Noninvasive Diagnosis of Latent Pulmonary Hypertension in COPD by Exercise-load Impedance Rheopneumogram: A Comparative Study with Right Heart Catheterization

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Summary: Impedance rheopneumogram (IRP) and right heart Swan-Ganz catheter examinations were simultaneously carried out in 63 patients. Two equations for calculating after-exercise-pulmonary-pressure (PAPm) were obtained by stepwise regresional analysis:

1) \[ PAPm(kPa) = -1.40 - 0.88 \ln Hs + 8.30 \cdot (B - F) + 5.78 \cdot Q - B/B - Y \]
   \[ (r = 0.730, \text{IRP is measured at rest}) \]

2) \[ PAPm(kPa) = 6.46 - 5.04 \cdot Hs/\sqrt{R - R} + 4.35 \cdot Q - B/B - Y - 19.34 \cdot (Q - C) \]
   \[ (r = 0.648, \text{IRP is measured after exercise}) \]

This is a new method for diagnosing latent pulmonary hypertension noninvasively.

Key words: Latent pulmonary hypertension, exercise-load test, noninvasive diagnosis, right heart catheterization

Chronic obstructive pulmonary disease (COPD), when it advances, often causes pulmonary hemodynamic abnormalities, of which the most important one is pulmonary arterial hypertension (PAH). At the earlier stage COPD may cause only latent PAH, that is to say, mean pulmonary arterial pressure (PAPm) is normal (PAPm < 2.67 kPa or 20 mmHg at rest), but increases significantly (PAPm ≥ 4.00 kPa or 30 mmHg) after exercise. It is important to detect latent PAH so that we can diagnose and treat PAH of COPD patients at its early stage\[1\]. However, up to date very few noninvasive diagnostic methods have been reported in the literature.

In recent years numerous researches done in China have proved that impedance rheopneumogram (IRP) is of great value to early diagnosis of cor pulmonale and noninvasive diagnosis of manifest PAH (PAPm ≥ 2.67 kPa or 20 mmHg at rest) in COPD patients\[2,3\]. But no report on the use of IRP to detect latent PAH has been available. The purpose of this study was, therefore, to investigate the possibility of using IRP to detect latent PAH noninvasively. To do so, right heart catheterization and IRP were performed simultaneously in 63 COPD patients both at rest and after supine cycling exercise.

Patients

63 patients included those who were admitted to our hospital from February, 1987 to July, 1988. Among them 54 were males and 9 females, the average age was 58.4 years. Detailed history was taken, routine physical examination was performed and routine laboratory examinations were done. Chest X-rays, heart ultrasonics, electrocardiogram, vectorcardiogram and
pulmonary function test were also performed. All cases were diagnosed as chronic bronchitis based on the diagnostic criteria set up by a relevant Chinese Academic Conference (1977). All patients were complicated with chronic obstructive emphysema, of whom 32 were complicated with chronic cor pulmonale. No pneumothorax, hydrothorax or other conditions which could affect the measurement of IRP were found.

METHODS

Examinations were done at the stable-stage of the disease. Vasodilators, sedatives and bronchodilators were stopped 48 h prior to the examinations.

Right heart catheterization was performed with routine method. Patients were in the resting supine position. Swan-Ganz catheters (5F, 110 cm, Edward Co., USA) were inserted percutaneously via an antecubital vein under local anesthesia. The pressure transducers (Statham P23 ID, Gould Co., USA) were positioned at the level of the maxillary line in the supine position. The pressure signals were shown on the fluorescent screen of the 8-channel physical recorder (Servomed, Hellige Co., Germany), and the positions of the catheter tips were judged by the typical pressure curves. Pulmonary pressure was averaged during several respiratory cycles. The pressure curves were also recorded on the paper together with other signals. The pressure transducer was calibrated with the column of mercury regularly.

\[ PAP_m = PAP_s + \frac{1}{3}(PAP_s - PAP_d) \]

IRP was performed according to the method recommended by the IRP Special Conference of the Cor Pulmonale Heart Function Workshop of China 1981. Signals from the IRP instrument (HB-3CG, China) were put into an 8-channel physical recorder. Pulmonary arterial pressure curve, electrocardiogram, IRP, differential curve of IRP and phonocardiogram were all recorded simultaneously. The paper speed was 100 mm/s (fig. 1).

After the examination at rest, the patients were asked to do supine cycling exercise (EGM-II supine cycling ergometer, China). The work load was 25 watts for 2 min and 50 watts for another 2 min (total 4 min). At the end of the exercise, pulmonary pressure curve, electrocardiogram, IRP, the differential curve of IRP and phonocardiogram were recorded simultaneously. During exercise the general condition of the patients and their ECG were continuously monitored.

Statistic analyses were performed according to routine methods and with the help of a computer.

RESULTS

In order to see if we can use IRP parameters measured at rest to predict pulmonary pressure at the end of exer-