

The Use of Percutaneous Transluminal Coronary Angioplasty in Myocardial Infarction

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To evaluate the effectiveness of percutaneous transluminal coronary angioplasty (PTCA) in the treatment of myocardial infarction, we reviewed the records of 508 consecutive patients treated within 6 hours of pain onset. Two hundred fifty-eight patients received direct PTCA without thrombolytic therapy, and 250 received thrombolytic therapy followed by immediate PTCA (within 24 hours, $n=73$) or delayed PTCA (later than 24 hours, $n=177$). The direct-PTCA group had the lowest initial success rate (92%) and the highest 1-week (8.1%) and 1-year (14%) mortality rates. Immediate PTCA had a 96% success rate, and 6.8% 1-week and 8.2% 1-year mortality rates. Delayed PTCA had the same initial success (96%), but lower 1-week (1.7%) and 1-year (2.3%) mortality. We conclude that both direct PTCA and combination treatment (thrombolytic therapy followed by PTCA) result in high rates of recanalizing occluded coronary arteries, but that combination treatment has higher initial success and survival rates, with delay in the use of PTCA producing the best survival rates. (*Texas Heart Institute Journal* 1991;18:263-8)

Key words: Angioplasty, transluminal percutaneous coronary; coronary artery bypass; heart catheterization; myocardial infarction, drug therapy; myocardial infarction, mortality; thrombolytic therapy; survival rate

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The role of percutaneous transluminal coronary angioplasty (PTCA) in myocardial infarction continues to undergo evolution and refinement as a consequence of continuing investigation, experience, and technical advances. When available, direct PTCA without thrombolytic agents has been proposed as the most rapid method to achieve reperfusion and myocardial salvage.^{1,2} However, it has significant limitations in clinical settings where access to catheterization laboratories and staff might not be immediate. Also, there have been no large, prospective, randomized studies of direct PTCA alone in comparison with thrombolytic therapy alone. Most of the data emerging from several studies of thrombolytic agents used in combination with PTCA^{3,4,5} have shown fewer complications and better outcomes when PTCA is performed several days after thrombolysis, rather than immediately following it. Fewer data are available to compare direct PTCA alone with the thrombolysis/PTCA combination therapy.⁶ Because our group has used all of these PTCA strategies, we reviewed the records of 508 consecutive patients treated for myocardial infarction with one or another of them, in order to evaluate the optimal use of PTCA in our experience.

Patients and Methods

From 1985 to 1990, 508 patients were treated with direct PTCA alone, or with thrombolytic agents administered within 6 hours of onset of a myocardial infarction and followed by PTCA at various intervals. Direct PTCA without thrombolytic therapy was used in 258 patients. Thrombolytic agents were used in 250 patients, with 73 receiving immediate PTCA (defined as PTCA undertaken less than 24 hours after onset of pain) and 177 patients receiving delayed PTCA (defined as PTCA undertaken at 24 or more hours after onset of pain). Of the immediate-PTCA group, 45 were treated with tissue plasminogen activator (t-PA) and 28 were treated with streptokinase. Of the delayed-PTCA group, 87 were treated with t-PA and 90 with streptokinase. Method of treatment was decided upon by the attending physician. Table I compares the characteristics of the direct-PTCA patients with those of patients receiving combination therapy.

TABLE I. Characteristics of Patients in the 2 Major Study Groups

	Direct PTCA			Thrombolytic Therapy and PTCA		
Number of patients	258			250		
Mean left ventricular ejection fraction	42%			44%		
	M	F	Total	M	F	Total
Number of patients	186	72	258	187	63	250
Mean age (years)	60	67	62	57	60	58
Prior MI (%)	19	11	17	18	17	18
Prior CABG (%)	16	12	15	11	8	10
Anterior MI (%)	46	35	43	38	35	38
Inferior MI (%)	54	65	57	61	65	62
1 vessel dilated (%)	94	97	95	93	94	93
2 vessels dilated (%)	4.8	2.8	4.3	6.4	6.3	6.4
3 vessels dilated (%)	0.6	0	0.4	0.5	0	0.4

