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Pulmonary perfusion is more uniform in the prone than in the supine position: scintigraphy in healthy humans

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Keywords

Continuous positive airway pressure, gravity dependence, lung perfusion, prone position, single-photon emission computed tomography, supine position

Comments

The authors have examined an area of lung function that is oftenoverlooked: studying ventilation changes with positivepressure ventilation or with the prone position.However, the trial used young healthy volunteers and it may not be directlyapplicable to older, injured lungs that are often the problem in ICU.Follow-up studies in different patient groups may reveal perfusiondifferences between the healthy and injured subjects.

Introduction

Much has been made of the prone position for patients withseverely impaired gas exchange in the intensive care unit (ICU). However, despite the apparentbenefit of this change in position, the underlying mechanisms are still notcompletely clear. Much radiological evidence [computed tomography (CT)] shows beneficial changesto the ventilation of a collapsed lung with the prone position. This studyexamines the theory that regional differences in lung perfusion, resultingin improved ventilation-perfusion ratios in the prone position, contributeto the clinical improvement seen in such patients.

Aims

The study aimed to examine lung perfusion by scintigraphy in healthyhuman volunteers in both supine and prone positions, during normal respirationand with 10 cm H_2O of continuous positive airway pressure (CPAP). The investigation aimed to examine whether thedominant dorsal lung perfusion in the supine position changes to a dominantventral perfusion in the prone position. The investigators also looked atwhether CPAP (by producing lung distension) altered positional variationsin lung perfusion.

Methods

Ten healthy volunteers were used in the study (after approval bylocal ethics and radiation protection committees). Three of thesubjects had their lung perfusion examined following either normalrespiration or CPAP. The other seven subjects were able to act as their owncontrols for normal respiration and CPAP.Lung perfusion was determined using technetium-99m labelledmacroaggregates of albumin, delivered intravenously. These macroaggregatesare rapidly trapped in the pulmonary capillaries in proportion to bloodflow. The radioactivity was measured using tomographic gamma cameraexamination [single-photon emission computed tomography (SPECT)].Activity profiles for the right lung for each individual were measuredduring normal breathing and after 10 min of 10 cm H_2O of CPAP.

Results

During normal breathing, the only differences in perfusion wereseen in the diaphragmatic sections of the lung. There was more uniform lungperfusion in diaphragmatic sections of lung in the prone position. WithCPAP, perfusion was greater in dependent areas while the volunteers weresupine. In the supine position there was a morepronounced effect of CPAP on gravitational blood flow dependence,especially in the diaphragmatic regions of the lung.

Discussion

The main findings of the study are:

1) lung perfusion was more uniformly distributed in the prone position
2) CPAP enhanced perfusion differences due to gravity, with a more pronounced effect in the supine than in the prone position.

The use of SPECT is now established as a technique for tomographicinvestigation of radiotracer distribution. The subtraction technique usedin this study (before and after injection of labelled albumin) allowed thevolunteers to act as their own controls. This had the advantage ofeliminating any anatomical variations. The right lung was used to avoid anyinterference with the heart.The authors concluded that the combination of gravity and other factors,such as vascular anatomy, results in a greater vertical gradient ofperfusion in the supine position than the prone position. With CPAP therewas a more marked gravity dependence on blood flow in the supine positionthan in the prone position. For these reasons, ventilation-perfusionmatching during positive pressure ventilation is probably less favourablein the supine position than in the prone position.

References

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