Section: Physiology

Original Research Article

THE STUDY OF PULMONARY FUNCTION TESTS IN OBESE AND NON-OBESE HYPERTENSIVE SUBJECTS

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Abstract

Background: Hypertension is a "silent killer". Majority of the persons suffering from hypertension are unaware of the disease. In accordance with the "rules of halves", 50% of persons do not know about their higher blood pressure; only 50% of cases who are aware of the disease are on medication. Further the patients put on treatment, only 50% are on proper antihypertensive therapy with their blood pressure regularly monitored. It was also reported that obesity is more commonly associated with hypertension. It is estimated that 75% of the incidence of hypertension is due to obesity. **Materials and Methods:** 150 cases included in the study were divided into three groups as under: Fifty cases of different age and sex who were normotensive, having body mass index less than 25kg/m^2 without any apparent ailment were evaluated and served as the control group. Fifty obese hypertensives of comparable age and sex having body mass index more than 30 kg/m^2. Fifty non-obese hypertensives of comparable age and sex having body mass index less than 30 kg/m^2. **Result:** Decline in mean value of FVC, FEV1, ERV, MVV was statistically highly significant in obese hypertensives as compared to normal. Decline in mean value of FVC, FEV1 was statistically highly significant between non-obese hypertensives as compared to normal but the decline in ERV was insignificant however decline in MVV was significant decline in mean value of FVC, FEV1, MVV was significant however decline in ERV was highly significant between obese hypertensives and non-obese hypertensives. Reduction in body weight as well as control of BP in hypertensives may increase these parameters and it is likely to increase the capability of meeting the varying oxygen demand under physiological conditions through adequate cardio-respiratory adjustment thus reducing mortality and mobility. **Conclusion:** The observations in the present study corroborate with the results reported by previous investigators and conclusions advanced by them.

INTRODUCTION

Hypertension is a "silent killer". Majority of the persons suffering from hypertension are unaware of the disease. In accordance with the "rules of halves", 50% of persons do not know about their higher blood pressure; only 50% of cases who are aware of the disease are on medication. Further the patients put on treatment, only 50% are on proper antihypertensive therapy with their blood pressure regularly monitored.

Hypertension has been causing concern as it increases the morbidity and mortality in majority of the population world over and India is no exception. hypertension is a cardiovascular adjustment to meet the oxygen requirement of the vital tissues which when stands compromised in normotensive persons due to inadequate supply of oxygen through the impaired respiratory functions in a chronic condition where the acute respiratory adjustment fails to meet the chronic demand.

According to WHO one billion people worldwide are obese 640 million are adults and 340 millions are adolescents. WHO estimates by 2025 167 millions people will become less healthy because they will become overweight and obese.

Obesity is a disorder of energy balance. It is associated with increased morbidity and mortality and a wide spectrum of medical and surgical diseases.

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It alters the relationship between the lungs, chest wall and diaphragm thus altering respiratory functions.

Obesity is becoming a global epidemic and in the last ten years. Obesity now prevails in all sections of people irrespective of whether it is a developed, developing or a poor country. Obesity has major adverse effects on health and is responsible for various cardiovascular diseases, diabetes mellitus type II, hypertension, high cholesterol and triglycerides, cerebrovascular accidents (CVA) gall stones, cancers of the breast and the colon, disordered breathing, sleep apnea syndrome and many other disorders.

The scientific study of vital capacity can be said to have commenced with Hutchison 1846, who devised a special instrument for this purpose, the spirometer.

Tiffeneau and Pinelli, 1947, introduced the concept of FEV1 as the proportion of vital capacity that could be expired in one second and used it as a guide to determine airway obstruction.

Obesity and hypertension have been found to be inter-related by various authors. It was reported that hypertension is about six times more common in obese subjects than in non-obese subjects. It was also reported that obesity is more commonly associated with hypertension. It is estimated that 75% of the incidence of hypertension is due to obesity.

It was reported that mean values of vital capacity (VC), total lung capacity (TLC) and maximum voluntary ventilation (MVV) were as per predicted value for degree of obesity. 29 subjects who lost a mean weight of 56 kg had a significant increase in vital capacity, expiratory reserve volume and maximum voluntary ventilation indicating a direct effect of degree of obesity on pulmonary function.

