Indications for Coronary Artery Bypass Surgery and Percutaneous Coronary Intervention in Chronic Stable Angina

Review of the Evidence and Methodological Considerations

Charanjit S. Rihal, MD; Dominic L. Raco, MD; Bernard J. Gersh, MB, ChB, DPhil; Salim Yusuf, FRCP, DPhil

By 2000, more than 1 202 000 percutaneous and 519 000 surgical revascularization procedures were being performed annually in the United States.[1] The 3 potential reasons to recommend myocardial revascularization are (1) to alleviate symptoms of myocardial ischemia, (2) to reduce the risks of future mortality, and (3) to treat or prevent morbidities such as myocardial infarction, arrhythmias, or heart failure. To minimize biases, this article focuses on data from prospective, randomized, controlled trials (RCTs) comparing coronary artery bypass graft (CABG) surgery, percutaneous transluminal coronary angioplasty (PTCA), stents, and medical therapy for chronic coronary artery disease (CAD). The data are interpreted in the context of a conceptual framework based on patient risk, methodological characteristics of the evidence, and the occurrence of clinically relevant end points.

CABG Surgery Versus Medical Therapy

Mortality

Of 7 RCTs conducted 2 decades ago, only 1 found a statistically significant difference in mortality between the medical and surgical groups. A trend toward lower mortality was noted in other trials.

Meta-analysis of all 7 trials,[2] totaling 2649 patients, demonstrated a reduction in mortality after CABG surgery, but this was not apparent for the first 3 years of follow-up (Figure 1). Thereafter, risk reductions were significant at 5, 7, and 10 years (relative risk [RR]=0.61, 0.68, and 0.83, respectively), although 40% of patients initially assigned to medical treatment subsequently underwent CABG surgery.[2]

Reductions in the risk of death varied between angiographic and clinical subgroups (Table 1) and were proportional to the number of diseased coronary arteries and degree of myocardial ischemia, particularly if disease of the left anterior descending artery was present. Although relative survival benefits were similar regardless of left ventricular function (RR=0.61 if normal, RR=0.59 if abnormal), the absolute benefit was greater among patients with an abnormal ejection fraction because the risk of death with medical therapy was twice as high in this group (5-year mortality, 25.2% versus 13.3%). Quantification of baseline risk with use of a multivariable equation incorporating both clinical and angiographic characteristics demonstrated that only patients at moderate and high risk with medical therapy benefited from CABG surgery, and those at low risk showed a trend toward increased mortality with CABG surgery (Table 2).

Myocardial Infarction and Other Nonfatal End Points

In these trials, the risk of subsequent myocardial infarction at 5 years was lower but not statistically significantly different (24.4% in the CABG group versus 30.7% for the medical group).[2] Most trials did not prospectively collect data on hospitalization for unstable angina, stroke, quality of life, or cost.

Comments on First-Generation RCTs

Only 2649 patients were enrolled in these trials. Almost all were men between 40 and 60 years of age. In current practice, however, women and elderly patients commonly have CABG surgery (most procedures are performed on patients ≥65 years old).[1] Only 20% had an ejection fraction less than 50%. Conducted 2 decades ago, these trials preceded numerous improvements in both surgical and medical treatments. Only 3% were receiving antiplatelet drugs at enrollment, half the patients were taking β-adrenergic blockers, and HMG-CoA reductase inhibitors were not available. Left internal thoracic artery conduits were used in only 14% of patients in the Coronary Artery Surgery Study.[3]

PTCA Versus Medical Therapy

The largest RCT of PTCA versus medical therapy enrolled 1018 relatively low-risk patients.[4] Most had mild symptoms (80% had Canadian Cardiovascular Society [CCS] class 0 to II), with relatively low-risk CAD (93% with 1- or 2-vessel

From the Division of Cardiovascular Diseases and Internal Medicine, Mayo Clinic, Rochester, Minn (C.S.R., B.J.G.); and St. Joseph's Healthcare and McMaster University (D.L.R.) and the Division of Cardiology (S.Y.), McMaster University, Hamilton Health Services Corporation, Hamilton, Ontario, Canada.

