Pulmonary Function Tests in Patients Undergoing Coronary Artery Bypass Graft Surgery and its Correlation with Outcome

Dinesh Kshirsagar¹, Nandakumar Beke², Vrushali Khadke², Deepak Phalgune³*

Abstract

Background: Pulmonary complications are one of the most common causes of postoperative morbidity and mortality after coronary artery bypass graft (CABG) surgery. There is paucity of data of CABG in abnormal pulmonary function tests (PFT) in Indian population.

Objectives: To study correlation of PFT with clinical outcome in patients undergoing CABG.

Methods: Three hundred seventy patients aged 35 to 65 years who underwent CABG between May 2015 and November 2016 and ready to participate were included for this prospective observational study. Each patient was subjected to detailed clinical history, clinical examination and PFT. Primary outcome measures were post CABG ventilator stay, intensive care unit (ICU) stay, and hospital stay. Fisher's exact tests was used to compare qualitative data whereas Mann-Whitney U test was used to find the significant difference between quantitative variables.

Results: Higher percentage of patients whose forced expiratory volume in one second (FEV1) was abnormal had longer ventilator stay, ICU stay and hospital stay as compared patients whose FEV1 was normal. Restrictive disease, obstructive disease, and mixed disease patients had longer ventilator stay, ICU stay and hospital stay as compared patients whose spirometry was normal.

Conclusion: Abnormal PFT was independent strong predictor of prolonged ventilation, longer length of ICU and hospital stay.

Introduction

Coronary artery disease (CAD) affects Indians with greater frequency and at a younger age than their counterparts in developed countries. An estimated 47 million Indians had CAD in 2010. Indian patients undergoing coronary artery bypass grafts (CABG) surgeries are often young and yet reveal a high burden of major modifiable CAD risk factors. The Global Burden of Disease project estimates that chronic obstructive pulmonary disease (COPD) causes death of at least 2.9 million people annually.

Obstructive airway diseases (OAD) primarily include asthma and COPD, which are the major contributors to morbidity and mortality in India. Recent studies have found that there is a strong association between ischemic heart disease (IHD) and hypertension (HTN) with increase in prevalence of OAD. Airway disorders are important factors for increase in postoperative pulmonary complications. Individuals with reduced forced expiratory volume in one second (FEV1) have increased cardiac mortality.

Moderately reduced FEV1 and forced vital capacity (FVC) had an association with an increased incidence of hospitalization due to heart failure. The present study was undertaken to study correlation of PFT with clinical outcome in patients undergoing CABG.

Material and Methods

Three hundred seventy patients aged 35 to 65 years who underwent CABG in Poona Hospital and Research Centre, Pune between May 2015 and November 2016 and ready to participate were included in the study. Permission was obtained from ethics committee.

References:


2. Senior Resident, Swami Ramanand Teerth Rural Medical college, Ambajogai, Maharashtra. Consultant, Dept. of Medicine, Consultant Research, Poona Hospital and Research Centre, Pune, Maharashtra. Corresponding Author. Received: 09.06.2018, Accepted: 22.12.2018
and scientific advisory committee of the institution.

Based on previously published study, setting an alpha error at 0.05, and power at 80%, sample size of 370 was calculated for the present prospective observational study by formula. Exclusion criteria were COPD patients, h/o previous cardiac surgery, and patients with known neuro- muscular disorder. Written informed consent was obtained from all patients after explaining them study in detail.

Each patient was subjected to detailed clinical history, clinical examination and PFT as per the pre-tested study proforma. Computerized spirometry was performed one day before surgery. FVC, FEV1, and ratio of FEV1/FVC was measured and recorded. Pulmonary functions were considered normal if they were ≥80% of the predictive values according to the patient’s age, sex, weight and height. PFTs were performed by using a RMS spirometer (Helios_v3.1). Patients were asked to refrain from smoking for one hour and using short acting bronchodilators for at least 4 hours before the testing. FEV1 and FVC were determined by taking the best of 3 trials. Predicted FEV1, and FVC were calculated according to the formula deducted from the National Health and Nutrition Examination Survey III. Observed measurements were reported as a percentage of the predicted for each individual patient.