It was studied that a significant difference in pulmonary function between the obese and non-obese subjects. They found that obese subjects had lower values of FRC, TLC, FVC, FEV1 and ERV. They also had a higher residual volume, residual volume to total lung capacity ratio, airway resistance and diffusing capacity.

The effects of Body Mass Index on lung volumes in 373 patients and found that there was a significant linear relationship between body mass index and vital capacity, total lung capacity, functional residual capacity and expiratory reverse volume. The values decreased exponentially with increasing body mass index such that morbid obesity resulted in greater change in functional residual capacity and expiratory reserve volume than mild obesity. At a BMI of 30 kg/m2, functional residual capacity and expiratory reserve volume were only 75% and 47% respectively of the values for a lean person with a BMI of 20 kg/m2. They concluded that BMI has significant effects on all the lung volumes and the greatest effects were on functional residual capacity and expiratory reserve volume.

Aims and Objectives

The aim of this study was to evaluate the respiratory parameters in obese and non-obese hypertensive subjects as compared to normotensive subjects.

The Objectives of this Study Were

- To study the spirometric indices in normotensive cases.
- To study the spirometric indices in obese hypertensive cases.
- To study the spirometric indices in non-obese hypertensive cases.

MATERIALS AND METHODS

The study was conducted in the Department of Physiology, govt. medical college Amritsar in collaboration with the department of Medicine. The study was conducted as a status study and subjects were randomly selected. A written, informed consent was obtained from each subject prior to inclusion in the study.

150 cases included in the study were divided into three groups as under:

Group A: Fifty cases of different age and sex who were normotensive, having body mass index less than 25kg/m2 without any apparent ailment were evaluated and served as the control group.

Group B: Fifty obese hypertensives of comparable age and sex having body mass index more than 30 kg/m2.

Group C: Fifty non-obese hypertensives of comparable age and sex having body mass index less than 30 kg/m2.

Group B &: Included the cases of hypertension Stage I and Stage II who were

Group C: stabilized under treatment.

RESULTS

[Table 1] showed there was highly significant difference in mean BMI in the three groups. The mean BMI in group A was 22.97 ±1.326 kg/m2, in Group B was 32.91 ± 3.114 kg/m2 and in group C was 26.18 ±1.572 kg/m2. The difference in body mass index between group A and Group B, that between Group A and Group C and that group B and Group C were highly significant ($p<0.001$).

[Table 2] showed the mean and SD of FVC was 3.466±0.466 L (Group A), 2. 633±0.527 L (Group B) and 2.937±0.312 L (Group C). The FVC decreased in group B and group C. On comparison between Group A and Group B, and Group A and Group C the differences were statistically highly significant (P<0.001HS). The difference between Group B and Group C was significant (P=0.002S).

Table 1: Comparison of BMI In Kg/m^2 in three Groups

Group	N	Range	Mean ± SD
Group A	50	20.31 – 24.92	22.97±1.326
Group B	50	30.10 – 47.81	32.91± 3.114

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Group C	50	21.93 – 29.76	26.18± 1.572

Statistical analysis for camparison between groups according to mean difference of BMI

Comparison	Mean Difference	P value#
Group A vs B	9.941	<0.001^{HS}
Group A vs C	3.411	<0.001^{HS}
Group B vs C	6.530	<0.001^{HS}

Table 2: Comparison of FVC (Liters) in three Groups

Group	N	Range	Mean ± SD
Group A	50	2.56-4.29	3.466±0.466
Group B	50	1.74-4.62	2.633±0.527
Group C	50	2.45-3.78	2.937±0.312

Statistical analysis for camparison between groups according to mean difference of FVC

Comparison	Mean Difference	P value#
Group A vs B	0.832	<0.001^{HS}
Group A vs C	0.528	<0.001^{HS}
Group B vs C	0.303	0.002S

