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Effect of Body Position on Gas Exchange in Patients With Idiopathic Pulmonary Alveolar Proteinosis*

No Benefit of Prone Positioning

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Background: **Prone positioning may improve oxygenation in patients with acute lung injury/ARDS. However, the beneficial effect of prone positioning on gas exchange has never been investigated in patients with diffuse pulmonary infiltrates who breathe spontaneously.**

Objective: **To evaluate the effect of body position on gas exchange in patients with idiopathic pulmonary alveolar proteinosis (PAP) with special reference to the benefit of prone positioning.**

Design: **A prospective study.**

Setting: **Tertiary medical center.**

Patients and methods: **Eight patients with PAP were studied on 25 occasions using spirometry, body plethysmography, and single-breath diffusing capacity of the lung for carbon monoxide (DLCO). Arterial blood gas levels were measured in the sitting position and in four lying positions randomly while patients breathed room air. To serve as control subjects, 16 age-matched healthy hospital personnel were studied. To evaluate the impact of oxygen therapy on positional effect in gas exchange, arterial blood gas levels were measured in the supine and prone positions in some PAP patients while breathing 40% oxygen.**

Results: **Normal to varying degrees of restrictive ventilatory defect and gas exchange impairment, as evidenced by DLCO, Pa_{O_2}, and alveolar-arterial oxygen pressure difference ($P[A\text{-}a]O_2$), were found in PAP patients. The ventilatory function parameters correlated positively with Pa_{O_2} and negatively with $P(A\text{-}a)O_2$. The values of Pa_{O_2} and $P(A\text{-}a)O_2$ measured in four lying positions showed no significant difference in both PAP patients and healthy control subjects. Furthermore, the differences in Pa_{O_2} and $P(A\text{-}a)O_2$ between measurements made in the supine and prone positions and the ratio of Pa_{O_2} measured in the prone position/Pa_{O_2} measured in the supine position were comparable between PAP patients and healthy control subjects. Arterial blood gas levels showed no significant difference between measurements made in PAP patients in the supine and prone positions while breathing 40% oxygen.**

Conclusions: **Positional change did not significantly affect gas exchange, and no benefit of prone positioning was found in both PAP patients and healthy control subjects. Further studies are needed to verify the benefit of prone ventilation in patients with diffuse pulmonary disorders who breathe spontaneously.** ***(CHEST 2005; 127:1058–1064)***

Key words: gas exchange; postural effect; prone positioning; pulmonary alveolar proteinosis

Abbreviations: ALI = acute lung injury; DLCO = diffusing capacity of the lung for carbon monoxide; FRC = functional residual capacity; KCO = diffusing capacity of the lung for carbon monoxide corrected by alveolar volume; $P(A\text{-}a)O_2$ = alveolar-arterial oxygen pressure difference; $P(A\text{-}a)O_2$-L = alveolar-arterial oxygen pressure difference measured in the left decubitus position; $P(A\text{-}a)O_2$-P = alveolar-arterial oxygen pressure difference measured in the prone position; $\Delta P(A\text{-}a)O_2$-PS = alveolar-arterial oxygen pressure difference measured in the prone position − alveolar-arterial oxygen pressure difference measured in the supine position; $P(A\text{-}a)O_2$-R = alveolar-arterial oxygen pressure difference measured in the right decubitus position; $P(A\text{-}a)O_2$-S = alveolar-arterial oxygen pressure difference measured in the supine position; Pa_{O_2} = alveolar oxygen tension; Pa_{O_2}-L = Pa_{O_2} measured in the left lateral decubitus position; Pa_{O_2}-P = Pa_{O_2} measured in the prone position; ΔPa_{O_2}-PS = Pa_{O_2} measured in the prone position − Pa_{O_2} measured in the supine position; Pa_{O_2}-R = Pa_{O_2} measured in the right lateral decubitus position; Pa_{O_2}-S = Pa_{O_2} measured in the supine position; PAP = pulmonary alveolar proteinosis; TLC = total lung capacity

Lung volumes and gas exchange may be affected by positional change.[1–4] Functional residual capacity (FRC) has been reported[2] to be lower when measured with the subject in the supine than when measured in the prone position, and this reduction of FRC occurred mainly in the dorsal lung regions.[5] As a consequence, prone positioning was advocated by Bryan[6] in 1974 as a means to expand the dependent lung regions. Clinically, prone positioning has been applied to patients with acute lung injury (ALI)/ARDS since 1976[7] as a strategy to improve oxygenation and to lessen the risk of ventilator-induced lung injury.[7–15] In terms of gas-exchange improvement, the reported[16] response rate of prone positioning ranged from 57 to 100%. Despite the promising response rate, prone positioning has not yet been accepted as a usual practice in the ICU. The lack of consensus on the optimal timing and duration of prone positioning, the lack of apparent criteria in patient selection, the lack of reliable parameters in predicting the favorable response of prone ventilation, and the varying severity and diversity of underlying causes of ARDS/ALI in patients who have been enrolled in studies[9,13,15,16] have led to inconclusive results in the use of treatment with prone positioning. Furthermore, a randomized controlled study[15] indicated that there was no significant benefit of prone positioning on long-term survival in patients with ARDS.

The mechanisms underlying improved oxygenation in patients with ALI/ARDS who have been treated by prone positioning remain speculative. An increase in FRC,[8,17] facilitation of the clearance of airway secretions,[8] improvement in the compliance of the respiratory system,[17] the recruitment of collapsed lung,[10,18] better ventilation/perfusion matching,[10,19] and decreased lung compression by the heart[20] all have been suggested. To dissect the mechanisms underlying gas-exchange improvement by prone positioning, several studies[19,21–31] were conducted using animals or healthy subjects, which gave contradictory results. Distinct lung conditions (healthy vs injured), respiratory status (spontaneous breathing vs mechanical ventilation), species difference (human vs animals), and different methodology used may account for these discrepancies.

The studies on prone positioning in patients with

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This work was supported by a grant from the Taipei Veterans General Hospital (TVGH91–02-04A).

Manuscript received April 13, 2004; revision accepted October 7, 2004.

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