Coronary artery thrombus as a risk factor for acute vessel occlusion during percutaneous transluminal coronary angioplasty: improving results

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SUMMARY Early experience with percutaneous transluminal coronary angioplasty (from October 1979 to March 1983 inclusive) showed that pre-existing coronary artery thrombus was associated with a significant increase in the incidence of acute coronary occlusion during angioplasty. Acute occlusion occurred in 11 (73%) of 15 patients with pre-existing thrombus compared with 18 (8%) of 223 patients without thrombus. The effect of improved technology (steerable guiding systems) and altered dilatation strategy (full intravenous heparinisation for 24 hours after the procedure and more intensive use of antiplatelet medications) was studied by review of angiograms from 297 consecutive patients without evidence of acute myocardial infarction who underwent angioplasty from April 1983 to March 1985 inclusive. Coronary artery thrombus was present in 34 (11%) patients, eight (24%) of whom had complete occlusion during or immediately after the procedure compared with 34 (13%) of 263 patients without thrombus.

Patients with pre-existing coronary artery thrombus continue to be at greater risk of complete occlusion than patients without thrombus, but this risk has declined significantly since the modification of the angioplasty procedure.

Advances in catheter technology and increasing operator experience have improved primary success rates in patients with symptomatic coronary artery disease who are treated by percutaneous transluminal coronary angioplasty.¹ In a considerable number of patients, however, angioplasty is still associated with serious complication or failure. Complete occlusion of the coronary artery during angioplasty is the most frequent serious complication related to the procedure. Although the occlusion often can be reopened by repeated angioplasty or by anticoagulants, in some patients the occlusion necessitates emergency coronary artery bypass surgery.^{2,3} In an early series we found that the presence of intraluminal coronary artery throm-

bus before angioplasty predisposes patients to complete occlusion.⁴ Complete and permanent occlusion occurred in 11 (73%) of 15 patients with pre-existing thrombus undergoing angioplasty compared with 18 (8%) of 223 patients without thrombus ($p < 0.001$). In the light of this experience the angioplasty procedure was modified by the routine use of steerable systems and heparin and antiplatelet drugs to prevent vessel occlusion. We have assessed whether these modifications have lessened the risk of vessel occlusion in patients with pre-existing coronary artery thrombus who undergo balloon angioplasty.

Patients and methods

Selection

Patients undergoing angioplasty at the Mayo Clinic from April 1983 to March 1985 inclusive were identified from a computerised data registry.

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Figure (a) Left anterior oblique view of right coronary artery showing severe stenosis in the proximal region and a filling defect consistent with intracoronary thrombus immediately downstream (arrow). (b) Right anterior oblique view showing filling defect just distal to high grade stenosis (arrow). (c) Angiogram taken during attempted dilatation. After initial success total occlusion developed at the stenosis with faint visualisation of the distal vessel. (From Mabin et al.⁴ Reproduced by permission of the American College of Cardiology.)

Patients who had combined streptokinase infusion and angioplasty during acute myocardial infarction and those with previously occluded vessels were excluded. The remaining 297 patients formed the basis of the study. The presence or absence of intracoronary thrombus before dilatation was determined by two experienced angiographers who were unaware of the outcome of the angioplasty. In a few instances they disagreed and a third opinion was obtained and a majority decision was reached. This evaluation procedure, the criteria for intraluminal

thrombus, and the angiographers performing this assessment were the same as those used in an earlier study.⁴ A detailed clinical and angiographic profile was available for each patient. Patients with myocardial ischaemia and angiographic lesions suitable for either dilatation or coronary artery bypass surgery were included.

Procedural details

Details of the angioplasty procedure have been reported.² The current study differs from the pre-

vious one in several important respects. In the present study, steerable catheter systems were used routinely and all patients received 5000–10 000 units of heparin intravenously at the beginning of the catheterisation. In addition, at the end of the procedure an intra-arterial femoral sheath was left in situ, protamine was not used, and full systemic heparinisation by continuous intravenous infusion was continued for 24 hours with careful laboratory monitoring to maintain an activated partial thromboplastin time that was longer than twice the normal values. All patients also received nitrates and calcium antagonists during the angioplasty and afterwards. In addition, an intensive effort was made to treat all patients with an antiplatelet regimen unless this was contraindicated or unless the patients were enrolled in a current continuing prospective placebo control study to evaluate the effects of aspirin and dipyridamole on restenosis. The usual regimen consisted of 75 mg of dipyridamole in combination with 325 mg of aspirin three times daily. This regimen was started 24 hours before dilatation and continued for at least three months after the procedure.

