Ambulatory Blood Pressure Monitoring in Chronic Obstructive Pulmonary Disease Patients

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Abstract

Background: Chronic Obstructive Pulmonary Disease (COPD) is now considered as multisystem disorder with high cardiovascular mortality. The study was carried out with an objective to observe the pattern and variation of blood pressure (BP) using ambulatory blood pressure monitoring (ABPM) in COPD patients.

Methods: Thirty six cases of COPD diagnosed by spirometry underwent ABPM for blood pressure evaluation. Thirty controls without COPD underwent spirometry and ABPM. Analysis were carried out both during wakefulness and sleep.

Results: Out of 36 COPD cases 25 were found to be hypertensive on ABPM, while 2 out of 30 controls were found to be hypertensive on ABPM. A significant difference was found between blood pressure levels during the wakefulness, sleep, and 24-hour BP amongst COPD cases and controls. Higher blood pressure levels were observed in COPD patients then in control, except for diastolic levels during wakefulness. The normal nocturnal dip was attenuated in COPD patients whereas physiological dip was present in controls.

Conclusions: COPD patients had higher blood pressure levels than the control group and had abnormal dipping pattern of blood pressure which may lead to high cardiovascular mortality in patients of COPD.

Introduction

Chronic obstructive pulmonary disease (COPD) is fourth leading cause of death and affects more than 10 million people in USA.¹ Its prevalence is 5% amongst Indian males and approximately 3.2% in Indian female over 40 years of age.²

The prevalence of hypertension is high among the world population and increases with the age range between 60 and 69 years of age, more than 50% of the individuals are affected by hypertension.³⁴ Above 70 years of age, in turn, the prevalence of hypertension reaches 75%. Mortality for cardiovascular diseases increases with blood pressure (BP) elevation.⁵⁶

In addition to showing scarce and conflicting data on blood pressure in patients with COPD, there is need for further studies to explain the behavior of blood pressure during sleep desaturation and, most importantly, its effects on target organs. Ambulatory blood pressure monitoring (ABPM) is the diagnostic tool that provides this analysis, thus permitting the knowledge of the pattern of blood pressure variations during wakefulness and sleep.⁷⁸ The objective of this study was to evaluate the pattern and variation of blood pressure in the 24 hours, in COPD patients, using ABPM parameters.

Material and Methods

This cross sectional study was conducted from June 2016 to June 2017 for a period of one year in a tertiary care center in northern India. A total of 36 COPD patients diagnosed by spirometry according to GOLD criteria were included in the study with 30 controls without COPD.

A detailed clinical history and thorough examination was carried out in every subjects, with emphasis on comorbid condition such as hypertension, renal failure, diabetes, ischemic heart disease. Treatment history was taken and presence of conditions that affect neuro-autonomic function (neuropathies, psychiatric illness) were ruled out. Spirometry was done to diagnose COPD according to GOLD criteria. Blood pressure was measured by sphygmomanometer three times at around 5 minutes intervals after subject rested for 20 minutes in sitting position, the mean of these three values was calculated as office BP. Then all subjects underwent 24hrs Ambulatory blood pressure monitoring with ABPM machine of Model number: (Mindray MC 6800, Manufactured by Shenzen Mindray Bio-Medical Electronics).

ABPM machine were programmed to obtain BP at every 30 minutes in day and every hour in night. Patients were educated that the device will automatically inflate the cuff and measure BP periodically over a 24 hour period. Patients were advised to continue with their normal daily activities, and take all their usual medications. Measurements obtained from ABP monitoring were interpreted by connecting the device with computer. Based on the readings patients were classified as hypertensive or non-hypertensive, patient were also classified as dippers, non-dippers and reverse dippers on the basis of dipping pattern. Normal BP as per criteria from ABPM guidelines⁸ are as follows Day BP: <135/85 mm of Hg, Night BP: <120/70 mm of Hg, Mean 24 hrs. BP:<130/80 mm of Hg. Dipping is defined as difference of mean BP between awake and sleep period and in normal individual the nocturnal dip is between 10% to 20%. Non-dippers are those whose nocturnal decline in BP is less than 10%. Complications like cerebro vascular disease, left ventricular hypertrophy

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and cardiovascular mortality and morbidity are observed more frequently in non-dipper patient. Reverse dippers are those whose dipping is less than 0% that is nocturnal BP is higher than diurnal BP, is more apparent in renal dysfunction with proteinuria and has worst prognosis.

