Comparison of spirometric values in sitting versus standing position among patients with obstructive lung function

Sajal De

ABSTRACT

Upright sitting is preferred position for spirometry. The spirometric values in seventy five adult patients with obstructive lung function in sitting versus standing position were compared. The forced vital capacity (FVC) in standing position were marginally more, but no change in forced expiratory volume (FEV₁) was observed. The agreement in diagnosing reversibility of obstruction in either position was high.

Key words: Body position, obstructive lung function, spirometry

INTRODUCTION

Spirometries are usually performed in upright-seated position. Spirometry in standing position is also acceptable, but usually avoided to reduce the risk of fall due to cough syncope during the procedure. A healthy individual can take deep inspiration in standing position, and thus the expiratory volume and flow increases in standing position.[1] No study had evaluated the effect of standing position during spirometry on classification of severity and reversibility of airflow obstruction among patients with obstructive lung function. Aim of this pilot study was to assess the changes in spirometric values among adult patients with obstructive lung function in sitting versus standing position.

MATERIALS AND METHODS

During this study, consecutive middle-aged patients who were previously diagnosed as having obstructive airway disease (bronchial asthma or chronic obstructive pulmonary disease with FEV₁/FVC ratio ≤ 0.70) and not having any known neuromuscular diseases during their routine outpatient department visit were recruited. Informed consents were taken from each patient. Spirometries were performed first in sitting upright position, followed by standing position using Jaeger Masterscope PC (Jaeger Co, Germany) as per American Thoracic Society (ATS) guideline.[2] Forced vital capacity (FVC), forced expiratory volume (FEV₁), and FEV₁/FVC were measured in both the conditions. To assess the bronchodilator response, each patient received 2 puffs of salbutamol (200 µg), and second spirometry was performed 15 minutes after the administration of salbutamol. The bronchodilator reversibility was defined as increase in FEV₁, and or FVC value of 12% and 200 ml as compared with the baseline value. Severity of airflow obstruction were classified as per ATS guideline.[2] MedCalc-version 12.3.0 was used for data analysis. Parameters were expressed as mean ± SD. Paired t-test was used to compare the changes, and Pearson correlation coefficient was used to assess the bi-variate relationship.

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A $P < 0.05$ was considered statistically significant.

**RESULTS**

Seventy-five patients with obstructive lung function were included in this study, and the mean age of study population was 61.2 $\pm$ 9.2 years (range 40 to 86), and 64 were male (85%). The mean body mass index (BMI) of study population was 21.7 $\pm$ 5.3 kg/m$^2$.

The severities of obstruction in sitting position were as follows: Mild obstruction 8.2%, moderate obstruction 12.3%, moderately severe obstruction 16.4%, severe obstruction 32.9%, and very severe obstruction 30.1%. The agreement in diagnosing the severity of obstruction in standing versus sitting position was 84%, and the over or under-diagnosis of severity of obstruction in either position was 8%.

Both pre and post-bronchodilator mean FVC value in standing position were more as compared to corresponding value in sitting position, but the magnitude of differences were small and statistically not significant ($P > 0.05$, Table 1). No significant effect of spirometry during standing position on FEV$_1$ value was observed. The spirometry in standing position had no significant effect on FEV$_1$ value. The changes in FVC and FEV$_1$ value in sitting versus standing position during pre- and post-bronchodilator spirometry exceeded the ATS recommended repeatability of spirometry criteria (i.e., the difference between the largest and the next largest FVC or FEV$_1$ should be $\leq 0.150$ L) in 26.6% to 40% and 2.6% to 5.3% cases, respectively. The Bland-Altman Plot of post-bronchodilator FVC and FEV$_1$ showed the values varied randomly in standing versus sitting position [Figures 1 and 2]. The relationship of change in either FEV$_1$ or FVC value in standing position with initial values or BMI was not observed.

The agreement in diagnosing reversible obstruction in sitting versus standing position was 86.6%. On standing position, additional 9.3% obstructions were classified as reversible obstruction. The relationship of change in FVC or FEV$_1$ value in change of body position with severity of obstruction was not found.

**DISCUSSION**

The effect of standing position during spirometry on spirometric values was found to be different across the studies. Pierson et al. had evaluated spirometry of 235 individuals with normal to severe ventilatory impairment in both sitting and standing position and observed that the sitting value of both FVC and FEV$_1$ were significantly more, but the magnitudes of differences were small.[3] Townsend alternated sitting-standing and standing-sitting testing sequence among 90 middle-aged subjects to avoid confounding effect of testing order and observed that both FEV$_1$ and FVC values in the standing position were more. [4] Gudmundsson et al. had evaluated 50 normal obese subjects (BMI $>$ 30 kg/m$^2$) and observed small improvement in FVC value only in standing position, [5] whereas we also observed small but statistically insignificant improvement in FVC value only.

**Table 1: Comparison of spirometry results in sitting versus standing position**

<table>
<thead>
<tr>
<th>Variables</th>
<th>Sitting</th>
<th>Standing</th>
<th>Mean difference (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-bronchodilator</td>
<td></td>
<td></td>
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<tr>
<td>FVC (L)</td>
<td>2.39 $\pm$ 0.63</td>
<td>2.41 $\pm$ 0.63</td>
<td>0.02 ($-0.01$ to 0.06)</td>
</tr>
<tr>
<td>FEV$_1$ (L/s)</td>
<td>1.20 $\pm$ 0.45</td>
<td>1.18 $\pm$ 0.46</td>
<td>$-0.01$ ($-0.03$ to 0.00)</td>
</tr>
<tr>
<td>Post-bronchodilator</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FVC (L)</td>
<td>2.73 $\pm$ 0.63</td>
<td>2.75 $\pm$ 0.64</td>
<td>0.01 ($-0.02$ to 0.05)</td>
</tr>
<tr>
<td>FEV$_1$ (L/s)</td>
<td>1.37 $\pm$ 0.48</td>
<td>1.37 $\pm$ 0.49</td>
<td>0.00 ($-0.02$ to 0.01)</td>
</tr>
</tbody>
</table>

Figure 1: Bland-Altman Plot of post-bronchodilator FVC in standing and sitting position showing the limits of agreement. Solid line represents mean difference (d) and dotted reference lines represent $d \pm 1.96$ SD

Figure 2: Bland-Altman Plot of post-bronchodilator FEV$_1$ in standing and sitting position showing the limits of agreement. Solid line represents mean difference (d) and dotted reference lines represent $d \pm 1.96$ SD
during spirometry in standing versus sitting position. Similar to study by McCoy et al.,[6] which showed peak expiratory flow rate didn’t differ significantly in sitting versus standing position among asthma patients, the FEV₁ value in our study did not differ significantly on standing versus sitting position.

The potential limitation of our study was small number of patients, and the order of spirometry was not randomized to avoid the confounding factors. We also failed to identify the factors responsible for variability in spirometric values in sitting versus standing position.

We concluded that the forced vital capacity among adult patients with obstructive lung function in standing position differ from sitting position, but the differences are both statistically and clinically not significant. The body position during spirometry makes little difference in diagnosing severity of obstruction due to minimal change in FEV₁ value; however, few additional airflow obstructions were classified as reversible in standing position due to improvement in FVC value.

REFERENCES


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