Table 3: comparison of FEV1 (Liters) in three groups

Group	N	Range	Mean ± SD
Group A	50	1.94-3.48	2.572±0.422
Group B	50	1.38-4.12	2.038±0.421
Group C	50	1.75-2.92	2.229±0.256

Statistical analysis for camparison between groups according to mean difference of FEV1

Comparison	Mean Difference	P value#
Group A vs B	0.5344	<0.001^{HS}
Group A vs C	0.3434	<0.001^{HS}
Group B vs C	0.1910	0.032S

[Table 3] shows the mean and SD of FEV1 was 2.572±0.422 L (Group A), 2.038±0.421 L (Group B) and 2.229±0.256 L (Group C). The FEV1was decreased in group B and group C. On comparison between Group A and Group B, Group A and Group C the differences were statistically highly significant (P <.001) and between Group B and Group C was significant (P= 0.0032).

Table 4: comparison of ERV (LITRES) in three groups

Group	N	Range	Mean ± SD
Group A	50	0.64-1.26	0.929±0.161
Group B	50	0.45-1.06	0.733±0.21
Group C	50	0.65-1.08	0.895±0.092

Statistical analysis for camparison between groups according to mean difference of ERV

Comparison	Mean Difference	P value#
Group A vs B	0.1954	<0.001^{HS}
Group A vs C	0.0334	0.557^{NS}
Group B vs C	0.1620	<0.001^{HS}

[Table 4] showed the mean and SD of ERV was 0.929±0.161 L (Group A), 0.733±0.21 L (Group B) and 0.895±0.092 L (Group C). The differences were highly significant between Group A and Group B, Group B and Group C (P<0.001^{HS}). The difference between Group A and Group C was not significant (P =0.557^{NS}).

Table 5: comparison of MVV (LITRES/Minute) in three groups

Group	N	Range	Mean ± SD
Group A	50	64-126	100.1±13.00
Group B	50	64-121	84.28±10.24
Group C	50	79-112	91.58±8.53

Statistical analysis for camparison between groups according to mean difference of MVV

Comparison	Mean Difference	P value#
Group A vs B	15.80	<0.001^{HS}
Group A vs C	8.50	0.002^{S}
Group B vs C	7.30	0.003^{S}

[Table 5] showed the mean and SD of MVV was 100.1±13 L/min (Group A), 84.28±10.24 L/min (Group B) and 91.58±8.536 L/min (Group C). On comparison the difference was statistically highly

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significant between Group A and Group B ($P<0.001^{HS}$). The differences were only significant between Group A and Group C ($P=0.002^{S}$) and Group B and Group C ($P= 0.003^{S}$)

DISCUSSION

Respiratory Parameters

Vital capacity, being a static volume by itself, is not of much value as a test of pulmonary function. However, it still forms a basis, from which, a member of dynamic indices can be derived, e.g. the timed volumes (FVC_1) and the flow rates. From an analysis of our study, it was observed that Forced Vital Capacity, Forced Expiratory Volume (FEV_1), Expiratory Reserve Volume and Maximum Voluntary Ventilation all showed significant differences within the three groups (p<.001). Comparison of Spirometer indicies in the three groups.

Forced vital capacity (FVC in litres)

Vital capacity of the lungs represents the maximum range of inspiratory and expiratory mechanisms of the individuals and is gauged by volume of air forced out by maximum expiratory effort after a maximum inspiratory effort.

In the present study the forced vital capacity in the various group revealed the lowest readings in Group B (2.633±0.527 L) followed by Group C (2.937±0.312 L) and the highest readings were recorded in Group A (3.466±0.466 L). In our study, we observed a statistically highly significant decrease in forced vital capacity in Group B (obese hypertensives with BMI>30 Kg/m^2) when compared to Group A (normotensives with BMI <25Kg/m^2) and Group C (non-obese hypertensives with BMI<30Kg/m^2).

FEV_1 has been used as a marker for cardiovascular mortality independent of age, gender and smoking history. A low FEV_1 has been found to be associated with an increased risk of cardiovascular disesaes. In our study, FEV_1 was lowest in Group B (2.039±0.4218 L) followed by Group C (2.229±0.2562 L) while it was highest in Group A (2.572±0.4227 L). This may imply that hypertension and obesity have a limiting effect on FEV_1. That obesity has a limiting effect on FEV_1 has been reported by various authors like Rubinstein et al[37] and Ahmet Baydur et al.