Statistical analysis

The statistical analysis was done using SPSS (Statistical package for social science) Version 15.0 statistical analysis software. The values were represented in number (%). Mean±SD. Student’s t-test was used while assessing spirometry data. P < 0.05 was considered statistically significant.

Sponsoring

Our study was not sponsored by any external sources.

Results

A total of 36 patients of COPD fulfilling the inclusion criteria were enrolled in the study and 30 healthy individual were also included in the study as controls.

Out of 66 cases enrolled in the study, 9 (13.64%) were females and rest 57 (86.36%) were males and male: female ratio was 1:0.16. Majority of overall (86.36%) as well as of Cases (86.11%) and Controls (86.67%) subjects were males. Difference in gender of subjects enrolled as cases and Controls was not found to be statistically significant (Table 1).

Proportion of Cases was higher as compared to Controls among 51-60 years (47.22% vs. 46.67%) while proportion of Controls was higher as compared to Cases among aged ≤50 years (36.67% vs. 36.11%). Proportion of Cases and Controls was similar in age group >60 years (16.67% each) Difference in age of Cases and Controls was not found to be significant (Table 2).

Out of 36 COPD cases 25 (69.44%) were hypertensive while 2 controls (6.67%) were found to be hypertensive on ABPM, though all the subjects had normal BP when measured by sphygmomanometer (Table 3).

Out of 27 hypertensive subjects 18 (66.67%) had higher mean BP during night and 24 h, 6 (22.22%) had higher night time BP and 2 (7.41%) had higher day time BP along with 24 h BP. Two subjects in whom only day time BP was higher belonged to control group.

Mean day time systolic BP of cases was found to be higher as compared to that of controls and this difference was found to be statistically significant (Table 4). All subjects enrolled as cases and Controls was not found to be statistically significant. All the enrolled in the study as controls (100.00%) were found to have normal dipping (Table 7).

Discussion

Although COPD affects the lungs, it also produces significant systemic consequences. With disease progression several other symptoms may develop and patients with moderate to severe COPD often have multi system disease and of all these cardiovascular diseases are of great concern and cause of mortality, and hypertension is important risk factor for cardiovascular mortality. COPD increases the cardiovascular risk two fold. The factors that correlate COPD with cardiovascular events are not fully understood. Studies demonstrate that chronic systemic inflammation and disorders of the nuerohumoral may be involved, and suggest that patients with COPD develop sympathetic hyperactivity, decreased vagal tonus

### Table 1: Gender comparison in study population

<table>
<thead>
<tr>
<th>Gender</th>
<th>Cases (n=66) No. (%)</th>
<th>Controls (n=30) No. (%)</th>
<th>Total (n=66) No. (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>31 (86.11)</td>
<td>26 (86.67)</td>
<td>57 (86.36)</td>
</tr>
<tr>
<td>Female</td>
<td>5 (13.89)</td>
<td>4 (13.33)</td>
<td>9 (13.64)</td>
</tr>
</tbody>
</table>

### Table 2: Age wise distribution and comparison of study population

<table>
<thead>
<tr>
<th>Age Group (years)</th>
<th>Cases (n=66) No. (%)</th>
<th>Controls (n=30) No. (%)</th>
<th>Total (n=66) No. (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤50</td>
<td>13 (36.11)</td>
<td>11 (36.67)</td>
<td>24 (36.36)</td>
</tr>
<tr>
<td>51-60</td>
<td>17 (47.22)</td>
<td>14 (46.67)</td>
<td>31 (46.97)</td>
</tr>
<tr>
<td>&gt;60</td>
<td>6 (16.67)</td>
<td>5 (16.67)</td>
<td>11 (16.67)</td>
</tr>
</tbody>
</table>

