNG) test battery, and 6) assessment of their complaint using pediatric dizziness questionnaire.

Neurological Assessment:

All pediatric participants who reported dizziness underwent thorough clinical neurological examinations. These examinations included assessments of mental status, head and face examinations, spinal and extremity evaluations, cranial nerve integrity evaluations, motor system, reflexes, and sensory system, as well as coordination and gait assessments. Additionally, EEG and MRI neuroimaging were requested.

Vestibular assessment

- **Office tests**

For the assessment of the vestibulo-ocular reflex, we performed head-shaking nystagmus, the head thrust test, and dynamic visual acuity. Tests for the vestibulospinal reflex included Romberg's test, the Fukuda stepping test, and the Clinical Test of Sensory Integration and Balance test.

- **Videonystagmography (VNG) test battery:**

Recordings were performed utilizing Ulmar VNG version (3.4.0.38) which involves using infrared goggles to monitor eye movements throughout visual stimuli and positional alterations. The VNG test battery included

oculomotor tests (saccade, smooth pursuit, optokinetic, and gaze-evoked nystagmus), searching for spontaneous nystagmus, positioning, positional tests, and bithermal caloric testing). To engage a child in VNG, finger puppets, small toys, or lighted spinners can be used as targets. This will help smooth bedside assessment of ocular alignment, range of motion, vergence saccades, and pursuit.

Pediatric Dizziness Questionnaire:

The questionnaire items were filled out by interviewing all parents of dizzy children, and the children themselves wherever available. It contains questions about the following: (a) description of dizziness, (b) significant medical history, (c) impact of dizziness on school, education, and everyday activities, (d) growth and educational history, (e) significant past medical history, and (f) family history [12].

These questions are grouped into seven diagnostic categories (general, vestibular, neurological, cervical, ocular, cardiovascular, and psychological) reflecting the different systems involved in balance control with overlapping of some category questions. In this study, only the vestibular and neurological categories were involved in the diagnosis of dizzy children who were incorporated.

There are 24 questions in each vestibular and neurological category. Therefore, a common denominator of 24 was used for our scoring system. Scoring points are assigned to 'yes' answers only. Accordingly, the vestibular category was assigned 1 point for a 'yes' answer in each of the 24 questions and was defined as associated or not with hearing loss. The neurological category was assigned 1 point for a 'yes' answer for every 24 questions. A percentage of impairment score was obtained and the total scoring of each system was described.

STATISCAL ANALYSIS

The data were processed on a computer using SPSS version 25. Qualitative data were reported as frequencies and percentages, and the Chi-square (X^2) test was performed to identify relationships between distinct qualitative variables. For quantitative variables, mean ± Standard deviation (SD), median, and Interquartile Range (IQR) were computed (for the non-normally distributed data). Independent sample t-test (t) was used to identify differences between different quantitative variables of normally distributed variables. Pearson's correlation (r) was used to estimate the association between the various metrics. The r value is always lying between -1 and 1. A p-value of <0.05 indicates a significant difference.

RESULTS

Demographic data revealed non-significant differences between groups concerning age and sex distribution (P>0.05) **(Table 1).** The mean duration of illness for cases was 13.40±13.27 months, with a median (IQR) of 9 (4-21) months. The present illness data is presented in **(Table 2).**

The neurological evaluation involved clinical examinations that exhibited normal findings in all participants. Therefore, EEG and MRI were further investigated. EEG test revealed that 10% of cases were positive with a provisional diagnosis of bitemporal epileptic discharges and frontal epilepsy. Examination by MRI showed only one positive case diagnosed with left-sided temporal sclerosis and right-sided small arachnoid cyst.

