The late open artery hypothesis—A decade later

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Background Early reperfusion after myocardial infarction has been proved to preserve left ventricular function and reduce mortality. However, a significant number of patients have persistent occlusion of the infarct-related artery late (days to weeks) after myocardial infarction because of ineligibility for thrombolytic therapy, failure of reperfusion, or reocclusion.

Methods In this report we review the data on the potential mechanisms and benefits of late reperfusion and present prospective data on the incidence of and current practice patterns for the management of persistently occluded infarct-related arteries late after myocardial infarction.

Results Although several studies have associated late patency of the infarct-related artery with improved long-term clinical outcome, they were nonrandomized and reflect selection bias. Furthermore, data on late patency from the largest study, Global Utilization of Steptokinase and Tissue Plasminogen Activator for Occluded Arteries (GUSTO-I), failed to confirm independent benefits of an open infarct-related artery 1 year after myocardial infarction. The randomized data on the effects of percutaneous transluminal coronary angioplasty for occluded infarct-related arteries late after myocardial infarction are limited and inconclusive.

Conclusions The hypothesis that late reperfusion by percutaneous coronary intervention days to weeks after myocardial infarction results in improved long-term clinical outcomes in asymptomatic patients with occluded infarct-related artery is currently being tested in the randomized, multicenter Occluded Artery Trial. (Am Heart J 2001;142:411-21.)
vival was not consistently associated with significant improvement in LV function.\textsuperscript{12,13} For any level of LVEF, mortality after thrombolytic therapy was found to be less frequent than without thrombolytic therapy.\textsuperscript{11,14} Further, reperfusion too late to limit infarct size, more than 6 hours after the onset of AMI and up to 12 hours or possibly even up to 24 hours, still conferred benefit.\textsuperscript{1} Mechanisms other than myocardial salvage seemed to be responsible for these observations. This potential time-independent benefit of late reperfusion led to the modification of the accepted early reperfusion paradigm and introduced the “late open artery hypothesis.”\textsuperscript{11,15}

### Observational clinical studies on the late open artery hypothesis

Experimental studies indicated that late reperfusion reduces infarct expansion and LV remodeling in the absence of myocardial salvage.\textsuperscript{16} Numerous clinical studies suggested that patients with a patent IRA late after AMI, regardless of reperfusion therapy, have a markedly lower mortality during follow-up than those with a persistently occluded IRA (Table I). In a study of 312 thrombolytic-treated patients by White et al,\textsuperscript{5} a patent IRA at a mean of 28 days after AMI was independently associated with improved clinical outcome during follow-up. This independent association was only evident in patients with reduced LVEF or if the IRA supplied >25\% of the left ventricle. Lamas et al\textsuperscript{20} reported similar findings in the Survival and Ventricular Enlargement (SAVE) study population; the incidence of congestive heart failure (CHF) and death was significantly lower in those with an open IRA compared with those with a closed IRA. Further, this association was independent of other patient characteristics, including LVEF and coronary anatomy. Similar beneficial effects of a patent IRA have been noted in patients who underwent mechanical revascularization for post-MI angina.\textsuperscript{21}

However, there are conflicting data. Puma et al\textsuperscript{23} recently analyzed 11,228 patients in the Global Use of Streptokinase and Tissue Plasminogen Activator to Open Occluded Coronary Arteries (GUSTO-I) with data on the patency of the IRA. The unadjusted mortality rate in patients with an open IRA (3-6 days after AMI) was significantly lower at 30 days and 1 year compared with that of the group with an occluded IRA (1.5\% and 3.3\% vs 6.3\% and 8.8\%). Although an open IRA remained an independent predictor of 30-day mortality, after adjustment for clinical and angiographic variables including LVEF, patency was not independently associated with lower 1-year mortality rate. Thus the largest retrospective analysis of the open artery hypothesis refuted the positive results reported in smaller studies.

