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ORIGINAL ARTICLE

Vestibular Assessment in Chronic Obstructive Pulmonary Disease Patients

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ABSTRACT

Background: Chronic Obstructive Pulmonary Disorder (COPD) is a common preventable and treatable disease which is characterized by persistent airflow limitation that is usually progressive and associated with an enhanced chronic inflammatory response in the airways and the lungs to noxious particles or gases.

Balance disorder is a common manifestation in people with COPD which may contribute to overall functional decline. COPD causes balance impairment through hypoxia of the inner ear, vestibular nuclei (which is more sensitive to hypoxia than other cerebral nuclei) and generalized cerebral hypoxia. In addition to musclo-skeletal weakness, visual deficits, vasculitis and poly-neuritis due to accumulation of toxins can occur.

Patients and methods: A total number of 50 patients were included in the present study. They were divided into 2 groups. The control group consisted of 20 healthy subjects with no history of COPD, vertigo or hearing loss. The study group consisted of 30 patients with history of COPD..

Results: Hearing affection and vestibular affection were significantly associated with COPD.

Conclusion: The hearing affection among COPD patients was apparent in the high frequency range. Also, vestibular affection was shown in tests that assessed postural control.

Key words: COPD, Hearing assessment, Vestibular evaluation

INTRODUCTION

Chronic Obstructive Pulmonary Disorder (COPD) is a common preventable and treatable disease which is characterized by persistent airflow limitation that is usually progressive and associated with an enhanced chronic inflammatory response in the airways and the lung to noxious particles or gases. It affects more than 5 percent of the population and is associated with high morbidity and mortality (the fourth leading cause of death in the world). **(1).**

Balance disorder is a common manifestation in people with COPD which may contribute to overall functional decline. COPD causes balance impairment through hypoxia of inner ear, vestibular nuclei and generalized cerebral hypoxia. In addition to musclo-skeletal weakness, visual deficits, vasculitis and poly-neuritis due to accumulation of toxins. All of these factors affect position sense in the feet and legs, increasing the balance dysfunction in those patients. **(2) (3).**

Screening tools such as questionnaires and office testing were developed to identify individuals at risk of falling and are frequently used as a part of falls prevention programs in hospitals. **(4).**

The diagnostic process of imbalance is more or less a complicated task especially in older adults. This diagnostic process must distinguish between otologic, central, medical, and psychogenic etiologies **(5).** Video-Nystagmography (VNG), especially the caloric test, has been the most important test of the vestibular function. The caloric test, despite its limitations, is a sensitive test for detecting common vestibular abnormalities **(6).**

However, caloric test alone does not reflect the functional ability of the patient to maintain balance in daily life conditions and to predict risk for falls. Moreover quantitative measurement of balance function by an objective test as computerized dynamic posturography test (CDP) is an integral part of the assessment of the functional ability and risk for falls in dizzy patients in general.

The use of this high technology vestibular laboratory testing provides adequate data about localization and quantification of vestibular abnormalities. However it is sometimes not feasible in COPD patients due to their health condition.

Accordingly, the present study was planned to develop a test battery approach to evaluate balance and functional status of those patients.

MATERIALS AND METHODS

Study setting: Ain Shams University Hospitals.

Materials:

I. Study group:

This is a prospective study design. It was carried on (30) patients.

The study group were selected from the chest department (inpatient or out

Patient clinic) and the audiology unit, Ain Shams University hospitals.

Written informed consent was obtained from all participants and the study was

approved by the research ethical committee of Faculty of Medicine, Ain

Shams University. The work has been carried out in accordance with The

Code of Ethics of the World Medical Association (Declaration of Helsinki) for

studies involving humans.

a) Inclusion ceiteria:

All adult COPD patients between the age of 40 and 60 years confirmed as COPD by criteria of Gold (2017) and accepted to participate in the study.

b) Exclusion criteria:

1) Patients with risk factors (like head trauma, diabetes, hypertension, and previous ear operations).

2) Patients with neurological deficits .

3) Eye problems.

II. Control group:

Consists of (20) healthy persons not complaining of audio-vestibular problems and also don't have any chest problems, diabetes or hypertension.

Equipments:

1- A double walled sound treated room I.A.C. model 1602.

2- Two channel audiometer interacoustics, model AC40, calibrated according to ANSI S.3.6, 1996.

3- Acoustic immitancemeter MAICO model MI34.

4- Tools used for office tests:

A. Frenzel glasses for head shake and head impulse test.

B. Medium-density foam to conduct mCTSIB.

C. Stop watch for counting time in walking test and mCTSIB.

5- Computerized four channel video-nystagmography (VNG) michromedical tech, meta4, software version4.5.

