	No. Cases	Pos. Scans	Neg. Scans
Meningioma	4	4	
Metastatic Ca.	5	4	1
Astrocytoma	3	3	
Glioblastoma	2	2	
Ependymoblastoma	1(1)	0	1(1)
Glioma (Unclassified)	1	1	
Malignant Lymphoma	1	1	
Hemangioma	2(1)	1(1)	1
Acoustic Neurinoma	2(2)	1(1)	1(1)
3rd Ventricle Tumor	2	0	2
Pineal Tumor	2	2	
Pituitary Adenoma	3	2	1
A-V Malformation	3	3	
Chr. Subdural Hematoma	2	2	
Brain Abscess	2	2	
TOTAL	35(4)	28(2)	7(2)

( ) posterior fossa

Studies on the Regional Pulmonary Blood Flow by ^{131}I-MAA Lung Profile Scanning (Gravitational changes in the distribution of pulmonary blood flow)

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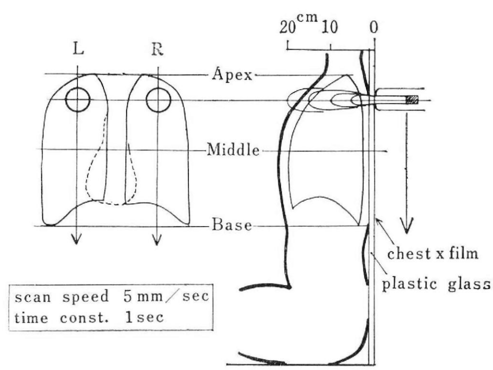
Recently it has been reported by many investigators that the normal distribution of pulmonary blood flow is affected by the hydrostatic pressure. In upright lung the blood flow decreases fairly steadily from the base to the apex there being virtually no flow at the apex. Today normal distribution of pulmonary blood flow has been well established, impaired distribution of pulmonary blood flow, however, has been poorly reported, although there is only striking exception. The patient with severe mitral stenosis or acute left ventricular failure has been found that the blood flow to the upper zone exceeds that to the lower zone in upright lung. We also previously studied the regional pulmonary blood flow of upright lung using ^{131}I-MAA profile scanning techniques in various cardiac disorders and noticed marked reduction of blood flow in the lower zones followed by marked increase in the upper zones in some cardiac diseases as severe mitral stenosis. At the same time hemodynamic studies were consecutively performed using the techniques of the right heart catheterization and the transseptal left heart catheterization. We have seen that upper to lower ratio of pulmonary blood flow of upright lung shows better correlation to the left atrial pressure than to the pulmonary arterial pressure.

Our present work is to study the distribution difference of pulmonary blood flow between the supine lung and the upright lung in various cardiopulmonary disorders.

Materials & Methods:

8 healthy volunteers and 41 patients with cardiopulmonary disorders were investigated.

The technique to be used is schematically shown in Fig. 1. The subject lies supine and about 50 μCi of ^{131}I-MAA (^{131}I-labeled



Lung Profile Scanning

Fig. 1

macroaggregated albumin) is injected intravenously. After supine 5 minutes he is seated on the scintillation apparatus equipped two probes with 2 inch NaI crystals and tapered collimators. Pairs of scintillation counters can move automatically by the electric motor from the apex to the base with 5 mm a minute of speed. The each lung is separately scanned on the posterior wall of chest from the apex to the base simultaneously by two each counter. The curve recorded by this lung profile scanning (lung linear scanning), showing the distribution of polmonary blood flow, has been named MAA-pulmogram. Thus supine pulmogram is obtained. In MAA method subsequent studies may be seen difficult, this technique, however, make it possible to measure repeatedly for further studies. Surely the radioactivity corresponding to supine pulmogram cannot be removed, but upright pulmogram is given as follows. The seated subject is injected approximately the same amount of ^{131}I-MAA and scanned usually. Radioactivity distribution curve including both supine curve and upright curve is obtained, this superimposed scan is then compared with the former scan (supine polmogram). In this way, upright pulmogram is derived.

The two pulmograms have equal geometry at the same point so that the ratio of upright scan to supine scan represents the change of distribution in the regional pulmonary blood flow caused by gravity (+G). Hence +G change ratio curve to be presented the upright distribution as a percentage of supine distribution of blood flow per unit lung volume is obtained.