### Alternative hypothesis for the apparent benefit from late open IRA

Observational reports compare patients with spontaneous reperfusion or who had fibrinolytic therapy or who were selected to have their occluded IRAs opened with those who failed reperfusion or who were not selected for revascularization. Thus, inferring that a late open artery leads to improved survival may not be scientifically correct. There are intrinsic biologic differ-

### Table I. Relationship between status of the infarct-related artery and long-term mortality

<table>
<thead>
<tr>
<th>Author</th>
<th>Year</th>
<th>No.</th>
<th>Initial therapy</th>
<th>Follow-up (mo)</th>
<th>Patent IRA</th>
<th>Occluded IRA</th>
<th>Relative risk reduction (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cigarroa et al\textsuperscript{17}</td>
<td>1989</td>
<td>179</td>
<td>Mixed</td>
<td>47</td>
<td>0</td>
<td>18</td>
<td>100</td>
</tr>
<tr>
<td>Gohlke et al\textsuperscript{18}</td>
<td>1991</td>
<td>102</td>
<td>NA</td>
<td>51</td>
<td>13</td>
<td>17</td>
<td>24</td>
</tr>
<tr>
<td>Galvan et al\textsuperscript{19}</td>
<td>1993</td>
<td>172</td>
<td>Mixed</td>
<td>43</td>
<td>1</td>
<td>17</td>
<td>94</td>
</tr>
<tr>
<td>White et al\textsuperscript{3}</td>
<td>1994</td>
<td>305</td>
<td>Thrombolytics</td>
<td>39</td>
<td>4.5</td>
<td>9.5</td>
<td>53</td>
</tr>
<tr>
<td>Lamas et al\textsuperscript{20}</td>
<td>1995</td>
<td>946</td>
<td>Mixed</td>
<td>42</td>
<td>11</td>
<td>24</td>
<td>54</td>
</tr>
<tr>
<td>Welty et al\textsuperscript{21}</td>
<td>1996</td>
<td>479</td>
<td>Mixed</td>
<td>34</td>
<td>4</td>
<td>17</td>
<td>76</td>
</tr>
<tr>
<td>Brodie et al\textsuperscript{22}</td>
<td>1996</td>
<td>565</td>
<td>Primary percutaneous transluminal coronary angioplasty</td>
<td>64</td>
<td>7.7</td>
<td>15</td>
<td>49</td>
</tr>
<tr>
<td>Puma et al\textsuperscript{23}*</td>
<td>1999</td>
<td>11,228</td>
<td>Thrombolytics</td>
<td>12</td>
<td>3.3</td>
<td>8.8*</td>
<td>65</td>
</tr>
</tbody>
</table>

Mixed, initial therapy included thrombolytic therapy and no thrombolysis; NA, not available. (Adapted from Hochman JS, Oersh BS. Acute myocardial infarction complications. In: Topol EJ, editor. Textbook of cardiovascular medicine. Philadelphia: Lippincott-Raven; 1998.)

*Data reflect unadjusted mortality rates. After adjustment for baseline clinical factors and LVEF, open IRA was not independently associated with improved 1-year survival.
ences in the local arterial or systemic factors among patients who have persistently occluded IRAs compared with those who have a patent IRA late after AMI. Statistical models using observational databases cannot adequately adjust for these variables. An open IRA late after AMI may be a marker for and not the direct cause of reduced mortality.

Several observations support this postulation. Abnormally elevated levels of lipoprotein(a) (Lp(a)) have been noted in patients with a persistently occluded IRA after AMI. Lp(a) has structural similarity to plasminogen and may inhibit plasminogen activation. Persistence of initial thrombotic occlusion in patients may be a marker of enhanced thrombotic or inadequate fibrinolytic systems and may contribute to their adverse long-term outcomes. Genetic factors such as insertion (I)/deletion (D) polymorphism in the angiotensin I–converting enzyme (ACE) gene determine plasma and tissue expression of ACE. Patients with DD genotype have 2- to 3-fold elevated levels of plasma and tissue ACE compared with ID or II genotypes. In patients with AMI the presence of DD genotype has been associated with larger tomographic infarct size and greater likelihood of persistent occlusion of IRA. Thus the presence of a particular genotype may predispose to persistent IRA occlusion and worse long-term outcome after AMI. Alternatively, after a fully transmural infarct, extensive microvascular plugging with absence of perfusion at the tissue level may result in failure of spontaneous or fibrinolytic-induced reperfusion of the myocardium or lead to subsequent reocclusion in the IRA and progressive LV dilation and dysfunction. Thus a multitude of factors may lead to persistent occlusion of the IRA and may independently predispose to adverse long-term outcome.