6- Computerized dynamic posturography (CPD) Neurocom international, equitest system, software version 8.4.

Methods:

Every included participant were subjected to the following:

1) Full COPD history taking:

- Personal history including (age, sex, BMI and smoking history).
- COPD history including (duration, symptoms such as cough, expectoration, wheezes, chest pain and co-morbidities such as hypertension, diabetes, ischemic heart disease and exacerbations, previous I.C.U. admission or mechanical ventilation).

2) Spirometry:

For grading of COPD.

3) Audio-vestibular history and examination:
Full description of vertiginous attacks and any associated symptoms.
4) Basic audiological evaluation: including
Pure tone audiometry (air conduction and bone conduction), speech audiometry and acoustic immitancemetry.
5) Vestibular assessment: including
A) Dizziness Handicap Inventory (DHI) questionnaire.
B) Vestibular office tests:
To evaluate postural control and gait
1- Fukuda stepping test.
2- One leg stance test.
3- Modified clinical test of sensory integration for balance (mCTSIB).
4- Head shake test.
5- Head thrust test.
C) Video-Nystagmography(VNG): including:
Occulomotor test, positional and positioning tests and bithermal caloric test.
D) Sensory Organization Test (SOT) of computerized dynamic posturography:
The SOT protocol objectively identifies abnormalities in the patient's use of the three sensory systems that contribute to postural control: somatosensory, visual and vestibular.

RESULTS

A total number of 50 patients were included in the present study. They were divided into 2 groups. The control group consisted of 20 healthy subjects with no history of COPD, vertigo or hearing loss. The study group consisted of 30 patients with history of COPD. Both groups were age matched and their age ranged from 40 to 60 years.
(COPD patients were referred from the Chest diseases department, male section).
There was a significant statistical difference between study group and control group as regarding pure tone thresholds (table 1). Two thirds of COPD patients were mildly handicapped, while the rest one third showed no handicapping according to DHI questionnaire scores (table 2). More than one third of the study group patients had abnormal office test results especially that assess postural control (table 3).
Abnormal VNG test results (positional and caloric) were detected in about quarter of study group (table 4).
Abnormal SOT test results were found in condition 5, 6 and the composite score in half of the study group. The total abnormality among studied COPD patients was 13 out of 30 patients, with percentage of 43.3 % (table 5). Hearing affection and vestibular affection are significantly associated with COPD (table 6).

Table 1. Comparison of pure tone audiometric thresholds (in dBHL) for both study group and control group:

Frequency	Study group (Mean-SD)	Control group (Mean-SD)	Independent t test	P
250 Hz	18.5±3.0	15.0±1.4	4.397	.000*
500 Hz	19.0±3.3	17.1±4.8	2.545	.004*
1 KHz	20.4±3.7	15.8±3.1	3.965	.000*
2 KHz	22.2±5.1	16.2±4.9	5.236	.002*
4 KHz	29.5±8.9	12.6±5.1	4.595	.000*
8 KHz	38.1±12.2	19.0±7.9	5.571	.000*

Table 2. Degree of handicapping among studied COPD patients according to DHI scores:

Group	Number	Percentage	Cut off limits of DHI Points
No Handicap	10	33.4 %	<16 points
Mild Handicapping	20	66.6 %	16-34 points
Moderate Handicapping	---	---	36-52 points
Severe Handicapping	---	---	>54 points

Table 3. Breakdown of vestibular office tests results in the study group:

		Study group	
		N	**%**
Head Shake	**-ve**	27	90.0%
	+ve	3	10.0%
Head Thrust	**-ve**	28	93.3%
	+ve	2	6.6%
One Leg Stance	**-ve**	21	70.0%
	+ve	9	30.0%
Fukuda Stepping Test	**-ve**	24	80.0%
	+ve	6	20.0%
mCTSIB	**-ve**	22	73.3%
	+ve	8	26.6%
Total abnormality in the office tests		12	40%

Table 4. Videonystagmography (VNG) test results among the study group patients:

			Study group
Occulomotor Test	-ve	N	30
		%	100.0%
	+ve	N	Zero
		%	Zero%
Positional and Positioning Tests	-ve	N	27
		%	90.0%
	+ve	N	3
		%	10.0%
Caloric Test	-ve	N	23
		%	76.6%
	+ve	N	7
		%	23.3%
Total abnormality in VNG test		8	26.6 %