The audiological examination revealed a bilateral type A tympanogram with preserved acoustic reflexes reflecting bilateral normal middle ear functions. Also, all participants

had bilateral normal hearing sensitivity with matching SRT and WRS% except for one patient who had a moderate left-sided sensorineural hearing loss with absent acoustic reflexes. There was a non-significant difference between the studied groups as regards hearing threshold at all tested frequencies (0.25-8 kHz) in both ears **(Supplementary Table 1).**

Vestibular evaluation was performed by office tests and confirmed with the VNG test battery. The study group showed a statistically significant higher latency and lower velocity in both directions of the saccadic test compared to the control group (Table 3). The study found a statistically significant difference between the groups in terms of slow phase velocity (SPV) in the left direction, with the study group showing higher mean SPV values. Additionally, there was a statistically significant difference between the groups regarding unilateral weakness and directional preponderance, with higher mean values observed in the study group **(Table 3).**All cases revealed vestibular impairment without an exact diagnosis. Thus, they will be followed up for more investigations for accurate diagnosis.

In the vestibular category of the Pediatric Dizziness Questionnaire, all participants in the study group gave "no" answers for most of the questions (Q4, Q7, Q10, Q11, Q15, Q16, Q17, and Q22). Only questions 3 and 5 had a high frequency of "yes" answers (70% and 80%, respectively) **(Supplementary Table 2).** On the other hand, in the neurological category of the questionnaire, all participants in the study group gave "no" answers for most of the questions (Q7, Q8, Q10, Q11, Q12, Q14, Q15, Q16, Q17, and Q18), while only questions 4 and 5 had a high frequency of "yes" answer (70% and 80% respectively) **(Supplementary Table 3).**

The total score of vestibular questions ranged from 1 to 12 with a mean of 4.1 ± 2.51, while neurological scores ranged from 0 to 11 with a mean of 3.2 ± 2.19. In addition, the questionnaire revealed that 45% of cases had vestibular disorders, 35% had neurologic disorders, and 20% had a combination of both. On the other hand, the percentage of impairment scores estimated 60% higher vestibular scores than the neurological ones in the study group. The rest of the patients (40%) had higher neurological scores **(Table 4).**

Table (1): Demographic data in the control and study groups**.**

Variable			**Study Group (n=20)**	**Control Group (n=20)**	**Tests**	
					X²	***p*-value**
Sex	Male	N	11	12	0.102	0.749
		%	55.0%	60.0%		
	Female	N	9	8		
		%	45.0%	40.0%		
Variable			**Study Group (n=20)**	**Control Group (n=20)**	**Tests**	
					t	***p*-value**
Age (years) Mean± SD			13.65±2.64	13.30±2.39	0.440	0.663

(X^2) Chi-square test, (*t*) Independent samples test.

Table (2): History of present illness and neurological findings of the study group.

Variable		Study group (n=20)	
Duration of illness (months) Mean± SD Median (IQR)		13.40±13.27 9 (4-21)	
		No. of cases	**%**
Duration of attack (minutes)	≤ 1	4	20
	≤ 10	6	30
	≤ 30	5	25
	≥ 60	5	25
Nature of complaint	Imbalance	9	45
	Rotation of surroundings	4	20
	Self-rotation	7	35
Aggravating factor	Spontaneous	10	50
	Stress	5	25
	Vehicles riding	2	10
	Rolling in bed	2	10
	Sudden head movements	2	10
	Leaning forward	2	10
	Loud sounds	1	5
Relieving factor	Rest	18	90
	Analgesics	4	20
	Medication	1	5
Associated Symptoms	No associated symptoms	9	45
	Nausea, vomiting	9	45
	Phono/photophobia	3	15
	Generalized headache	2	10
	Temporal headache	2	10
EEG	Negative	18	90
	positive	2	10
MRI	Negative	19	95
	positive	1	5

N.B: symptoms may be overlapped in some cases. EEG:electroencephalogram, MRI: Magnetic resonance imaging

Table (3): Videonystagmography (VNG) within the control and study groups.