**Potential effects of late reperfusion after MI**

**LV remodeling**

In an animal model of late reperfusion, re-establishing coronary flow at a point in time too late to limit infarct size limited infarct expansion and LV dilation. Several factors may be responsible for this benefit. Conversion of a histologically bland infarct to one with contraction bands and possibly more hemorrhage and edema results in a thicker and stiffer (less expanded) infarct segment. Accelerated healing, very small residual islands of myofibrils, preserved interstitial collagen, and scaffolding effect of a blood-filled vasculature may all play a role in limiting LV dilation. However, animal models of late reperfusion do not reflect the complex interplay of several factors that may affect LV remodeling in patients, such as dynamic opening and closing of the IRA, ischemic preconditioning, and the consequences of stunned and hibernating myocardium. Reperfusion of a completed infarct days to weeks after infarction has not been tested in an animal model.

Clinical observations support the beneficial effect of a late open IRA on LV function, regardless of the mode of reperfusion. Jeremy et al studied patients not receiving reperfusion therapy and found a direct correlation between the degree of perfusion of IRA after MI and changes in LV volume, independent of infarct size. In patients with anterior MI receiving thrombolytic therapy, a residual diameter of the IRA >1.5 mm was shown to be associated with smaller LV end-systolic volume (LVESV) during follow-up than when the residual IRA diameter was <1.5 mm. In the Antithrombotics in Prevention of Reocclusion in Coronary Thrombolysis (APRICOT) trial, patients with anterior MI who had a patent IRA within 48 hours of thrombolysis but who had an occluded IRA at repeat cardiac catheterization at 3 months had no improvement in LV function or stabilization of LVESV, in contrast to those with a patent IRA at 3 months. Likewise, Pizzetti et al demonstrated that patients who underwent successful percutaneous revascularization within 18 days of an anterior MI had markedly less LV dilation and deterioration in function over 6 months compared with those with failed percutaneous transluminal coronary angioplasty (PTCA) and a persistently occluded IRA. In addition, late reperfusion may also restore function in hibernating myocardium that can coexist within the risk region of an occluded IRA.

**Electrical stability**

An open IRA may improve the electrical stability of the heart. Several but not all uncontrolled studies have suggested a significant decrease in the frequency and severity of signal-averaged ECG (SAECG) abnormalities after thrombolysis. In the Late Assessment of Thrombolytic Efficiency (LATE) study, patients who received recombinant tissue plasminogen activator (rtPA) late (6-24 hours) after symptom onset demonstrated improved SAECG compared with patients treated with placebo. However, although patients treated between 12 and 24 hours demonstrated SAECG improvements similar to those of patients treated in the 6- to 12-hour time window, no significant mortality benefit was observed in this cohort followed up for 35 days, nor for those in the whole LATE trial population followed up for 1 year. Boehrer et al demonstrated that mechanical opening of an occluded IRA 1 to 2 weeks after AMI led to the disappearance of abnormal late potentials. In contrast, Dzavik et al noted no significant difference in the resolution of late potentials in patients with revascularization (24 ± 25 after AMI) of an occluded IRA compared with conservative therapy. Ventricular tachycardia (VT) induction by programmed electrical stimulation has been associated with the absence of reperfusion. A higher incidence of inducible
sustained VT and higher rates of subsequent clinical VT or ventricular fibrillation have been observed during 1 year of follow-up of patients without reperfusion compared with patients with severe LV dysfunction but successful reperfusion.38,39 However, late revascularization of an infarct zone may in itself predispose to VT by altering the electrical substrate. Steinberg et al40 reported that placement of a bypass graft across a non-collateralized totally occluded coronary artery supplying an infarct zone was strongly and independently associated with the development of VT postoperatively.

