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# Defect in Lung Perfusion and Ventilation Scanning of Patients with Permanent Transvenous Implantable Pacemaker*)

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## ABSTRACT

Lung perfusion and ventilation scanning with $^{99m}$Tc-MAA and $^{81m}$Kr-Gass were studied in 138 patients with permanent transvenous implantable pacemaker.

There were observed segmental or subsegmental defects in lung perfusion and ventilation scanning which were considered to be probably lung embolism of 47 cases.

The incidence of lung embolism was high during the first postoperative 6 months, and it also increased progressively with aging.

The patient with ischemic heart disease or valvular disease or hypertension showing heart failure or chest oppression or palpitation and dizziness had a tendency of high incidence of lung embolism.

From this finding, it might be said that the prophylactic treatment against thromboembolism is necessary especially within 6 months after pacemaker insertion in the patient more than 60 years of age with ischemic heart disease or valvular disease showing heart failure, chest oppression or palpitation and dizziness.

## INTRODUCTION

There has been considerable evidence to indicate that patients with arrhythmia have significant risk of cerebral embolism and the incidence of it could not be suppressed even after pacemaker implantation. The most common type of pacemaker is transvenous implantable in which tip of the electrode is placed in the right ventricle through the vein and the right atrium. It is supposed that thromboembolism of the great vein and/or the right atrium, and pulmonary thromboembolism might be produced occasionally as a complication of transvenous implantable pacemaker.

In the beginning, thromboembolism of the great vein and the right atrium had been considered to be scarce, but several case reports related to them are found in recent literature.

The purpose of this study is to determine the incidence of pulmonary embolism after pacemaker implantation with radionuclide lung perfusion and ventilation scanning using $^{99m}$Tc-MAA and $^{81m}$Kr-Gass.

## METHOD

Study patients: 138 patients with artificial transvenous implantable pacemaker were studied. There were 77 men and 61 female, and their age ranged from 22 to 85 years (average 65.4). They comprised 49 A-V block, 29 Sick Sinus Syndrome I (SSS I), 22 Sick Sinus Syndrome II (SSS II), 17 Sick Sinus Syndrome III (SSS III) and 21 slow heart beat with atrial

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fibrillation.

Radionuclide scanning method: Lung perfusion and ventilation scanning was performed 3 months to 5 years after pacemaker implantation.

5 millicuries of $^{99m}$Tc-MAA was injected through the subcutaneous vein of the arm and the patient was placed in supine position for 5 minutes.

Then image of lung perfusion scanning in each view yielding a total accumulation of about 700K counts in the entire image was recorded in four positions (the anterior, posterior and bilateral) using Gamma camera (GCA 401, Toshiba).

The lung ventilation scanning was recorded under the continuous inhalation of $^{81m}$Kr-Gass which was created by passing the moist oxygen gass through the cylinder of 10 millicuries of $^{81}$Rb. The image of lung ventilation scanning in each view yielding a total accumulation of about 200–300K counts in the entire image at four positions was recorded using Gamma camera. Moreover, V/Q image was recorded.

Interpretation of lung perfusion and ventilation scanning: A remarkable defect which is equivalent to a sement or subsegment was interpreted as positive, lung embolism, in unprocessed raw images in black-grey-white image recorded in the film (Fig. 1).

It was also studied on the relationship between the occurence of lung embolism and preoperative ECG, underlying disease, sex, age, clinical sign and symptom, blood pressure, bleeding time, platelet count, blood glucose and serum lipids.

