e-ISSN: 0975-1556, p-ISSN:2820-2643

Available online on www.ijpcr.com

International Journal of Pharmaceutical and Clinical Research 2024; 16(1); 1922-1927

Original Research Article

Correlation of Breath Holding Time with Spirometry in Health and Disease – A Cross Sectional Study

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Received: 25-10-2023 / Revised: 23-11-2023 / Accepted: 26-12-2023

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Conflict of interest: Nil

Abstract:

Background: Spirometry is the most widely used and an important method of evaluating the pulmonary functions. Although an accurate and easy method of evaluating the pulmonary function, spirometry carries numerous disadvantages. The important limitations of spirometry include, requirement of a machine for performing spirometry, trained personnel to perform, patient effort and understanding to perform, equipment calibration, risk of transmission of infection, etc. Hence, there was a need for a technique which is simple, easy to perform, non-machine, non-technician dependent, and equivalent to spirometry. There are numerous bedside spirometry techniques. One among them is the Single Breath Holding Time, which measures the maximum time to which a person can hold his breath after maximal inspiration. Hence, an attempt was made to see the correlation of single breath holding time with spirometry, so that Single Breath Holding Time can be used as an alternative to spirometry in resource poor settings.

Aims and Objectives: To determine the correlation of breath holding time with standard measures, post bronchodilator FEV1, FVC and FEV1/FVC ratio, so that breath holding test can be taken as a non-machine, non-technician dependent, bedside surrogate test for lung function test.

Methods: It is a cross sectional study from July 2021 to June 2022 done at Government Stanley Medical College, Chennai and Government Hospital of Thoracic Medicine, Tambaram Sanatorium. 175 cases, who need to undergo spirometry for any clinical indication were included in the study. Single breath holding time was also done for those patients and its correlation with spirometry is analyzed in the study.

Results: The 175 patients were divided into normal, obstructive and restrictive, based on Spirometry. The Breath Holding Time showed strong correlation with FEV1, FVC and FEV1/FVC ratio in all three categories (p value < 0.005) - normal, obstructive and restrictive patients. Single Breath Holding Time is less than 16 seconds in patients with both obstructive and restrictive pattern, whereas Single Breath Holding Time is more than 25 seconds in normal individuals.

Conclusion: Single Breath Holding Time shows strong correlation with FEV1, FVC and FEV1/FVC. Hence, Single Breath Holding Time can be used as a simple bedside, non-machine, non-technician dependent alternative to spirometry in resource poor settings. It can also be used as a point of care test, to decide on further work-up of the patient.

Keywords: breathe hold time, spirometry, Copd, asthma, pulmonary function test, bedsidepft.

Introduction

Pulmonary function testing is an important aspect of evaluating the respiratory diseases. Spirometry is the most commonly used method for assessing the pulmonary ventilatory functions. Spirometry measures the air flow during inspiration and expiration. Hence, spirometry is used for measuring the dynamic lung volumes and capacities. Though very useful in arriving at a diagnosis, this spirometry has numerous limitations. Few practically troublesome limitations of spirometry include requirement of an equipment with proper software for its interpretation, technician to perform the test, proper patient understanding, risk of spread of infections, adequate training for the operating technician, and difficulty in carrying it to places like ICU or bedside of the patient. Hence, there was a need to find a test that could overcome the shortcomings of spirometry. Then came the concept of bedside spirometry. There are numerous bedside spirometry techniques like candle blowing,

single breath count, single breath holding time, etc. Among the various bedside spirometry tests, single breath holding time is one of the simple techniques which measures the maximal time a person can hold a breath after deep inspiration. Many studies are done all over the world comparing the various bedside pulmonary function tests with standard spirometry. Here, we have also attempted to see the correlation of single breath holding time with spirometry parameters of FEV1, FVC and FEV1/FVC. If there is a good correlation of breath holding time with spirometry, then it can be used as a simple, non- machine, non-technician dependent, bedside alternative to spirometry. Owing to its simplicity and cost effectiveness, Breath holding time has been suggested as reasonable alternative to spirometry in resource poor settings with the added advantages of independence form technician and machine. This study aims to verify this claim.

Aims & Objectives

The aim of the study is to determine the correlation of breath holding time with standard spirometry (post bronchodilator FEV1, FVC and FEV1/FVC ratio), so that breath holding time can be used as a non-machine, non-technician dependent, bedside, surrogate test for lung function test.

Materials and Methods

Type of Study: Cross Sectional Study

Study Population: Patients attending OPD in Government Stanley Medical College and Government Hospital of Thoracic Medicine, Tambaram Sanatorium, who need to undergo Spirometry for any clinical indication

Sample size: 175

Study Duration: 1 year

Inclusion Criteria:

All patients above the age of 18 years who need to undergo Spirometry for any clinical indication

Exclusion Criteria:

- Patients who are unwilling to participate in the study
- Patients whose spirometry are not acceptable and valid as per ATS standard
- Patients who have absolute or relative contra-indication for Spirometry
- Myocardial Infarction within the last one month
- Conditions which can lead to suboptimal test
- Chest, facial, oral or abdominal pain
- Stress Incontinence
- Dementia and confusion
- Active pulmonary tuberculosis
- Acute exacerbation of COPD
- Acute Severe Asthma
- Hemoptysis
- Post Covid patients

Ethical Considerations:

Study was approved by Institutional Ethical Committee. Informed written consent were obtained from all the study participants. Confidentiality of the participants in the study are maintained

Data Collection Tools: All study details are entered in a structured study proforma.