Collateral blood flow

A patent IRA may prove beneficial by providing capacity for collateral blood flow to another coronary territory should subsequent coronary artery occlusion occur in a different coronary bed.5 In patients with subacute or chronic coronary artery occlusions, collateral circulation from the non-IRA to the infarct zone serves to maintain viability of the myocardium distal to the occlusion. Well-developed collaterals are associated with preserved resting systolic regional ventricular function. After PTCA of an asymptomatic total occlusion, reocclusion has been reported to result in symptoms and clinical events.41-43 This may be explained by changes in collateral flow after PTCA. Doppler-measured collateral flow reserve to distal to the occlusion is reduced by 50% after PTCA of subacute (>4 weeks) coronary artery occlusions.44 Collateral flow reserve remains reduced at 24 hours when transient total reocclusion is induced. This loss of rapidly recruitable collateral flow reserve may explain the occurrence of angina, MI, or death with reocclusion after PTCA for total occlusion, despite clinical stability of the patient before PTCA.41-43

Prevalence of occluded IRA late after AMI

The prevalence of the occluded IRA varies with the nature of the MI, the mode of reperfusion, and the time of patency assessment. In untreated patients with ST-elevation MI, an occluded IRA is noted in 87% of patients within 4 hours, 65% within 12 to 24 hours, 53% at 15 days, and 45% at 1 month.6,45,46 Data from National Registry of Myocardial Infarction indicate that only 30% to 40% of eligible patients undergo attempts at early reperfusion.3 Consequently, significant proportions of patients with AMI do not receive reperfusion therapy and are likely to have a persistently occluded IRA. In patients who receive thrombolytic therapy, at least 20% have an occluded artery >3 days after AMI.2,20,47,48 Although primary angioplasty achieves combined Thrombolysis in Myocardial Infarction (TIMI) grade 2 and 3 flow in >90% of patients, TIMI grade 3 flow has been demonstrated only in about 75% of patients.49,50 In addition, persistent occlusion of IRA because of initial failure or subsequent reocclusion occurs in 5% to 10% of patients.49,51 Thus approximately one third of all patients admitted with AMI will have an occluded coronary artery >3 days after the onset of symptoms.
Prior randomized clinical trials of late reperfusion

There have been only 4 small randomized studies that assessed the role of balloon PTCA to achieve late reperfusion (Table II). The Thrombolysis and Angioplasty in Myocardial Infarction (TAMI-6) study randomized 197 patients with ST-elevation MI primarily to receive tPA versus placebo and secondarily to PTCA or no PTCA (n = 71) for those who had an occluded IRA 12 to 48 hours after AMI.53 Although initial patency was established in 81% of the patients randomized to PTCA, only 60% had a patent IRA at 6 months. Conversely, those with an initially occluded vessel and no attempted PTCA had a 38% spontaneous patency rate. At 6 months no difference was seen between the PTCA and no-PTCA groups with respect to ventricular volumes and systolic function. The Total Occlusion Post-Myocardial Infarction Intervention Study (TOMIIS) pilot evaluated 44 patients with an occluded IRA who were randomized to no PTCA or PTCA performed at a mean of 21 days after Q-wave MI.54 The PTCA success rate was only 72% in the 25 patients randomized to that strategy. Reocclusion further reduced IRA patency at 4 months to a low rate of 43%. There was no overall significant difference in LV size or function between those assigned to PTCA versus no PTCA. Horie et al52 studied the effect of revascularization by PTCA in 83 patients with anterior MI >24 hours after onset. The end-systolic volume index and end-diastolic volume index were significantly smaller in the PTCA group compared with the no-PTCA group at 6 months; the mean LVEF was not different. Long-term follow-up over 50 months revealed a statistically significant decrease in the combined end point of death, recurrent AMI, and CHF, mainly derived from a decrease in the incidence of CHF; death and recurrent AMI were not significantly different. Although these results are encouraging, the small sample size, failure to evaluate patients for the presence of significant inducible ischemia, and the absence of prospective objective definition and adjudication of end points, particularly the subjective end point of CHF in this unblinded trial, significantly limited the conclusions of this study. The more recent British TOAT study (The Open Artery Trial, TOAT) enrolled 66 patients with first Q-wave anterior MI, LVEF <0.50, occluded left anterior descending artery and no ischemia on symptom-limited exercise treadmill test. Patients were randomly assigned to medical therapy alone or percutaneous intervention with stents and medical therapy.41 During 12-month follow-up adverse clinical outcomes including death, MI, stroke, CHF, and revascularization were significantly more common in patients who had their IRA opened compared with those undergoing medical therapy. Similar abnormalities of the SAECG were observed in both groups at 1 year.55 Further, end-systolic and end-diastolic volume unexpectedly increased more in patients undergoing PTCA than in patients treated conservatively (Table II). Perhaps emboli after PTCA obstruct the microvasculature and reduce myocardial tissue perfusion resulting in adverse ventricular remodeling. All patients were on ACE inhibitors and >80% were on β-blockers. Thus the available randomized data on late reperfusion are conflicting and inconclusive. However, in the current era of primary angioplasty for acute MI and more efficient thrombolytic regimens, the clinical significance of the occluded IRA has to be assessed before a clinical trial is planned.

