Clin. Cardiol. 24, 656–662 (2001)

The Effect of Thrombolytic Therapy on Left Ventricular Aneurysm Formation in Acute Myocardial Infarction: Relationship to Successful Reperfusion and Vessel Patency

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Summary

Background: Although there is increasing evidence for the beneficial effect of thrombolytic therapy on global left ventricular (LV) function in acute myocardial infarction (AMI), the data concerning the early effect of thrombolytic therapy on the incidence of left ventricular aneurysm (LVA) formation and its relationship to clinical and angiographic determinants are limited.

Hypothesis: The study aimed to determine the independent factors involved in the development of LVA and to evaluate whether thrombolytic therapy has any preventive effect on the development of LVA in AMI.

Methods: In all, 350 consecutive patients suffering from a first attack of AMI were included. Of these, 205 who arrived within 12 h of onset of symptoms received thrombolytic therapy (thrombolytic group) and the remaining 145 patients served as control group. All patients received aspirin and maximal-dose anticoagulation with intravenous heparin therapy. Early successful reperfusion was assessed by enzymatic and electrocardiographic evidence, and late vessel patency was evaluated according to Thrombolysis in Myocardial Infarction (TIMI) classification. Patients with TIMI grade 2 or 3 flow were considered to have vessel patency.

Results: The overall incidence of LVA was 11.7% (41/350), and no statistical difference was found between the incidence of LVA between the two groups (11.7 vs. 11.7%, $p > 0.05$). However, the patients receiving thrombolytic therapy and exhibiting a patent infarct-related artery (PIRA) (n = 125, 61%), had a significantly reduced incidence of LVA compared with those who did not (7.2 vs. 18.8%, $p = 0.015$). In univariate analysis, vessel patency, proximal left anterior descending artery (LAD) stenosis, total LAD occlusion, multivessel disease, and hypertension were found to be important factors in LVA formation after AMI. After adjustment for other clinical and angiographic variables, total LAD occlusion (odds ratio [OR] 3.62, 95% confidence interval [CI] 2.45–8.42, $p = 0.0014$), absence of PIRA (OR 2.92, 95% CI 1.41–09, $p = 0.0037$) and proximal LAD stenosis (OR 2.11, 95% CI 1.05–4.71, $p = 0.045$) remained the independent determinants of LVA formation after AMI.

Conclusion: Our data indicate that not all patients who received thrombolytic therapy, but only those with PIRA had evidently reduced the incidence of LVA. Patients with total LAD occlusion, with proximal LAD stenosis, and without PIRA were found to have increased risk for formation of LVA after AMI. These findings indicate that the presence of vessel patency has a preventive effect on LVA formation in AMI.

Key words: left ventricular aneurysm, myocardial infarction, thrombolytic therapy, successful reperfusion, vessel patency

Introduction

Formation of left ventricular aneurysm (LVA) represents one of the untoward complications of acute myocardial infarction (AMI), and its reported incidence varies from 3.5 to 38%.[1,2] Clinical and experimental studies have shown that LVA formation results from expansion of infarcted tissue within the first 2 to 14 days of AMI,[3–5] and therefore it is reasonable to assume that limiting the necrosis with thrombolytic therapy as soon as possible after AMI prevents infarct expansion and the development of LVA. Although there is increasing evidence that thrombolytic therapy improves global LV function in AMI,[6–9] the data regarding the early effect of thrombolytic therapy on the incidence of LVA formation and its relationship to clinical and angiographic determinants are limited.

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Received: September 21, 2000
Accepted with revision: February 21, 2001

In spite of an extensive literature search of Medline for the effects of thrombolytic therapy on LVA formation, the only relevant report we could identify was one from the TIMI Phase I and Open Label study that reported that the patients who developed LVA had significantly less successful sustained reperfusion than those who did not.[10] However, this study did not include any control group to compare the effect of thrombolytic therapy on LVA formation and did not deal with the independent determinants responsible for the development of LVA other than reperfusion. Therefore, the present prospective study was designed to evaluate whether the use of thrombolytic therapy reduces the incidence of early LVA formation compared with a control group and to determine the independent clinical and angiographic factors involved in the development of LVA after AMI.

Methods

Study Population

We prospectively studied 350 consecutive patients admitted to our coronary care unit between January 1997 and January 2000 with the diagnosis of first AMI. The exclusion criteria were (1) age > 75 years; (2) prior history of AMI, cardiac surgery, and valvular disease; (3) non-Q wave AMI; (4) complete left bundle-branch block; and (5) cardiomyopathy. All patients gave written informed consent, and the study protocol was approved by the Ethical Committee of our institution.

