Association of Hypertension and Pulmonary Functions

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Abstract— *Association between cardiac dysfunction and abnormal pulmonary function has remained controversial since long. The objective of this study is to find out the association of hypertension and its severity on pulmonary functions. Study was conducted on 30 hypertensive (study group) and 30 non hypertensive (control group) subjects identified from Medical OPD of SMS Hospital, Jaipur. Pulmonary functions were assessed of both hypertensive (study group) and non hypertensive (control group) subjects by Medspiror). Among pulmonary function tests, difference in means of FVC, FEV_1 PEFR, $FEF_{25-75\%}$, MVV and FVC/ FEV_1 were found less with significant difference in cases group with predominantly restrictive type of effects are observed. Female's shows lower values than male hypertensive subjects. Furthermore, FVC, FEV_1, PEFR, $FEF_{25-75\%}$, MVV, FVC/ FEV_1 were not found to be associated with severity of illness. An inverse relation is found between hypertension and pulmonary functions predominantly restrictive type of pattern. While non significant effects are observed with severity of illness.*

Keywords— Pulmonary function tests, Hypertension, Restrictive disease, Medspiror

Abbreviations: PFT Pulmonary function tests, HT Hypertension, FVC forced vital capacity, FEV_1forced expiratory volume in I[st] second, PEFR peak expiratory flow rate, $FEF_{25-75\%}$ forced expiratory flow during middle half of FVC, MVV maximum voluntary ventilation

1. INTRODUCTION

Hypertension is an increasingly important public health challenge worldwide and it is one of the major causes for morbidity and mortality.[1] Thus, the National High Blood Pressure Education Program reports that the global burden of hypertension is approximately 1 billion individuals and more than 7 million deaths per year may be attributable to hypertension[2]. Moreover, hypertension has been linked to multiple other diseases including cardiac, cerebrovascular, renal and eye diseases[3]. Beside the well-established association between hypertension and vascular co morbidities, several studies showed that blood pressure and lung function are associated[4-9]. It could be demonstrated that higher forced vital capacity (FVC) is a negative predictor of developing hypertension[7,8] . Moreover, some studies found an association between reduced pulmonary function, including both low FVC and low forced expiratory volume in one second (FEV1), and hypertension.[5,6,9] Engström et al[4] found that the incidence of cardiovascular disease and death associated with hypertension is increased in the presence of reduced lung function.

Thus the association between cardiac dysfunction and abnormal pulmonary function has remained uncertain for years. The objective of this study is to find out the effect of hypertension and its severity on pulmonary functions.

2. MATERIAL AND METHODS:

A case-control study was conducted on 30 hypertensive patients and age sex matched 30 controls at Department of Physiology, SMS Medical College, Jaipur. Cases were recruited at OPD of Medicine, SMS Hospital, Jaipur. Cases were diagnosed to have hypertensive by physician according to WHO criteria [10]

Mild Hypertension -SBP 140-159 mmHg, DBP 90-99 mmHg

Moderate hypertension - SBP 160-179 mmHg, DBP100-109 mmHg

Severe Hypertension – SBP >180 mmHg, DBP>110 mmHg

Blood pressure was measured using a calibrated mercury manometer. Three independent blood pressure measurements were taken with a 5-minute pause after a rest of at least 5 minutes in a sitting position on the right arm. The mean of the last two measurements was used for the current analyses. These cases were further screened out for smoking and acute/chronic pulmonary disease, any of case should not be smoker or having any acute/chronic pulmonary disease. Extremes of ages were also excluded i.e. <20 years and >60 years. Age and sex matched non-smoker and free from any acute/chronic pulmonary disease 30 controls were also identified from the community.

The purpose of the study was explained to the participant and informed consent form was obtained. Then all subjects underwent screening with detailed history, anthropometry and spirometry. Detailed Pulmonary functions tests (PFTs) including FVC, FEV_1, PEFR, $FEF_{25-75\%}$, MVV & FEV_1/FVC were measured by Medspiror, for 3 times at every 15 minutes interval and best of 3 readings was taken in a quiet room in sitting positioned with wearing nose clips, according to American