DEFINITIONS

Coronary artery thrombus—The angiographic criteria for coronary artery thrombus have been described elsewhere^{5–7} (Figure). Criteria included (a) the presence of an intraluminal filling defect surrounded by contrast material and seen in multiple projections, (b) absence of calcium within the defect, and (c) persistence of contrast material within the lumen. The appearance of intraluminal filling defects within the distal part of the vessel was considered to be consistent with a coronary artery thrombus.

Coronary artery dissection—The angiographic criterion for coronary artery dissection after dilatation was the presence of a large intimal flap and double lumen or presence of contrast material within the vessel wall.

Unstable angina—The definition of unstable angina was that used in the National Heart, Lung, and Blood Institute PTCA Registry⁸: that is, new

onset of exertional chest pain, or new onset of chest pain at rest or with minimal effort, or an unexplained increase in the pattern of stable angina pectoris within the preceding two months.

Successful dilatation—A successful dilatation was defined as an increase of >40% in the pre-angioplasty luminal diameter of the stenosis without subsequent coronary artery bypass operation.

STATISTICAL ANALYSIS

The significance of differences between groups was assessed by use of the Fisher exact test and χ^2 test.

Results

Clinical features—Thirty four patients (26 men and eight women; mean age 58, range 34–77) had angiographic evidence of intraluminal coronary thrombus before angiography (Table 1). The mean duration of angina was 20 months (range 1 to 36). Two hundred and sixty three patients (163 men and 100 women; mean age 59, range 30–88) did not have a thrombus (Table 1). The mean duration of angina in these 263 patients was 28 months (range 1 to 54 months). There was no significant difference between the groups in the number of patients with previous or recent myocardial infarction.

There was thrombus in the left anterior descending coronary artery in 18 (53%) patients, the right coronary artery in 13 (38%), the circumflex coronary artery in five (15%), and in a saphenous vein bypass graft in two (6%) (Table 2). The mean percentage of stenosis of the luminal diameter, estimated from multiple projections, was identical (89%) in patients with and those without coronary artery thrombus.

Relation of intraluminal thrombus to acute occlusion—Acute occlusion occurred during or within four hours of the procedure in eight (24%) of the 34 patients with coronary artery thrombus, compared with 11 (73%) of 15 patients in the earlier series ($p < 0.01$), and in 34 (13%) of the 263 patients without thrombus (24% *vs* 13%, $p = 0.17$) (Table 3). Major dissection was not seen in any patient with

Table 1 Clinical details of 297 patients undergoing balloon angioplasty (April 1983–March 1985)

Characteristic	Patients			
	With thrombus*		Without thrombus*	
	No	%	No	%
Unstable angina	30	88	217	83
Variant angina	4	12	11	4
History of previous myocardial infarction	19	56	103	39
Recent myocardial infarction (< 1 mnth)	8	24	49	19

*Determined from angiogram before balloon angioplasty.

Table 2 Sites of coronary stenosis* in patients with and without intraluminal thrombus

Site	With thrombus (34)†			Without thrombus (263)†		
	Patients		Segments	Patients		Segments
	No	%		No	%	No
Left anterior descending artery	18	53	18	155	59	171
Circumflex artery	5	15	5	58	22	61
Right artery	13	38	15	87	33	106
Graft	2‡	6	—	10§	4	—
Single vessel disease	16	47	—	91	35	—

*Mean percentage stenosis before percutaneous transluminal coronary angioplasty was 89% in both groups.

†Determined from angiogram before balloon angioplasty.

‡One graft from aorta to right coronary artery and one from aorta to left anterior descending artery.

§Three grafts from aorta to right coronary artery, three from aorta to left anterior descending artery, and four from aorta to left circumflex artery.