Incidence and contemporary management of occluded IRA: Data from pretrial screening for the Occluded Artery Trial

To prospectively define the incidence of occluded IRAs after initial treatment of AMI, to evaluate current management patterns of asymptomatic occluded IRAs, and to assess the feasibility of conducting a randomized trial to test the late open artery hypothesis, all patients admitted with AMI who subsequently underwent cardiac catheterization within 60 days of their index events were logged at 9 Canadian and 52 US tertiary care centers.56 Patients undergoing primary angioplasty were excluded. Of the 2694 patients who underwent cardiac catheterization at a mean of 4.8 days after MI, 1106 patients (42%) had an occluded IRA (TIMI grade 0-1 flow). The site of occlusion was located in the proximal portion of the IRA in 67% of patients. The mean LVEF was 0.46 ± 0.13 and an EF <0.50 was noted in 56% of patients. A prospectively defined clinical indication for revascularization, on the basis of established guidelines,4 was present in 41% of patients with occluded IRA.

Angiographic differences between patients with and without a clinical indication for revascularization are shown in Table III. Predictably, significant triple-vessel disease was more common and single-vessel disease less common in the group with an indication for revascularization. The presence of proximal occlusion of the IRA, the mean LVEF, and the number of patients with LVEF <0.50 were similar in the 2 groups. Among the 1106 patients with an occluded IRA, 581 (52%) underwent PTCA. The overall rates of PTCA performed on patients with occluded IRA were similar between the centers in the United States and Canada (52% vs 56%). Importantly, 53% of patients with no predefined indication for revascularization underwent PTCA.4 The rates of PTCA performed in the absence of a clinical indication for revascularization varied among centers.
Interventional challenges in maintaining patency of occluded IRA

A trial to test the late open artery hypothesis can be successfully performed only if sustained patency of the IRA can be reliably achieved in the majority of patients. Balloon angioplasty of chronic or subacute coronary occlusions is limited by low procedural success and high rates of restenosis.57

Stents have improved the procedural outcomes after intervention for chronic occlusions (Table IV). Pooled results obtained from 4 studies involving a total of 374 patients with chronically occluded coronary arteries demonstrated significant reduction in restenosis (31.0% vs 65.8%) and reocclusion (8.2% vs 23.7%) with a primary stenting strategy compared with PTCA without stenting.58 The more recent, larger multicenter Total Occlusion Study of Canada (TOSCA) studied a broadly selected population with nonacute native coronary occlusions and demonstrated significantly superior long-term patency rates (failure of sustained patency 10.9% vs 19.5%) with stent placement compared with balloon PTCA.42 The risk of restenosis and target vessel revascularization was also significantly reduced with stent placement.

