I. Introduction

The association between impaired lung function and ischaemic heart disease has been established by many studies. Many researchers have noted the increased incidence of cardiovascular disease in individuals who had been earlier detected to have subnormal pulmonary function by spirometry. There is also evidence for greater recurrence of adverse cardiovascular events in those patients with ischaemic heart disease who have impaired lung function, in comparison with those with normal pulmonary function. Mortality has been found to be greater among individuals with ischaemic heart disease who had impaired lung function. Pulmonary function can be conveniently and quite accurately be assessed by spirometry in an outpatient setting. It has been speculated that a systemic inflammatory process may be contribute towards the impairment of lung function and the development of coronary artery disease. This may also explain the frequent coexistence and association between the two disorders. So significant is this association that Forced Expiratory volume in one second (FEV1) as assessed by spirometry has been termed not just a lung function test but a marker of cardiovascular disease in individuals who have impaired lung function. Pulmonary function, itself may be responsible for impaired lung function. Mortality has been found to be higher among patients with ischaemic heart disease who have impaired lung function, in comparison with those with normal pulmonary function.

Association between impaired lung function and cardiovascular disease has been reported by many studies. Recent research seems to indicate that a systemic inflammation may be the mechanism underlying the impairment of lung function and the development of coronary artery disease. There is also evidence for greater recurrence of adverse cardiovascular events in those patients with ischaemic heart disease who have impaired lung function, in comparison with those with normal pulmonary function.

Mortality has been found to be
greater among individuals with ischemic heart disease who had impaired lung function.\textsuperscript{5} Forced expiratory volume in one second (FEV1) as assessed by spirometry has been termed not just a lung function test but a marker of premature death from ischemic heart disease.\textsuperscript{8,9,10} A high incidence of pulmonary functional abnormalities in patients with coronary artery disease, who previously had no pulmonary disease, was noted in certain studies.\textsuperscript{11, 12} Thus, it has been suggested that ischemic heart disease, itself may be responsible for impaired lung function. This impaired lung function may, in turn reduce survival in cases of ischemic heart disease (especially among the elderly).\textsuperscript{13}

II. Materials And Methods

Study Design

The prospective study was conducted on elderly patients with ischemic heart disease visiting Subharti Medical College hospitals between December 2015 and July 2017. Detailed history was elicited from the subjects of the study, followed by physical examination. Detailed history pertaining to respiratory function was recorded utilizing a questionnaire containing questions modeled after the St George Respiratory Questionnaire. Testing of pulmonary function by spirometry was done. Assessment of pulmonary function was then based on the standard accepted values of the pulmonary function variables for the Indian population.\textsuperscript{14,15,21} Statistical Analysis

Descriptive statistical analysis has been carried out in the present study. Results on continuous measurements are presented on Mean ± SD (Min-Max) and results on categorical measurements are presented in Number (%). Significance is assessed at 5 % level of significance. Analysis of variance (ANOVA) has been used to find the significance of study parameters between three or more groups of patients, Student test (two tailed, independent) has been used to find the significance of study parameters on continuous scale between two groups (Inter group analysis) on metric parameters, Pearson correlation has been performed to find the relationship of age, BMI and EF with Pulmonary function tests. The Statistical software namely SAS 9.2, SPSS 15.0, Stata 10.1, MedCalc 9.0.1, Systat 12.0 and environment ver.2.11.1 were used for the analysis of the data.

Inclusion Criteria
• Age above 60 years
• Presence of coronary artery disease which has been proven by coronary angiography or Any patient with a documented history of myocardial infarction/acute coronary syndrome will be recruited for the study, irrespective of whether angiogram has been done.

Exclusion Criteria
• Age below 60 years.
• Patients who are known cases of chronic pulmonary disease.
• Occurrence of myocardial infarction, acute coronary syndrome or CABG within a period less than 4 weeks prior to pulmonary function testing.
• Patients who have congestive cardiac failure.
• Patients who have spinal deformities.
• Patients who are morbidly obese.

III. Observations

Table 1: Age distribution of patients studied

<table>
<thead>
<tr>
<th>Age in years</th>
<th>No of patients</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>60-69</td>
<td>33</td>
<td>58.9</td>
</tr>
<tr>
<td>70-79</td>
<td>20</td>
<td>35.7</td>
</tr>
<tr>
<td>80 &amp; above</td>
<td>3</td>
<td>5.4</td>
</tr>
<tr>
<td>Total</td>
<td>56</td>
<td>100</td>
</tr>
</tbody>
</table>

Table 2: Assessment of Pulmonary function variables according to number of vessels