Correspondence to Charanjit S. Rihal, MD, Division of Cardiovascular Diseases and Internal Medicine, Mayo Clinic, 200 First St SW, Rochester, MN 55905. E-mail rihal@mayo.edu

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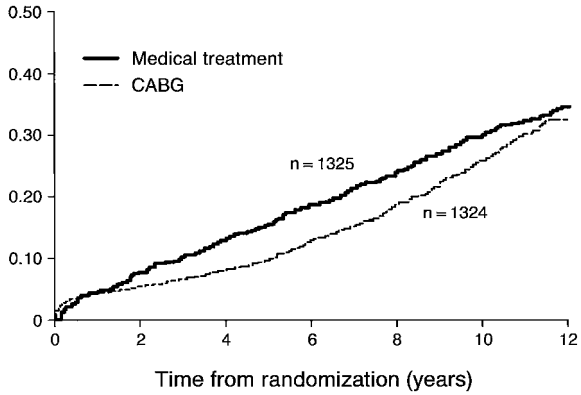

Figure 1. Overall survival after random allocation to medical treatment or coronary artery bypass graft (CABG). At 5, 7, and 10 years, 10.2%, 15.8%, and 26.4% of patients, respectively, assigned to CABG had died, compared with 15.8%, 21.7%, and 30.5% of their medically assigned counterparts. Risk reductions (RR) were significant at all 3 time points (RR=0.61, 0.68, 0.83). Reprinted from Yusuf et al[2] by permission of Elsevier Science (*The Lancet*. 1994;344:563–570).

CAD, 94% with normal ventricular function). Death or myocardial infarction occurred in 6.3% of PTCA patients and 3.3% of medical therapy patients (absolute difference, 3.0%; 95% confidence interval [CI], 0.4% to 5.7%; $P=0.02$). The combined rates of death, myocardial infarction, and nonprotocol revascularization were ≈25% in both groups by 3 years of follow-up, primarily because of repeat procedures in the PTCA group for restenosis and for progression of symptoms among the medical group. Patients with grade II or worse angina had less angina and longer treadmill exercise times after PTCA. Patients in the angioplasty group experienced quicker improvement in quality-of-life measures, but by 3 years, no significant differences were present, partly because 27% of the medical group underwent angioplasty.[5]

The Atorvastatin Versus Revascularization Treatment (AVERT) trial[6] randomly assigned 341 patients with CCS class 0 to II angina to receive either percutaneous coronary intervention (PCI) plus "usual" medical care or to medical care incorporating aggressive therapy with atorvastatin. During 18 months, the cumulative incidence of ischemic events was greater after PCI (21% versus 13%, $P=0.048$), but differences were late, possibly related to progression of disease. Greater improvements in anginal symptoms (54% versus 41%, $P=0.009$) occurred with PTCA.

These findings are reinforced by a systematic review[7] of 6 prospective RCTs involving 1904 patients. Compared with initial medical therapy, treatment with PTCA was associated with a lower RR for angina (RR=0.70; 95% CI, 0.50 to 0.98) but a greater need for subsequent CABG (RR=1.59; 95% CI, 1.09 to 2.32). Risks of death, myocardial infarction, or subsequent PTCA were not significantly different (Figure 2).

Conclusions

Among low-risk patients with symptomatic CAD (CCS class II or greater angina and average mortality <1% per year), PTCA significantly improves symptoms and quality of life. No impact is observed on subsequent procedures or myocar-

TABLE 1. Outcomes of Various Subgroups in Medical Therapy Versus CABG Trials at 5 Years

Subgroup	Patients, n	Medical Treatment Mortality Rate, %	Odds Ratio (95% CI)	*P* for CABG vs Medical Treatment
Vessel disease				
One vessel	271	9.9	0.54 (0.22–1.33)	0.18
Two vessels	859	11.7	0.84 (0.54–1.32)	0.45
Three vessels	1341	17.6	0.58 (0.42–0.80)	<0.001
Left main artery	150	36.5	0.32 (0.15–0.70)	0.004
LAD disease present				
One or 2 vessels	524	14.6	0.58 (0.34–1.01)	0.05
Three vessels	929	19.1	0.61 (0.42–0.88)	0.009
Left main artery	96	32.7	0.30 (0.11–0.84)	0.02
Overall	1549	18.3	0.58 (0.43–0.77)	0.001
LV function				
Normal	2095	13.3	0.61 (0.46–0.81)	<0.001
Abnormal	549	25.2	0.59 (0.39–0.91)	0.02
Exercise test status				
Normal	585	11.6	0.78 (0.45–1.35)	0.38
Abnormal	1400	16.8	0.52 (0.37–0.72)	<0.001
Severity of angina				
Class 0, I, II	1716	12.5	0.63 (0.46–0.87)	0.005
Class III, IV	924	22.4	0.57 (0.40–0.81)	0.001

CABG=coronary artery bypass graft; CI=confidence interval; LAD=left anterior descending; LV=left ventricle.