Methodology:

- 175 cases, who needed to undergo Spirometry for clinical indications.

Spirometry was performed in sitting position, with a nose clip attached.

- The ATS guidelines for Spirometry were followed.

Broncho dilation was achieved using a pMDI Salbutomol 400microgram

- Best of three successive test readings was taken as final result and the primary values, i.e., post bronchodilator forced vital capacity [FVC], forced expiratory volume in the first second [FEV1] were noted.
- Then single breath holding time was performed by all participants within 3 minutes to avoid the waning effect of bronchodilator.
- Participants were asked to hold the breath after a normal tidal volume breath, till the breaking point.
- Breath hold test manoeuvre was performed 3 times with a gap of 5 minutes and the best of the 3 values were included for analysis.

Results

The collected data were analysed with IBM SPSS Statistics for Windows, Version 23.0. (Armonk, NY: IBM Corp). To describe about the data descriptive statistics frequency analysis, percentage analysis was used for categorical variables and the mean & S.D were used for continuous variables.

To find the significant difference in the multivariate analysis the one-way ANOVA with Tukey's Post-Hoc test was used. To find the significance in categorical data Chi- Square test was used.

In all the above statistical tools the probability value .05 is considered as significant level.

Table 1: Age distribution of our study population

Age distribution		
	Frequency	Percent
18 - 20 yrs	8	4.6
21 - 30 yrs	19	10.9
31 - 40 yrs	32	18.3
41 - 50 yrs	38	21.7
51 - 60 yrs	49	28.0
61 - 70 yrs	23	13.1
71 - 80 yrs	6	3.4
Total	175	100.0

Table 2: PFT pattern distribution of our study population

PFT pattern		
	Frequency	Percent
Normal	79	45.1
Obstructive	60	34.3
Restrictive	36	20.6
Total	175	100.0

Table 3: Comparison of Age with PFT pattern by Pearson's Chi-Square test

			PFT pattern			**Total**	**χ 2 - value**	**p-value**
			Normal	**Obstructive**	**Restrictive**			
Age	18 - 20 yrs.	Count	7	1	0	8	30.907	0.002 **
		%	8.9%	1.7%	0.0%	4.6%		
	21 - 30 yrs.	Count	14	1	4	19		
		%	17.7%	1.7%	11.1%	10.9%		
	31 - 40 yrs.	Count	15	12	5	32		
		%	19.0%	20.0%	13.9%	18.3%		
	41 - 50 yrs.	Count	20	9	9	38		
		%	25.3%	15.0%	25.0%	21.7%		
	51 - 60 yrs.	Count	14	21	14	49		
		%	17.7%	35.0%	38.9%	28.0%		
	61 - 70 yrs.	Count	9	12	2	23		
		%	11.4%	20.0%	5.6%	13.1%		
	71 - 80 yrs.	Count	0	4	2	6		
		%	0.0%	6.7%	5.6%	3.4%		
Total		Count	79	60	36	175		
		%	100.0%	100.0%	100.0%	100.0%		
** Highly Statistical Significance at $p < 0.01$ level								

Table 4: Comparison of Gender with PFT pattern by Pearson's Chi-Square test

				PFT pattern		**Total**	**x 2 value**	**p-value**
			Normal	**Obstructive**	**Restrictive**			
Gender	Female	count	19	18	17	54	6.255	0.044
		%	24.1%	30.0%	47.2%	30.9%%		
	Male	count	60	42	19	121		
		%	75.9%	70.0%	52.8%	69.2		
	Total	count	79	60	36	175		
		%	100%	100%	100%	100%		
Statistical significance at $p < 0.05$ level								

Table 5: Comparison of Smoking History with PFT pattern by Pearson's Chi-Square test

				PFT pattern				
			Normal	**Obstructive**	**Restrictive**	**Total**	**x 2-value**	**p-value**
Smoking History	No	count	79	19	36	134	102.627	0.0005**
		%	100%	31.7%	100%	76.6%		
	Yes	count	0	41	0	41		
		%	0.0%	68.3%	0.0%	23.4%		
Total		count	79	60	36	175		
		%	100%	100%	100%	100%		
Highly Statistical significance at p< 0.01 level								

Table 6: Comparison of Biomass Exposure with PFT pattern by Pearson's Chi-Square test