CABG = coronary artery bypass grafting; MI = myocardial infarction; PTCA = percutaneous transluminal coronary angioplasty

PTCA

All PTCA was performed after diagnostic coronary arteriography and pretreatment with 10,000 units of intravenous heparin (followed by 5,000 units every hour). Other premedication usually included aspirin and calcium channel blockers. During PTCA itself, we did not routinely administer dextran or intravenous or sublingual calcium channel blockers. Following the procedure, heparin was continued for at least 8 hours (usually for 24). Access was by the femoral artery, and our operators chose a variety of guiding and balloon catheters. In general, only the infarct-related artery was dilated (95% of the time for direct PTCA and 93% of the time for combination therapy). Operators used multiple inflations of 30 to 90 seconds, at pressures of 2 to 12 atm. Success was defined as reduction of the stenosis to less than 50% of luminal diameter.

Thrombolytic Therapy

Tissue plasminogen activating factor was administered as a 100-unit dose over 3 hours (60 mg in the 1st hour, and 20 mg each in the 2nd and 3rd hours). Streptokinase was administered as an average dose of 1.5 million units over 1 hour. Heparin was begun at the end of thrombolytic infusion, and continued for 1 to 4 days. All patients in the combination-therapy group received thrombolytic agents within

6 hours of pain onset, and underwent a subsequent PTCA (either immediate or delayed) in accordance with the methods outlined above.

Follow-up

Of the 258 patients receiving direct PTCA, all except 2 patients lost to follow-up were seen routinely in the office for at least 1 year (mean follow-up, 151 weeks). Of the 256 patients subject to follow-up, 87 (34%) were restudied within a year, usually due to angina or a positive exercise stress test.

Of the 250 patients receiving combination therapy, all except 2 patients lost to follow-up were seen routinely in the office for at least 1 year (mean follow-up, 93 weeks in the immediate-PTCA group, and 128 weeks in the delayed-PTCA group). Of the patients subject to follow-up, 20 (28%) of the immediate-PTCA group and 57 (32%) of the delayed-PTCA group were restudied within 1 year, due to angina, congestive heart failure, or a positive exercise stress test.

Results

Initial success in the direct-PTCA group was 92%, compared with 96% in both the immediate- and the delayed-PTCA groups (Table II). Mortality rates at 1 week and 1 year were 8.1% and 14%, respectively,

TABLE II. Results of Percutaneous Transluminal Coronary Angioplasty (PTCA)

	Direct PTCA (%)	Thrombolytic Therapy and Immediate PTCA (%)	Thrombolytic Therapy and Delayed PTCA (%)
Initial success	92	96	96
Mortality			
<1 week	8.1	6.8	1.7
<1 year	14.0	8.2	2.3

for the direct-PTCA group; 6.8% and 8.2%, for the immediate-PTCA group; and 1.7% and 2.3%, for the delayed-PTCA group. The initial success rates and the 1-week and 1-year survival rates were improved in the thrombolysis/PTCA groups, compared with the direct-PTCA group. The delayed-PTCA group showed the best survival, at 1 week and 1 year.

Direct PTCA

Of the 258 patients in this group (Table III), 237 (92%) experienced successful opening of the occluded artery by PTCA alone. In the successful cases, 1-week mortality was 7.6% and 1-year mortality was 12%, significantly better than the comparable mortality rates in our patients with failed direct-PTCA (1 week, 14%; and 1 year, 19%). Of these 237 patients whose procedures were successful, only 0.8% underwent coronary artery bypass grafting (CABG)

TABLE III. Initial Results, by Category, of Direct Percutaneous Transluminal Coronary Angioplasty