Variable		Study group (n=20)	Control Group (n=20)	Tests	
				t	*p*
Saccade test					
Right Mean±SD	**Latency millisecond**	281.4±42.4	243.4±29.52	3.289	**0.002***
	Velocity°/second	308.2±71.67	388.55±70.98	-3.562	**0.001***
	Accuracy%	91.05±7.86	93.4±5.83	-1.074	0.290
Left Mean±SD	**Latencymillisecond**	276.5±39.74	248.9±23.89	2.662	**0.011***
	Velocity°/second	309.05±53.45	362.05±60.82	-2.927	**0.006***
	Accuracy%	92.55±9.07	94.35±5.58	-0.756	0.454
Smooth pursuit test					
Right Mean±SD	**0.3Hz**	0.86±0.09	0.83±0.08	1.091	0.282
	0.45 Hz	0.81±0.11	0.82±0.09	-0.157	0.876
Left Mean±SD	**0.3Hz**	0.84±0.09	0.82±0.07	0.689	0.495
	0.45 Hz	0.8±0.1	0.83±0.08	-0.868	0.391
OPK					
Right Mean±SD	**Gain**	0.81±0.11	1.33±1.9	-1.318	0.195
	SPV °/second	14.42±1.74	14.38±2.19	0.064	0.949
Left Mean±SD	**Gain**	1.01±1.65	1.29±1.68	-0.238	0.813
	SPV °/second	13.59±3.04	11.87±1.89	2.146	**0.038***
Caloric test					
Right Mean±SD	**Cold**	15.85±8.77	20.63±6.31	-1.945	0.059
	Warm	14.39±9.23	20.47±7.02	-2.307	**0.027***
Left Mean±SD	**Cold**	14.91±10.61	20.89±7.68	-2.008	**0.049***
	Warm	16.95±8.69	20.38±7.18	-1.341	0.188
Unilateral Weakness %		12.40±7.563	4.70±1.949	4.4	**<0.001***
Directional Preponderance %		15.55±7.79	7.8±2.46	4.242	**<0.001***
(t) Independent sample t-test, SPV: slow phase velocity, OPK: optokinetic nystagmus.					

Table (4): Total score of Pediatric Dizziness Questionnaire among the study group.

	No. of cases	Minimum	Maximum	Mean ± SD
Vestibular	20	1	12	4.1 ± 2.51
Neurological	20	0	11	3.2 ± 2.19
			N (%) N=20	
Vestibular insults > Neurological insults			12 (60%)	
Neurological insults > Vestibular insults			8 (40%)	

DISCUSSION

Balance is essential for a child's proper growth and psychophysical well-being. Vestibular assessment is an important method in the examination of pediatric cases experiencing dizziness [13]. In the present, study 40 children were included and subdivided into two groups; the control group included 20 healthy children and the study group included 20 children complaining of dizziness, matched with the control group in age and gender. There were no significant differences between the study and control groups concerning age with a homogenous gender distribution (Table 1).

In the current study, the mean ± SD of the duration of illness reported by children with dizziness was denoted to be 13.40±13.27 months. As regards the duration of attacks of dizziness, the majority of cases (30%) lasted ≤

10 minutes, 25% of cases lasted ≤ 30 minutes, 25% of cases lasted ≥ 60 minutes, and finally 20% of cases lasted ≤ 1 minute (Table 2). Our results matched that in literature among dizzy children. Similarly, Swain et al. [7] stated that the most common duration of vertiginous attacks occurring in childhood period lasted for 10 minutes. In their study, the duration of vertiginous attacks occurred in <10 minutes in 45 children (41.66%), <1 minute in 29 children (26.85%), ≥ 60 minutes in 27 children (25%), and may last for days in 7 children (6.48%).

The nature of the dizziness complaints varied among the dizzy children involved in this study. Forty-five % of cases presented with an imbalance complaint, followed by 35% presented with a sense of self-rotation, then 20% presented with a sense of rotation of the surroundings (Table 2). Conversely, Haripriya et al. [8] reported a different distribution of the dizziness description. They denoted a higher percentage of cases (50.6%) presented with a complaint of rotation of the surroundings, followed by 29.2% presented with self-rotation, and then 20.2% presented with other symptoms, such as linear displacement, syncope, imbalance, etc. This different distribution of dizziness complaints could be attributed to that the study of Haripriya et al. [8] included a wide age range (from 1 to 18 years old), categorized into different age subgroups: 1–6 years (preschool), 7–12 years (school age), and 13–18 years (adolescents).

