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Role of Coronary Angioplasty in Acute Myocardial Infarction

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Aggressive approach in the form of thrombolysis and percutaneous transluminal coronary angioplasty (PTCA) has revolutionized the management of acute myocardial infarction (MI). Thrombolysis has emerged as the single most effective strategy to have favorably modified the natural history of acute MI. There now exists overwhelming evidence highlighting the beneficial effects of intravenous thrombolysis both in terms of limiting myocardial damage and improving survival (1-4).

PTCA has evolved simultaneously and been used in the management of acute MI (5,6). Whereas the guidelines for thrombolysis in acute MI are well established (7), considerable controversy exists as to the appropriate place of PTCA in the management of acute MI. We review the status of PTCA in acute MI, in light of available information from several recent randomized controlled trials, and attempt to establish pragmatic guidelines for its use in acute MI (8-10).

Pathophysiology of Acute MI and Rationale for Intervention Strategies

Ample evidence has confirmed atherosclerotic plaque fissuring followed by thrombus formation as the underlying pathologic process causing coronary artery occlusion resulting in acute MI. DeWood and colleagues (11) demonstrated occlusive thrombus in 86% of patients undergoing angiography within 4 hours of the onset of acute MI. Coronary occlusion results in myocardial ischemia, leading to ventricular dysfunction and myocardial necrosis. Restoration of antegrade flow during this early period of acute MI can arrest the progression of myocardial cell death and salvage function in jeopardized myocardium. This can be achieved chemically with thrombolysis and mechanically with PTCA.

PTCA: Definition of Terms

PTCA strategies can be divided into two broad groups:

1. Primary PTCA (PTCA without thrombolysis): This approach involves direct PTCA for acute MI as first-line therapy without initial thrombolysis.

2. Combination therapy: Under this strategy all patients at the time of presentation with an acute MI are first treated with thrombolysis. PTCA is integrated in this approach as prophylactic PTCA, salvage PTCA, or elective PTCA:

   A. Prophylactic PTCA (immediate PTCA following thrombolysis): This aggressive approach involves thrombolysis combined with immediate PTCA at the time of presentation for all patients with an acute MI who demonstrate significant residual stenosis following thrombolysis, regardless of symptoms. The rationale for this approach is that despite successful thrombolysis, the majority of patients are still left with an open but significantly stenosed coronary artery. PTCA is performed to open up the residual stenosis.

   B. Salvage PTCA (for failed thrombolysis): This approach involves PTCA only if the patient demonstrates failure of thrombolysis clinically either by having persistent ischemia in the form of ongoing chest pain or by hemodynamic deterioration such as worsening left ventricular failure or evolving cardiogenic shock (12,13).

   C. Elective PTCA (for postinfarction or provokable angina): This conservative approach involves thrombolysis as the initial therapy at the time of presentation with acute MI. PTCA is reserved only for patients who manifest ischemia later on during the hospital course, either in the form of postinfarction angina or provokable ischemia by exercise stress testing.

   Various situations where PTCA can be considered in acute MI are schematically depicted in Fig 1.

Primary PTCA

Introduced by Hartzler and associates (6) in 1983, this approach involves direct transfer of the patient with an evolving acute MI to the cardiac catheterization laboratory without initial thrombolysis. Cardiac catheterization is performed to identify the infarct-related coronary artery, and mechanical reperfusion is achieved by the use of a guide wire and balloon.

Advantages of primary PTCA are:

1. It can be used for patients who have a contraindication to receiving thrombolytic therapy.

2. It has a higher recanalization rate. The recanalization rate with primary PTCA is 99% in patients with single-vessel disease (14) and 90% in patients with multivessel disease (15), compared to a 70% recanalization ceiling rate achieved with most available intravenous thrombolytic agents.

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3. There is no risk of cerebral hemorrhage. The most catastrophic complication of thrombolysis with profound long-term disability is intracerebral hemorrhage. The reported incidence of intracerebral hemorrhage is 0.1% to 0.2% with streptokinase (1,2), 0.5% with tissue plasminogen activator (16), and 0.4% with anisoylated plasminogen streptokinase activator complex (17). There have been no reports of intracerebral bleeding after primary PTCA therapy.

Disadvantages of primary PTCA are:
1. There are several logistical constraints. The most obvious problem is to get the patient in the cardiac catheterization laboratory within 4 to 6 hours of the onset of symptoms. This also requires the availability of facilities and skilled personnel able to perform expeditious PTCA. If applied on a large scale, the cost of the procedure may become prohibitive.
2. The high reocclusion rate (13%) following primary PTCA negates the initial gain and requires a repeat PTCA.
3. There are also some technical problems. Prompt and sudden mechanical reperfusion with primary PTCA has been associated with complicating arrhythmias and reperfusion injury especially in patients with inferior wall MI (18). Distal embolization of the thrombus can compromise collaterals. Although initial recanalization of the infarct-related artery is achieved in a high proportion of cases, due to an unstable evolving situation the artery may close again despite full anticoagulation and intracoronary nitroglycerin administration. This open-close-open artery cycle may sometimes be prolonged before final success is achieved.

Despite its disadvantages, primary PTCA is a useful approach to consider in the following specific situations:
1. When a patient presents with cardiogenic shock.
2. If associated conditions such as recent major surgery, gastrointestinal bleeding, recent stroke, or refractory hypertension contraindicate the use of thrombolysis.
3. When the diagnosis of acute MI is uncertain, such as in patients with a convincing history of acute MI but uninterpretable ECG due to left bundle branch block. The risks of thrombolysis may outweigh its benefits in this situation if the diagnosis turns out to be incorrect.
4. When patients with known coronary anatomy develop acute MI in-hospital at a time when rapid access to the catheterization laboratory supported by skilled operators experienced in performing expeditious PTCA is available. However, initial treatment with intravenous thrombolysis is still advised as preparations are made to transport the patient to the catheterization laboratory.