Despite the apparent superiority of stents in maintaining sustained patency of an occluded artery, reocclusion still occurs in about 8% to 11% of patients.32,58 Further, there is a 9% risk of procedural failure because of the inability to cross the occlusion.42 Several large clinical trials have demonstrated that adjunctive therapy with glycoprotein IIb/IIIa inhibitors improved outcome in patients undergoing percutaneous coronary interventions (PCI).59,60 Although data on the impact of these newer agents in patients with chronic coronary occlusions are lacking, the recent Evaluation of IIb/IIIa Platelet Inhibitor for STENTing (EPISTENT) trial demonstrated the efficacy of abciximab as an adjunct to coronary stent placement in reducing mortality, recurrent MI, and target vessel revascularization.61 These data suggest that use of glycoprotein IIb/IIIa inhibitors should improve outcome in patients undergoing stent implantation for chronically occluded coronary arteries. Complications of angioplasty of chronic total occlusions are uncommon.42 Although death is unusual,33,62 a small but finite risk of Q-wave MI and emergency bypass surgery does exist and in general is about 1%.57 A more common complication seems to be postprocedural creatine phosphokinase (CPK) release, which occurs more frequently after stent placement than balloon PTCA of occluded vessels (7.9% vs 2.4%) and usually is less than 5 times the upper limit of normal.42 However, post-PCI CPK release has been significantly reduced by glycoprotein IIb/IIIa inhibitors.61

Occluded IRA

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>All patients (n = 1106)</th>
<th>Indication positive (n = 431)</th>
<th>Indication negative (n = 655)</th>
<th>P value *</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extent of disease [%]</td>
<td></td>
<td></td>
<td></td>
<td>&lt;.001</td>
</tr>
<tr>
<td>1-vessel</td>
<td>42</td>
<td>32</td>
<td>49</td>
<td></td>
</tr>
<tr>
<td>2-vessel</td>
<td>29</td>
<td>28</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>≥3-vessel</td>
<td>29</td>
<td>40</td>
<td>21</td>
<td></td>
</tr>
<tr>
<td>Identity of IRA [%]</td>
<td></td>
<td></td>
<td></td>
<td>NS</td>
</tr>
<tr>
<td>RCA</td>
<td>43</td>
<td>40</td>
<td>44</td>
<td></td>
</tr>
<tr>
<td>LAD</td>
<td>33</td>
<td>32</td>
<td>34</td>
<td></td>
</tr>
<tr>
<td>LCX</td>
<td>16</td>
<td>19</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>Not specified</td>
<td>8</td>
<td>8</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>Proximal occlusion [%]</td>
<td></td>
<td></td>
<td></td>
<td>NS</td>
</tr>
<tr>
<td>Mean LVEF [%]†</td>
<td>67</td>
<td>68</td>
<td>66</td>
<td></td>
</tr>
<tr>
<td>LVEF &lt;0.50 [%]</td>
<td>56</td>
<td>59</td>
<td>53</td>
<td></td>
</tr>
<tr>
<td>Rates of PTCA</td>
<td>52</td>
<td>52</td>
<td>53</td>
<td></td>
</tr>
</tbody>
</table>

NS, Not significant; RCA, right coronary artery; LCX, left circumflex artery.
*Comparison P value between patients with and without an indication for revascularization.
†n = 312 indication positive, n = 443 indication negative, 755 all patients.

### Occluded Artery Trial

Despite the recognition of the need for a randomized clinical trial to test the late open artery hypothesis,11,47,65,66 such a study was impractical until recently because of the technical difficulties involved in the initial opening and subsequent maintenance of the patency of occluded IRAs. With the advent of advanced guide wire techniques, stents, and improved antiplatelet regimens, the initial success of mechanical reperfusion has
increased and the incidence of reocclusion and restenosis has been reduced. Release of cardiac markers is reduced by glycoprotein IIb/IIIa inhibitors.61 These factors have made it possible to conduct a randomized trial of late opening of the IRAs. The magnitude of the problem and trial feasibility were demonstrated in the pretrial screening data; practice patterns in the management of asymptomatic patients with occluded IRA late after AMI vary significantly, with clinicians selecting PTCA or medical therapy only with an equal frequency.56 The National Heart, Lung, and Blood Institute–funded Occluded Artery Trial (OAT) is testing the hypothesis that opening an occluded IRA with PCI, including stents 3 to 28 days after an AMI in asymptomatic patients who are at increased risk (LVEF \( \leq 0.50 \) or proximal occlusion of a large coronary artery), will reduce the composite end point of death, recurrent nonfatal reinfarction, and New York Heart Association class IV CHF over an average 3-year follow-up. Important secondary end points include the comparison of medical costs of the 2 treatments and assessment of the cost-effectiveness of percutaneous revascularization in the study population. Concurrent ancillary studies will evaluate the angiographic status of the IRA during follow-up and also the influence of viable myocardium, if any, within the infarcted region. A similar trial, la Desobstruction Coronaire en Post-Infarctus (DECOPI) is ongoing in France.

