

Effect of Tripod Position on Objective Parameters of Respiratory Function in Stable Chronic Obstructive Pulmonary Disease

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ABSTRACT

Objective. To examine changes in respiratory dynamics in patients with chronic obstructive pulmonary disease (COPD) sitting leaning forward with hands supported on the knees (tripod position), a posture frequently assumed by patients in respiratory distress.

Methods. Spirometry, maximal inspiratory and expiratory pressures (MIP and MEP) generated at the mouth, and diaphragmatic excursion during tidal and vital capacity maneuver breathing measured by B-mode ultrasonography were studied in 13 patients with stable COPD in sitting, supine and tripod positions.

Results. Mean±SD age of patients was 52.2±6.8 years. Median disease duration was three years. There was no statistically significant difference in spirometry for sitting, supine and tripod positions (FEV₁: 1.11±0.4L, 1.14±0.5L and 1.11±0.4L; p=0.99), respectively, (FEV₁/FVC: 49.2±11.0, 53.7±8.5 and 48.5±11.3, p=0.37), mouth pressures (MIP: 102.9±28.9, 90.6±29.1 and 99.2±32.9 cm H₂O, p=0.61 and MEP: 100.8±29.9, 100.4±34.4 and 90.6±32.6 cmH₂O, p=0.74) and diaphragmatic movements during tidal (16.1±5.9, 20.1±6.8 and 16.6±6.2 mm, p=0.22) and forced breathing (33.9±11.0, 43.1±19.6 and 37.4±17.1 mm, p=0.35).

Conclusion. Commonly measured indices of respiratory function were not different in the tripod compared to sitting and supine positions. [Indian J Chest Dis Allied Sci 2009;51:83-85]

Key words: COPD, Posture, Respiratory dynamics, Tripod, Diaphragm.

INTRODUCTION

Patients with chronic obstructive pulmonary disease (COPD) in respiratory distress often various maneuvers such as pursed lips breathing, sighing and sitting with leaning forward supporting hands on their knees. The latter is called the tripod position because of the characteristic use of three points of support. Several authors have hypothesised that the forward leaning posture probably helps by optimising recruitment of accessory muscles,¹ or conversely by promoting relaxation of accessory muscle consequent upon fixation of arms and hence reducing the use of upper chest muscles.² Alternatively, cephalad displacement of a short flattened diaphragms could lead to stretching and greater tension generation,³ and hence improve diaphragmatic function. The evidence has however been inconsistent and conflicting. Only one of these studies actually involved fixing the upper limbs on the knees, the classic tripod position.⁴ We hypothesised that fixed arms would

probably splint the upper chest wall and that improved diaphragmatic function would explain the benefit observed in tripod position. We used spirometry, measurement of pressures generated at the mouth during maximal inspiration and expiration, and ultrasonography for direct visualisation and measurement of diaphragmatic function in three primary postures to elucidate the effect of posture on respiratory dynamics.

MATERIAL AND METHODS

We enrolled 13 patients with stable COPD (defined as no exacerbations in the preceding four weeks) after obtaining informed consent. The diagnosis of COPD was based on the characteristic features on history and examination with typical radiographic abnormalities and confirmed by pulmonary function tests (PFTs). An exacerbation was defined as the occurrence of two of the following: worsening dyspnoea, increased expectoration and increased purulence of sputum.⁵ Baseline demographic

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variables were obtained in all the patients. Active smoking was defined as smoking within the past six months. Patients with co-morbidities such as hypertension, diabetes mellitus, congestive heart failure, tuberculosis, bronchiectasis and intercurrent respiratory illness were excluded. Ethical clearance was obtained from the Institute's Internal Review Board.