Criteria for Myocardial Infarction

The criteria for infarction included at least two of the following: (1) ST-segment elevation of ≥ 2 mm in two or more leads in the standard 12-lead electrocardiogram (ECG), (2) severe chest pain lasting for > 30 min, and (3) typical rise and fall of cardiac enzymes. Infarct localization was established as the site of observed ST-segment elevations. The ST-segment elevation was anterior in 191 (54.5%), inferior in 140 (40%), and inferolateral in 19 (5.5%) patients.

Thrombolytic, Anticoagulant, and Antiplatelet Therapy

Of the 350 patients, 205 (180 men and 25 women, mean age 55 ± 12.4 years) who arrived within 12 h of onset of symptoms and who had no contraindications received thrombolytic therapy. Of these, 170 patients received streptokinase (1,500,000 IU intravenously [IV] over 1 h), and 35 received rt-PA (100 mg IV in 2 h). The administration of the thrombolytic agent was immediately followed by a 5,000 IU IV bolus of heparin and then by a continuous infusion that was targeted to maintain the partial thromboplastin time ratio at about 2 (range 1.7–2.3). Aspirin (300 mg/day) was started on the first day of AMI in all patients. A total of 145 (125 men and 20 women, mean age 55 ± 9.5 years) with AMI did not receive thrombolytic therapy, either because of contraindications or their late arrival, and only received heparin and aspirin therapy as mentioned above. These served as the control group. No major bleeding such as intracranial hemorrhage was observed in the thrombolytic group. Minor bleeding complications occurred in 16 patients (7.8%), mostly at the site of vascular punctures. Three patients (1.4%) had gastrointestinal bleeding complication that was resolved by medical therapy.

Early reperfusion was considered successful if (1) observation by ECG showed a resolution of maximal ST-segment elevation by at least 50% within 2 h from the beginning of thrombolytic therapy, and (2) peak plasma CK-MB level occurred within 12 h from the onset of symptoms.

Coronary Angiography

Selective coronary angiography was performed in all study patients within 2 weeks after AMI, using Judkins technique in multiple standard and angulated views for optimal visualization of diseased segments. Left ventriculography was performed in the 30° right (RAO) and 60° left anterior oblique (LAO) projections and LV end-diastolic pressure was measured before ventriculography.

Grading of Coronary Artery Disease

Coronary angiograms were analyzed by two independent angiographers for extent of coronary artery disease (CAD), for grading of coronary collateral vessels, and for assessment of LVA formation and LV wall motion (LVWM) score; these angiographers were blinded to the patient's clinical data. Interobserver variation was investigated by kappa (κ) statistics. High intraobserver variability was found between two observers regarding extent of CAD ($\kappa = 0.91$, $p < 0.0001$), in grading collateral score ($\kappa = 0.87$, $p < 0001$), and in LVA and LVWM score ($\kappa = 0.82$, $p < 0.0001$). In cases of noncoincidence, the angiographers reached a consensus. Patients were categorized as having single-, double-, or triple-vessel disease when ≥ 50% narrowing of intraluminal diameter was present in one or more coronary arteries, or a major branch, or both. When a stenosis of ≥ 50% was observed before the first septal branch, LAD disease was considered proximal.

Vessel Patency in the Infarct-Related Artery

Flow in the infarct-related artery was rated according to Thrombolysis in Myocardial Infarction (TIMI) classifications.[11] Patency was defined as TIMI 2 or 3 in the infarct-related artery, and the artery was termed occluded when TIMI 0 or 1 flow was present. Total occlusion represented TIMI 0 flow in the infarct-related coronary artery.

Grading of Coronary Collateral Vessels

The Rentrop grading scale[12] was used to quantify the extent of collateral filling. According to the scale, 0 = no visible filling of any collateral channels, 1 = filling of side branches without visualization of the epicardial segment, 2 = partial filling of the epicardial artery by collateral vessels, 3 = complete filling of the epicardial artery by collateral vessels. Grade 0 or 1 was

defined as "poor" and grade 2 or 3 was defined as "good" collateral supply to the infarct region.