### Table 3: Presence of Hypertension in study population

<table>
<thead>
<tr>
<th>Cases (n=36) No. (%)</th>
<th>Controls (n=30) No. (%)</th>
<th>Total (n=66) No. (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normotensive</td>
<td>11 (30.56)</td>
<td>28 (93.33)</td>
</tr>
<tr>
<td>Hypertensive*</td>
<td>25 (69.44)</td>
<td>2 (6.67)</td>
</tr>
</tbody>
</table>

### Table 4: Comparison of mean systolic and diastolic blood pressure at day time in study population

<table>
<thead>
<tr>
<th>BP Category</th>
<th>Cases (n=36) Mean ± SD</th>
<th>Controls (n=30) Mean ± SD</th>
<th>Student 't' test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Systolic BP</td>
<td>129.19 ± 8.82</td>
<td>120.87 ± 6.31</td>
<td>7.815 &lt;0.001</td>
</tr>
<tr>
<td>Diastolic BP</td>
<td>71.92 ± 3.75</td>
<td>71.60 ± 7.00</td>
<td>0.234 0.815</td>
</tr>
</tbody>
</table>

### Table 5: Comparison of mean systolic and diastolic blood pressure at night time in study population

<table>
<thead>
<tr>
<th>BP Category</th>
<th>Cases (n=36) Mean ± SD</th>
<th>Controls (n=30) Mean ± SD</th>
<th>Student 't' test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Systolic BP</td>
<td>122.36 ± 2.88</td>
<td>91.27 ± 6.42</td>
<td>27.868 &lt;0.001</td>
</tr>
<tr>
<td>Diastolic BP</td>
<td>75.25 ± 5.38</td>
<td>56.40 ± 5.29</td>
<td>14.602 &lt;0.001</td>
</tr>
</tbody>
</table>

### Table 6: Comparisons of mean systolic and diastolic blood pressure (24 h) in study population

<table>
<thead>
<tr>
<th>BP Category</th>
<th>Cases (n=36) Mean ± SD</th>
<th>Controls (n=30) Mean ± SD</th>
<th>Student 't' test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Systolic BP</td>
<td>132.42 ± 6.09</td>
<td>110.80 ± 4.25</td>
<td>16.382 &lt;0.001</td>
</tr>
<tr>
<td>Diastolic BP</td>
<td>72.25 ± 4.54</td>
<td>62.60 ± 6.20</td>
<td>7.292 &lt;0.001</td>
</tr>
</tbody>
</table>

### Table 7: Comparison of dipping pattern in study population

<table>
<thead>
<tr>
<th>Dipping</th>
<th>Cases (n=36) No. (%)</th>
<th>Controls (n=30) No. (%)</th>
<th>Total (n=66) No. (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dippers</td>
<td>0 (0)</td>
<td>30 (100.00)</td>
<td>30 (45.45)</td>
</tr>
<tr>
<td>Non-dippers</td>
<td>34 (94.44)</td>
<td>0 (0)</td>
<td>34 (51.52)</td>
</tr>
<tr>
<td>Reverse dippers</td>
<td>2 (5.56)</td>
<td>0 (0)</td>
<td>2 (3.03)</td>
</tr>
</tbody>
</table>

p<0.001
and dysautonomia.\textsuperscript{11-14} All cases and controls included in the study were normotensive by office method but results from ABPM were different, all the cases were diagnosed as hypertensive while only two controls were diagnosed as hypertensive by ABPM.