The aggravating factors of dizziness in the current study varied also among the participants. In about half of the cases (50%), dizziness arose spontaneously. Meanwhile, it was aggravated by physical or psychological stress in 25% of cases, during vehicle riding, rolling in bed, sudden head movements, or leaning forward in 10% (for each factor), and with loud sound exposure in 5 % of cases (Table 2). However, contrary to our findings, Wiener-Vacher et al. [14] denoted that stress and ocular fatigue were the most common triggering factors, accounting for 60% of cases. These differences could stand for their larger sample size and wider age range (starting from 3 years of age). Moreover, most of the participants in their study group were found to have ophthalmological disorder as the only problem after complete audio-vestibular testing.

On the other hand, dizziness in most cases (90%) was relieved by rest, analgesics in 20%, and medications in 5%. Symptoms associated with dizziness involved nausea and vomiting in 45%, headache in 20 %, and phono/photophobia presented in 15%. However, 45% of cases didn't complain of any other symptoms (Table 2). A relatively different distribution of the associated symptoms was reported by Swain et al. [7]. Nausea and vomiting were the most common symptom (in 85 children; 78.70%), followed by headache (in 41 children, 37.96%), hearing loss (in 15 children, 13.88%), tinnitus and aural fullness (each in 7 children, 6.48%), diaphoresis (in four patients, 3.70%), vision impairment (in 3 children, 2.77%), and lastly the altered consciousness (in 2 children, 1.85%). This study differed from our study as it involved a larger sample size and included all possible causes of dizziness other than neurological and vestibular causes.

The outcome of neurological evaluation

In the present study, dizzy children were presented first to the neurology clinic. Full clinical examinations were performed and revealed normal findings in these children. As a complementary tool for the evaluation of children with dizziness, all participants in the study group underwent EEG and neuroimaging with MRI. Positive EEG findings, which means the presence of epileptic activity, were found in two cases (10%); one revealed bitemporal epileptic discharges with secondary generalization and the other revealed frontal epilepsy (Table 2). Korkmaz and Ekici [15]also used EEG in the evaluation of their dizzy participants and reported the presence of epileptic activity in 7% of cases.

Additionally, neuroimaging, especially brain MRI is usually important in the evaluation of dizzy children either to confirm or exclude an organic cause of dizziness. Positive MRI findings were found in only one case (5%) that revealed a left-sided temporal sclerosis and a right-sided small arachnoid cyst (Table 2).Nearly similar outcomes were noticed by

Raucci et al.[16]whoreported the presence of MRI findings in 2.5% of cases.

The outcome of vestibular evaluation

As a following step, all participants were referred for full audio-vestibular evaluation. The audiological examination revealed normal middle ear functions and bilateral normal hearing sensitivity with matching SRT and WRS% in all participants, except for one patient who had moderate left-sided sensorineural hearing loss with absent acoustic reflexes.

The vestibular function could be assessed via VNG which plays a major role in the diagnosis of dizziness and helps to differentiate the location of the lesion between the central and peripheral part of the vestibular system. In the current study, the saccadic test revealed abnormalities in the form of delayed latency and slower velocity in both directions in the study group (Table 3). Similarly, Wu et al. [17] denoted saccadic abnormalities, in addition to pursuit, gaze-evoked, and optokinetic test abnormalities, specifically with central vestibular disorders.