			PFT pattern			Total	χ 2 - value	p-value
			Normal	**Obstructive**	**Restrictive**			
Biomass Exposure	No	Count	77	52	36	165	10.132	0.006 **
		%	97.5%	86.7%	100.0%	94.3%		
	Yes	Count	2	8	0	10		
		%	2.5%	13.3%	0.0%	5.7%		
Total		Count	79	60	36	175		
		%	100.0%	100.0%	100.0%	100.0%		
** Highly Statistical Significance at p < 0.01 level								

Table 7: Comparison of Chest X-ray with PFT pattern by Pearson's Chi-Square test

			PFT pattern					
			Normal	**Obstructive**	**Restrictive**	**Total**	**χ 2 - value**	**p-value**
Chest X-ray	B/L HI	Count	0	45	0	45	119.531	0.0005 **
		%	0.0%	75.0%	0.0%	25.7%		
	Interstitial opacities	Count	0	0	1	1		
		%	0.0%	0.0%	2.8%	.6%		
	Normal	Count	79	15	35	129		
		%	100.0%	25.0%	97.2%	73.7%		
Total		Count	79	60	36	175		
		%	100.0%	100.0%	100.0%	100.0%		
** Highly Statistical Significance at p < 0.01 level								

Table 8: Comparison of FEV1% with PFT pattern by One way ANOVA test

Variable	**PFT pattern**	**N**	**Mean**	**SD**	**F-value**	**p-value**
FEV1%	Normal	79	81.20	11.33	150.379	0.0005 **
	Obstructive	60	43.68	16.38		
	Restrictive	36	48.75	13.01		
** Highly Statistical Significant at p < 0.01 level						

Table 9: Comparison of FVC% with PFT pattern by One way ANOVA test

Variable	**PFT pattern**	**N**	**Mean**	**SD**	**F-value**	**p-value**
FVC%	Normal	79	84.14	11.44	62.366	0.0005 **
	Obstructive	60	64.22	20.72		
	Restrictive	36	50.86	14.29		
** Highly Statistical Significant at p < 0.01 level						

Table 10: Comparison of FEV1/FVC% with PFT pattern by One-way ANOVA test

Variable	**PFT pattern**	**N**	**Mean**	**SD**	**F-value**	**p-value**
FEV1/FVC%	Normal	79	94.09	5.29	263.217	0.0005 **
	Obstructive	60	66.25	10.04		
	Restrictive	36	93.17	6.88		
** Highly Statistical Significant at p < 0.01 level						

Table 11: Comparison of SBHT with FEV1, FVC & FEV1/FVC by Pearson's Chi-Square

Correlations				
		FEV1	FVC	FEV1/FVC
SBHT	r-value	.754**	.632**	.536**
	p-value	.0005	.0005	.0005
	N	175	175	175
**. Correlation is significant at the 0.01 level.				

Table 12: Comparison of SBHT with PFT pattern by One way ANOVA test

Variable	PFT pattern	N	Mean	SD	F-value	p-value
SBHT	Normal	79	31.92	5.31	371.990	0.0005 **
	Obstructive	60	13.43	3.40		
	Restrictive	36	14.67	3.30		
** Highly Statistical Significant at $p < 0.01$ level						

Discussion

The main aim of the study is to see the correlation of breath holding time with spirometry parameters in health and disease. Thus, 175 patients having any indication for spirometry are included in the study.

In our study, 49% of the study population was in the 51-60 years age group. 69% of the study population were males and 31% were females. Depending upon the PFT pattern, the study population was divided into normal, obstructive pattern and restrictive pattern. In our study, 79 patients (45.1%) showed normal spirometry pattern, 60 patients (34.3%) showed obstructive spirometry pattern and 36 patients (20.6%) showed restrictive pattern on spirometry.

The breath holding time was done for all the patients after spirometry. The mean breath holding time in normal patients was 31.92. Whereas the mean breath holding time in patients with obstructive pattern is 13.43 and the mean breath holding time in patients with restrictive pattern is 14.67. All the above obtained results are highly significant with a p value of 0.0005. Thus single breath holding time correlated significantly with spirometry.

The results of my study are similar to the study done by Vipin Aggarwal et al in 2018, which compared the Single Breath Holding Time with FEV1, FVC and PEFR. This study also showed similar results, which concluded that there was high significant correlation with post bronchodilator FEV1 and FVC, although there was low strength in cases of PEFR, particularly in patients with obstructive pattern.

Limitations

Single centre study Hospital based study Done in Indian population and hence a study population consisting of all ethnicity and races would help us in getting a better correlation

Conclusion

Thus, the study shows a significant correlation between single breath holding time and FEV1, FVC and FEV1/FVC. Breath holding time is reduced in patients with respiratory pathology, both obstructive and restrictive abnormalities. Whereas breath holding time is higher in normal individuals. Thus, single breath holding time can be used as a simple, bedside, non- machine, non-technician dependent test to assess if there is any respiratory abnormality, in resource poor settings. And it can also be used as the initial test in assessing the patients before spirometry is performed. Hence in resource poor settings, where spirometry is not available, single breath holding time can be used as a bed side surrogate test for spirometry.

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