Table 5. Comparison of SOT test results between both study group and control group: (Fisher's exact test was used)

	study group				control group				Independent t test	P
	Mean	SD	Min	Max	Mean	SD	Min	Max		
Condition1	94.03	1.0	93.00	96.00	94.05	.94	93.0	96.00	-.059	0.95
Condition2	92.40	.81	91.00	94.00	93.35	.59	92.0	94.00	-4.49	0.23
Condition3	91.77	.86	91.00	94.00	92.65	.49	92.0	93.00	-4.62	0.07
Condition4	83.83	2.3	80.00	90.00	85.15	2.41	83.0	89.00	-1.90	0.06
Condition5	68.73	6.8	60.00	80.00	73.25	1.77	70.0	76.00	-3.43	.002*
Condition6	65.83	4.5	59.00	74.00	71.10	2.05	68.0	75.00	-5.57	.000*
Composite Score	74.40	7.7	60.00	87.00	82.55	1.88	80.0	85.00	-5.55	.000*

Table 6. Relation between severity of COPD with hearing loss and vestibular affection in the study group:

		N	Mean	Std. Deviation	Independent t test	P
Hearing affection		30	37.51	20.66	-.058	.004
Vestibular affection		30	41.28	21.49	.705	.002

DISCUSSION

A total number of 50 patients were included in the present study. They were divided into 2 groups. The control group consisted of 20 healthy subjects with no history of COPD, vertigo or hearing loss. The study group consisted of 30 patients with history of COPD. Both groups were age matched and their age ranged from 40 to 60 years.

(COPD patients were referred from the Chest diseases department, male section).

Pure tone audiometric thresholds for COPD patients revealed that about 56.6 % (17 patients) had hearing loss especially in the high frequency range (mean 29.5 ± 8.9 and 38.1 ± 12.2 for 4 and 8 KHz respectively in the study group while it was 12.6 ± 5.1 and 19.0 ± 7.9 in the control group for the same frequencies) so that, the present study showed that hearing loss is associated with COPD (***table 1)***.

These results were in agreement with **(7)** who found hearing loss from 4000 Hz and higher frequencies, also decreasing hearing thresholds was common in the high frequencies in patients with hypoxia, while all patients have normal type A tympanogram.

According to **(8)** the mean pure tone audiometric thresholds (PTA) was 13.9 ± 9.7 dB in patients with mild OSA and it was 14.1 ± 10.5 dB in patients with moderate to severe OSA. In the left ear, the mean PTA was 13.6 ± 10.3 dB in patients with mild OSA and 13.8 ± 11.2 dB in patients with moderate to severe OSA.

(8) Concluded that -unlike the results of the present study- the difference between the groups was not significant for either ear.

The present study showed that twenty COPD patients (two thirds of the study group) were mildly handicapped especially in the functional and physical aspects ***(table 2).***

(8) Found that the physical sub scores of group 2 (moderate to severe OSA) were significantly higher than the scores of group 1 (mild OSA).

The results of the present study revealed that studied COPD patients showed abnormal office test results especially on performing office tests that assess postural control (one leg stance, Fukuda stepping test and mCTSIB tests) with percentage of 40 % (more than one third) ***(table 3).***

(9) revealed that patients in the acute exacerbation group were able to stand on one leg for only 7.2 seconds (median value) and this test was almost impossible to be performed with eyes closed (with a median value of 1.5 seconds).

(9) Concluded that patients in moderate and severe COPD stages (especially those in acute exacerbation) had a high risk of fall.

Eight COPD patients (about quarter of the study group) had abnormal VNG test results especially in the positional, positioning and caloric tests ***(table 4)***.

All the thirty COPD cases have no abnormality according to spontaneous nystagmus or the ocoulometer tests (saccade, tracking and optokinetic).

These results were in agreement with a case-control study by **(10)** which was carried out on 35 obstructive sleep apnea syndrome (OSAS) patients. They found that caloric tests in the OSAS group demonstrated abnormal findings in 27 patients and normal vestibular functions in eight patients.

The present study showed that about half of the study group has abnormalities on performing SOT with percentage of 43.3 %. These abnormal results were in conditions 5, 6 and the composite score ***(table 5)***.

The results of the present study were in agreement with **(11)** who investigated deficits in postural control and fall risk in people with chronic obstructive pulmonary disease. Patients with COPD showed a 10.8% lower score on the SOT and experienced more falls than the control group.

On the other hand, these results disagreed with a case-control study by **(12)** who found no significant relation between the case and the control groups, they also concluded that both groups (with and without COPD) showed a similar performance in the Foam-Laser Dynamic Posturography test.

CONCLUSION

The hearing affection among COPD patients was apparent in the high frequency range. Also, vestibular affection was shown in tests that assessed postural control. Vestibular office tests might be helpful in screening COPD patients for functional evaluation of their balance system. Sensory organization test is an accurate laboratory test for evaluation of balance in COPD patients.

Declaration of interest

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

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