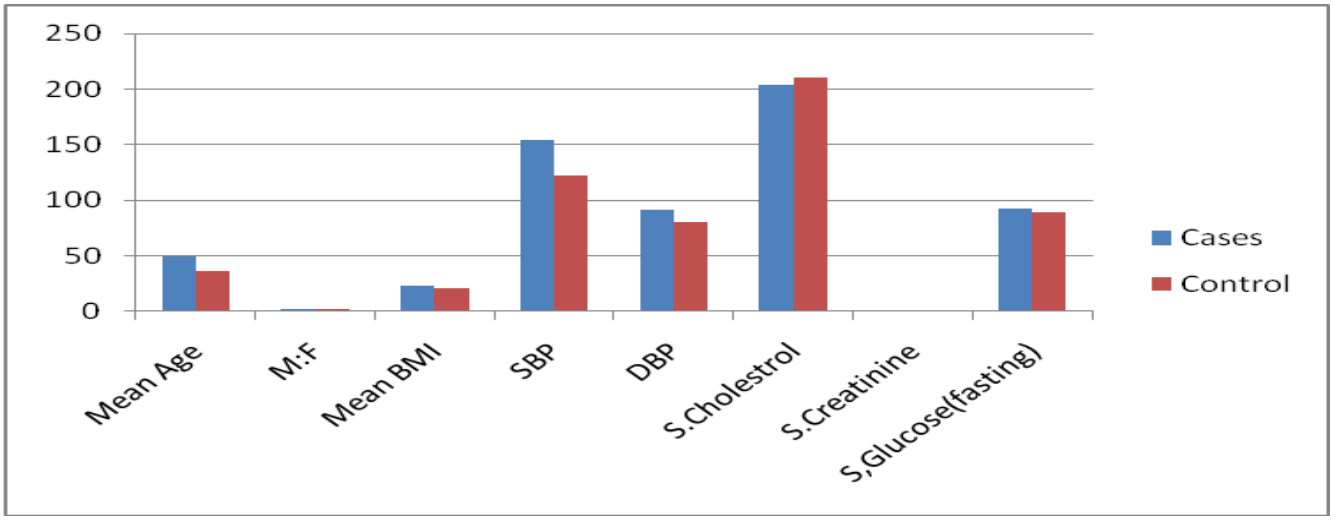
Thoracic Society/European Respiratory Society ATS/ERS guidelines.[11,12] Medspiror is a computerized spirometer self calibrating, which fulfils the criteria for standardized lung function tests.

Significance of difference of pulmonary parameters in both the groups was inferred with unpaired 't' Test. Association of pulmonary function test with diabetic variants were interpreted by one way ANOVA test.

3. RESULTS:

In the present study difference in means of age, sex, BMI, Serum glucose levels, Serum Cholesterol and Serum Creatinine between cases and controls were not significant (P<0.05), whereas mean Systolic blood pressure (SBP), Diastolic BP was found significantly more in cases group. (Fig. 1)

Figure 1: **Matching of case and controls**



Even though Hypertensive patients did not have any respiratory symptoms but they did have underlying sub-clinical restrictive patterns of lung functions. Regarding pulmonary function defects in the present study, it was observed that normal functioning of lung was found significantly (P<0.001) more in control group whereas restriction was found significantly (P<0.001) more in cases group and there was no significant (p>0.05) difference in obstructive lung functions in both the groups. (Table 1)

Table No.1
Pulmonary Function Defects Comparison of Cases with Controls

S.NO.	**Pulmonary Function Defects**	**Cases** **N=30 (100%)**	**Control** **N=30 (100%)**	**Chi-squre Test at 1 DF** **P Value** **LS**
1	**Restriction**	19 (63.33)	2 (6.67)	18.755 0.001 **HS**
2	**Obstruction**	5 (16.67)	11 (36.67)	2.131 0.14 **NS**
3	**Mixed**	5 (16.67)	3 (10)	0.144 0.704 **NS**
4	**Normal**	1 (3.33)	14 (46.67)	12.800 0.001 HS

When pulmonary function tests of both study and control group were compared it was found that the difference in means of all the variables of PFT i.e. FVC, FEV_1 PEFR, $FEF_{25-75\%,}$ MVV and FVC/ FEV_1 were found with significant variation in both the groups in this study. Means of FVC, FEV_1 PEFR, $FEF_{25-75\%,}$ MVV and FVC/ FEV_1 were found significantly less in cases group .(Table 2)

Table No.2
Pulmonary Function Tests Comparison of Cases with Controls

S.NO.	**Pulmonary Function Test**	**Cases N=30**	**Control N=30**	**Un-Paired 't' Test (58DF) P Value**	**LS**
1	**FVC**	1.86±0.85	2.81±0.69	-4.753 0.001	**HS**
2	**FEV_1**	1.48±0.77	2.65±0.73	-6.040 0.001	**HS**
3	**PEFR**	3.73±1.79	6.57±2.52	-5.032 0.001	**HS**
4	**$FEF_{25-75\%}$**	1.93±0.85	3.89±1.35	-6.729 0.001	**HS**
5	**MVV**	70.07±27.40	112.57±33.38	- 5.39 0.001	**HS**
6	**FEV_1/FVC**	82.20±24.32	93.83±8.46	-2.47 0.016	**S**

When these PFT were compared sex wise in hypertensive (study) group in the present study it was revealed that there was significant ($p<0.05$) lower values of these pulmonary function tests in females than males in hypertensive subjects except in case of MVV & FVC/FEV_1.(Table 3)

