

## ***Early Detection of Left Atrial Thrombus in Acute Cardiogenic Cerebral Embolism by Transesophageal Echocardiography***

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### **Abstract**

Re-embolization tends to occur during the first 14 days after the onset of cardiogenic cerebral embolism. The usefulness of early transesophageal echocardiography (TEE) was investigated in 64 patients (33 men and 31 women, mean [ $\pm$ SD] age  $70.1 \pm 12.6$  years) who underwent TEE within 30 days of the onset of cardiogenic cerebral embolism. Patients were retrospectively classified into two groups based on the time from the onset of the embolism to performance of TEE: group A consisted of 33 who underwent TEE within 4 days of the onset and group B consisted of 31 who underwent TEE 5 to 30 days after the onset.

Transthoracic echocardiography visualized a left atrial thrombus in two patients, and TEE detected thrombi in 14 patients: 11 in group A and 3 in group B. Lethal re-embolization occurred in two patients in group A who had highly mobile thrombi. Early TEE may be useful for detecting left atrial thrombi and predicting the risk of re-embolization in patients with acute cardiogenic cerebral embolism.

### **Key Words**

**Cerebrovascular circulation, Echocardiography (transesophageal), Thrombosis (left atrial), Thromboembolism (cerebral)**

### **INTRODUCTION**

Re-embolization occurs in 13 to 20% of patients usually within 14 days of the onset of cardiogenic cerebral embolism and adversely affects the patient's prognosis<sup>1-4</sup>). Factors that contribute to re-

currence include low plasma level of antithrombin III, dehydration, the use of diuretics, and the presence of rheumatic heart disease, prosthetic valves, and intracardiac thrombi<sup>5</sup>). Detection of intracardiac thrombi by transthoracic echocardiography is unreliable. Transesophageal echocardiography (TEE)

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## Selected abbreviations and acronyms

TEE=transesophageal echocardiography
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provides excellent visualization of the left atrium and left atrial appendage<sup>6</sup>, and may be more sensitive for detection of left atrial thrombi than transthoracic echocardiography<sup>7,8</sup>. However, TEE is a semiinvasive procedure and its usefulness for detection of an intracardiac thrombus in the early phase of cardiogenic cerebral embolism<sup>9</sup> has not been established.

We investigated the usefulness of TEE for detection of thrombi in patients with acute cardiogenic cerebral embolisms.

## METHODS

## Study group

We studied 64 consecutive patients with cardiogenic cerebral embolisms (33 men and 31 women, mean [ $\pm$ SD] age  $70.1 \pm 12.6$  years, range 32 to 93 years) who underwent TEE within 30 days of developing embolisms. Cardiogenic embolisms were diagnosed according to the criteria of Yasaka *et al.*<sup>5</sup> All patients exhibited a newly developed neurological deficit and the presence of a potential source of a cardiogenic embolism, such as valvular heart disease in 26 patients, prosthetic valves in 2, cardiomyopathy in 1, myocardial infarction in 3, and/or atrial fibrillation in 47. Patients with risk factors for atherosclerosis included 7 patients with diabetes mellitus and 24 with hypertension. In addition, patients showed at least one of the following features: sudden onset of clinical symptoms in association with a maximal focal neurological deficit; evidence of embolization in other parts of the body; angiographic features such as visualization of an embolic shadow and reopening of a previously occluded vessel; and computed tomographic features such as hemorrhagic infarction and a clearly defined hypodense area involving the cortex.

Patients were retrospectively divided into two groups based on the time from the onset of the stroke to performance of TEE. Group A consisted of 33 patients who underwent TEE within 4 days of the onset; group B consisted of 31 patients who underwent TEE 5 to 30 days after the onset of stroke (Table 1). There were no significant differences in clinical characteristics between the groups. The

Table 1 Clinical characteristics

	Group A (n=33)	Group B (n=31)
Age (yr)	72.4 $\pm$ 13.0	67.9 $\pm$ 12.0
Male	16 (49%)	17 (55%)
Atrial fibrillation	23 (70%)	16 (52%)
Time from onset to TEE (days)	1.2 $\pm$ 1.1	10.6 $\pm$ 6.2**
Anticoagulation before admission	4 (12%)	2 (6%)
Death in hospital	2 (6%)	2 (6%)

\*\* $p < 0.01$  vs group A.

