Lateral Decubitus Position Generates Discomfort and Worsens Lung Function in Chronic Heart Failure*

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Background: **Lateral decubitus position is poorly tolerated by heart failure patients.**
Study objectives: **To evaluated pulmonary function and lung diffusion in heart failure patients in the following five body positions: sitting, prone, supine, and left and right decubitus.**
Setting: **Heart failure unit of a university hospital.**
Subjects: **We studied 14 chronic heart failure patients in New York Heart Association class III and 14 healthy volunteers.**
Measurements and results: **After 15 min of a selected position, subjects were evaluated by a discomfort scale, ear oximetry, and pulmonary function, which included FEV_1, FVC, vital capacity (VC), alveolar volume, and diffusing capacity of the lung for carbon monoxide (DLCO) with subcomponent membrane resistance (DM) and capillary volume. In healthy subjects, we observed a reduction of DLCO and capillary volume in both lateral decubiti. Some discomfort was documented in both lateral decubiti when selected positions were compared with the sitting position. In the sitting position, pulmonary function suggested slight restriction ([mean ± SD] FVC, 89.8 ± 22.3% predicted; FEV_1, 84.7 ± 16.9% predicted, VC, 88.6 ± 21.5% predicted; and FEV_1/VC, 74 ± 7) with low DLCO (73 ± 19% predicted). Compared with sitting, lung mechanics were unchanged in prone and supine positions; FEV_1, FVC, and FEV_1/VC were lower when patients were lying on their side, with unchanged alveolar volume and VC. DLCO was similar when comparing sitting, prone, and supine positions, and it was lower in lateral decubitus because of the lower capillary volume (vs sitting) and DM (vs prone and supine). Body position-related FVC and DLCO reduction were greatest in the largest hearts (ΔFVC and ΔDLCO vs left ventricle diastolic volume $R = 0.524$, $p < 0.05$ and $R = 0.630$, $p < 0.02$, respectively; ΔFVC and ΔDLCO vs cardiothoracic index $R = 0.539$, $p < 0.05$ and $R = 0.685$, $p < 0.01$, respectively).**
Conclusions: **In heart failure, lateral decubitus airway obstruction and lung diffusion impairment become greater as heart dimensions increase.** *(CHEST 2005; 128:1511–1516)*

Key words: cardiomegaly; gravity; heart failure; lung diffusion; pulmonary function

Abbreviations: DLCO = diffusing capacity of the lung for carbon monoxide; DM = membrane resistance; VC = vital capacity.

It has frequently been observed that heart failure patients report discomfort when lying on their side. It has also been shown[1,2] that heart failure patients avoid the left lateral decubitus position during sleep. Although the idea that the heart can affect regional lung distension is nothing new,[3] and the differences between erect, prone, and supine positions have been extensively studied in healthy subjects[4–7] and in patients with cardiac[8] and lung[9] diseases, to our knowledge, the effect of lying on one side, in terms of the mechanical properties of the lungs and of gas diffusion, has never been evaluated in heart failure patients. The present study was,

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therefore, undertaken to assess whether the clinically reported complaints of breathing difficulties and/or general discomfort in the lateral position is associated with a difference in lung mechanics and gas diffusion in patients with chronic heart failure while in such body positions.