Assessment of Left Ventricular Aneurysm and Wall Motion Score

Left ventricular aneurysm was diagnosed angiographically with the Coronary Artery Surgery Study (CASS) protocol.[2] Aneurysm was considered to be present if all of the following three criteria were found: (1) protrusion of the involved segment, displaying either akinetic or dyskinetic motion; (2) absence of trabeculation in the involved segment; and (3) well-defined demarcation of the infarcted segment. The LAO ventriculogram was divided into five segments, consisting of the anterobasal, anterolateral, apical, diaphragmatic, and posterobasal regions. In addition to the CASS protocol, RAO ventriculograms were also taken into account for detecting LVA, and for this purpose RAO ventriculograms were divided into two segments—the septal and lateral regions. The aneurysms then were classified according to these divisions or their combinations. Also, these divided segments were scored numerically according to their motion as follows: normal 1, moderate hypokinesia 2, severe hypokinesia 3, akinesia 4, dyskinesia 5, aneurysm 6. The sum of these graded scores was evaluated as total LVWM score, which was modified from the CASS Study.[2] The LVWM index, which was used to determine the infarct expansion, was derived from this score by dividing LVWM score by the number of total segments.

Statistical Analysis

Data are expressed as mean ± standard deviation. The relation between the continuous variables was evaluated by using unpaired Student's *t*-test, and chi-square tests were used to compare the means of proportions. The kappa statistic was used to assess the intraobserver variability. Multivariate modeling was performed using logistic regression analysis. A p value < 0.05 was considered significant. The SPSS statistical program (version 9.0) (Statistical Package for Social Sciences, SPSS Ltd., Chicago, Ill., USA) was used to perform all statistical calculations.

Results

Clinical Features (Table I)

No significant difference was found in age, gender, weight, risk factors for CAD, or location of AMI between the two groups. Time from onset of chest pain to arrival at hospital was significantly higher in the control group than in the thrombolytic group (12 ± 23 vs. 5 ± 4 h, $p < 0.0001$).

Angiographic Features of the Patients with and without Thrombolytic Therapy (Table II)

There were significantly more patients with well-developed coronary collateral vessels (Rentrop grade 2–3) in the control group than in thrombolytic group (42.1 vs. 22.4%, respectively, $p < 0.0001$). As expected, early reperfusion and patency in the infarct-related artery (PIRA) were both higher in the thrombolytic group than in the control group (early reperfusion 66.3 vs. 35.1%, $p < 0.0001$, and PIRA 61 vs. 31.7%, respectively, $p < 0.0001$). The overall incidence of LVA was 11.7(%). No statistical difference was found in the frequency of LVA between the control and the thrombolytic groups (17/145, 11.7 vs. 24/205, 11.7%, respectively, $p > 0.05$).

TABLE I Baseline clinical characteristics of the study groups with and without thrombolytic therapy

Clinical variables	Patients with thrombolytic therapy (Thrombolytic group) (n = 205, 59%)	Patients without thrombolytic therapy (Control group) (n = 145, 41%)	p Value
Age (years)	55 ± 12.4	55 ± 9.5	NS
Male (%)	180 (87.8)	125 (86.2)	NS
Risk factors			
Family history (%)	65 (31.7)	42 (28.9)	NS
Smoking (%)	77 (37.5)	52 (35.8)	
Hypercholesterolemia (%)	72 (35.1)	46 (31.7)	
Hypertension (%)	72 (35.1)	47 (32.4)	
Diabetes mellitus (%)	38 (18.5)	26 (17.9)	
Previous angina (%)	135 (65.8)	102 (70.3)	NS
Location of MI (%)			
Anterior (%)	114 (55.5)	77 (53.2)	NS
Inferior (%)	76 (37.1)	64 (44.2)	NS
Posterior (%)	3 (1.5)	1 (0.6)	NS
Inferoposterolateral (%)	12 (5.9)	3 (2)	NS
Time from onset of chest pain to arrival at hospital (h)	5 ± 4	12 ± 19	0.0001

Data are presented as mean ± SD or number (%) of patient groups.

Abbreviations: MI= myocardial infarction, NS = not significant, SD = standard deviation.