Moreover, the caloric test is considered a reliable test that detects unilateral peripheral vestibular insults, although it only examines the horizontal semicircular canal and its neuronal interconnections at ultra-low frequencies (0.002-0.004 Hz). The major indicators of the caloric test include unilateral weakness, Directional Preponderance, and canal response [18]. The current study showed a statistically significant difference between the control and study groups concerning the warm caloric test in the right ear, cold caloric test in the left ear, unilateral weakness, and Directional Preponderance (Table 3). These statistically significant differences were clinically insignificant as they did not reach the cutoff point of unilateral weakness (> 20%). There was also a moderate, negative correlation (r= -0.522, p= 0.018) between age and directional preponderance. On the contrary, Mallinson and Longridge [19] found a weak correlation between age and caloric weakness or directional preponderance. They explained their findings by the low stimulus amplitude signal supplied by the caloric test that does not challenge the semicircular canal system sufficiently to reveal its defects.

The outcome of the pediatric dizziness questionnaire

Children with vestibular dysfunction and dizziness may appear with a variety of subjective problems. As a result, clinicians can quantify the intensity and significance of dizziness or vestibular loss by employing newly created questionnaires [2]. In our study, we chose the Pediatric Dizziness Questionnaire [12] to help us evaluate the complaints of the participants.

Regarding the description of pediatric dizziness questionnaire items scores in this study, the mean score of the vestibular category was 4.1 ± 2.51 ranging between 1 and 12 and the mean score of the neurological category was 3.2 ± 2.19 ranging between 0 and 11. Moreover, the predominant diagnoses of the evaluation of patients using the Pediatric Dizziness Questionnaire were vestibular disorder in 45 % of cases (9 cases), a neurologic disorder in 35% (7 cases), and combined vestibular and neurologic disorder in 20 % (4 cases) (Table 4).

Differently, Elghaffar et al. [20] reported higher mean scores for the vestibular category (8.3 ± 3) and the neurological category (5.6 ± 3.7). They also demonstrated that 36.2% of cases were diagnosed as vestibular dizziness, 5.8% for neurological causes, and 13.7% for combined vestibular and neurological, which are lower than that of our findings. Their study was a cross-sectional study that involved a larger number of dizzy children. In addition, they used the whole form of the Pediatric Dizziness Questionnaire including all seven categories (general, vestibular, neurological, cervical, ocular, cardiovascular, and psychological).

It can be concluded that the usage of the questionnaire in the present study was beneficial. It complemented our investigation of dizzy pediatric participants and helped to confirm the diagnosis by the questionnaire's answers.

The limited number of sample size is one of the limitations of the current study. Furthermore, not all historical information that was collected from the parents and events that could affect the conclusion have been

thoroughly recorded. For a more accurate assessment of the vestibular functions in children complaining of dizziness, it is suggested that future studies should implement a larger number of patients and apply different vestibular laboratory testing. This will more clarify the complementary role of vestibular to neurological assessment in dizzy children.

Conclusion

Dizziness in children is a challenging medical condition. Comprehensive medical history including pediatric dizziness questionnaire, audio-vestibular evaluation, and clinical neurological examination form a multidisciplinary approach in the assessment of dizziness in children. Neurological evaluation alone may fail to diagnose dizziness in children, but when combined with vestibular assessment, it can address some hidden conditions and help to confirm vestibular and clinical neurological findings in children complaining of dizziness.

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Supplementary data

Supplementary Table (1): Audiological assessment within the control and study groups.					
Variable		**Study Group (n=20)**	**Control Group (n=20)**	**Tests**	
				t	***p***
250 Hz Mean±SD	**Right**	13±3.77	11.25±2.22	1.789	0.082
	Left	13.25±9.07	11.25±2.22	0.958	0.344
500 Hz Mean±SD	**Right**	11.25±3.58	11.5±2.35	-0.261	0.796
	Left	13±9.38	11.5±2.35	0.694	0.492
1 kHz Mean±SD	**Right**	10.25±2.55	11.51±2.34	0.438	0.664
	Left	12.75±10.32	11.51±2.34	1.192	0.241
2 kHz Mean±SD	**Right**	10±1.62	11.49±2.3	0.000	1.000
	Left	13.5±12.47	11.49±2.3	1.255	0.217
4 kHz Mean±SD	**Right**	9.5±2.76	9±2.05	0.650	0.520
	Left	12.5±8.66	9±2.05	1.759	0.087
8 kHz Mean±SD	**Right**	12.5±8.66	9±2.05	1.759	0.087
	Left	13±7.33	9±2.08	1.831	0.075
SRT dB HL Mean±SD	**Right**	10±2.81	11.5±2.34	0.000	1.000
	Left	12.25±9.52	11.51±2.34	1.056	0.297
WRS% Mean±SD	**Right**	97.8±2.04	99.44±1.4	-4.819	0.196
	Left	95.8±15.11	99.4±1.47	-1.061	0.295