Table 3 Comparison between present series and earlier series

	Present series				Earlier series			
	With thrombus		Without thrombus		With thrombus		Without thrombus	
	No	%	No	%	No	%	No	%
No of patients	34		263		15		223	
Acute occlusion:								
Remained occluded	3	9	16	6	11	73	18	8
Reopened	5	15	18	7	0		0	
Total	8	24*	34	13*	11	73†	18	8†

*p=0.17; †p<0.001.

thrombus in whom occlusion occurred. Acute occlusion occurred in 34 (13%) of the 263 patients without thrombus, compared with 18 (8%) of 223 patients without thrombus in the earlier series ($\chi^2=2.98$; p=0.08). In the 42 patients in whom occlusion occurred, the vessel was successfully reopened non-surgically in 23 (54%); the acute occlusion was successfully reopened by dilatation in five (63%) of the eight patients with coronary artery thrombus and in 18 (53%) of the 34 patients without thrombus (NS).

Discussion

In an earlier study our group reported a very strong correlation between the presence of coronary artery thrombus before angioplasty and the subsequent development of complete occlusion during or immediately after dilatation.⁴ In the present study, although the frequency of complete occlusion was higher in patients with thrombus, this complication was significantly less common (73% vs 24%). Five of the eight patients with thrombus in whom an abrupt occlusion occurred had the vessel successfully reopened non-surgically.

The validity of this study depends on the accuracy of determining the presence of intracoronary thrombus by contrast angiography. The criteria that we

used have been validated in surgical and pathological specimens.^{5,6} Nevertheless, the sensitivity and specificity of angiography for the identification of coronary artery thrombus remain unknown. In a series of 20 patients who had acute myocardial infarction without angiographic evidence of thrombus, thrombi were found at operation in five (25%).⁵ Small thrombi or thrombi adhering to the vessel wall may be difficult to detect angiographically; hence angiography may actually underestimate the true frequency of coronary artery thrombus. On the other hand, the presence of an intraluminal filling defect may not represent a thrombus.^{9,10}

Because this was a retrospective study we can only speculate about the reasons for the improvement in the results. In addition to increased operator experience the exclusive use in the current study of steerable angioplasty systems (which help the operator to negotiate coronary stenoses), the use of continuous heparin infusions for 24 hours after angioplasty, and the intensive use of antiplatelet regimens seem to be important. We used to give protamine at the end of each procedure to reverse the action of heparin and to ensure adequate haemostasis. Subtle but nevertheless potentially important technical factors that may have contributed to the improved results include optimisation of balloon size, longer observation period in the catheterisation laboratory after

dilatation, and less stringent criteria for repeat dilatation when the arterial segment appeared to be hazy on the angiogram. The increase in our success rate for reopening acutely occluded vessels is both gratifying and not entirely explicable; steerable angioplasty systems may have been the most important factor.

Although all of these procedural modifications may be exerting a favourable influence on the outcome of dilatation, it is not possible to determine which changes had the most profound impact on these improved results. There was a non-significant increase in the incidence of occlusion in the non-thrombotic group in the current series. This increase may reflect a change in patient selection, in particular a more aggressive dilatation strategy in relatively high risk patients with multivessel disease. Whereas increasing operator experience might be expected to account for some of the improvement in results, the absence of a decline in the incidence of occlusion in patients without thrombus suggests that antiplatelet drugs may have been more important. The optimal dose of aspirin in this setting is unknown, but data from several recent clinical trials suggest that, when given in doses of approximately 1200 mg per day, aspirin exerts a beneficial effect,^{11 12} although a lower dose may suffice.¹³

The mechanism of acute occlusion in patients with intracoronary thrombus in the absence of dissection is also unknown. Potential mechanisms include endothelial damage and platelet deposition; alternatively, the presence of an intraluminal thrombus in the coronary artery may be simply a marker for a hypercoagulable state¹⁴ or impaired local thrombolysis. Little is known about local in vivo haemostatic mechanisms in the coronary artery at the time of balloon dilatation in patients. Experimental data from the pig angioplasty model support the use of antiplatelet drugs.¹⁵

CONCLUSION

Continuous intravenous heparin infusion for 24 hours and use of antiplatelet drugs, possibly in association with the use of steerable angioplasty systems and increasing operator experience, reduced the incidence of complete occlusion in patients with pre-existing coronary artery thrombus. Nevertheless, complete occlusion continues to be more common in the presence of intraluminal thrombus. Assuming that the coronary anatomy of patients with stable or unstable angina makes them suitable for angioplasty, we believe that the presence of an intraluminal thrombus itself need not be a contraindication to the procedure. Percutaneous transluminal coronary angioplasty, however, should be undertaken with caution in these patients.

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