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TABLE 2. CABG Surgery Versus Medical Therapy: Subgroup Analysis of 5-Year Mortality by Risk Strata

Tertile of Risk*	Patients, n	5-Year Medical Mortality Rate, %	Odds Ratio (95% CI)	*P*
Low	783	6.3	1.17 (0.66–2.07)	0.60
Medium	784	13.9	0.55 (0.34–0.88)	0.01
High	783	25.2	0.54 (0.37–0.77)	0.001

*Tertiles of risk determined by a stepwise risk score incorporating both clinical (age, angina, myocardial infarction, diabetes, hypertension) and angiographic (ejection fraction, lesion location) variables.

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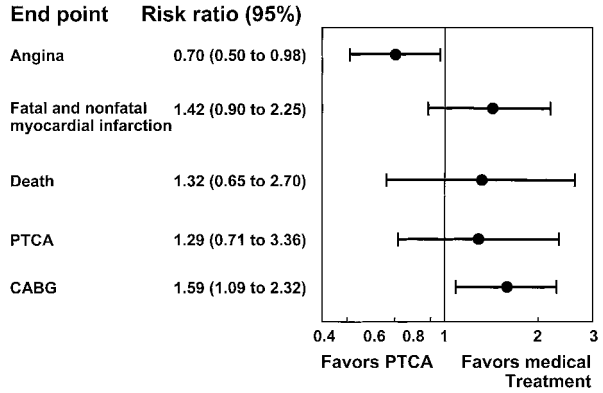

Figure 2. Pooled risk ratios for various end points from 6 randomized, controlled trials comparing percutaneous transluminal coronary angioplasty (PTCA) with medical treatment in patients with nonacute coronary heart disease (CABG=coronary artery bypass grafting; n=953 for PTCA and 951 for medical treatment). Reproduced from Bucher et al[7] by permission of *British Medical Journal*.

dial infarction, and the need for CABG increases. These data suggest that PTCA is indicated if the desired level of anginal relief and physical activity cannot be achieved with medical therapy alone, but that prophylactic PTCA cannot be recommended for the treatment of coronary artery stenosis in the absence of angina or ischemia.

Recent Hybrid Trials

Several trials have compared medical treatment with revascularization. The Asymptomatic Cardiac Ischemia Pilot (ACIP) study prospectively assigned 558 patients who had asymptomatic ischemia to 1 of 2 medication groups or routine revascularization with CABG or PTCA. Despite the relatively small sample size, after 2 years of follow-up, mortality was significantly lower among patients assigned to routine revascularization (1.1% versus 6.6% and 4.4% for the 2 medical groups, $P<0.02$), as were rates of death or myocardial infarction (4.7% revascularization versus 12.1% and 8.8%, $P<0.04$).[8] The Medicine, Angioplasty, or Surgery Study (MASS)[9] prospectively enrolled 214 patients who had proximal left anterior descending artery stenoses to CABG surgery with an internal thoracic arterial conduit, PTCA, or medical therapy alone. After a mean follow-up of 3 years, 98% of CABG, 82% of PTCA, and 32% of medically treated patients were asymptomatic. Rates of death or myocardial infarction were low in all 3 groups (CABG group, 1%; PTCA group, 2%; medical group, 1.4%). When subsequent procedures were considered, the combined end point of death, myocardial infarction, or repeat revascularization occurred in 3% of the CABG group, 24% of the PTCA group, and 17% of the medical group.

A recently published Swiss study[10] randomly assigned 305 elderly patients with severe angina (mean age, 80 years; 44% women; 78% CCS III to IV angina despite a mean of 2.5 antianginal drugs) to immediate invasive or continued medical strategies. Of patients assigned to an immediate invasive approach, 52% received PTCA and 21% had CABG surgery; 22% continued medical treatment because they were unsuitable for any revascularization. Patients assigned to the invasive strategy experienced more rapid improvement in measures of angina and quality of life (statistically significant improvement at 6 months), but patients assigned to continued medical therapy attained equivalent improvements by 12 months (partly because of a 48% delayed revascularization rate). The proportion of patients who experienced death or myocardial infarction by 1 year did not differ (17.0% invasive versus 19.7% medical; hazard ratio, 0.90; 95% CI, 0.53 to 1.53; $P=0.71$). Although small, this study supports the important roles of both aggressive medical therapy and selected revascularization procedures in improving symptoms and quality of life in elderly patients.