TABLE II Comparison of angiographic findings between two groups of patients with and without thrombolytic therapy

Clinical variables	Patients with thrombolytic therapy (Thrombolytic group) (n = 205, 59%)	Patients without thrombolytic therapy (Control group) (n = 145, 41%)	p Value
Coronary artery disease			
0-vessel (%)	11 (5.4)	4 (2.8)	NS
1-vessel (%)	89 (43.4)	66 (45.5)	
2-vessel (%)	69 (32.7)	47 (32.4)	
3-vessel (%)	38 (18.5)	28 (19.3)	
Mean no. of diseased vessel	1.64 ± 0.84	1.68 ± 0.81	NS
Lesion stenosis			
LAD (%)	80.7 ± 16.5	85.8 ± 16.9	NS
Cx (%)	78.5 ± 17.9	79.4 ± 18.6	
RCA (%)	78.7 ± 17.5	82.3 ± 16.7	
LAD			
Proximal lesion (%)	36 (17.6)	20 (13.7)	NS
Total occlusion (%)	47 (22.9)	40 (27.5)	
EDP (mmHg)	13.9 ± 5.54	14.5 ± 5.66	NS
LV score	14.5 ± 5.12	14.5 ± 4.3	NS
Collateral			
Poor (%) [a]	159 (77.6)	84 (57.9)	< 0.0001
Good (%) [b]	46 (22.4)	61 (42.1)	
Early reperfusion (%) [c]	136 (66.3)	51 (35.1)	< 0.0001
PIRA (%) [d]	125 (61)	46 (31.7)	< 0.0001
Aneurysm (no. of patients)	24 (11.7)	17 (11.7)	NS
Location of aneurysm			
Anterolateral-apical-septal (%)	16 (7.8)	8 (5.5)	NS
Apical-septal (%)	3 (1.2)	5 (3.4)	
Anterior-apical (%)	2 (1)	3 (2.1)	
Inferior-posterobasal (%)	3 (1.2)	1 (0.7)	
Time from the start of thrombolytic therapy to catheterization (day)	10 ± 6	11 ± 5	NS

Data are presented as mean ± SD or number (%) of patient groups.

[a] Rentrop classification grade 0–1.

[b] Rentrop classification grade 2–3.

[c] Peak of CK-MB before 12 h and ST-segment depression of ≥ 50% in the first 2 h.

[d] PIRA = patency in infarct-related artery (TIMI 2 or 3 flow).

Abbreviations: LAD = left anterior descending artery, Cx = circumflex artery, RCA = right coronary artery, EDP = end-diastolic pressure; LV = left ventricular, SD = standard deviation, NS = not significant.

Comparison of Patients with and without Left Ventricular Aneurysm (Tables III and IV)

Patients with LVA had increased end-diastolic pressure (EDP) compared with patients without LVA (21.4 ± 13.1 vs. 13.8 ± 8.7 mmHg, respectively, $p < 0.0001$). Total occlusion of the LAD artery was found to be significantly higher in patients with LVA than in patients without LVA (65.5 vs. 18.4%, $p < 0.0001$). A proximal lesion of the LAD, multivessel disease, and hypertension were all observed more often in patients with than in those without LVA (26.8 vs. 14.6%, $p = 0.04$; 65.9 vs. 48.2%, $p = 0.04$, and 48.7 vs. 30.4%, $p = 0.05$, respectively). Patients with LVA showed a lesser frequency of PIRA than those without LVA (26.8 vs. 51.8%, $p = 0.002$). The LAD was responsible for LVA formation in 37 of 41 patients (90%) with LVA, and was found to be occluded (TIMI 0 or 1 flow) in 31 of these patients (84%).

Effect of Vessel Patency on Left Ventricular Aneurysm Formation (Table V)

When patients who received thrombolytic therapy were divided into two subgroups according to the achievement of reperfusion, it was observed that those exhibiting PIRA in association with a successful early reperfusion (n = 125, 61%), had a significantly reduced incidence of LVA compared with those without reperfusion and PIRA (7.2 vs. 18.8%, $p = 0.015$). Similarly, patients who did not receive thrombolytic therapy and had patency in the infarct-related artery (spontaneous thrombolysis) also had a lower incidence of LVA than

TABLE III Factors associated with left ventricular aneurysm formation after acute myocardial infarction (univariate analysis)