Table 2 Echocardiographic findings

	Group A (n=33)	Group B (n=31)
TTE findings		
Left atrial size (mm)	40.0 $\pm$ 9.1	38.1 $\pm$ 8.7
Left atrial thrombus	2 (6%)	0
TEE findings		
Left atrial thrombus	11 (33%)	3 (10%)*
Spontaneous echo contrast	13 (39%)	10 (32%)
Patent foramen ovale	3 (10%)	4 (13%)

\* $p < 0.05$  vs group A.

TTE=transthoracic echocardiography.

study protocol was in agreement with the guidelines established by the Ethics Committee of our institution. Informed consent was obtained from all patients.

## Echocardiographic examinations

Transthoracic color Doppler echocardiography was performed on the same day as TEE. Standard parasternal and apical views were obtained with an Aloka SSD 9000 color Doppler imaging system (Aloka Co., Tokyo, Japan) interfaced with a 2.5- or 3.5-MHz transducer. TEE was performed with the patient in the left lateral decubitus position using an Aloka 870 imaging system interfaced with a biplanar transesophageal 5-MHz transducer. The pharynx was anesthetized by lidocaine spray in all patients, but intravenous administration of 5 to 10 mg of diazepam for sedation was not used in patients with consciousness disturbance. Heart rate was monitored by limb leads, oxygenation was monitored by pulse oximeter, and respiration rate was monitored by assistants. Intracardiac thrombi, spontaneous echo contrast and interatrial shunts were examined by TEE. Spontaneous echo contrast was defined as a swirling, 'smoke-like' cloud in the

**Table 3** Clinical and echocardiographic findings in patients with intracardiac thrombi

Patient No.	Age/Sex	Onset to TEE (days)	Thrombus				Recurrence of embolism	Clinical outcome
			Site	Number	Mobility	Disappearance		
Group A								
1	67/M	0	LAA	1	+	+	-	Alive
2	74/M	0	LAA	2	+	+	-	Alive
3	87/M	0	LAA, LA	1	++		+	Dead
4	63/M	1	LAA	1	+	+	-	Alive
5	58/M	2	LAA	1	+		-	Alive
6	86/M	2	LAA	1	-		-	Alive
7	71/M	3	LAA	1	+	+	-	Alive
8	66/F	3	LAA	1	+		-	Alive
9	71/M	3	LAA	1	+		-	Alive
10	74/M	3	LAA	2	+		-	Alive
11	69/F	3	LA	1	++		+	Dead
Group B								
12	80/M	8	LAA	1	-		-	Alive
13	74/F	10	LAA	2	+	+	-	Alive
14	75/M	28	LA	1	+	+	-	Alive

++ : highly mobile, cord-like thrombus.

LAA=left atrial appendage; LA=left atrium; M=male; F=female.

left atrium. Although not all patients underwent contrast echocardiography, interatrial shunts were diagnosed when contrast-containing blood traversed the septum and appeared in the left atrium after Valsalva maneuver. After TEE, antibiotics were given intravenously for 3 days. All transthoracic and transesophageal echocardiograms were recorded on a Sony 9500 S-VHS videocassette recorder and were reviewed by two separate observers.

### Statistical analysis

Data are expressed as mean  $\pm$  SD. Intergroup differences in continuous variables were analyzed by the unpaired Student's *t*-test. Categorical variables were analyzed by the  $\chi^2$  test. A *p* value  $<0.05$  was considered statistically significant.