Methodological Considerations for Comparison of PTCA and CABG

Moderate- to High-Risk Patients

Several potential outcomes can be assessed: mortality, nonfatal events, symptoms, costs, and surrogate laboratory end points. Because PTCA and CABG have not been shown to decrease nonfatal myocardial infarction in comparison with medical therapy, the inclusion of nonfatal myocardial infarction in a composite end point could dilute statistical power and preclude detection of a difference. Similarly, inclusion of low-risk patients in whom CABG has *not* been shown to improve survival, such as those with single-vessel disease, would decrease the ability to detect mortality differences between 2 modes of revascularization.

Because CABG surgery is associated with a 30% to 50% mortality risk reduction in moderate- and high-risk subgroups at 5 years compared with medical therapy, the detection or exclusion of a risk difference of half this magnitude (15% to 25%) between CABG and PTCA would be clinically important. If PTCA was superior to CABG, it could reasonably be concluded that PTCA is superior to both medical therapy (indirect extrapolation) and CABG (direct inference). However, if CABG surgery is superior to PTCA in terms of survival, then PTCA could either be superior or inferior to medical therapy. If enough data were available, the CI of any observed difference between CABG surgery and PTCA could be narrow enough (eg, $20\pm10\%$) to make this inference.

If no difference were observed between CABG and PTCA, it could be concluded that PTCA is equivalent to CABG only if trials were large enough to reliably detect or exclude relative differences in mortality of $\approx$20% (with narrow CIs)

and included a large number of patients in whom CABG improved prognosis. Approximately 600 deaths would be needed in the "control" group to exclude an RR difference of 20% with 90% power; thus, trials with ≈8000 moderate- to high-risk patients would be needed. Even with trials of this magnitude, one could guarantee that only 40% to 50% of the survival benefit of CABG surgery was preserved by PTCA (by noninferiority analysis). To show that PTCA maintains at least 50% of the demonstrated benefit of CABG on 5-year mortality, the upper CI for the RR of a PTCA versus CABG comparison should not exceed 1.15 (1-sided CI, $\alpha=0.025$). To have 90% power to exclude differences smaller than this, a sample size of 16 800 would be needed if 5-year CABG mortality were 10% and 25 000 if it were 7%. If the confidence limits of any difference included the possibility that PTCA was worse than CABG by 50% (RR), it could not be inferred that PTCA had a favorable effect on survival in comparison with medical therapy.

Low-Risk Patients

Among low-risk patients (annual mortality <1%), assessing mortality differences between PTCA and CABG could be moot because CABG has not been shown to decrease mortality. Approximately 16 000 patients would need to be followed for 5 years to reliably detect a 20% risk difference between the 2 modes of revascularization. With ≈4000 patients, only a very large RR difference between PTCA and CABG surgery (eg, 50%) could be demonstrated. Available data from individual trials or meta-analyses are insufficient to exclude differences on the order of 20% because of small sample sizes.

Among low-risk patients, therefore, the most relevant comparison is between PTCA and medical therapy. Such trials are unlikely to demonstrate a difference in mortality between PTCA and medical therapy unless PTCA is harmful. The inclusion of nonfatal myocardial infarction, overall rates of which are unaffected by CABG or PTCA, into a composite end point could dilute relative differences and decrease the likelihood of detecting differences. Because both PTCA and CABG are effective in relieving angina and myocardial ischemia, a relevant composite end point could be death, myocardial infarction, or severe angina (similar to the primary end point of the Trial of Invasive versus Medical Therapy in Elderly Patients[10]).

Conclusions

These considerations indicate that to compare reliably the relative effect of PTCA versus CABG and to avoid missing clinically important differences, the following conditions must be met: (1) inclusion of groups of patients in whom surgery has been shown to be superior to medical therapy, (2) inclusion of a sufficient number of patients, (3) follow-up of at least 4 to 5 years to accrue a sufficient number of outcomes and to obtain data well beyond the periprocedural period, and (4) a high rate of compliance with the original treatment allocation. If a substantial proportion of patients "cross over" (30% to 40% by 5 years), the ability to detect differences in survival is eroded substantially.