	Aneurysm		
	Present (n = 41)	Absent (n = 309)	p Value
Age	56 ± 11	55 ± 10	NS
Female (%)	5 (12.2)	40 (12.9)	NS
Male (%)	36 (87.8)	269 (87.1)	NS
Thrombolytic therapy (%)	24 (58.5)	181 (58.6)	NS
Risk factors (%)			
Family history (%)	14 (34.1)	102 (33)	NS
Smoking (%)	15 (36.5)	114 (36.8)	NS
Hypercholesterolemia (%)	17 (41.5)	101 (32.7)	NS
Hypertension (%)	20 (48.7)	93 (30.4)	0.048
Diabetes mellitus (%)	11 (26.8)	53 (17.2)	NS
Previous angina (%)	25 (60.9)	205 (66.3)	NS
Angiographic factors			
Proximal LAD occlusion (%)	11 (26.8)	45 (14.6)	0.042
Total LAD occlusion (%)	27 (65.8)	60 (19.4)	<0.0001
Multivessel disease (%)	27 (65.9)	149 (48.2)	0.04
Good collateral (%)	15 (36.6)	93 (30)	NS
PIRA (%)	11 (26.8)	160 (51.8)	0.002
LVWMI	3.12 ± 1.3	1.7 ± 0.9	<0.0001
EDP (mmHg)	21.4 ± 13.1	13.8 ± 8.7	0.001
Time to onset of thrombolytic therapy (h)			
0–1 h (%)	3 (12.5)	38 (21.1)	NS
1–3 h (%)	12 (50)	95 (52.8)	
3–6 h (%)	7 (29.2)	40 (22.2)	
6–12 h (%)	2 (8.3)	7 (3.9)	

Abbreviation: LVWMI = left ventricular wall motion index. Other abbreviations as in Table II.

those who had an occluded artery, but this difference did not reach statistical significance (4.3 vs. 15.2%, p = 0.09).

Discussion

The results of the present study can be summarized as follows: (1) No statistical difference was found between the incidence of LVA in patients who had received thrombolytic therapy and those who did not; (2) however, patients with successful reperfusion had significantly reduced LVA formation; and (3) total occlusion of the LAD, absence of vessel PIRA, and proximal LAD stenosis were found to be independent determinants of LVA formation after AMI.

Determinant Factors for Left Ventricular Aneurysm Formation

In some previous studies, many factors such as single-vessel disease,[14, 15] multivessel disease,[2, 16, 17] absence of collateral vessels,[14, 15] presence of hypertension,[18] and absence of previous angina[13] were determined to be independent predictors

TABLE IV Independent factors associated with left ventricular aneurysm formation after acute myocardial infarction (multivariate analysis)

	OR (95% CI)	p Value
Total LAD occlusion [a]	3.62 (2.45-8.42)	0.0014
No patency in infarct-related artery [b]	2.92 (1.41-6.09)	0.0037
Proximal LAD occlusion	2.11 (1.05-4.71)	0.045

[a] TIMI 0 flow.

[b] TIMI 2 or 3 flow.

Abbreviations: LAD = left anterior descending artery, OR = odds ratio, CI = confidence interval.

for the development of LVA after AMI. The important role of the proximal stenosis of the LAD in the development of LVA was established by Inuoe *et al.*[14] In an other study, reported by Forman *et al.*, total occlusion of the LAD was shown to be a significant determinant of LVA formation after AMI.[15]

In the present study, after adjustment for other clinical and angiographic variables, total LAD occlusion, vessel PIRA, and proximal LAD stenosis remained the three independent determinants of LVA formation after AMI, and these findings are consistent with Forman *et al.* and Inuoe *et al.*[14, 16] The major risk factors were not found to be independent factors in the formation of LVA although there was a trend that hypertension was more common in patients with LVA. These results were in agreement with Faxon *et al.* and Inuoe *et al.* who also showed that there were no association between hypertension, diabetes mellitus, and the development of LVA.[2, 14]

In many previous studies, it was also shown that well-developed coronary collateral vessels (CCV) have a protective effect against infarct expansion and LVA formation.[15, 19, 20] However, we were not able to show any association between LVA formation and CCV. In our study, patients with or without LVA did not differ in coronary collateral development. More interesting, the control group, who had less reperfusion and vessel PIRA showed better collateral score than did the thrombolytic group (Table II). This finding can be supported

TABLE V Percent prevalence of left ventricular aneurysm for occluded and patent infarct-related coronary arteries in patients with and without thrombolytic therapy

Patients (n = 350)	LV aneurysm (n = 41) (11.7%)	p Value
With thrombolytic (n = 205)		
Patent (n = 125) (%)	9 (7.2)	0.015
Occluded (n = 80) (%)	15 (18.8)	
No thrombolytic (n=145)		
Patent (n = 46) (%)	2 (4.3)	0.09
Occluded (n = 99) (%)	15 (15.2)	

Patent = TIMI 2 or 3 flow.
Occluded = TIMI 0 or 1 flow.
Abbreviation: LV= left ventricular.

by the observations of Araie *et al.* who demonstrated that patients with AMI showed an inverse relation between the percentage of recanalization and angiographically detected collateral flow.[21]

Effects of Sustained Successful Reperfusion on Left Ventricular Aneurysm Formation