Depending on result of PFT, study population was divided into groups as per diagnosis and that was compared to post CABG outcome. PFT patterns were described as restrictive, obstructive or mixed according to the following definition. 1. Restrictive disease- A reduced FVC with a normal or increased FEV1/FVC ratio. 2. Obstructive disease- Values below 70% of FEV1/FVC ratio and below 80% predicted for the FEV1 were used to define airflow obstruction. Using the fifth percentile lower limit of normal (LLN) instead of the fixed value avoids misclassification of asymptomatic older patients as having COPD.

3. Mixed disease-Characterized by coexistence of obstruction and restriction, and was defined physiologically when both FEV1/FVC and FVC were below the 5th percentiles of their relevant predicted.

Smokers were defined as patients smoking at the time of admission or stopped smoking one month before admission. Post CABG outcome measures were ventilator stay, ICU stay, and hospital stay.

Data analysis was done by using SPSS (Statistical package for social sciences) for Windows version 20, IBM Corporation, Chicago, USA. Prevalence of obstructive disease and restrictive disease was determined by calculating the proportion of patients with obstructive and restrictive disease amongst the recruited population. Qualitative data are expressed by using frequency and percentage (%). Quantitative data such as ventilator stay, ICU stay, and total hospital stay are expressed by using mean and standard deviation (SD). Fisher’s exact test was used to compare qualitative data variables. Mann-Whitney U test was used to find the significant difference between quantitative variables. P value <0.05 was considered significant.

**Results**

Of 370 patients 274 (74.1%) were males and 96 (25.9%) were females. Seventy two (19.5%), 155/370 (41.9%), and 143 (38.6%) patients were between the age group of 35-50, 51-60 and 61-65 respectively. In this study 72(19.5%) patients were smokers. Two hundred fifty one (67.8%) and 282(76.2%) patients had diabetes mellitus and hypertension respectively. Two hundred seventy six (74.6%), 51/370 (13.8%), 32/370 (8.6%) and 11/370 (3.0%) patients had normal spirometry, restrictive, obstructive and mixed disease respectively. Two hundred seventy two (73.6%), 43 (11.6%), 51 (13.8%) and 4 (1.1%) patients required ventilator for ≤ 24 hours, 25-36 hours, 37-48 hours and > 48 hours respectively. Two hundred sixty one (70.5%), 105 (28.4%), and 4 (1.1%) patients required ICU stay for ≤ 72 hours, 73-96 hours, and > 96 hours respectively. Three hundred twenty eight (88.6%), 37 (10.0%), and 5 (1.4%) patients required total hospital stay for ≤ 8 days, 9-10 days, and > 10 days respectively.

As depicted in Table 1, there was statistically significant difference between duration of ventilator and FEV1. Higher percentage of patients whose FEV1 was abnormal [34/73(46.6%)] had ventilator duration ≥ 37 hours as compared patients whose FEV1 was normal [21/297 (7.1%)]. As depicted in Table 2, there was statistically significant difference between duration of ICU stay and FEV1. Higher percentage of patients whose FEV1 was abnormal [54/73 (74.0%)] had ICU stay ≥ 73 hours as compared patients whose FEV1 was normal [55/297 (18.5%)]. As depicted in Table 3, there was statistically significant difference between duration of hospital stay and FEV1. Higher percentage of patients whose FEV1 was abnormal [26/73 (35.6%)] had hospital stay ≥ 9 days as compared patients whose FEV1 was normal [16/297 (5.4%)].