(t) Independent sample t-test.

Supplementary Table (2): Vestibular questions of Pediatric Dizziness Questionnaire.							
Questions		**N**	**%**	**Questions**		**N**	**%**
Question V 1 وصف الدوار؟ هل تدور؟ العالم يدور؟	No	14	70	**Question V 9** ما الذي يجعل الدوار اسوأ؟ السعال، العطس او الامساك؟	No	16	80
	Yes	6	30		Yes	4	20
Question V 2 وصف الدوار؟ احساس بالتحرك صعودا و هبوطا؟ احساس بالتحرك جنب الي جنب؟	No	16	80	**Question V 10** ما الذي يجعل الدوار اسوأ؟ الغوص؟	No	20	100
	Yes	4	20		Yes	0	0
Question V 3 وصف الدوار؟ صعوبة و عدم اتزان في المشي- سقوط؟؟	No	6	30	**Question V 11** ما الذي يجعل الدوار اسوأ؟ ركوب الطائرة؟	No	20	100
	Yes	14	70		Yes	0	0
Question V 4 وصف الدوار؟ صعوبة و عدم اتزان في المشي في الظلام؟	No	20	100	**Question V 12** ما الذي يجعل الدوار اسوأ؟ وسائل النقل؟	No	17	85
	Yes	0	0		Yes	3	15
Question V 5 وصف الدوار؟ هل تحدث الدوخة في صورة نوبات متكررة؟	No	4	20	**Question V 13** ما الذي يجعل الدوار اسوأ؟ الاصوات الصاخبة؟	No	17	85
	Yes	16	80		Yes	3	15
Question V 6 قبل النوبة؟ عدوي فيروسية/ اعراض اضطراب الاذن؟	No	16	80	**Question V 14** ما الذي يجعل الدوار اسوأ؟ المرتفعات؟	No	19	95
	Yes	4	20		Yes	1	5
Question V 7 ما الذي يجعل الدوار اسوأ؟ بعض المواد الغذائية المملحة؟	No	20	100	**Question V 15** ما الذي يجعل الدوار اسوأ؟ اصابة بالرأس او الرقبة؟	No	20	100
	Yes	0	0		Yes	0	0
Question V 8 ما الذي يجعل الدوار اسوأ؟ عن تغيير بعض مواضع الرأس او دوران الرأس؟	No	17	85	**Question V 16** ما الذي يجعل الدوار اسوأ؟ مهدئات؟	No	20	100
	Yes	3	15		Yes	0	0
Question V 17 ما الذي يجعل الدوار اسوأ؟ بعض المضادات الحيوية الوريدية؟	No	20	100	**Question V 21** هل لدي الطفل اعراض خاصة بالاذن؟	No	15	75
	Yes	0	0		Yes	5	25
Question V 18	No	16	80	**Question V 22**	No	20	100

ما الذي سجعل الدوار تتحسن؟ عن تغيير وضع الجسم او مواضع الرأس او عدم تحريك الرأس؟	Yes	4	20	هل لدي الطفل عيب خلقي بالاذن؟	Yes	0	0
Question V 19 الاعراض المصاحبة للدوار؟ حركة او رقرقة بالعين؟	No	19	95	**Question V 23** هل تاخر الطفل في النطق و الكلام و اللغة؟	No	16	80
	Yes	1	5		Yes	4	20
Question V 20 الاعراض المصاحبة للدوار؟ فقد السمع، تغيير في السمع او شعور بامتلاء بالاذن؟	No	15	75	**Question V 24** هل يعاني الطفل من صعوبة في التعليم؟	No	18	90
	Yes	5	25		Yes	2	10

Supplementary Table (3): Neurological questions of Pediatric DizzinessQuestionnaire.