Materials and Methods

We studied 14 subjects with chronic severe heart failure (mean [± SD] age, 62 ± 8 years; one woman and 13 men) attributable to dilated cardiomiopathy. The study was carried out under stable clinical conditions with an optimized drug regimen for at least 2 months. Drug therapy included the following types: diuretics in all cases, β-blocker in 12 of 14 cases, ACE-inhibitors in 7 cases, AT1 blockers in 6 cases, antialdosterone drugs in 12 cases, amiodarone in 8 cases, and digitalis in 2 cases. The etiology of dilated cardiomyopathy was coronary artery disease in eight cases and idiopathic cardiomiopathy in six cases. All of the patients were in New York Heart Association class III with a peak oxygen consumption of 14.4 mL/min/kg (± 2.7; 50 ± 11% predicted) and a ventilation/carbon dioxide production slope of 36 (± 6). We also studied 14 healthy volunteers, recruited from hospital employees and friends (age, 61 ± 8 years; 2 women and 12 men). Patient study inclusion criteria included a cardiothoracic index > 45% at chest radiograph and a left diastolic volume > 130 mL at echocardiography. Study exclusion criteria were as follows: (1) previous cardiac or thoracic surgery; (2) obesity defined as body mass index > 28; (3) presence of lung, pleural, chest wall, or muscular disease; and (4) presence of smoking history. The healthy subjects had a negative medical history, normal echocardiogram, and cardiopulmonary exercise test, and all of them were nonsmokers. The patients with heart failure had a chest radiograph for cardiothoracic index determination. This index was measured as the ratio of the transverse diameter of the heart in relation to the diameter of the thoracic cavity. Echocardiographic parameters were collected in all of the patients to determine left ventricle volumes and ejection fraction.[10] We evaluated the standard pulmonary function, including FEV_1, FVC, and vital capacity (VC), alveolar volume, and diffusing capacity of the lung for carbon monoxide (DLCO). To allow for measurements in the various body positions, a 30-cm rigid tube was inserted between the mouthpiece and the spirometer. This tube was used in all positions, as well as for instrument calibration. Morris et al[11] prediction equations were used for FEV_1 and FVC, and the equations of Crapo and Morris[12] were used for DLCO. The alveolar volume was measured by using a standard single-breath technique with methane as an indiffusible gas. DLCO was measured with the single breath-constant expiratory flow technique (model 2200; SensorMedics; Yorba Linda, CA).[13] Diffusion subcomponents, capillary volume, and membrane resistance (DM) were also measured by applying the method of Roughton and Forster.[14] For this purpose, subjects inhaled gas mixtures containing 0.3% CH_4 and 0.3% CO, with three different oxygen fractions equal to 20%, 40%, and 60%, respectively, and balanced with nitrogen. Ear oximetry was also recorded. Measurements were made on separate consecutive working days, while subjects were sitting, supine, prone, and recumbent on the left and right side. Patients remained in the selected position for 15 min before any measurements were taken. The order of the positions was random. We also evaluated subjects' discomfort by asking how they felt in a specific body position when compared with the sitting position. The relative discomfort scale was numerical, from 1 to 5, with 3 being equal to the sitting position, 1 being much worse, 2 being slightly worse, 4 being slightly better, and 5 being much better. The discomfort evaluation was carried out immediately before the pulmonary function evaluation. With the exception of the chest radiograph, all of the control subjects underwent the same research protocol as the patients.

Statistical Analysis

Data were reported as the mean ± SD. Comparisons between heart failure and healthy subjects were done in the sitting position by an unpaired *t* test. Comparisons within each group were made with the sitting position by a paired *t* test after an analysis of variance evaluation by applying the Bonferroni correction as needed (four comparisons). Correlations were evaluated by linear regression analysis. The discomfort scale is reported both in numerical values and in percentages and was statistically evaluated by a signed-rank test.

Results

All of the patients tolerated each study body position without major complaints. In the patient group, discomfort scale results relative to the sitting position showed an increase in discomfort in the left-side and right-side positions ($p < 0.05$; median, 3, 3, 2, and 2, respectively in prone, supine, left-side, and right-side positions). The percentage of distribution of the discomfort scale is reported in Table 1. The cardiothoracic index was 57.4 ± 6.4%. Echocardiographic parameters revealed the following: left ventricular diastolic volume 220 ± 81 mL, left ventricular systolic volume 152 ± 72 mL, and left ventricular ejection fraction 33 ± 7%. In the standard sitting position, pulmonary function tests suggested a slight restrictive disease as evidenced by the FVC, FEV_1, VC, and FEV_1/VC data (Table 2). No major changes were observed, in terms of lung mechanics (Table 2), among the sitting, prone, and supine positions. The FVC was greatest in sitting, prone, and supine position in seven, five, and two of the subjects, respectively; and FEV_1 was greatest in sitting, prone, and supine position in eight, four, and two subjects, respectively. Compared with the sitting position, FEV_1, FVC, and FEV_1/VC were lower when patients were lying on one side, whereas the alveolar volume and VC were unchanged (Table 2).

Table 1—*Discomfort Scale Relative to Sitting Position**

Position	Discomfort Scale				
	1	2	3	4	5
Prone	0 (0)	3 (21.4)	9 (64.3)	1 (7.1)	1 (7.1)
Supine	0 (0)	4 (28.6)	9 (64.3)	1 (7.1)	0 (0)
Right decubitus	2 (14.3)	8 (57.1)	3 (21.4)	1 (7.1)	0 (0)
Left decubitus	3 (21.4)	6 (42.9)	3 (21.4)	2 (14.3)	0 (0)

*Values given as No. of patients and (% distribution). 1 = much worse; 2 = slightly worse; 3 = sitting position; 4 = slightly better; 5 = much better.