Mean duration of ventilator stay was 20.7(±1.7), 36.2(±2.5), 43.7(±4.7), and 43.8(±4.9) hours for normal spirometry, restrictive disease, obstructive disease, and mixed disease patients respectively. As depicted in Table 4, there was statistically significant difference between spirometry diagnosis and duration of ventilator support. Patients who had obstructive, restrictive and mixed disease had longer duration of ventilator support than patients whose spirometry was normal. Mean duration of ICU stay was 71.8(±1.6), 74.6(±3.4), 89.0(±6.4), and 86.4(±7.2)
### Table 3: FEV1 and duration of hospital stay

<table>
<thead>
<tr>
<th>Hospital stay</th>
<th>FEV1</th>
<th>Total (%)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Normal (%)</td>
<td>Abnormal (%)</td>
<td></td>
</tr>
<tr>
<td>≤ 8 days</td>
<td>272(100.0)</td>
<td>4 (0.0)</td>
<td>0.001</td>
</tr>
<tr>
<td>9 - 10 days</td>
<td>48 (14.6)</td>
<td>32 (88.6)</td>
<td>0.001</td>
</tr>
<tr>
<td>&gt; 10 days</td>
<td>0 (0.0)</td>
<td>0 (0.0)</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>328 (100.0)</td>
<td>37 (100.0)</td>
<td></td>
</tr>
</tbody>
</table>

Fisher’s exact test was used.

### Table 4: Spirometry and duration of ventilator stay

<table>
<thead>
<tr>
<th>Spirometry diagnosis</th>
<th>Duration of ventilator stay</th>
<th>Total (%)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>≤ 24 h (%)</td>
<td>25 – 36 h (%)</td>
<td>&gt; 48 h (%)</td>
</tr>
<tr>
<td>Normal spirometry</td>
<td>244 (93.5)</td>
<td>32 (10.5)</td>
<td>0 (0.0)</td>
</tr>
<tr>
<td>Restrictive disease</td>
<td>17 (6.5)</td>
<td>34 (23.3)</td>
<td>0 (0.0)</td>
</tr>
<tr>
<td>Obstructive disease</td>
<td>0 (0.0)</td>
<td>29 (27.0)</td>
<td>3 (75.0)</td>
</tr>
<tr>
<td>Mixed disease</td>
<td>0 (0.0)</td>
<td>10 (9.5)</td>
<td>1 (25.0)</td>
</tr>
<tr>
<td>Total</td>
<td>261 (100.0)</td>
<td>43 (100.0)</td>
<td>51 (100.0)</td>
</tr>
</tbody>
</table>

Fisher’s exact test was used.

### Table 5: Spirometry and duration of ICU stay

<table>
<thead>
<tr>
<th>Spirometry diagnosis</th>
<th>ICU stay duration</th>
<th>Total (%)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>≤ 72 h (%)</td>
<td>73 – 96 h (%)</td>
<td>&gt; 96 h (%)</td>
</tr>
<tr>
<td>Normal spirometry</td>
<td>244 (93.5)</td>
<td>32 (10.5)</td>
<td>0 (0.0)</td>
</tr>
<tr>
<td>Restrictive disease</td>
<td>17 (6.5)</td>
<td>34 (23.3)</td>
<td>0 (0.0)</td>
</tr>
<tr>
<td>Obstructive disease</td>
<td>0 (0.0)</td>
<td>29 (27.0)</td>
<td>3 (75.0)</td>
</tr>
<tr>
<td>Mixed disease</td>
<td>0 (0.0)</td>
<td>10 (9.5)</td>
<td>1 (25.0)</td>
</tr>
<tr>
<td>Total</td>
<td>261 (100.0)</td>
<td>43 (100.0)</td>
<td>51 (100.0)</td>
</tr>
</tbody>
</table>

Fisher’s exact test was used.

### Table 6: Spirometry and duration of hospital stay

<table>
<thead>
<tr>
<th>Spirometry diagnosis</th>
<th>Hospital stay duration</th>
<th>Total (%)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>≤ 8 days (%)</td>
<td>9 – 10 days (%)</td>
<td>&gt; 10 days (%)</td>
</tr>
<tr>
<td>Normal spirometry</td>
<td>275 (83.8)</td>
<td>1 (2.7)</td>
<td>0 (0.0)</td>
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<tr>
<td>Restrictive disease</td>
<td>48 (14.6)</td>
<td>3 (8.1)</td>
<td>0 (0.0)</td>
</tr>
<tr>
<td>Obstructive disease</td>
<td>2 (0.6)</td>
<td>26 (70.3)</td>
<td>4 (80.0)</td>
</tr>
<tr>
<td>Mixed disease</td>
<td>3 (0.9)</td>
<td>7 (18.9)</td>
<td>1 (20.0)</td>
</tr>
<tr>
<td>Total</td>
<td>328 (100.0)</td>
<td>37 (100.0)</td>
<td>5 (100.0)</td>
</tr>
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</table>

Fisher’s exact test was used.