Measurements were carried out in three primary postures in three settings. First, the patients were subjected to spirometry using a rolling seal electronic spirometer (PK Morgan, UK, model S232)⁶ in sitting, supine and tripod positions in a random order with sufficient rest in between the tests. Tripod position was defined as sitting with leaning forward on a firm stool with hands supported on knees. Each test was carried out after the patient had been in that posture for five minutes. The best of three readings was taken. Next, MIP and MEP measured at the mouth were recorded in the three primary postures in random order⁷ using a Pmax mouth pressure monitor (Morgan Medical Limited, UK). The best of three readings was recorded. Finally, diaphragmatic excursion during normal tidal and forced vital capacity maneuver breathing was measured by B-mode ultrasonography by a qualified sinologist using a

Table 1. Baseline anthropometric, demographic and lung function characteristics of the study population

| Variable | Values (n=13) |
|--------------------------------------|-----------------------------|
| Age (years) | 52.2 ± 6.8 (Range 45 to 70) |
| No. of males (%) | 10 (77%) |
| Height (m) | 1.61 ± 0.09 |
| Body mass index (m/kg ²) | 19.5 ± 3.7 |
| Median disease duration (years) | 3 (Range 1 to 8) |
| Smoker | |
| Current | 5 |
| Ex | 5 |
| No | 3 |
| Pack-years | 20 (0 to 72) |
| FEV ₁ (L) | 1.11 ± 0.4 |
| FEV ₁ % | 39.4 ± 13.0 |
| FEV ₁ /FVC | 49.2 ± 11.0 |
| Six-minute walk distance (m) | 417.9 ± 88.5 |

Values expressed as Mean±SD or in absolute numbers. M=Meter, kg=Kilogram, L=Litre, FEV₁=Forced expiratory volume in one second, in sitting posture, FVC=Forced vital capacity in sitting posture.

3.5MHz sector transducer (Model ATL, HDI 3000, Philips Bothel, USA). A fixed point on the right lateral chest wall was chosen on the anterior axillary line to obtain a longitudinal plane of the right hemidiaphragm which included the maximal renal bipolar length. The adjacent posterior aspect of the hemidiaphragm was identified. A craniocaudal displacement line was marked with a cursor at the midpoint of the kidney and the excursion of the hemidiaphragm was measured along this line with another cursor at the same depth from the transducer. Diaphragmatic excursion was measured during both tidal breathing and during a vital capacity maneuver. For each maneuver, at least three satisfactory readings were taken. The higher of two values which agreed most closely were taken for tidal breathing and the best of three efforts was taken for forced breathing. All measurements were repeated in the three primary postures. All patients underwent a six-minute walk distance test to determine the baseline functional exercise tolerance.

Statistical Analysis

Descriptive data was recorded for all patients. The mean values of parameters measured in three postures were compared using the non-parametric Kruskal-Wallis test. A *p* value of ≤0.05 was considered significant for all analyses.

RESULTS

The anthropometric, demographic and baseline sitting pulmonary function test variables of the study population are presented in table 1. The three non-smokers had a history of significant exposure to biomass fuel. Nine (69%) had stage 3 or 4 COPD by GOLD criteria⁸. Table 2 shows the effect of change in posture on lung function test parameters. There was no difference in the spirometric variables and in pressures generated at the mouth during maximal inspiratory and expiratory maneuvers in the three different postures. Though there was no statistical significance between the three postures in the degree of excursion of the diaphragm, it tended to be higher in the supine posture as compared to the other postures.

Table 2. Variation of lung function parameters between the three positions in the study patients

| Variable | Sitting | Supine | Tripod | P* |
|------------------------------------|------------|------------|-----------|------|
| FEV ₁ (L) | 1.11±0.4 | 1.14±0.5 | 1.11±0.4 | 0.99 |
| FEV ₁ % | 39.4±13.0 | 39.9±2.8 | 39.0±11.4 | 0.98 |
| FVC (L) | 2.3±0.7 | 2.1±0.8 | 2.3±0.7 | 0.73 |
| FEV ₁ /FVC | 49.2±11.0 | 53.7±8.5 | 48.5±11.3 | 0.37 |
| MMFR (L) | 0.6±0.3 | 0.7±0.3 | 0.6±0.3 | 0.95 |
| MIP (cmH ₂ O) | 102.9±28.9 | 90.6±29.1 | 99.2±32.9 | 0.61 |
| MEP (cmH ₂ O) | 100.8±29.9 | 100.4±34.4 | 90.6±32.6 | 0.74 |
| Tidal excursion of diaphragm (mm) | 16.1±5.9 | 20.1±6.8 | 16.6±6.2 | 0.22 |
| Forced excursion of diaphragm (mm) | 33.9±11.0 | 43.1±19.6 | 37.4±17.1 | 0.35 |