On the other hand the pulmogram scanned on the midline of each lung expresses rather accurately the radioactive intensity at the region and that has good reproducibility, so that the area under the pulmogram represents the regional pulmonary blood flow. There is good evidence that on this scan using this apparatus, the sum of counting efficiency in the upper half of the lung equals experimentally that in lower half of the lung, when radioactivity distributes uniformly. From the area under the pulmograms, each distribution index of pulmonary blood flow is calculated. Right pulmonary perfusion index (right upper index, right lower index), left pulmonary perfusion index (left upper index, left lower index), and upper to lower ratio of pulmonary blood flow, are commonly used.

Normal values of perfusion index in upright lung are 52-55 in right index, 45-48 in left index and 0.30~0.60 in upper to lower ratio.

In this study, +G change of pulmonary perfusion index and +G mean change ratio of lower lung are used. +G change of pulmonary perfusion index is calculated from the difference of pulmonary perfusion index between upright lung and supine lung.. +G change would be affected by intravascular absolute pressure and vascular resistance of lower zone. +G change ratio representing mean value of +G change ratio curve in lower lung is not affected by intravascular pressure nor vascular resistance itself, but by change of resistance. Under the hydrostatic gradient, the driving pressure (arterial minus venous pressure) of each level is kept constant, because hydrostatic pressure affects equally upon pulmonary arterial and venous pressure. So that change of flow generally means change of resistance. The transmural pressure in upright lung increases down the zone, because the pressure inside the vessels increases down the zone while the pressure outside (alveolar or tissue) is constant.

Results & Discussion:

+G change ratio curve of a normal volunteer is shown in Fig. 2. +G mean change ratio and +G change reveal 138% and 20.6 respectively. This curve also represents the pulmonary perfusion of upright lung per unit lung volume, because the pulmonary blood flow in supine healthy subject would distribute evenly through whole lung. In some severe mitral stenosis which has marked increase in upper to lower ratio, the gravitational changes are not observed at all. However there are some cases with mitral stenosis showing increase in upper to lower ratio, which have a little +G change but have normal change ratio of lower zone. It follows from this that these cases has increased intravascular pressure and resistance but still keep good distensibility of the vessels against increase in hydrostatic pressure. There may be of course mitral stenosis with normal pulmonary circulation in which +G change and +G change ratio are normal.

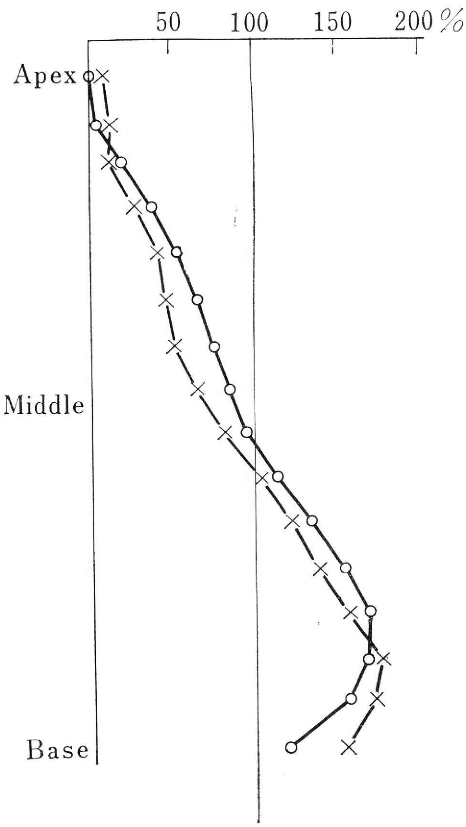


Fig. 2. +G change ratio curve (normal subject, 64 y., male) +G mean change ratio of lower lung shows 138%, and +G change of pulmonary permonary perfusion index shows 20.6. Circles; right lung, crosses; left lung.

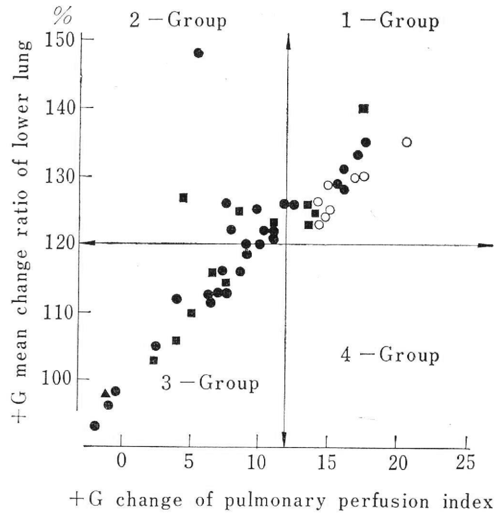


Fig. 3. +G change of pulmonary perfusion index and +G mean change ratio of lower lung.
○ normal subjects.
■ lung diseases.
● cadiac diseases.