We observed a statistically significant decrease in expiratory reserve volume in obese subjects (Group B) when compared to non-obese subjects (Group A and Group C). The expiratory reserve volume in the various groups revealed the lowest recordings in Group B 0.733±0.21 L) followed by Group C (0.895±0.092 L) and the highest readings were recorded in Group A (0.929±0.161 L). Our findings were thus comparable to those of Ray et al, Rubinstein et al, Richard Jones et al.

396 PFT were assessed in a study FVC was 80% with a decrease in body mass index arose. TLC was 100% and VEF 84% with decreased in BMI.

We noticed a highly significant difference in the maximum voluntary ventilation between Group A and Group B but the differences between Group B and Group C as also between Group A and Group C were just significant. It does indicate that Body Mass Index >30kg/m^2 significantly decreases the Maximum Voluntary Ventilation in hypertensives.

Obesity might impair pulmonary function by several mechanisms. Obese individuals have an increased demand for ventilation and breathing workload, respiratory muscle insufficiency, decreased functional residual capacity and expiratory reserve volume and early closure of airways during expiration. Obesity also influences the upper airway reflexes, lung mechanics and may affect the central control of breathing.

In a study 'spirometric evaluation of lung functions in middle aged obese hypertensive and non-hypertensives' pulmonary functions like FVC, FEV_1, FEV_1% and PEF were evaluated in 20 obese normotensives (BMI of 33.19±2.59), 20 obese hypertensives (BMI 32.89±2.58) and 20 normal (BMI 22.36±1.54) of age group of 40-60 years. It was observed that FVC was 84.45±15.73%, 76.60±13.38%and 94.82±13.07% in all three groups, similarly FEV_1 was 89.35±16.48%, 78.65±17.62%, and 95.62±15.11%, PEF was 81.14±20.54%, 71.09±19.29%and 91.49±23.21% respectively.

In a Clinical study pulmonary function after weight loss in obese women undergoing roux –en-Y Gastric byepass, the data of 112 children were analysed with mean age of 14.4 (range 8.5-18.9) years and 62.5%were girls. The mean SD score-BMI was +3.38 at baseline and +2.91 after the intervention. Lung function improved significantly FVC increased by 3.08% (95%CI 1.16%to 5.00%) of the predicted value, $FEV_1$by 2.91% (95%CI 1.11%to4.71%) of predicted value, ERV by 14.8% (95%CI 8.66%to 20.88%) of the predicted value. The increase in ERV correlated with the reduction in SDS-BMI and with the reduction in waist circumference.

A common offending agent that affects both pulmonary and cardiovascular system such that FEV_1 serves as epiphenomenon of this "third" factor. The relationship may be confounded by various measured and unmeasured variables. Lung processes may be causally linked to cardiovascular disease for which several lines of evidence re available.

Lung function parameters were recorded and data obtained was statistically analysed and following results were obtained.

CONCLUSION

- Decline in mean value of FVC, FEV1, ERV, MVV was statistically highly significant in obese hypertensives as compared to normal.

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- Decline in mean value of FVC, FEV1 was statistically highly significant between non-obese hypertensives as compared to normal but the decline in ERV was insignificant however decline in MVV was significant.
- Decline in mean value of FVC, FEV1, MVV was significant however decline in ERV was highly significant between obese hypertensives and non-obese hypertensives.
- The decline in these parameters in obese hypertensives specially decrease in ERV is indicative of reduced capacity of meeting cardiovascular demands in different physiological conditions, this could be the cause for increase in morbidity as well as mortality.

Reduction in body weight as well as control of BP in hypertensives may increase these parameters and it is likely to increase the capability of meeting the varying oxygen demand under physiological conditions through adequate cardio-respiratory adjustment thus reducing mortality and mobility.

The observations in the present study corroborate with the results reported by previous investigators and conclusions advanced by them.

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