Wider application of primary PTCA beyond specific situations should wait until further information is available from large-scale trials proving its superiority over thrombolytic therapy.

**Lessons From Randomized Trials**

The impetus for combining thrombolysis therapy with PTCA stemmed from the hypothesis that the two-way approach of clot dissolution and plaque compression should achieve better re-occlusion with minimal residual stenosis.

The goal of three significant trials—the Thrombolysis and Angioplasty in Myocardial Infarction study, the European Cooperative Study, and the Thrombolysis in Acute Myocardial Infarction phase 2 trial—was to clarify the role of PTCA following thrombolysis. Each trial was different in design. The results of these three randomized trials are not encouraging for the routine immediate PTCA strategy, even though patients were entered early after symptom onset when the potential for myocardial salvage was the greatest (Table). Although the reinfarction and reocclusion rates were similar, the in-hospital mortality, hemorrhagic complications, and the need for emergency coronary bypass grafting were greater in patients randomized to the immediate PTCA strategy. Also, the residual stenosis noted within hours of receiving thrombolytic therapy may improve over the next 24 hours and may not be severe enough to require PTCA. Thus, routine immediate PTCA following thrombolysis for acute MI has no additional benefit and may in fact be harmful.
Salvage PTCA for Failed Thrombolysis

Salvage PTCA is a fallback measure for failed thrombolysis, rather than a primary strategy. Unfortunately, there are currently no definite noninvasive means of identifying patients who fail thrombolysis. Certain clinical situations such as persistent chest pain, hemodynamic deterioration in the form of worsening heart failure, or cardiogenic shock suggest failed thrombolysis and necessitate salvage PTCA. Undertaken in the immediate period following acute MI, salvage PTCA carries greater risk in terms of higher acute complication rate.

Elective PTCA for Postinfarction or Provocable Angina

Elective PTCA for postinfarction angina or a positive exercise stress test offers several advantages over immediate PTCA. The procedure is not only safer but bleeding complications are minimized since PTCA is performed at a time distant from thrombolysis. A substantial proportion of patients may remain asymptomatic or may reoccur and therefore PTCA can be appropriately avoided. In terms of technical feasibility and success rates, both strategies are comparable. One potential disadvantage of this approach is denying the benefit of salvage PTCA for failed thrombolysis to a subgroup of patients in whom failed thrombolysis is not manifested clinically. Some evidence suggests that an open infarct-related artery favorably affects ventricular remodeling, functions as a conduit to collateral channels, enhances healing, and prevents postinfarction arrhythmias. However, it is not yet established whether salvage PTCA for this subgroup improves survival (12).

PTCA for Acute MI: The Henry Ford Hospital Experience

The Henry Ford Hospital experience of PTCA in acute MI (patients presenting within 24 hours of the onset of symptoms) consists of 96 consecutive patients seen between June 1984 and June 1991. PTCA was done in the infarct-related artery only in patients with persistent chest pain despite full medical treatment, those in whom thrombolysis failed, or in those with a contraindication to the use of thrombolytic therapy. Mean time to PTCA from the onset of chest pain was 9.9 hours (range 1 to 24 hours). The overall success rate of PTCA was 90% (86 of 96 patients). Thrombolytic therapy was given intravenously prior to PTCA in 19 (20%) patients and intracoronary during PTCA in 34 (35%) patients. There were 40 (42%) anterior, 47 (49%) inferior, and 9 (9%) lateral wall infarctions.

In terms of complications there was only one PTCA-related death and no emergency surgery. PTCA was unsuccessful in 10 (10%) patients. Long-term follow-up through July 1991 (mean 42 ± 23 months) is available in 79 (82%) patients. Of these 79 patients, eight have died, four of a definite cardiac cause, and 71 (90%) are alive. Of these 71 patients, 56 (71%) are asymptomatic and eight (10%) have minimal symptoms. Nine (11%) patients have moderate angina. Of the patients who underwent repeat cardiac catheterization for symptoms, 13 (16%) had restenosis of the previously angioplastied artery. Of these 13 patients, eight had repeat PTCA, two had elective coronary artery bypass grafting, and the remaining three were treated medically. Our experience suggests that PTCA can be performed with a high degree of success, low complication rate, and good long-term results in properly selected patients with acute MI.

Recommendations

Based on the results of the trials discussed as well as our own experience, we propose a practical approach to PTCA in acute MI (Fig 2). All patients with suspected acute MI who present within 6 hours of the onset of chest pain and have no contraindication to thrombolysis should receive intravenous streptokinase. If the diagnosis of acute MI is uncertain or a contraindication to thrombolysis exists, primary PTCA should be considered. This recommendation is operative only when it is suspected that a large amount of myocardium is at risk and the timing is favorable for immediate mobilization of facilities and personnel.

If the patient becomes unstable at any stage following thrombolysis, i.e., develops ongoing ischemia or cardiogenic shock or medically uncontrollable heart failure, cardiac catheterization with a view to salvage PTCA should be considered. Stable patients should be observed closely. If a predischarge submaximal
Fig 2—Flow sheet of suggested indications for PTCA in acute MI. See text for details.

exercise stress test is positive in asymptomatic patients, cardiac catheterization should be performed. All other patients may be treated medically and followed, preferably with a repeat exercise stress test at six weeks. A positive stress test is an indication for cardiac catheterization with a view to PTCA.

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