Trials of PTCA Versus CABG Surgery

Nine prospective RCTs with a total of 5200 patients have compared balloon angioplasty with CABG surgery.[9] The largest trial was the Bypass Angioplasty Revascularization Investigation (BARI).[11] Five-year mortality among patients assigned to CABG was 10.7% and 13.7% among those assigned to PTCA (absolute difference, 3.0%; 95% CI, −0.2% to 6.0%; $P=0.19$). Although the difference was not statistically significant, power was less than 40% to detect the observed risk difference. At 10 years of follow-up, mortality was 26% after CABG versus 29.3% after PTCA ($P=0.12$).[12] The entire difference was confined to patients who had treated diabetes mellitus (n=353; 10-year mortality, 43.9% CABG versus 55.9% PTCA; $P=0.012$). No difference in survival was noted among the rest of the patients (n=1476; 10-year mortality, 21.8% CABG versus 23.2% PTCA; $P=0.50$). Importantly, only ≈15% of screened patients with CAD were eligible for enrollment in BARI.[11]

A recent systematic review of available data demonstrated a trend toward lower mortality with CABG (absolute risk reduction [ARR], 1.1%; 95% CI, −0.1% to 2.3%; $P=0.08$) at 3 years of follow-up and no difference in rates of nonfatal myocardial infarction (ARR, 1.2%; 95% CI, −1.8% to 4.2%; $P=0.42$).[13] Rates of repeat procedures were significantly higher after PTCA (absolute risk increase, 34%; 95% CI, 28% to 42%; $P<0.001$).[13] Unfortunately, longer-term follow-up is not available from all trials. Substudies have demonstrated that PTCA and CABG produce similar benefits on quality-of-life measures and are roughly equivalent in cost over 3 to 5 years of follow-up.[14,15]

For patients with single-vessel disease, most of the data come from the Randomised Intervention Treatment of Angina trial, which included 456 patients with single-vessel disease.[15] After a median 6.5 years of follow-up, no significant difference in death or myocardial infarction was found (16.7% CABG versus 19.3% PTCA), although repeat interventional procedures were required much more frequently after PTCA (38% versus 12%, $P=0.01$). These findings are complemented by meta-analysis of data from patients with single, proximal left anterior descending artery disease,[13] which found no difference in occurrence of cardiac death or myocardial infarction.

In summary, 5200 patients with CAD have been enrolled in 9 trials of PTCA (balloon angioplasty) versus CABG surgery. No trial individually had sufficient power to detect or exclude differences in mortality, and various composite clinical end points were used. The main findings are that, in the populations studied, cumulative mortality and death or myocardial infarction rates were no different and that repeat procedures are required more frequently after PTCA. The low proportion of screened patients eligible for enrollment raises questions about generalizability of the results. Restenosis is a major limitation of PTCA, but initial morbidity is less and anginal relief nearly equivalent by 3 years.

Methodological Considerations

Are PTCA and CABG equivalent modes of revascularization for multivessel disease among angiographically eligible patients, except for restenosis? To answer this question, the

marked heterogeneity of what is termed "multivessel disease" must be considered. A patient with discrete lesions of the right coronary and circumflex arteries who has a normal left ventricle or a patient with diffuse 3-vessel disease and an ejection fraction of 30% can rightly be classified as having multivessel disease; yet, the inherent prognoses and the potential risks and benefits of revascularization vary considerably. In the PTCA versus CABG trials, relatively low-risk patients were enrolled; fewer than 20% had left ventricular dysfunction and almost 70% had 1- or 2-vessel disease. In a meta-analysis of 8 trials,[16] the observed first-year mortality of 2.6% and 1.1% per year thereafter confirms the relatively low-risk status of these patients. Although patients enrolled in BARI had higher observed mortality rates, even in this trial, nearly 60% of patients had 2-vessel CAD, whereas 60% of patients enrolled in the earlier CABG versus medical therapy trials had 3-vessel or left main CAD.[2] Therefore, the trials comparing the 2 modes of revascularization include a significant proportion of patients in whom CABG has not been shown to be superior to medical therapy, and the total enrollment of 5200 patients yields low power to demonstrate differences in mortality on the order of 20% to 30%. The 95% CIs suggest the absolute risk of mortality after CABG surgery could be lower by 2.3% (23 fewer deaths per 1000 patients treated by 3 years) or higher by 0.1% (1 more death per 1000 patients treated by 3 years).[13]