Discussion

The purpose of this research was to study the correlation between the preoperative PFT and outcome after CABG surgery. In this study preoperative PFT was performed in all the 370 patients prior to cardiac surgery. They were classified a normal spirometry, obstructive, restrictive and mixed disease. In this study 94 patients (25.4 %) had an abnormal PFT. The findings are similar to studies conducted by Leavitt BJ et al., Gao D et al., and Samules LE et al.

The previous studies reported that FEV1 is a good predictor of postoperative pulmonary complication after surgery. In the present study association between FEV1 and higher ventilator stay was statistically significant. This was also reported in study conducted by Légaré J et al. There is a decrease in lung volume postoperatively in CABG patients. It is further decreased in patients with abnormal PFTs. There is mean reduction of approximately 40–50% in FEV1 and FVC on the first and third postoperative day in CABG. Thus, in patients with prior FEV1 abnormality further reduction in FEV1 postoperatively leads to hypoxia.

In this study a lower FEV1 was significantly associated longer ICU stay. This was stated in previous studies conducted by Najafi M et al., El-Sobkey SB et al., and Rosenfeld R et al. In this research, patients with abnormal FEV1 had significantly longer hospital stay. This was reported in previous studies conducted by Canver CC et al. and Najafi M et al.

In this study patients with restrictive lung disease have less ventilator stay as compared to obstructive lung disease and mixed disease. This is also documented in previous study conducted by O’Boyle F et al.

In the present study, mean duration of ventilator stay was 20.7, 36.2, and 43.7 hours for normal spirometry, restrictive disease, and obstructive disease patients respectively. The findings are similar to the studies conducted by Canver CC et al., Najafi M et al., and Woods SE et al.

In this study patients with restrictive lung disease have less ventilator stay as compared to obstructive lung disease and mixed disease. This is also documented in previous study conducted by O’Boyle F et al.

Mean duration of ICU stay was 71.8(±1.6), 74.6(±3.4), 89.0(±6.4), and 86.4(±7.2) hours for normal spirometry, restrictive disease, obstructive disease, and mixed disease patients respectively. In this study, patients with obstructive lung disease required longer ICU stay (89.0 hours) as compared to patients with restrictive lung disease (74.6 hours) and patients with normal lung function (71.8 hours). These findings are similar to previous studies. Patients with an abnormal PFT have decreased vital capacity, along with difficulty in weaning off from ventilator and episode of respiratory failure. These factors are collectively responsible for increase in hospital and ICU stay.

In this research mean duration of hospital stay was less (7.1 days) for normal spirometry patients as compared to obstructive disease patients (9.4 days). Similar finding is reported in previous study conducted by Manganas H, et al.

Cigarette smoking is a powerful risk factor for CAD, myocardial infarction, and cardiac causes of death. In this study 13.4% patients had smoking...
history. Patients with obstructive, restrictive, mixed disease and normal spirometry 75%, 8%, 63.6% and 13% were smoker respectively. In this study 51% patients with smoking history had normal spirometry. Patients with abnormal PFT with smoking history have prolonged ventilator stay, ICU stay and total hospital stay as compared to patients with normal spirometry. Similar results are reported in previous studies.43-46 There are some limitations to the study such as only preoperative PFT was done. Follow up PFT post CABG need to be done. We did not analyze mortality as outcome because no mortality was observed within 7 days of CABG. Longer follow up of the patients is required. Further studies with larger sample size and diverse settings need to be conducted to substantiate these findings.

Conclusions
Abnormal PFT was independent strong predictor of prolonged ventilation, longer length of ICU and hospital stay in patients undergoing CABG. Abnormal FEV1 alone predicted prolonged ventilation, longer length of ICU and hospital stay in patients undergoing CABG.

References