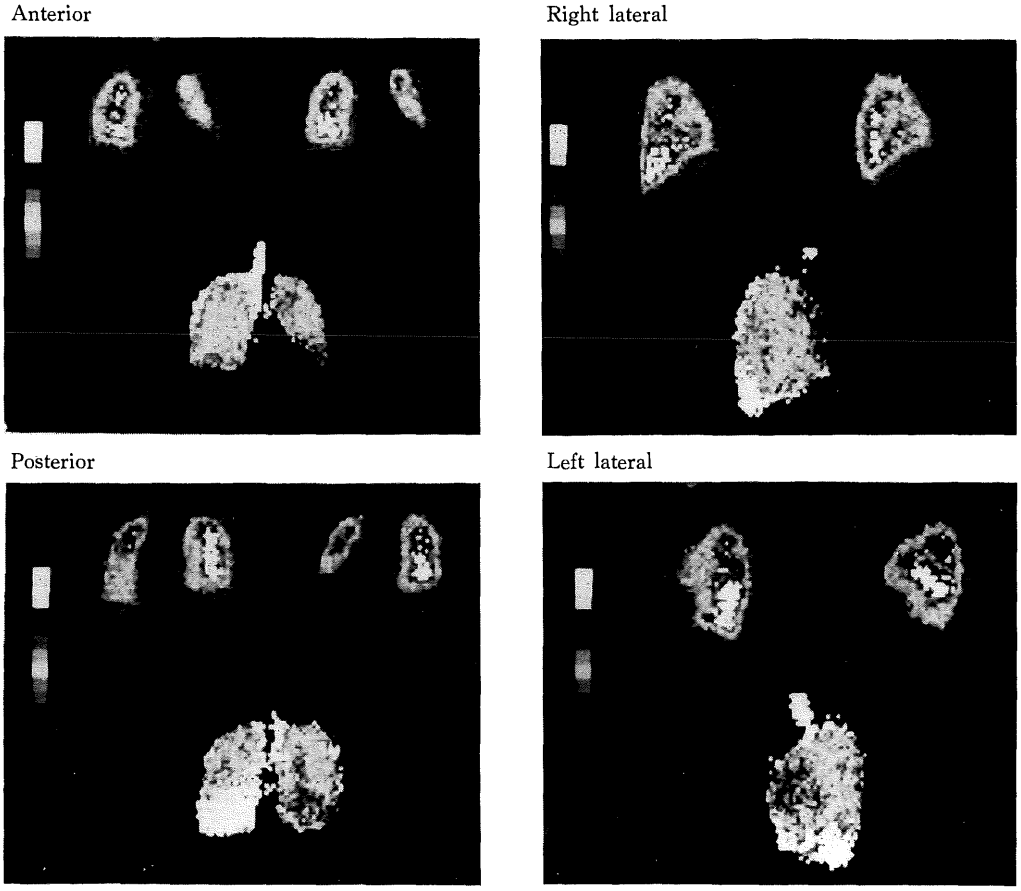


**Fig. 1.** Photograph of radionuclide lung perfusion scanning and ventilation scanning using $^{99m}$Tc-MAA and $^{81}$Kr-Gass in a 62-year-old female with pacemaker showing embolism at the right 3rd, 6th, 8th, and left 3rd, 6th–10th segments. Left top: Ventilation image, Right top: Perfusion image, Bottom: V/Q image.

## RESULT

There were observed segmental or subsegmental defects in lung perfusion and ventilation scanning which were considered to be due to lung embolism in 47 among total 138 cases (34.1%), appearing to the right side in 7 cases, the left side in 13 cases and both sides in 27 cases.

The incidence of it was highest during the first postoperative 6 months and, it, thereafter, decreased gradually. (Fig. 2)

According to the preoperative ECG, the patient with SSS III showed high incidence of lung embolism and that with slow heart beat with atrial fibrillation did low incidence. (Table 1)

The incidence of lung embolism according to underlying disease is shown in Table 2. The patient with valvular disease or ischemic heart disease showed a tendency of high incidence of lung embolism.

According to sex and age, there was not found remarkable difference of incidence of embolism due to sex, while it increased progressively with aging. (Table 3)

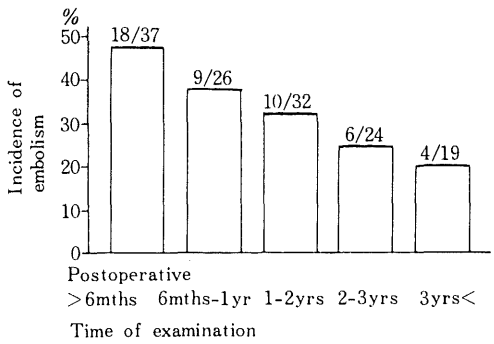


**Fig. 2.** Relation bstween the incidence of lung embolism and the time of radionuclide lung scanning

**Table 1.** Incidence of lung embolism according to preoperative electrocardiographic finding

| | No. of Patients | Patients with lung embolism | % |
|---|---|---|---|
| A-V block | 49 | 19 | 38.8 |
| SSS Type I | 29 | 10 | 34.5 |
| SSS Type II | 22 | 7 | 31.8 |
| SSS Type III | 17 | 8 | 47.1 |
| Slow Heart Beat with Af | 21 | 3 | 14.3 |
| Total | 138 | 47 | 34.1 |