Table No. 3
Pulmonary Function Tests Comparison of Male with Females

S.NO.	**Pulmonary Function Test**	**Males N=21**	**Females N=9**	**Un-Paired 't' Test (28DF) P Value**	**LS**
1	**FVC**	2.00±0.83	0.91±0.477	3.666 0.001	**HS**
2	**FEV_1**	1.62±0.74	0.60±0.41	3.863 0.001	**HS**
3	**PEFR**	4.03±1.76	1.75±0.44	3.800 0.001	**HS**
4	**$FEF_{25-75\%}$**	2.05±0.84	1.09±0.50	3.176 0.004	**S**
5	**MVV**	73.65±28.04	46.75±10.90	2.767 0.01	NS
6	**FEV_1/FVC**	82.92±22.28	77.50±41.75	0.466 0.645	NS

Furthermore, It was also found in this study that FVC, FEV_1, PEER, $FEF_{25-75\%,}$ MVV and FVC/ FEV_1 were not found to be associated with severity of illness. There was no linear correlation found between PFT and severity of illness. (Table 4)

Table No. 4
Association of Pulmonary Function Tests with Hypertensive Variants

S.No.	Hypertensive Variants	Pulmonary Function Tests					
		FVC	FEV_1	PEFR	$FEF_{25-75\%}$	MVV	FEV_1/FVC
	SBP						
1	**<140mmHg (N-7)**	1.73±0.85	1.65±0.84	4.61±2.42	2.05±0.97	74.86±25.81	95.14±7.54
2	**140-160 mmHg (N-17)**	1.98±0.84	1.52±0.73	3.53±1.46	1.96±0.87	73.76±29.36	79.12±25.75
3	**>160 mmHg(N-6)**	1.65±1.07	1.20±0.96	3.25±1.98	1.67±0.80	54.00±23.60	75.83±32.28
4	**ANOVA**	F 0.40	F 0.54	F 1.14	F 0.34	F 1.27	F 1.32
	P Value	0.676	0.587	0.336	0.718	0.296	0.285
	LS	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
	DBP						
1	**<90mmHg (N-9)**	1.56±0.86	1.44±0.75	3.57±1.47	1.74±0.93	70.78±20.23	93.44±8.79
2	**90-95 mmHg (N-9)**	1.87±0.84	1.59±0.86	4.43±2.08	2.01±0.84	74.67±28.67	83.89±26.43
3	**>95 mmHg(N-12)**	2.07±0.90	1.44±0.83	3.32±1.85	1.97±0.84	66.08±33.41	72.50±28.98
4	**ANOVA**	F 0.88	F 0.11	F 1.00	F 0.26	F 0.24	F 2.00
	P Value	0.425	0.899	0.380	0.772	0.792	0.154
	LS	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

4. Discussion

Pulmonary function testing has been a major step forward in assessing the functional status of the lungs.[12] In this study restrictive type of lung function defects were observed in hypertensive patients, other authors also had reported similar findings.[4, 6, 13, 14]

Present study showed that all the pulmonary parameters, that is FVC, $FEV_{1,}$, FEF_{25-75} , MVV and PEFR were significantly reduced in hypertension subjects as compared with the healthy controls ($P < 0.001$). The ratio FEV_1 /FVC is lesser in hypertensive patients ($P < 0.05$) shows a restrictive type of abnormalities develops in lungs. Well comparable findings of reduction in all parameters of PFT in hypertension, was reported by other authors.[6,9,14,15]

Further more in the present study association not found between PFT and severity of hypertension. Schnabel et al.[14] reported that high blood pressure was associated with reduced lung function (for both % predicted FVC and FEV1) in general adult population adjusting for gender and other covariates. In our study female shows lesser values than male hypertensive subjects. In contrast to our study, Margretardottir et al [6] found that significantly stronger inverse association between FVC and hypertension in men than in women. Few longitudinal associations [4,7,8, 9] between lung function and incidence of hypertension have been reported. Sparrow et al.[8] and Selby et al.[7] reported a significant association between FVC and the incidence of hypertension. A study from the People's Republic of China [9] reported weaker associations between lung function (For both FVC and FEV1) and incidence of hypertension among men and women. But significant inverse association was observed only for women. Engström et al. [4] reported that blood pressure increase was inversely related to lung function for men 55 to 68 years of age.

The reasons for the association between reduced lung function and hypertension are not known. It is possible that left ventricular failure causes pulmonary vascular engorgement and interstitial oedema, which may reduce the compliance of the lungs. This would ultimately results in mild restrictive disease manifested by lower values for FVC. Thus FVC may predict risk of cardiovascular disease by its association with hypertension.

CONCLUSIONS

An inverse relation is found between hypertension and pulmonary functions predominantly restrictive type of pattern. While non significant effects are observed with severity of illness and there is also less lung function capacities are observed in female hypertensive subjects. The study provides a convenient and efficient way to select the subjects at high risk of cardiovascular disease. So the pulmonary function testing may provide a measure of overall vigor and general health.

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