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Quantitated scintillation scanning for the measurement of lung perfusion

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A method using quantitated lung scans is described for the accurate proportioning of lung perfusion. The results obtained by this method have been compared directly with those obtained from bronchospirometry, and a good correlation has been obtained ($r = +0{\cdot}93$).

The measurement of lung perfusion by bronchospirometry was first described by Björkman in 1934. The method is cumbersome and unpleasant for the patient, since it involves intratracheal intubation. Nevertheless, it is still a standard method for the measurement of individual lung perfusion. In 1964, Wagner, Sabiston, McAfee, Tow, and Stern described their preliminary findings with a new radioisotope lung scanning procedure. They injected macroaggregates of ^{131}I labelled human serum albumin into a peripheral vein, localized the accumulation of radioactivity in the lung with a Scintiscanner, and postulated that the concentration of radioactively labelled micro-emboli in the various parts of the lung was directly related to pulmonary blood flow.

In this study we have compared the blood flow in each lung, as determined by bronchospirometry, with the individual lung perfusion, as determined by a quantitative Scintiscanning procedure.

MATERIALS AND METHODS

Twenty patients suffering from carcinoma of the bronchus or bullous emphysema were studied.

Bronchospirometry was carried out with a double lumen Carlen's catheter connected to Godart Pulmotest spirometers filled with oxygen. The patients were sedated with haloperidol and the catheter was passed under local anaesthesia (one amethocaine lozenge followed by crico-thyroid injection of 10% cocaine and a laryngeal spray with 4% lignocaine).

Lung scans were performed using a Picker Magna Scanner V, with a 265 hole, 5 in. focus collimator. Human serum albumin, labelled with approximately 300 μCi ^{131}I, was macroaggregated by heating at its isoelectric point. Scans were made in both the prone and supine positions immediately after injection of the macroaggregates.

The quantity of radioactivity in each lung was measured by scaling the amplified scintillation counter pulse output. The number of counts accumulated in successive 4-cm. horizontal strips was recorded, and activity profiles were constructed by plotting the counts accumulated in each 4-cm. strip on the ordinate against the mid-position of the strip in centimetres from the spine of the first thoracic vertebra on the abscissa (Fig. 1). Activity profiles were constructed for each lung in both the prone and supine positions. The sum of the areas under the activity profiles of the right lung were expressed as a percentage of the sum of the areas under the activity profiles of both lungs. This percentage represents the proportion of the dose of ^{131}I macroaggregated albumin which accumulates in the right lung.

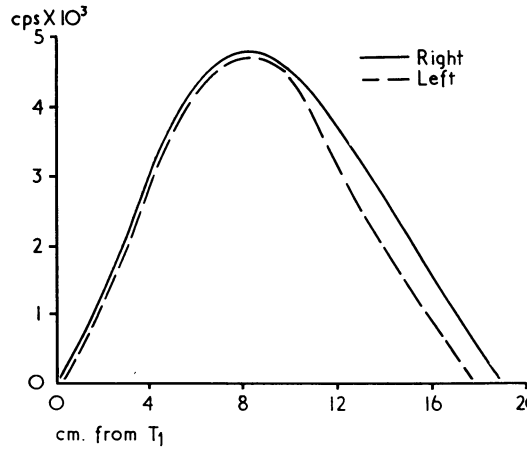

FIG. 1. *Normal activity profiles of right and left lungs. Counts accumulated in successive 4-cm. horizontal strips on ordinate; distance of strip from spine of T_1 on abscissa.*

RESULTS

The percentage of the dose of ^{131}I macroaggregated albumin which accumulated in the right lung ranged from 10% to 83%. The percentage oxygen uptake per minute in the right lung ranged from 20% to 86%. Figure 2 shows

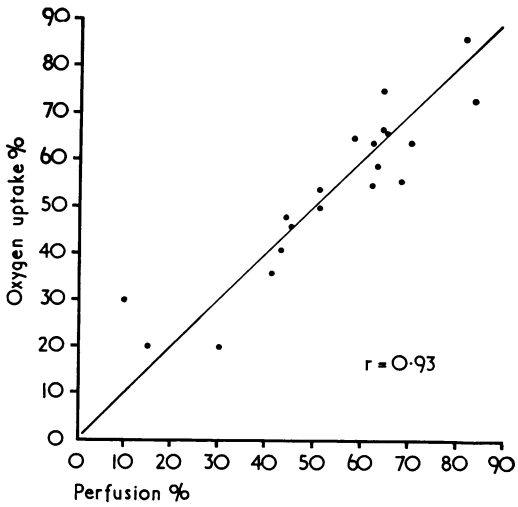

FIG. 2. *Comparison between proportion of total lung perfusion in right lung obtained by quantitative lung scanning and bronchospirometry* ($r = +0{\cdot}93$).

the comparison between the results obtained for oxygen uptake and the percentage of the dose of ^{131}I macroaggregated albumin which accumulated in the right lung ($r = +0{\cdot}93$).

DISCUSSION

It will be seen from Fig. 2 and the r value of +0·93 that a quantitated lung scan provides information about the relative proportion of lung perfusion which compares very favourably with that obtained by bronchospirometry, and these observations accord well with those of Lopez-Majano, Chernick, Wagner, and Dutton (1964), who obtained a good correlation between differential oxygen uptake and a semi-quantitative radioisotope lung scanning technique.

In 1960, Dyson, Hugh-Jones, Newbery, Sinclair, and West used ^{15}O with a half life of only 2 minutes for the determination of relative ventilation and perfusion in different regions of the lung. Since then ^{133}Xe, with a half life of 5·27 days, has been used to measure regional ventilation and perfusion (Ball, Stewart, Newsham, and Bates, 1962; Bentivoglio, Beerel, Bryan, Stewart, Rose, and Bates, 1963; Dollery and Gillam, 1963; Dawson, Kaneko, and McGregor, 1965), but until recently no direct comparisons have been made between overall lung perfusion measured with ^{133}Xe and bronchospirometry. Arborelius (1965) gave ^{85}Kr intravenously and compared the amount of ^{85}Kr exhaled from each lung during bronchospirometry. Arborelius' method was cumbersome, since it involved the collection of ^{85}Kr in Douglas bags, but the relationship between ^{85}Kr exhaled and oxygen uptake was good. In 1968 Miörner, using batteries of four scintillation counters positioned over the back and front of the chest, compared radiospirometry with ^{133}Xe with bronchospirometry and found good agreement.

In our studies, using quantitated lung scans following the administration of ^{131}I labelled microemboli, information was obtained not only about the relative perfusion of each lung but also about the distribution of perfusion within the lungs, since a rectilinear scanner with a resolution of 2 cm. was used. Thus, it was sometimes possible to obtain information about local perfusion from the scan which was not always obtainable from pulmonary angiography. Such detailed information cannot be obtained from ^{133}Xe studies even when batteries of scintillation counters are used, but Newhouse and his co-workers (Newhouse, Wright, Ingham, Archer, Hughes, and Hopkins, 1968) have recently gone some way towards achieving this by quantitating the regional output from a gamma camera using ^{135}Xe.

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