**Summary**

Although a decade has elapsed since the initial description of the potential merits of late patency of the IRA, the hypothesis has not been adequately tested. Data from pretrial screening for OAT indicate that more than a third of patients have persistently occluded IRA after the initial treatment of AMI. Many of these patients are asymptomatic but have characteristics that are associated with adverse long-term prognosis such as proximal location of occlusion or reduced LV function. Although most of these patients do not have a clinical indication for revascularization, about 50% undergo clinically driven percutaneous intervention. This practice pattern varies significantly among tertiary care centers. Current technology has made it feasible to open and maintain patency of most occluded IRAs. The recently revised 2001 American College of Cardiology/American Heart Association Percutaneous Coronary Intervention Guidelines state that PCI for establishing an open artery in asymptomatic patients after an MI is a class IIb recommendation, on the basis of expert opinion.66 This acknowledges that there is conflicting evidence and a divergence of opinion about the efficacy of PCI in this setting. Of note, the guidelines do not recommend PCI (class III contraindicated) for asymptomatic patients with failed thrombolysis within 48 hours after MI.

The hypothesis that late mechanical reperfusion in patients with asymptomatic occluded IRAs will improve long-term clinical outcomes remains to be proved and is currently being tested in OAT. If the hypothesis is proven, there will be clinical ramifications pertaining to post-MI testing to ascertain the patency status of the IRA.

### Table IV. Clinical trials comparing stenting versus PTCA in patients with nonacute coronary artery occlusions

<table>
<thead>
<tr>
<th>Trial</th>
<th>No.</th>
<th>PTCA Reocclusion</th>
<th>PTCA Restenosis</th>
<th>STent Reocclusion</th>
<th>STent Restenosis</th>
<th>P value</th>
<th>STent Reocclusion</th>
<th>STent Restenosis</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stenting in Chronic Coronary Occlusion43</td>
<td>114</td>
<td>26%</td>
<td>16%</td>
<td>.058</td>
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<td></td>
<td>74%</td>
<td>32%</td>
<td>&lt;.001</td>
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<tr>
<td>Gruppo Italiano di Studio sulla Stent nelle Occlusioni coronariche62</td>
<td>110</td>
<td>34%</td>
<td>8%</td>
<td>.004</td>
<td></td>
<td></td>
<td>68%</td>
<td>32%</td>
<td>.0008</td>
</tr>
<tr>
<td>Mori et al67</td>
<td>96</td>
<td>11%</td>
<td>7%</td>
<td>.04</td>
<td></td>
<td></td>
<td>57%</td>
<td>28%</td>
<td>.005</td>
</tr>
<tr>
<td>Stent vs Percutaneous Angioplasty in Chronic Total Occlusion58</td>
<td>85</td>
<td>24%</td>
<td>3%</td>
<td>.01</td>
<td></td>
<td></td>
<td>64%</td>
<td>32%</td>
<td>.01</td>
</tr>
<tr>
<td>Total Occlusion Study of Canada42</td>
<td>410</td>
<td>20%</td>
<td>11%</td>
<td>.02</td>
<td></td>
<td></td>
<td>70%</td>
<td>55%</td>
<td>&lt;.01</td>
</tr>
</tbody>
</table>

*NS, Not significant.*
We thank the coordinators and investigators (see the American Heart Journal Web site for appendix) who collected data for their dedication and hard work.

References


Appendix

OAT centers that collected screening log data

Clinical Coordinating Center, St Luke’s–Roosevelt Hospital Center, New York, NY: Study Chairs:
Judith Hochman, MD, Study Coordinator, and Emilie Godfrey, MS, RD

Study Co-chairs:
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