A STUDY OF REGIONAL PULMONARY GAS EXCHANGE USING RADIOTRACERS

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Respiration involves the exchange of gases between the environment and the blood across the alveolar membrane. Four processes characterize the dynamics of gas exchange: ventilation, diffusion, perfusion and chemical binding with hemoglobin. A study was undertaken to investigate each of these processes, utilizing accelerator production and high yield synthesis of four gaseous radiotracers (('81m)Kr, CH(,3)('18)F, ('11)CO, ('15)O(,2)). Conventional gamma camera images and ancillary physiological data were acquired. Mathematical models were developed to predict the tracer clearance from the lungs during a breath hold and during washout post breath hold.

Images of the insoluble ('81m)Kr synchronized with the tidal breathing maneuver depict regional ventilation. Tracer bolus inhalation, relative compliance and regional phase information are obtained from krypton dynamic studies.

More soluble CH(,3)('18)F is used to determine regional pulmonary perfusion during a breath hold. Respiratory clearance of seven, inert, positron-emitting radiotracers define the tracer volume of distribution.

The tight-binding of ('11)CO to hemoglobin permits the regional measurement of carbon monoxide pulmonary diffusion capacity. A relative CO blood:gas partition coefficient is calculated from the washout of no-carrier-added levels of ('11)CO and verified by in vitro radiometric measurements.

Regional oxygen pulmonary diffusion capacity determined from ('15)O(,2) clearance during a breath hold reveals results similar to those obtained with CO.

All experimental data are in good agreement with the predictions of a two-compartment open model. A more advanced oxygen model is presented that incorporates radioactive oxygen exchange with stable oxygen on the hemoglobin molecule and metabolic removal of the tracer at the tissues.