<table>
<thead>
<tr>
<th>Pulmonary Function variables</th>
<th>Number of vessels</th>
<th>Number of vessels</th>
<th>Number of vessels</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>One</td>
<td>Two</td>
<td>Three</td>
<td></td>
</tr>
<tr>
<td>FVC</td>
<td>3.30±10.44</td>
<td>7.92±13.56</td>
<td>1.11±14.03</td>
<td>&lt;0.001**</td>
</tr>
<tr>
<td>FEV1</td>
<td>8.85±18.71</td>
<td>4.38±10.16</td>
<td>0.22±13.36</td>
<td>0.001**</td>
</tr>
<tr>
<td>EV1/FVC</td>
<td>0.85±15.45</td>
<td>6.38±21.01</td>
<td>1.22±21.64</td>
<td>0.763</td>
</tr>
<tr>
<td>PEF</td>
<td>7.70±20.89</td>
<td>4.53±14.58</td>
<td>34.6±6.42</td>
<td>0.004**</td>
</tr>
</tbody>
</table>
lung function begins to decline slowly and steadily from middle age into old age. The deterioration may accelerate in old age. It is thought that a loss of elastic tissue may lead to mild subclinical emphysema even in healthy non-smokers. FEV1 declines 30 – 35 ml per year. Vital capacity decreases while the residual volume increases leaving total lung capacity in charged functional residual capacity also increases with age. This may leave the diaphragm at a mechanical disadvantage, particularly if there is an association loss in height of the thorax due to osteoporosis collapse of thoracic vertebrae etc.

The diffusing capacity declines linearly with age. This loss is compounded by decline of pulmonary function associated with ischemic heart disease in the elderly. Much evidence has been gathered in recent times indicating a decline in lung function consequent to coronary artery disease. Enright et al found that coronary artery disease, on an average was associated with 40 – 100 ml decrements in FEV1 and 50-150 ml decrements in FVC in the elderly, even in non-smokers, and in the absence of heart failure. Low FEV1 has been shown to be a significant risk factor for cardiac and all cause mortality. Thus, the elderly patients with ischemic heart disease and suboptimal lung function represents a group at very high risk for cardiac and all cause mortality, including fatal arrhythmias. The study involved 56 subjects – 41 males (73.2%) and 15 females (26.8%), who met the inclusion and exclusion criteria. (A total of 75 subjects had met the inclusion and exclusion criteria. Detailed history was elicited from the subjects of the study, followed by physical examination. Detailed history pertaining to respiratory function was recorded utilizing a questionnaire containing questions modeled after those contained in the St George Respiratory Questionnaire. In addition to routine investigations, testing of pulmonary function by spirometry was done. Assessment of pulmonary function was then based on the standard accepted normal values of the pulmonary function variables for the Indian population. The calculations were based on the validated equations derived by Udwalla et al and Kamath et al for the Indian population.

All the subjects were non smoker and essentially asymptomatic at the time of spirometry. Most of the subjects of this study were aged between 60 – 69 years (58.9%) mean age 69.29 ± 5.66 years. The mean body mass index of the subjects of 22 subjects this study was 25.78 ± 3.67 kg/m2 (39.3%) had an optimum BMI < 25 kg/m2 but ≥ 18.5 kg/m2. 25 subjects (44.6%) were overweight (BMI 25 – 30 kg/m2) and 9 (16.1%) individuals were obese (BMI > 30 kg/m2). Vital capacity decreases while the residual volume increases leaving total lung capacity in charged functional residual capacity also increases with age. This may leave the diaphragm at a mechanical disadvantage, particularly if there is an association loss in height of the thorax due to osteoporosis collapse of thoracic vertebrae etc.

Table 3: Assessment of Pulmonary function variables according to variations in ejection fraction (EF)

<table>
<thead>
<tr>
<th>Pulmonary Function Variables</th>
<th>Variations in EF</th>
<th>Variations in EF</th>
<th>Variations in EF</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>50-54</td>
<td>55-59</td>
<td>60 &amp; above</td>
<td></td>
</tr>
<tr>
<td>FVC</td>
<td>5.13±13.38</td>
<td>9.30±15.93</td>
<td>8.75±10.78</td>
<td>0.004**</td>
</tr>
<tr>
<td>FEV1</td>
<td>5.36±20.54</td>
<td>0.13±18.44</td>
<td>5.75±12.97</td>
<td>0.015*</td>
</tr>
<tr>
<td>EV1/FVC</td>
<td>0.14±18.86</td>
<td>7.83±18.11</td>
<td>5.75±14.88</td>
<td>0.692</td>
</tr>
<tr>
<td>PEF</td>
<td>7.82±14.72</td>
<td>1.13±17.41</td>
<td>6.25±14.15</td>
<td>0.009**</td>
</tr>
</tbody>
</table>

FVC, FEV1 and PEF are significantly increasing with increase in ejection fraction (EF)

IV. Discussion

Low FEV1 has been shown to be a significant risk factor for cardiac and all cause mortality, including fatal arrhythmias. The study involved 56 subjects – 41 males (73.2%) and 15 females (26.8%), who met the inclusion and exclusion criteria. (A total of 75 subjects had met the inclusion and exclusion criteria. Detailed history was elicited from the subjects of the study, followed by physical examination. Detailed history pertaining to respiratory function was recorded utilizing a questionnaire containing questions modeled after those contained in the St George Respiratory Questionnaire. In addition to routine investigations, testing of pulmonary function by spirometry was done. Assessment of pulmonary function was then based on the standard accepted normal values of the pulmonary function variables for the Indian population. The calculations were based on the validated equations derived by Udwalla et al and Kamath et al for the Indian population.