## RESULTS

### Complications of transesophageal echocardiography

There was no significant change in heart rate in any patient. Artificial ventilation by self-expanding bag was needed in one patient because transient apnea occurred after sedation. Serious complications such as aspiration pneumonia, ventricular arrhythmia, hematemesis, or dissection of aorta did not occur

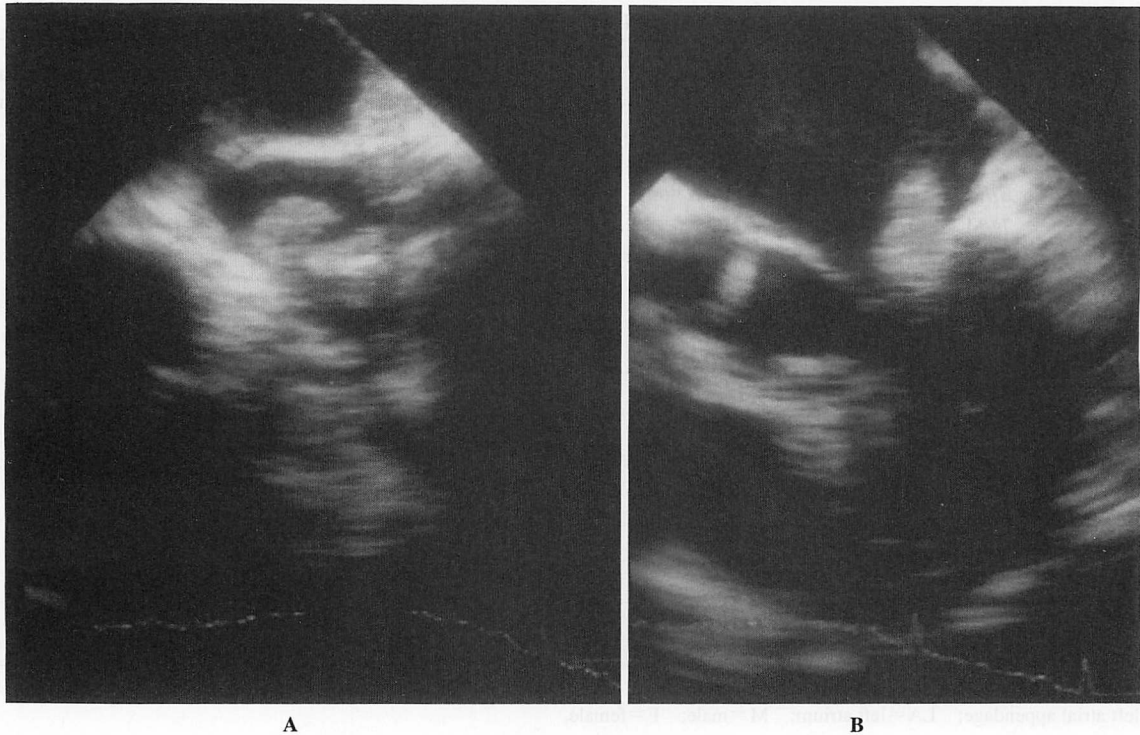
in any patient.

### Echocardiographic findings

Standard transthoracic echocardiography visualized left atrial thrombus in only two patients (Table 2). TEE detected left atrial thrombi in 14 patients; 11 in group A and 3 in group B. Thus, the incidence of intracardiac thrombi was significantly higher in group A than in group B. There were no significant differences in the incidences of spontaneous echo contrast or patent foramen ovale between the groups, although not all patients underwent contrast echocardiography.

### Transesophageal echocardiographic findings in patients with intracardiac thrombi

TEE detected one thrombus in 11 patients, and two thrombi in 3 (Table 3). Re-embolization occurred in two patients in whom thrombi in the left atrium or the left atrial appendage showed marked mobility; both patients died in the hospital due to re-embolization. One of these patients (case 3) had nonvalvular atrial fibrillation and a cord-like, highly mobile, left atrial thrombus originating from the left atrial appendage (Fig. 1). The other patient (case 11) was admitted to our hospital with a fever and impaired consciousness. She had a highly



**Fig. 1** Transesophageal echocardiograms of a patient with re-embolization (case 3)  
 The patient had two thrombi in the left atrial appendage (A), one of which extended to the left atrium near the mitral valve (B).