**Table 2.** Incidence of lung embolim according to underlying disease

| Underlying disease | No. of Patients | Patients with lung embolism | % |
|---|---|---|---|
| Ischemic heart disease | 81 | 36 | 44.4 |
| Unknown | 46 | 9 | 19.6 |
| Cardiomyopathy | 7 | 1 | 14.3 |
| Valvular disease | 2 | 1 | 50.0 |
| Miscellaneous | 2 | 0 | 0 |
| Total | 138 | 47 | 34.1 |

**Table 3.** Incidence of lung embolism according to sex and age

| | No. of Patients | Patients with lung embolisn | % |
|---|---|---|---|
| Sex | | | |
| Male | 77 | 25 | 32.5 |
| Female | 61 | 22 | 36.1 |
| Age (Yr) | | | |
| -49 | 14 | 2 | 14.3 |
| 50-59 | 35 | 7 | 20.0 |
| 60-69 | 32 | 13 | 40.6 |
| 70-79 | 45 | 19 | 42.0 |
| 80- | 12 | 6 | 50.0 |

**Table 4.** Incidence of lung embolism according to symptom and arterial systolic blood pressure

| | No. of Patients | Patients with lung embolism | % |
|---|---|---|---|
| Clinical symptom | | | |
| Heart failure | 35 | 14 | 40.0 |
| Adams-Stokes attack | 38 | 12 | 31.6 |
| Dizziness | 36 | 10 | 27.8 |
| Chest oppression | 22 | 8 | 36.4 |
| Dizziness & Palpitation | 7 | 3 | 42.9 |
| Arterial systolic blood pressure | | | |
| - 90 mmHg | 3 | 0 | 0 |
| 91-110 mmHg | 20 | 7 | 35.0 |
| 111-130 mmHg | 52 | 16 | 30.8 |
| 131-150 mmHg | 40 | 12 | 30.0 |
| 151- mmHg | 23 | 12 | 52.0 |

**Table 5.** Bleeding time, platelet count, blood glucose, and serum lipids in the patients with and without lung embolism.

| | Patients without embolism | Patients with embolism |
|---|---|---|
| Bleeding time (min) | 2′18″±0′44″ | 1′55″±0′43″ |
| Platelet count ($\times 10^4$) | 19.3±7.0 | 18.9±1.4 |
| Blood glucose (mg/dl) | 106.5±20.5 | 102.3±3.6 |
| Total serum lipid (mg/dl) | 573.3±130.1 | 608.4±120.4 |
| Cholesterol (mg/dl) | 199.3±32.6 | 204.5±35.2 |
| Triglyceride (mg/dl) | 126.6±51.6 | 108.2±14.7 |
| NEFA (uEq/L) | 0.42±0.19 | 0.46±0.04 |
| Phospholipid (mg/dl) | 194.4±21.1 | 201.3±36.0 |
| HDL-chol. (mg/dl) | 42.3±2.1 | 48.7±116.6 |

The patient with dizziness and palpitation, heart failure or chest oppression showed high incidence of embolism. The patient with hypertension had also hish incidence of it. (Table 4)

There was not observed significant difference of bleeding time, platelet count, blood glucose and serum lipids between the groups with and without lung embolism. (Table 5)

## DISCUSSION

There were observed segmental or subsegmental defects in lung perfusion and ventilation scanning of 47 among 138 cases with permanent transvenous implantable pacemaker. A decrease in lung perfusion results from A-V shunt, bronchiectasis, vasoconstriction, lung cancer, reversal of pulmonary blood flow, heart failure, pleural effusion or elevation of the diaphragm[8].