Although there are many reports concerning the beneficial effect of thrombolytic therapy on global LV function,[6–9] the number of studies concerning the preventive effect of reperfusion on LVA formation is limited. In one of these, Kanamasa *et al.* showed that percutaneous transluminal coronary angioplasty (PTCA) performed within the first 48 h after AMI prevents LVA formation and remodeling.[22] In an other study, Chen *et al.* reported that delayed PTCA could reduce the dyskinetic area and aneurysm formation after AMI.[23]

To our knowledge, until the present study, the effect of thrombolytic therapy on LVA formation was investigated only in a retrospective study from TIMI Phase I and Open Label study.[10] The investigators reported that patients who developed LVA had significantly less successful sustained reperfusion than those who did not. The main difference between our study and that of Kayden *et al.*[10] was that we included a control group. Furthermore, the independent determinants involved in LVA formation were also studied in both groups. We demonstrated that patients with successful reperfusion had lower rates of LVA than did patients without reperfusion. These findings confirmed the findings of Kayden *et al.*, who showed that patients who developed LVA had significantly less successful sustained reperfusion than those who did not.[10] In the present study, both reperfusion achieved by thrombolytic therapy and spontaneous thrombolysis showed a decrease in the incidence of LVA formation, but the latter did not reach statistical significance. This absence of statistical significance could be related to the relatively small sample size in the control group.

We also documented that most of the patients with LVA (30/41, 73.1%) were found to have TIMI 0 or 1 flow in the infarct-related artery (see Table V). From this observation it can be speculated that patients in whom sufficient blood was supplied to the infarct-related artery were less prone to LVA formation, while patients without patency in the infarct-related artery had an increased risk for LVA formation. This finding is consistent with the concept that achieving arterial patency (open artery hypothesis) was the predominant mechanism for the prognostic benefit of thrombolytic therapy.[24]

However, the occurrence of LVA formation in patients with successful reperfusion and vessel patency in the LAD indicated that mechanisms other than reperfusion may also be involved in the pathogenesis of LVA or dysfunction. In a recent study, Akasaka *et al.* showed that, beyond arterial patency, crude angiographic flow grades and simple coronary flow reserve may also have an effect on the microcirculation and may play a role in the recovery of the left ventricle.[25] Therefore, it is obvious that further studies are needed to clarify the exact mechanisms that have an impact on LV dysfunction during AMI and reperfusion.

Clinical Implications

Our study showed that the LAD artery (mostly with proximal stenosis or total occlusion in any part) is chiefly responsible for aneurysm formation after AMI. Therefore, our findings support the concept that, beyond thrombolytic therapy, efforts (such as PTCA or surgery) to achieve an increase in patency rates, particularly in proximal or totally occluded LAD lesions, during AMI could be helpful in diminishing the rate of LVA formation and related complications.[22, 23]

Study Limitations

The main limitation of the present study is that it included only the aneurysms that developed in the first 2 weeks after AMI. The LVAs that developed after the first two weeks of AMI were excluded from the study. However, it was shown that the risk period for aneurysm formation ranged from Day 1 to Day 14 after infarction and no new LVA formation was observed between 2 weeks and 3 months.[3] From these observations it seems likely that a presumably small number of undetected aneurysms may not have greatly influenced the overall results, particularly in comparison with matched groups. Another limitation was the lack of a randomized design. While the patients who arrived within 12 h of the onset of chest pain received thrombolytic therapy, others who arrived later than 12 h or who had contraindications for thrombolytic therapy received only heparin and aspirin therapy. This may have contributed to the tendency toward reduced aneurysm formation in the thrombolytic group. However, we did not observe such a tendency in the thrombolytic group. Moreover, it is obviously unethical to randomize the patients to thrombolytic therapy or aspirin and heparin therapy.[26] The last limitation is that either streptokinase or rt-PA was used as a thrombolytic agent and, because of the small number of patients in rt-PA group, no comparison was made between these two thrombolytics for the preventive effect of LVA.

Conclusion

The present study demonstrates that of the patients who received thrombolytic therapy for AMI, only those with vessel patency in the infarct-related artery had a reduced incidence of LVA formation, and that total LAD occlusion, absence of vessel patency in the infarct-related artery, and proximal LAD stenosis were independent determinants of LVA formation after AMI. These findings indicate that the presence of vessel patency has substantial preventive effect on LVA formation in AMI and support the opinion that the successful, sustained reperfusion in patients with AMI who received thrombolytic therapy is mostly associated with less LVA formation.

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