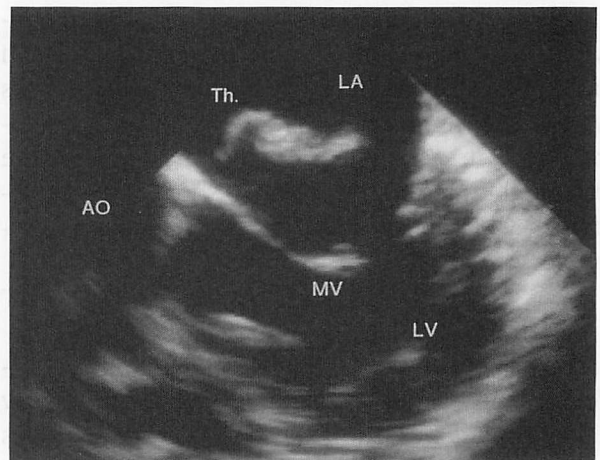
mobile left atrial thrombus (**Fig. 2**) that was found at autopsy to have bacterial endocarditis at its base. In other patients, thrombi were confined to the left atrial appendage and were immobile or only slightly mobile. Follow-up TEE was performed in seven patients and disappearance of thrombi was confirmed from a week to a year in six patients (**Fig. 3**).

**Cause of deaths in hospital**

Two patients in group A died of re-embolization. In group B, one patient died of disseminated intravascular coagulation due to carcinoma of the bile duct and another patient died of heart failure.