Carriero et al while studying the impact of comorbidity in COPD patients, found that hypertension was prevalent in about 63.2\% of the patients.\textsuperscript{15}

Incalzi et al in their study from 270 COPD patients discharged after acute exacerbation found most common comorbidity was hypertension.\textsuperscript{16}

In the INDACO Observational pilot study on comorbidity in COPD found prevalence of hypertension to be about 52.1\%.\textsuperscript{17}

Similarly, Luis Garcia Olmas et al in a cross sectional study on comorbidity in COPD found prevalence of hypertension to be about 53\%.\textsuperscript{18}

Mean 24-hour blood pressure levels are the gold-standard parameter among those obtained by ABPM, because they are more accurately correlated with target-organ damage, morbidity and mortality. We found that Mean 24-hour systolic and diastolic values were higher in the COPD group than in control group. Our data were consistent with study of Neila Anders Aider et al.\textsuperscript{19} except they got no significant difference in diastolic pressure.

In our study during wakefulness higher mean, minimum and maximum systolic blood pressure levels were observed in the COPD group than control group. Though no significant differences in diastolic blood pressure levels (mean, minimum and maximum values) were observed between the groups during wakefulness. Similar findings were found in a study of Neila Anders Aider et al.\textsuperscript{15} The Syst-Eur substudy demonstrated that isolated systolic hypertension in older patients is associated with attenuated sleep dip, with an inverse association between blood pressure dip and cardiovascular risk.\textsuperscript{20}

In our study during sleep mean, minimum and maximum systolic blood pressure (SBP) levels, as well as mean minimum and maximum diastolic blood pressure (DBP) levels were higher in the COPD group than control group.

Similar observation was found in Neila Anders Aider et al. Mean, minimum and maximum systolic blood pressure (SBP) levels, as well as mean and minimum diastolic blood pressure (DBP) levels during sleep were higher in the COPD group.\textsuperscript{19}

The most important measures of circadian variation are the nocturnal dip and the morning surge.\textsuperscript{21} Nocturnal hypertension (non-dipping pattern) is the most important finding associated with increased target organ involvement and increased cardiovascular (CV) morbidity and mortality. The prognostic impact of BP variability is largely dependent on the variability of BP over time, but the many measures of variability that may be obtained from ABPM make this an interesting alternative.

Ambulatory blood pressure monitoring allows blood pressure to be intermittently monitored during sleep, and was useful to determine whether the patient is a dipper or non-dipper—that is to say whether or not blood pressure falls at night compared to daytime values. A night time fall is normal and desirable. Absence of a night time dip is associated with a higher risk of left ventricle hypertrophy and cardiovascular mortality. In addition, nocturnal hypertension is associated with end organ damage and is a much better indicator than the daytime blood pressure reading.

Even cases with normal BP by ABPM had non-dipping pattern in our study, this shows COPD patients have attenuated sleep dip or abnormal dipping pattern whereas those without COPD showed physiological mean sleep dip.

All controls had normal dipping pattern and all cases were non-dippers and two of them had reverse dipping. Other authors have also shown abnormal dipping pattern in COPD patents.\textsuperscript{19,23-25}

Conclusion

COPD patients have high cardiovascular mortality and high BP is one of the important risk factor for mortality in cardiovascular patients and abnormal dipping is also associated with high cardiovascular mortality, left ventricular hypertrophy, and end organ damage. In our study all cases and controls who were included had normal office BP but results from ABPM where different. All cases were diagnosed as hypertensive while in control only two were diagnosed as hypertensive by ABPM. Even cases with normal BP by ABPM had abnormal dipping pattern in our study. But the subjects enrolled in the study as Controls were found to have normal dipping pattern.

As our study population was small, we suggest more studies with large number of patients to assess the routine role of ABPM in COPD patients. We also suggest to assess the role of ABPM after treating patients of COPD showing high BP and abnormal dipping pattern with antihypertensive medicines.

References

7. Morillo MG, Amato MCM, Condino Filho SP. 24 hour recording of blood pressure in smokers and non-smokers. Arq Bras Cardiol 2006; 87:504-11.
15. Carriero A, Santos J, Rodrigues F. Impact of comorbidity in


