

Incomplete Revascularization

A valid strategy or suboptimal approach?

BY JAMES R. MARGOLIS, MD

This article is a practical review from an experienced practitioner. For a scholarly analysis of this topic, the reader is referred to the excellent review by Ong and Serruys.¹

There is evidence in the surgical literature that less-than-complete revascularization leads to reduced survival.²⁻⁴ This is probably also true for percutaneous coronary intervention (PCI), but the literature in this regard is less convincing. The difference between coronary artery bypass surgery (CABG) and PCI is that complete revascularization in bypass surgery must be accomplished during

the initial procedure, whereas PCI can be done in stages. Although complete revascularization is a laudable objective, it is not always possible—neither with CABG nor PCI.

DEFINITION OF COMPLETE REVASCULARIZATION

Complete revascularization has been variously defined in the literature. None of the proposed definitions are perfect. Some definitions that may be useful to the practitioner include (1) revascularization of the distributions

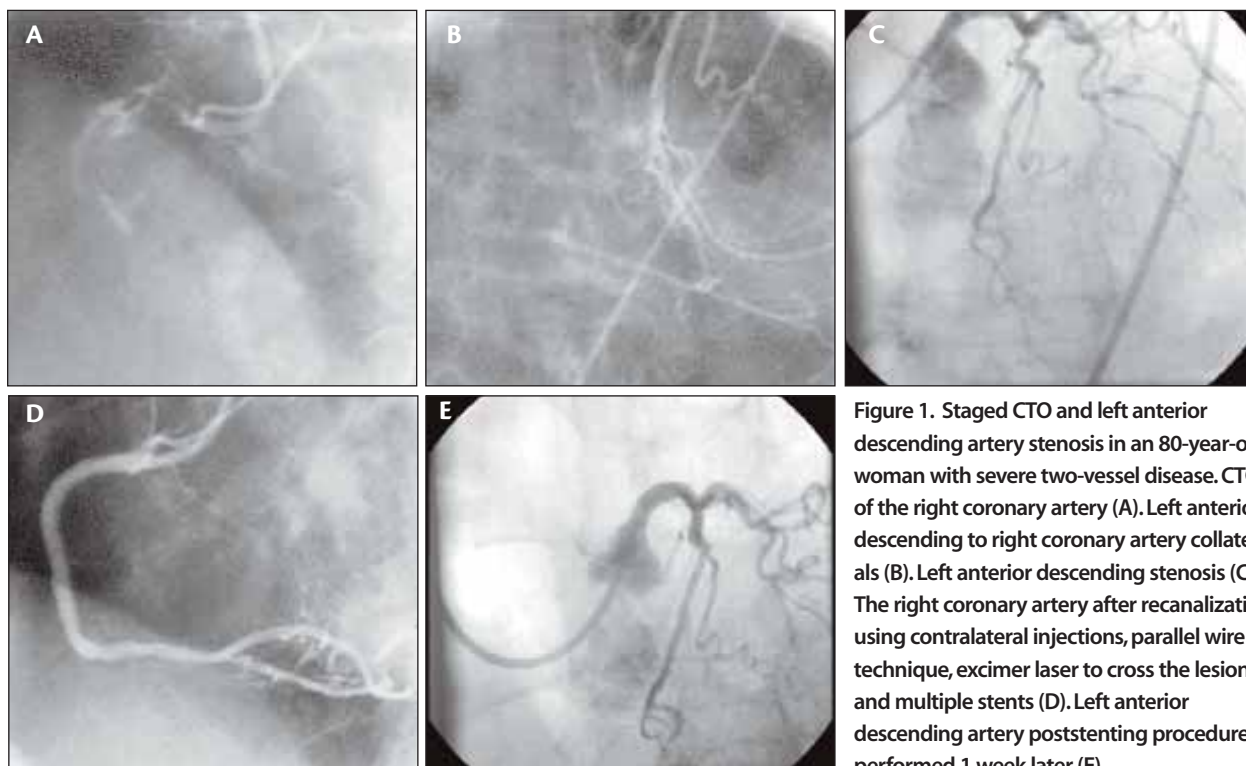


Figure 1. Staged CTO and left anterior descending artery stenosis in an 80-year-old woman with severe two-vessel disease. CTO of the right coronary artery (A). Left anterior descending to right coronary artery collaterals (B). Left anterior descending stenosis (C). The right coronary artery after recanalization using contralateral injections, parallel wire technique, excimer laser to cross the lesion, and multiple stents (D). Left anterior descending artery poststenting procedure performed 1 week later (E).

