The Benefit of Complete Revascularization and Efficacy of Complete Revascularization in a Single Setting

Comprehensive and well-documented data demonstrate that complete revascularization has distinct clinical advantages, especially in patients with complex multivessel disease.

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Complicated multivessel disease (MVD) remains a clinical challenge for interventional cardiologists, posing two important questions: (1) what clinical evidence shows the benefit of complete revascularization (CR) over incomplete revascularization (IR), and (2) can complex multivessel coronary artery disease be adequately treated using percutaneous coronary intervention (PCI) in a single setting?

Available data suggest that CR, potentially in a single setting as opposed to a staged procedure, has advantages, especially for patients with MVD. These advantages include:

- Reduced incidence of all-cause mortality, myocardial infarction (MI), and major cardiac and cerebrovascular events (MACCE)
- Less early recurrent ischemia and need for subsequent procedures
- Preserved, and possibly improved, left ventricular function in select patients

COMPLETE REvascularization LEADS TO BETTER OUTCOMES

Real-world data from the New York State PCI Reporting System, along with three separate trials (ARTS-I, ARTS-II, and SYNTAX) comparing revascularization of MVD patients with PCI to coronary artery bypass grafting (CABG), all showed that IR is very common, with rates approaching 70%. Yet, considerable evidence supports CR in high-risk coronary artery disease.

Improved Survival and Reduced MACCE

Using stress myocardial perfusion single-photon emission computed tomography (SPECT), Hachamovitch et al demonstrated that coronary revascularization, compared with medical therapy alone, leads to a greater survival benefit in patients with large zones of ischemia. Figure 1 compares the cardiac death rate among patients with progressive percentages of myocardial ischemia. With increasing amounts of inducible ischemia, there was a mortality benefit among those treated with coronary revascularization compared to medical therapy alone.

Revascularization in patients with > 20% ischemic myocardium was associated with a markedly lower cardiac mortality (2% vs 6.7%) than the group treated with medical therapy alone (P < .0001).

The SYNTAX trial randomized patients with coronary artery disease to revascularization with PCI or CABG. In the PCI group, cardiac death was lower when CR was achieved (6% with CR vs 9.1% with IR, P = .049), with a trend toward

Ischemic Myocardium and Mortality

![Figure 1. Mortality progressively increased in medically treated cases but not in those managed with revascularization. OMT, optimal medical therapy](image-url)
all-cause mortality (11.9% vs 15.9%; \(P = .052\)). Cardiac death and all-cause mortality were also significantly lower among CABG group patients who received CR. In the Mayo Clinic PCI Registry, a cohort of 5,350 patients presenting with MVD who underwent PCI (either with bare-metal or drug-eluting stents), CR was associated with a survival benefit. In fact, the best survival was noted in patients without diabetes undergoing CR. The poorest survival was in diabetic patients who underwent IR.\(^5\)

In a meta-analysis assessing three trials comparing PCI with CABG (SYNTAX, PRECOMBAT, and BEST), a reduction in MACCE was reported in the PCI cohort when CR was achieved (CR MACCE 15.3% vs IR MACCE 19.5%; \(P = .025\)). An even larger meta-analysis of 38 publications, including 156,240 patients with MVD undergoing PCI, showed an overall advantage with CR in terms of the death (odds ratio [OR], 0.69; 95% CI, 0.61-0.78), repeat revascularization (OR, 0.60; 95% CI, 0.45-0.80), myocardial infarction risk (OR, 0.64; 95% CI, 0.50-0.81), and postprocedural MACCE (OR, 0.63; 95% CI, 0.50-0.79).\(^6\)

Protected PCI With Impella\(^*\) Linked to Increased Survival

The Roma-Verona Registry in Italy assessed patients with MVD and reduced left ventricular ejection fraction (LVEF) undergoing Protected PCI with Impella (Abiomed, Inc.).\(^7\) The registry showed patients undergoing the most CR (based on the British Cardiovascular Intervention Society myocardial jeopardy score) had a survival advantage over those undergoing various degrees of incomplete revascularization (Figure 2).\(^8\)

Although the primary endpoint in this study was mortality, an improvement in LVEF was also experienced by the majority of patients (Figure 3). The extent of coronary revascularization correlated with both LVEF recovery and survival.

**IMPROVED OUTCOMES WITH SINGLE-STAGE REVASCULARIZATION**

**Reduced All-Cause Mortality**

A prospective, observational, multicenter registry analysis (and the largest study of its kind) showed that single-stage CR improved long-term survival in patients with non-ST-segment elevation myocardial infarction (NSTEMI) and MVD. Outcomes from 19,980 patients, of which roughly half underwent single-stage acute CR during PCI, were compared with a propensity-matched group undergoing revascularization of only the implicated (culprit) vessel. Patients who underwent single-stage CR experienced a 5-year survival advantage for all-cause mortality (\(P = .0001\)) (Figure 4).\(^9\)

**Reduced MACCE and Target Lesion Revascularization Rates**

Similarly, in a retrospective analysis of the SYNTAX study, staged cases were compared with patients undergoing single-setting PCI. Overall, a higher incidence

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**Figure 2.** Survival curves according to extent of revascularization.

**Figure 3.** LVEF improvement during follow-up after Protected PCI.
of all-cause mortality was demonstrated in staged cases versus PCI in a single setting at 5 years (n = 778; 21.9% vs 12.6%; P = .006). Additionally, staging was associated with an increased incidence of urgent revascularization (32.8% vs 24.8%; P = .035), stroke (5.4% vs 1.9%; P = .031), and MACCE (48.1% vs 35.5%; P = .004) (Figure 5). The SMILE randomized controlled trial was designed to examine the effects of staging coronary revascularization among NSTEMI patients with MVD. The primary endpoints (rates of MACCE, reinfarction, rehospitalization for unstable angina, and repeat coronary revascularization) were compared between a single-stage and multistage CR procedures. In SMILE, 584 patients were randomized during their index hospitalization either to one-stage PCI (n = 264) or to multistage PCI (n = 263). Results showed a significant reduction in both MACCE rates (hazard ratio [HR], 0.549; 95% CI, 0.363-0.828; P = .004) and target vessel revascularization rates (HR, 0.522; 95% CI, 0.310-0.878; P = .013) in the subgroup that received CR in a single setting.11

**Protected PCI With Impella Reduces Acute Kidney Injury During Single-Stage, Multivessel PCI**

Because CR in a single setting often requires longer procedure times and larger amounts of contrast, acute kidney injury (AKI) is a concern. Studies have shown that patients with AKI after PCI have higher in-hospital mortality rates.12 A retrospective single-center study of PCI with Impella support during high-risk PCI found that mechanical circulatory support reduced the overall AKI risk, even in those cases in which there was preexisting chronic kidney disease.6 Furthermore, treatment of MVD in a single setting may induce hemodynamic instability that can be mitigated with the Impella heart pump. Impella has demonstrated positive patient outcomes in several clinical studies and postmarket registries.13-15

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![Figure 4. Kaplan-Meier curves show improved all-cause mortality after PCI with complete, single-stage CR in patients with MVD and NSTEMI.](image-url)

![Figure 5. SYNTAX data shows improved 5-year outcomes with CR compared to staged procedures. CVA, cerebrovascular accident.](image-url)
CONCLUSION

CR leads to improved outcomes in terms of mortality, MI, repeat revascularization, and MACCE rates. Perhaps more controversial is the view that single-stage CR in patients with MVD is associated with better outcomes in MACCE and revascularization rates when compared with multistage PCI. Interventional cardiologists should consider achieving CR in a single setting based on a growing data set that CR has clinical advantages for patients with MVD.