	Initial Success	Initial Failure	Total
Number of patients	237 (92%)	21 (8%)	258
Mortality			
<1 day	3.8%	14%	4.6%
<1 week	7.6%	14%	8.1%
<1 year	12.0%	19%	14.0%
CABG			
<1 day	0	4.8%	0.4%
<1 week	0.8%	4.8%	1.2%
<1 year	5.1%	4.8%	5.0%

CABG = coronary artery bypass grafting

operations within 1 week, whereas 4.8% of the 21 patients whose PTCA procedures failed had CABG operations within 1 week. However, a total of 5.1% of patients with successful PTCA underwent CABG operations within 1 year, while patients with failed procedures had no further CABG operations within 1 year, the rate holding at 4.8%. During clinical follow-up, 71 of the direct-PTCA patients (28%) developed angina after a mean period of 151 weeks (Table IV). Eighty-seven patients (34% of those followed) underwent coronary angiography during the 1st year after the procedure, with 42 patients (48% of the restudies and 16% of the total followed) showing evidence of restenosis (Table V).

Immediate PTCA

Seventy-three patients received thrombolytic therapy followed by PTCA within the first 24 hours (Table VI). Forty-five of these patients received t-PA, and the remaining 28 received streptokinase. Initial PTCA success was achieved in 70 patients (96%); all 3 failures were in the streptokinase-treated patients. Among those patients with failed procedures, there were no deaths within the 1st week, but 2 of the 3 patients were lost to follow-up after discharge. Neither of these patients received a CABG operation within the 1st week, but the 3rd patient who experienced PTCA failure did undergo CABG within 1 day,

TABLE IV. Redevelopment of Angina upon Clinical Follow-up

	Angina Recurrence		Mean Follow-up
	Yes	No	
Direct PTCA	28%	72%	151 wks
Immediate PTCA	26%	74%	93 wks
Delayed PTCA	22%	78%	128 wks

PTCA = percutaneous transluminal coronary angioplasty; wks = weeks

TABLE V. Restenosis, by Category, in Patients Restudied within 1 Year

	Restudied (% of total)	Restenosis (% of total)
Direct PTCA (n=256)*	34	16
Immediate PTCA (n=71)*	28	14
Delayed PTCA (n=177)	32	16

PTCA = percutaneous transluminal coronary angioplasty
* Excludes patients lost to follow-up.

and survived during 1 year of follow-up. Overall for the group of 73, 1-day mortality was 5.5%, 1-week mortality 6.8%, and 1-year mortality 8.2%. A CABG operation was performed on 2 patients within the 1st day, but no additional bypass operations were performed within the 1st week. Within 1 year, 6.8% of the patients had received bypass operations. At clinical follow-up at a mean of 93 weeks, 19 patients (26%) had developed angina (Table IV). Twenty patients (28% of those followed) underwent coronary arteriography within 1 year, usually due to angina or a positive exercise stress test, with 10 patients (50% of the restudies and 14% of the total followed) showing evidence of restenosis (Table V).

TABLE VI. Results, by Category, of Thrombolytic Therapy in Combination with Percutaneous Transluminal Coronary Angioplasty

	PTCA <24 Hours			PTCA >24 Hours		
	Initial Success (n=70)	Initial Failure (n=3)*	Combined (n=73)	Success (n=170)	Failure (n=7)	Combined (n=177)
Mortality						
<1 day	4	0	4 (5.5%)	1	1	2 (1.1%)
<1 week	5	0	5 (6.8%)	2	1	3 (1.7%)
1 year	6	0	6 (8.2%)	2	2	4 (2.3%)
CABG						
<1 day	1	1	2 (2.7%)	2	1	3 (1.7%)
<1 week	1	1	2 (2.7%)	2	2	4 (2.3%)
1 year	4	1	5 (6.8%)	3	3	6 (3.4%)

CABG = coronary artery bypass grafting; PTCA = percutaneous transluminal coronary angioplasty

* Two of these patients were lost to follow-up after 1 week.