Questions		N	%	Questions		N	%
Question N 1 وصف الدوار؟ احساس بالضعف اوقرب الاغماء؟	No	14	70	**Question N 9** ما الذي يجعل الدوار اسوأ؟ التفكير ، الاجهاد الذهني؟	No	19	95
	Yes	6	30		Yes	1	5
Question N 2 وصف الدوار؟ الانقطاع او التعتيم؟	No	19	95	**Question N 10** ما الذي يجعل الدوار اسوأ؟ اصابة بالرأس او الرقبة؟	No	20	100
	Yes	1	5		Yes	0	0
Question N 3 وصف الدوار؟ الغشيان او الاغماء؟	No	18	90	**Question N 11** ما الذي يجعل الدوار اسوأ؟ الاسبرين، المسكنات؟	No	20	100
	Yes	2	10		Yes	0	0
Question N 4 وصف الدوار؟ صعوبة و عدم اتزان في المشي- سقوط؟؟	No	6	30	**Question N 12** ما الذي يجعل الدوار اسوأ؟ مهدئات؟	No	20	100
	Yes	14	70		Yes	0	0
Question N 5 وصف الدوار؟ هل تحدث الدوخة في صورة نوبات متكررة؟	No	4	20	**Question N 13** الاعراض المصاحبة للدوار؟ الصداع النصفي؟	No	15	75
	Yes	16	80		Yes	5	25
Question N 6	No	13	65	**Question N 14**	No	20	100

قبل النوبة؟ هل يوجد مقدمة للاعراض (خوف من الصوت او الضوء)؟	Yes	7	35	الاعراض المصاحبة للدوار؟ ارتباك، اضطراب او فقدان الوعي، فقدان الذاكرة؟	Yes	0	0
Question N 7 ما الذي يجعل الدوار اسوأ؟ شرب القهوة، الشاي، الكولا او اكل الشيكولاتة؟	No	20	100	**Question N 15** الاعراض المصاحبة للدوار؟ نقص حس او خدر حول الفم او اليدين او الساقين؟	No	20	100
	Yes	0	0		Yes	0	0
Question N 8 ما الذي يجعل الدوار اسوأ؟ فرط التنفس؟	No	20	100	**Question N 16** الاعراض المصاحبة للدوار؟ تشنجات في الذراعين او الساقين؟	No	20	100
	Yes	0	0		Yes	0	0
Question N 17 الاعراض المصاحبة للدوار؟ صعوبة في الكلام او البلع او اختناق؟	No	20	100	**Question N 21** هل تأخر هذا الطفل في مهارات الفهم بالمدرسة او باللعب؟	No	19	95
	Yes	0	0		Yes	1	5
Question N 18 الاعراض المصاحبة للدوار؟ عدم التناسق او الترابط في الحركات؟	No	20	100	**Question N 22** هل تاخر الطفل في النطق و الكلام و اللغة؟	No	16	80
	Yes	0	0		Yes	4	20
Question N 19 الاعراض المصاحبة للدوار؟ حركة او رقرقة بالعين؟	No	19	95	**Question N 23** هل يعاني الطفل من صعوبة في التعليم؟	No	18	90
	Yes	1	5		Yes	2	10
Question N 20 هل تأخر هذا الطفل في الحركة؟	No	18	90	**Question N 24** هل لدي الطفل اي سلوك نفسي غير طبيعي؟	No	19	95
	Yes	2	10		Yes	1	5

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