**p* value calculated using nonparametric Kruskal-Wallis test. All values expressed as Mean±SD, FEV₁=Forced expiratory volume in one second, FVC=Forced vital capacity, MMFR=Mid maximal flow rate, MIP=Maximal inspiratory pressure, MEP=Maximal expiratory pressure.

DISCUSSION

Postures and maneuvers adopted by patients in acute respiratory distress have always been fascinating but yet not fully explained scientifically. The tripod position has been historically described as a clinical sign of patient in respiratory distress. Few studies have been carried out to assess the effect of posture and position on respiratory dynamics. Most studies have assessed erect and supine postures and found that assuming supine posture from sitting or erect posture results in an increase in indices of airflow resistance and a greater excursion of the diaphragm.^{9,10} Very few studies have looked at the effect of forward leaning position. These could not demonstrate any improvement in airway obstruction, minute ventilation or oxygenation.^{2,4} Forward leaning was found to cause a reduction in the activity of the scalene and sternocleidomastoid muscles measured by electromyography.⁴ It also caused an increase in MIP,¹¹ and an improvement in thoracoabdominal movements.^{4,11} Though inconsistent and sometimes conflicting, these studies suggested that the improvement of dyspnoea in patients with COPD was due to a more optimal position of the diaphragm on its length-tension curve. This was thought to be due to reduction in tension imposed by abdominal muscles and a decrease in downward pressure of the viscera attached to the diaphragm, facilitating excursion of the diaphragm.

We conducted this quasi-physiological experiment in stable COPD patients who would be able to perform the tests in different postures. We hypothesised that leaning forward in a seated position with upper limbs fixed on the knees would splint the upper chest diverting the energy demands toward the main muscle of inspiration, and that leaning forward would reduce the abdominal visceral pressure on the diaphragm. Any improvement in ventilation and gas exchange would have to occur in the lower lung zones. We failed to demonstrate any change in spirometric parameters on changing posture from sitting or lying down to tripod position. Neither was there any change in the maximal pressure generated at the mouth during inspiration or expiration. Though the diaphragm excursion was higher in the supine posture as compared to sitting, a fact documented in previous studies, it was not significantly different in the tripod position.¹² The FVC was lesser in the supine position, a finding seen in a previous study,¹³ but there was no significant difference between the three postures. Failure to demonstrate any change in respiratory mechanics by change of posture may suggest that there might be other factors at play than just change in the former. However, it would be prudent to note that respiratory mechanics are a dynamic process, more so in patients in acute respiratory distress. Bronchoconstriction and dynamic hyperinflation in a sick patient with COPD would place the diaphragm at a progressively increasing disadvantage, a process we could not reproduce in this cohort of stable COPD patients. Further, the study was

limited by small numbers. The very small change induced by posture suggests that there may be factors other than the ones measured, such as altered ventilation perfusion balance. This needs to be investigated. The observation that only some patients adopt this posture seems to suggest that there may not be universal benefit. Whether this is due to variations in strengths of abdominal and accessory muscles that are brought into play during forceful expiration remains to be investigated.

In summary, it is clinically difficult to reproduce the respiratory dynamics of a sick patient and other mechanisms might be able to explain the perceived benefits of assuming tripod position in some patients. The commonly measured indices of respiratory function were not different in tripod position compared to sitting and supine in patients with stable COPD.

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