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COVER STORY

TABLE 1. ADVANTAGES OF STAGING

Safety

- Less contrast per procedure
- Less radiation per procedure
- Less trauma to a weak heart
- Less physician fatigue = more likely to do a better job

May Be Less Expensive

- Cost of multiple 1-day hospitalizations may be less than one prolonged hospitalization caused by a PCI complication
- In our practice, single-vessel PCI is usually an outpatient procedure

May Be More Convenient for Patient

- Multiple 1-day hospitalizations are more convenient than a serious complication or death

of the left main and three major coronary arteries, (2) revascularization of all ischemia-producing arteries and branches, (3) revascularization of all arteries >2.5 mm, and (4) revascularization of all stenosed or occluded vessels regardless of size.

The last definition is impractical, and any attempts to achieve this level of revascularization will likely do more harm than good. It is mentioned only because such complete revascularization has been and is being attempted both surgically and in the PCI suite.

EVIDENCE FAVORING COMPLETE REVASCLARIZATION

In the review by Ong and Serruys,¹ the authors concluded that although the surgical literature reflects an advantage for complete revascularization on the basis of post ad hoc analyses, there is no prospective randomized study that has shown more than a trend in favor of complete surgical revascularization. Evidence favoring complete revascularization with PCI is even less convincing. Incomplete revascularization after PCI leads to a higher incidence of subsequent PCI and/or CABG procedures but not to increased mortality.^{5,6} Despite the lack of class 1A evidence favoring complete revascularization, it is generally conceded that this is an appropriate goal for both CABG and PCI. Evidence favoring recanalization of chronic total occlusions (CTOs) is also limited to post ad hoc analyses but is quite compelling in relation to improvement in left ventricular (LV) function and survival benefits.^{7,8}

ANDREAS GRUENTZIG'S ORIGINAL CONCEPT

Andreas Gruentzig, the father of angioplasty, conceived of PCI not as a single procedure but rather as a

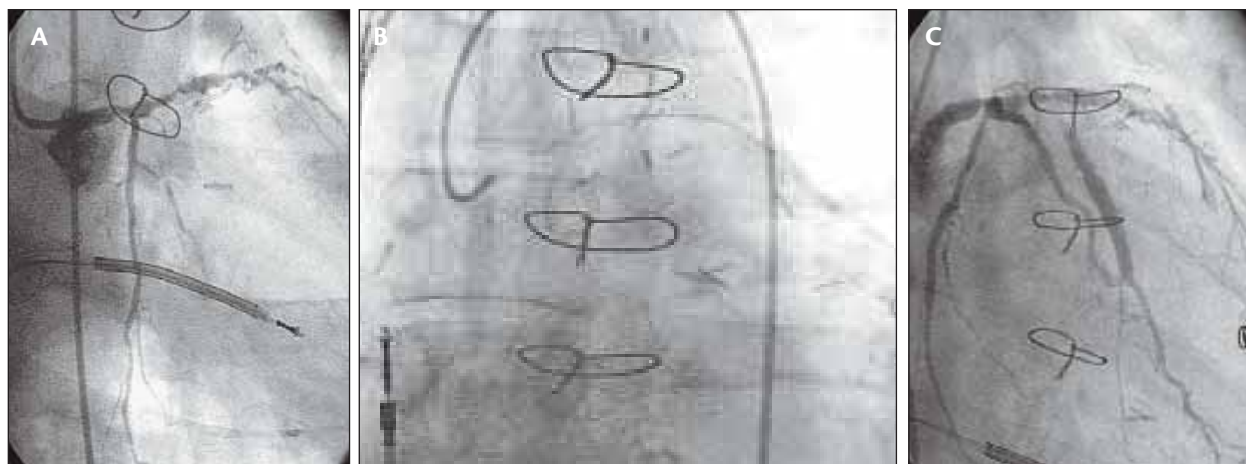


Figure 2. Treatment of the culprit lesion in a patient with poor LV function and new-onset angina pectoris 12 years after CABG. Subtotal occlusion of obtuse marginal branch (OMB) with recently occluded saphenous vein graft to OMB (A). Saphenous vein graft to OMB (B). After PCI/stent of OMB (C). Note that the proximal left anterior descending artery was treated as a second-stage procedure; the left main trunk was not treated, and the patient was asymptomatic at 1-month follow-up at full activity.

series of procedures performed over many years. Gruentzig conceived of PCI as solutions to a series of single-vessel disease problems. In his mind, the treatment was limited to patients with single-vessel disease. When the single stenotic vessel was treated, any new lesion in that or another vessel would again present as single-vessel disease. Now that it is common to treat multivessel disease with PCI, it is still possible to visualize multivessel disease as a series of single-vessel disease problems and treat them according to the Gruentzig paradigm. This is done by staging procedures with the treatment of one or two vessels in a single sitting and staging other vessels for future procedures.

Rationale for a Staged Approach

Complex disease in high-risk patients does not have to be treated in a single procedure. The key to turning a high-risk patient into a standard-risk patient is procedure staging. Because this approach requires multiple hospitalizations, it would appear to be more expensive and more inconvenient for patients and physicians. However, there are numerous advantages to staging that may override the potential disadvantages (Table 1).