There was not found any clinical sign of those conditions in the positive 47 cases. Therefore, the authors regarded most of defects in lung perfusion as pulmonary embolism.

Intravascular thrombosis is thought to be produced by venous stasis, injury of vein wall and/or clotting tendency[12].

Balau and his coworkers[2] found evidence of innominate and subclavian venous thrombosis in 14 among 49 patients with pacemaker. Stoney and his coworkers[17] reported that 11 among 34 venograms obtained in 32 patients with permanent transvenous electrode demonstrated severe obstruction with collateral circulation. Becker and his coworkers[4] reported three cases with thrombosis surrounding the catheter electrode and one of them dead on the first postoperative day. Crook and his coworkers[5] reviewed a series of 125 patients with permanent transvenous pacemaker and found 3 cases of occlusion of the subclavian vein. Kinney and his coworkers[10] studied 8 cases of pacemaker associated thrombus resulting in morbidity or mortality and concluded that the average age of these patients was 74, and 50% were male, and the symptoms referable to the catheter clot occurred about two months following pacemaker insertion.

Kreg and Zrbe[11] said that thromboembolism was a rare but life threatening complication in the patient with transvenous implantable pacemaker.

From the above mentioned matters, it is thought that the transvenous implantable pacemaker might induce thrombus in the vein, in the right atrium and ventricle, and thromboembolism in the pulmonary artery in a significant number of patient with transvenous implantable pacemaker beyond expectation.

Kinney and his coworkers[10] stated that etiology of death of thrombosis surrounding the catheter electrode was inlet obstruction to the right heart or pulmonary embolism, and the mortality rate was 75%.

Sidd and his coworkers[16], Prozan and his coworkers[14], Kaulbach and Krukonis[9], and Reynolds and his coworkers[15] presented cases of fatal pulmonary embolism after the insertion of transvenous implantable pacemaker. On the incidence of pulmonary embolism, it occurred in 1 among 156 patients in one series[6], and in 4 among 112 patients of second series[4]. In our series, a defect in lung perfusion scanning was observed in 47 among 138 cases, and incidence of it was high during the first postoperative 6 months and, thereafter, it decreased gradually. It is thought that the patient with transvenous implantable pacemaker has high possibility of pulmonary embolism during the first postoperative 6 months, after which it becomes lower and/or recanalization of occluded pulmonary artery occurs.

Right atrial thrombosis causes severe persistent congestive heat failure[6], and it is believed that the most common factors predisposing to thromboembolism event is congestive heart failure and aging[10,13].

Griepp and his coworkers[7] described a patient with congestive heart failure who developed subclavian venous thrombosis seven days after pacemaker insertion through the right internal jugular vein, but no episode of venous thrombosis in 87 cases who received pacemaker insertion through the arm vein. The authors experienced 11 cases who received pacemaker insertion through the internal jugular vein up to this time, while there was not found any remarkable symptom or sign due to venous thrombosis or pulmonary embolism among them.

The symptom of pulmonary embolism is varied and includes fever, hemoptysis, chest pain, dyspnea, weakness and increased right heart failure[10].

It was reported that chronic type of pulmonary embolism took asymptomatic course[1]. All of our cases are considered to be chronic type of pulmonary embolism and take asymptomatic course.

Nicolosi and his coworkers[13] recommended echocardiography and angiocardiography in the case with sign of severe congestive heart failure despite a normally functioning endocardial pacemaker and proper medical support.

A reasonable management of pulmonary embolism is consisted of the prophylaxis and treatment of thrombosis surrounding the electrode.

Adequate medical care to control heart failure is also important, since it is believed that the factor predisposing to thromboembolism in the right atrium is congestive heart failure. Kinney and his coworkers[10] suggested that pacemaker patient with congestive heart failure and elderly patient should receive anticoagulation therapy, and they also removed thrombose surrounding the catheter electrode upon cardiopulmonary bypass in the case with recurrent pulmonary embolism.

The authors have apllied dipyridamole or trapidil for the prevention of cerebral embolism in patient with pacemaker long before this study, and it is thought that this medication might suppress the occurrence of venous and atrial thrombosis or pulmonary embolism even a little.

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