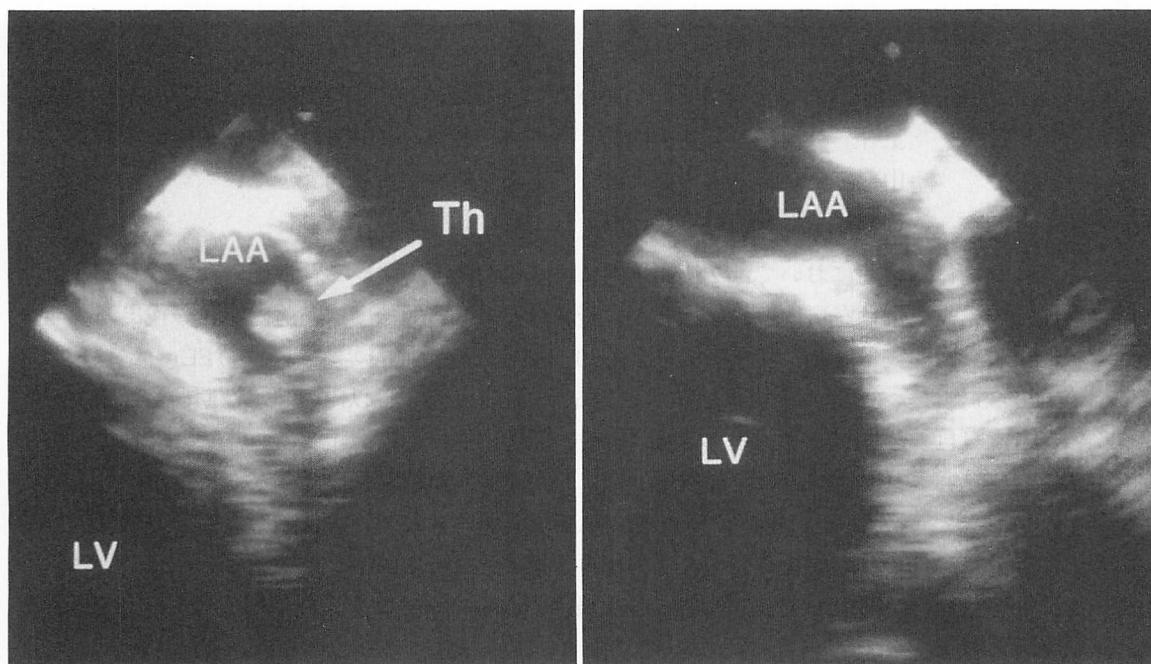
**DISCUSSION**

Left atrial thrombi were detected in 14 patients by TEE and in 2 by transthoracic echocardiography, confirming the superiority of TEE<sup>6,8</sup>. TEE detected thrombi in 11 (33%) of 33 patients who underwent TEE within 4 days of the onset of stroke, and in 3 (10%) of 31 patients who underwent TEE 5 to 30 days after the onset of stroke. These results confirm that embolization usually recurs within the first 14 days after onset<sup>1-4</sup>. There were no significant



**Fig. 2** Transesophageal echocardiogram of a patient with re-embolization (case 11)  
 The thrombus was found at autopsy to have bacterial endocarditis at its base.  
 Th=thrombi; AO=aorta; MV=mitral valve; LV=left ventricle. Other abbreviation as in Table 3.

intergroup differences in the number of patients receiving anticoagulant treatment before TEE, or in the incidence of risk factors for re-embolization, such as spontaneous echo contrast<sup>10</sup> and patent foramen ovale<sup>11</sup>. Thus, the time elapsed between the



**Fig. 3** Transesophageal echocardiograms of a patient (case 1) with thrombi in the left atrial appendage

*Left:* TEE obtained on admission.

*Right:* TEE performed 2 weeks later showed disappearance of the thrombi. There was no clinical or laboratory evidence of re-embolization.

Abbreviations as in Table 3, Fig. 2.

onset of stroke and the performance of TEE might explain the difference in the detection rate of intracardiac thrombi between the groups. Intracardiac thrombi are known to regress over time<sup>12</sup>, and some residual thrombi in group B might have disappeared before TEE.

Residual thrombi after stroke may be caused by fragments of a thrombus or multiple thrombi that float away to become the embolus. This theory is supported by the findings that two residual thrombi were present after stroke in three patients in the present study. New thrombi may also develop in the left atrium because fibrinopeptide A levels are markedly elevated and thrombin is activated during the first week after stroke<sup>13</sup>.

Despite anticoagulation therapy, re-embolization occurred in two patients who had left atrial thrombi. One patient had a cord-like highly mobile thrombus extending from the left atrial appendage to the left atrium, the other patient had a highly mobile left atrial thrombus that was caused by bacterial endocarditis. In the other 12 patients, thrombi were immobile or only slightly mobile; re-embolization did not occur in these patients.

### CONCLUSION

The present results suggest that early TEE is useful not only for detecting left atrial thrombi but also for predicting the risk of re-embolization in patients with acute cardiogenic cerebral embolism.

## 要 約

## 心原性脳塞栓症における早期経食道心エコー図法の左房内血栓検出について

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心原性脳塞栓急性期においては2週間以内に再塞栓が起きやすいことが知られている。心原性脳塞栓の主な原因は左房内血栓であるが、経胸壁心エコー図法では左房内血栓の検出率が非常に低い。今回、我々は心原性脳塞栓発症後30日以内に経食道心エコー図法(TEE)を施行した64例(男33例,女31例,平均年齢70.1±12.6歳)を発症後4日以内の超急性期群(A群:33例)と5-30日目の群(B群:31例)の2群に分け、左房内血栓の検出頻度について比較検討した。

まず経胸壁心エコー図法では全症例中2例にしか左房内血栓を検出できなかったが、TEEでは14例で検出された。それらのうち11例はA群,3例はB群で、A群のほうが多かった。また、A群で可動性の高い血栓を認めた2例は再塞栓で死亡した。

心原性脳塞栓急性期のTEEは左房内血栓を検出できるのみでなく、再発を予測する上でも有用と考えられた。

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