Complete revascularization of multivessel disease can be done safely as a single procedure in many cases. Staging should be considered when one or more lesions are complex; the patient is elderly, frail, or with reduced renal function; or when the first or second lesion takes longer than expected. Staging is always better than a long procedure that results in a complication. It is our practice to stage at least 50% of our multivessel disease cases. The

majority of these patients are discharged on the day of their procedures, including elderly patients with comorbid disease.

The Problem of CTOs

Staging is particularly important in patients with CTOs. CTOs are the most common barrier to complete revascularization with PCI. Studies suggest that failure to recanalize a CTO adversely affects LV function and long-term survival.^{7,8} Staging is mandatory when one of the vessels treated is a CTO (Figure 1). Because recanalization of CTOs requires long case and fluoroscopy times and large amounts of radiocontrast, it is unwise to treat additional vessels at the time of CTO recanalization.

Failure to recanalize a CTO precludes complete revascularization. In most cases, CTOs should be attempted before PCI of other vessels. If CTO recanalization is successful, other vessels can be treated at one or more separate procedures. If CTO recanalization fails, consideration should be given to CABG in which complete revascularization is possible.

RATIONALE FOR INCOMPLETE REVASCUARIZATION IN INDIVIDUAL PATIENTS

Although complete revascularization should always be the goal, there are many patients who will benefit from PCI even when complete revascularization cannot be accomplished. These patients are generally symptomatic and are not good candidates for bypass surgery. Such patients include the elderly, patients with previous CABG, patients with poor LV function, and patients with

uncrossable CTOs or untreatable heavily calcified lesions. In these patients, PCI is being performed solely for symptom relief. The patients generally present with new-onset angina or acceleration of previous angina in the setting of chronic stable coronary artery disease. Coronary angiography reveals severe and diffuse multivessel disease, frequently with occlusion of one or more bypass grafts.

The key to treating such patients is identification and treatment of the culprit lesion. New-onset symptoms are usually caused by either new lesions or occlusion of a bypass graft. In the former case, new lesions are generally easy to treat. In the latter instance, it is safer to treat the chronically occluded native vessel than to attempt recanalization of the occluded bypass graft (Figure 2).

Identifying and treating only the culprit lesion is critical because treating the wrong vessel can lead to serious complications in these compromised patients. In complex patient subsets with previous coronary bypass surgery, identification of the culprit is not always straightforward. We prefer to do diagnostic coronary angiography with PCI in a separate setting to be sure to identify the culprit lesion and make appropriate treatment plans.

WHEN COMPLETE REVASCLARIZATION BECOMES INCOMPLETE REVASCLARIZATION

Complete revascularization becomes incomplete when a bypass graft occludes, restenosis occurs, or new disease intervenes. In order to ensure that revascularization remains complete, long-term follow-up is necessary and is particularly important during the first year.

REVASCLARIZATION OF THE WHOLE VESSEL: THE PROBLEM WITH INTERMEDIATE LESIONS

Eighty percent of lesions that cause myocardial infarction and sudden death are <70% occlusive before plaque rupture.⁹ The vast majority of these lesions reside in the proximal one third of the three major arteries.^{10,11}

Dealing with such lesions is less of a problem for the cardiac surgeon than for the interventional cardiologist. The normal resting site for bypass grafts is distal to the proximal one third of bypassed arteries. In PCI, treatment of only ischemia-producing lesions (diameter stenoses >70%; minimum lumen area, <4 mm²; fractional flow reserve, <0.8) leaves behind innumerable intermediate lesions that may be prone to rupture.

At this time, no one knows the best way to treat intermediate lesions. Studies of this problem are in progress (IBIS, PROSPECT),¹² but the results are still pending. In

our practice, we routinely use IVUS-VH (virtual histology) to evaluate intermediate lesions and help make decisions regarding whether to stent.

CONCLUSION

Although there is no class 1A evidence to support its use, complete revascularization is a desirable goal whether patients are treated with CABG or PCI. Patients who have been completely revascularized probably have better LV function and may live longer than those who are incompletely revascularized. If complete revascularization cannot be accomplished with PCI, CABG should be considered. In most cases, revascularization should be considered to be complete when all diseased major coronary arteries and all side branches ≥ 2.5 mm have been treated and/or when all ischemia-producing lesions have been treated. Whether to stent intermediate lesions remains a conundrum. Incomplete revascularization is justified for symptom relief in elderly and high-risk patients and those with significant comorbidities.

With PCI, it is not necessary to achieve complete revascularization in a single procedure. Staging should be considered for high-risk patients, in the presence of complex disease, and especially with CTOs. Complete revascularization may not remain complete. Patients must be carefully followed for restenosis, occlusion of bypass grafts, and the appearance of new disease. ■

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