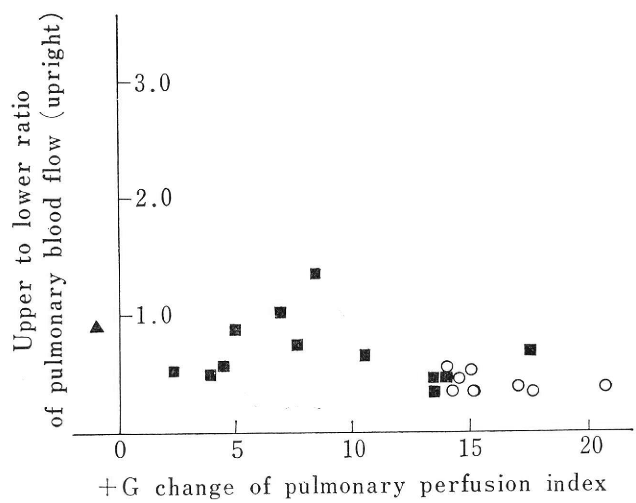


Fig. 4
Open circles represent normal subjects; closed circles, patients with cadiac diseases; squares, pulmonary diseases; and triangle, primary pulmonary hypertension.

In this point of view, the cardiopulmonary disorders would be divided into three groups; the first group has normal pulmonary circulation, the second group has the increased pressure inside vessels, but keeps some distemsibility, and the third group has marked increase in vascular pressure and resistance and may have organic change of vasculature. These consideration on many cardiopulmonary disorders were done, the correlation between +G change and +G change ratio in lower zone being shown in Fig. 3. Otherwise the interrelationships between gravitational

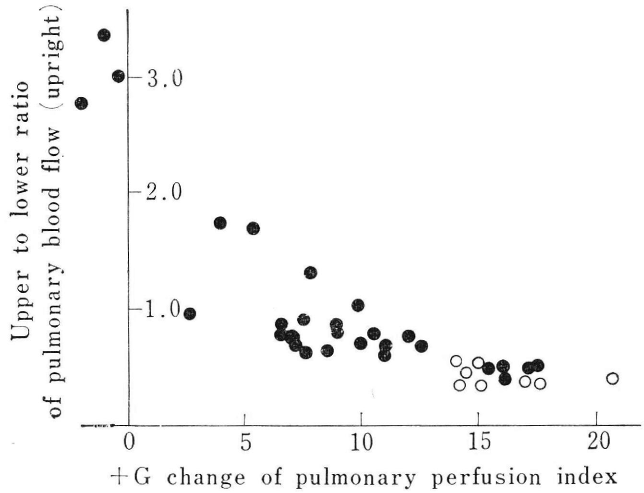


Fig. 5

changes and regional pulmonary blood flow were investigated and shown in Fig. 4, 5. In- These findings suggests that decreased +G verse correlation is seen in cardiac diseases. change would be due to increaed intravascular absolute pressures, because according to our previous studies, upper to lower ratio of upright lung results in good correlation to left atrial pressures. Cardiac diseases in severe cases are obviously distinguished from lung diseases in these figures. Triangle sign is a case of primary pulmonary hypertension with 60 mmHg of mean pulmonary arterial pressure. The impaired pulmonary circulation could be assessed equally in cardiac diseases and pulmonary diseases by measuring the gravitational changes, both diseases, however, may be distinguished by measuring regional pulmonary blood flow. This suggests that postocapillary pulmonary hypertension would be differenciated from precapillary pulmonary hypertension.

Summary:

Studying the gravitational change in the distribution of pulmonary blood flow by using ^{131}I-MAA lung profile scanning, various interesting results were obtained. Impaired pulmonary circulation in various cardiopulmonary disorders can be diagnosed clinically in this technique.

A Study on Lung-Scans Using ^{131}I MAA

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Clinical experiments on scintigrams using ^{131}I-MAA, of 23 cases with lung cancer, were carried out and especially the change of picture on their scintigrams before and after the irradiation of ^{60}Co, were investigated and discussed.

All of the patients whose chest radiograms revealed abnormal shadow on only one side of lung, were found to have more impaired distribution of pulmonary blood flow on the affected side than that on the healthy side.

While no change was seen on their radio-