All the subjects were non smoker and essentially asymptomatic at the time of spirometry. Most of the subjects of this study were aged between 60 – 69 years (58.9%) mean age 69.29 ± 5.66 years. The mean body mass index of the subjects of 22 subjects this study was 25.78 ± 3.67 kg/m2 (39.3%) had an optimum BMI < 25 kg/m2 but ≥ 18.5 kg/m2. 25 subjects (44.6%) were overweight (BMI 25 – 30 kg/m2) and 9 (16.1%) individuals were obese (BMI > 30 kg/m2). Coronary angiogram had here done for 42 subjects while the remainiing 14 had documented history of MI/ACS. Of the subject who had undergone angiography 20 had single vessel disease (35%) 13 had double vessel disease (23.2%) and 9 had triple vessel disease (16.1%).

The patients were considered in two groups-those aged between 60 and 70 years and those aged above 70 years. All respiratory function parameters in this study have been expressed as a percentage of the normal predicted value in the Indian population. In this study, 18 out of 36 subjects (50%) aged between 60 and 70 years had a Forced Vital Capacity less than 70% of predicted. In those aged above 70 years, 8 out of 20 subjects (40%) had a Forced Vital Capacity less than 70% of predicted. 8 out of 36 subjects (22.2%) aged between 60 and 70 years had a FEV1 less than 70% of predicted. 6 out of 20 subjects (25%) had a FEV1 less than 70% of predicted.

Enright et al studied a cohort of elderly (over age 64 years) subjects who were somewhat healthier than average for that population. They excluded subjects who were current smokers or had smoked more than 20 pack-years. They also eliminated subjects with asthma, chronic bronchitis, and emphysema. The measurements were made at least 3 months after cardiac surgery or myocardial infarction. In this healthier average cohort, the authors found slightly decreased values of FEV1 and FVC insubjects with coronary heart disease. They found that coronary artery disease, on an average was associated with 40 – 100 ml decrements in FEV1 and 50-150 ml decrements in FVC in the elderly, even in non-smokers, and in the absence of heart failure. 23 out of 36 subjects (63.88%) aged between 60 and 70 years had a FEV1/FVC ratio greater than 100% of predicted and 1 individual (2.77%) had a ratio less than 70% of predicted. In those aged above 70 years, 16 out of 20 subjects (80%) had a FEV1/FVC ratio greater than 100% of predicted none had a ratio less than 70% of predicted. The predominant defect was of restrictive type (57.14%). The other patterns noted in this study were normal...
Spirometric Assessment of Pulmonary Function in The Elderly with Ischemic Heart Disease

(12.51%), obstructive (13%) and combined (7.14%). Scanlon has speculated that ischemic heart disease can cause pulmonary restriction. All the subjects in this study had a PEFR which was less than that predicted in normals. The Peak Expiratory Flow Rate (PEFR) reflects the strength and condition of respiratory muscles and the degree of airflow limitation in large airways.

Studies have shown PEFR to be a predictor of mortality in the elderly. PEFR is alsoa predictor of mortality in ischemic heart disease. Zureik M; Kauffmann F, et al. have suggested that low PEFR may be related to the development of atherosclerotic plaques. Thereby, it could possibly further aggravate coronary artery disease.

In this study, a significant decline in FVC as a percentage of predicted (p <0.001), FEV1 as a percentage of predicted (p =0.692), the overall pattern being primarily restrictive. The average ejection fraction among the study subjects was 51.752%. The spirometrically assessed variables FEV1 as a percentage of predicted (p =0.0.015), FVC as a percentage of predicted (p =0.004) and PEF as a percentage of predicted (p = 0. 0.009) increase significantly with increases in cardiac ejection fraction. However, cardiac ejection fraction did not have any significant influence on the FEV1/FVC ratio as a percentage of predicted (p = 0.692), the overall pattern being predominantly restrictive.

V. Conclusions

In this study subnormal pulmonary function was detected in elderly individuals with ischemic heart disease, as evidenced by FEV1, FVC and PEFR values which were significantly lower than that predicted for normal subjects. The pattern of the pulmonary function defect was of restrictive type in the majority. In this study, FEV1, FVC and PEFR values as a percentage of predicted tended to decrease as the number of coronary arteries involved increased. In this study, FEV1, FVC and PEFR values as a percentage of predicted tended to increase as the ejection fraction increased.

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