Delayed PTCA

One hundred seventy-seven patients received PTCA more than 24 hours (mean, 72 hours) after thrombolytic treatment (Table VI). Of these, 87 received t-PA and 90 received streptokinase, with no difference between choice of thrombolytic agent and subsequent PTCA success. The initial success rate was 96%. One-day mortality was 1.1%, 1-week mortality was 1.7%, and 1-year mortality was 2.3%. The rate of CABG operations subsequent to PTCA was 1.7% at 1 day, 2.3% at 1 week, and 3.4% at 1 year. Clinical follow-up for at least 1 year (mean, 128 weeks) revealed angina in 39 patients (22% of the total group). Fifty-seven patients (32% of the total) underwent coronary arteriography within 1 year, with 29 patients (51% of the restudies and 16% of the total group) showing evidence of restenosis (Table V).

Discussion

Current treatment of early myocardial infarction focuses upon reestablishing blood flow through the occluded coronary artery to the area of myocardial ischemia. Multiple trials have shown that early reperfusion by thrombolytic agents alone has decreased myocardial infarction size, improved left ventricular function, decreased the occurrence of congestive heart failure, and improved survival.⁷⁻¹³ Other, more limited studies have indicated similar benefits when using direct PTCA without thrombolytic therapy.^{1,2,14-16} Because elapsed time to reestablishment of blood flow is a major determinant of clinical outcome, use

of direct PTCA for acute myocardial infarction has been restricted to the limited number of centers where rapid access to catheterization laboratories and staff is available. However, in this review of our experience, the use of direct PTCA had a lower rate of success than did the combination of initial treatment with thrombolytic agents followed by PTCA. This combination-treatment strategy was associated with improved survival rates at 1 week and 1 year, and with an overall lower incidence of CABG operations. Our rate for direct-PTCA success (92%) is comparable to those in most other studies, although lower than the best reported rate of 99%.^{1,2,17,18} Our success rate for PTCA following thrombolytic therapy (96%) is also comparable to most published rates.^{3-5,19}

The timing of PTCA following thrombolytic therapy has been widely investigated. The most recent studies show (in the majority of patients) no advantage in performing PTCA immediately after thrombolytic therapy, when compared with delaying PTCA. The delayed-PTCA strategy, indeed, has been associated with a lower incidence of complications and improved clinical outcome.^{3-5,20,21} Our data agree with this conclusion, showing improved mortality rates at 1 week (1.6%) and at 1 year (2.3%) in the delayed-PTCA group, when compared with the immediate-PTCA group (6.8% and 8.2%, respectively). Rates of CABG operations were also lower at 1 year in the delayed-PTCA group (3.4%, compared with 6.8%).

The rates of redeveloping angina were similar in all 3 groups, as were the rates of restenosis. The low overall rate of restenosis (in comparison with the usual range) probably reflects the limited number of restudies—due to the fact that we usually restudied only symptomatic patients.

Limitations

Although this study reports on a large group of patients treated at a single institution for acute myocardial infarction, it is uncontrolled and retrospective in nature. Patients were not selected at random for the various treatment courses; rather, individual staff members made therapeutic decisions based on clinical considerations, which may have had an effect on success and survival rates. Despite this, characteristics of the patients before treatment, as outlined in Table I, were similar in the 2 major groups.

Conclusion

In the treatment of acute myocardial infarction, PTCA can be used alone or in combination with thrombolytic therapy. Both methods have a high success rate in reestablishing coronary blood flow and in improving clinical outcome. Direct PTCA is

limited by its availability, but thrombolytic therapy followed by PTCA is widely available. In reviewing our experience, we find that direct PTCA has no advantage in most patients over the sequential use of thrombolytic agents followed by PTCA; direct PTCA, in fact, was associated with lower initial success and survival rates. Moreover, delay in the performance of PTCA after thrombolytic therapy was associated with an improved survival rate, in comparison with PTCA performed immediately after thrombolytic therapy.

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