Relative Impact of PTCA and CABG Surgery Among Patients With Diabetes Mellitus

Among patients with diabetes mellitus in the BARI randomized trial, the estimated 7-year mortality was 23.6% after CABG and 44.3% after PTCA, a difference equating to ≈200 lives per 1000 patients treated ($P=0.0011$).[17] This difference was confined to diabetic patients who received at least 1 internal thoracic artery graft (7-year survival, 83.2%, n=140), whereas those who received only saphenous vein grafts had a 7-year survival (54.5%, n=33), similar to those who had PTCA (55.5%, n=170). Interestingly, the risk of subsequent myocardial infarction did not differ between groups.[17,18] When available data from the Emory Angioplasty versus Surgery Trial and the Coronary Angioplasty versus Bypass Revascularization Investigation are included, an advantage in favor of CABG is apparent at 4 years (ARR, 8.6%; 95% CI, 2.2% to 15%; $P<0.01$) but not at 6.5 years (ARR, 3.9%; 95% CI, −17% to 25%; $P=0.71$).[13]

This observation has generated intense interest and debate. The key methodological question is whether the observed outcomes among diabetic patients in BARI are real or simply the result of chance. These findings must be interpreted carefully because analyses of subgroups can overestimate or even mislead the direction of treatment effect,[19] and overall trial results could be a better indicator of treatment effect than the apparent effect within a subgroup. The observations of the BARI trial have not been reproduced consistently in other large trials or observational datasets, including the BARI registry, with physician-selected revascularization.[20] In both trials and observational datasets, however, diabetes mellitus is clearly a marker for higher risk, and prognosis is worse after either PTCA or CABG surgery.[11] One resolution to the apparent dilemma could be that higher-risk patients derive a mortality benefit from CABG surgery, and longer-term outcomes of both procedures are equivalent in lower-risk patients.

Impact of Stents on Outcomes After Revascularization

Initially used for treatment of coronary artery dissections after angioplasty, stents are now used widely in many patient subsets, frequently as an alternative to medical therapy or CABG surgery. Twenty-five RCTs studied the effects of stents versus balloon angioplasty on the clinical outcomes of death, death or myocardial infarction, and repeat procedures in patients with chronic CAD. The results have been analyzed systematically by the National Institute of Clinical Excellence of the National Health Service of the UK.[21] Although unblinded, with crossovers allowed and with no single definitive study, consistency of results across trials was observed. In the aggregate, no significant differences were observed in overall mortality at 4 to 11 months of follow-up (0.85% stent versus 1.3% PTCA; odds ratio [OR], 0.68; 95% CI, 0.40 to 1.14) or myocardial infarction (4.4% stent versus 3.6% PTCA; OR, 1.23; 95% CI, 0.86 to 1.72). The odds of revascularization procedures were nearly 50% lower with stenting (12.4% versus 20.6%; OR, 0.54; 95% CI, 0.45 to 0.65).

Several prospective RCTs have compared stenting with CABG surgery. Meta-analysis of data from 3 RCTs with a total enrollment of 2643 patients[13] indicates no significant differences in mortality (ARR in favor of stenting, 0.82; 95% CI, −4.3 to 5.9; $P=0.75$) or nonfatal myocardial infarction (ARR in favor of stenting, 2.9%; 95% CI, −0.6% to 5.1%; $P=0.01$) at 3 years. The 1-year 15% repeat revascularization rate observed after stenting is approximately half the corresponding 1-year repeat revascularization rate after balloon angioplasty and is consistent with the findings of the stent versus balloon trials described previously.[16] The need for repeat procedures remains significantly higher after stenting compared with CABG surgery (ARR in favor of CABG, 15%; 95% CI, 10% to 20%; $P<0.001$).

Of the 1205 enrollees in the Arterial Revascularization Therapy Study trial, 208 (17%) were diabetic.[22] Diabetic patients experienced higher rates of death, myocardial infarction, and repeat revascularization at 1 year (39.3% after stenting versus 17.7% after CABG; absolute difference, 21.6%; $P<0.001$), largely because of a much lower need for repeat revascularization after CABG (3.1% versus 22.3%, $P<0.001$). Diabetes was an independent predictor of adverse events at 1 year (RR, 2.07). More data and longer-term follow-up are needed.

Early data indicate that new developments in stent technology such as local drug elution further reduce the need for repeat procedures but do not influence rates of death or myocardial infarction.[23]

Database Studies

To minimize biases, we have focused on available data from prospective RCTs. Data from large prospective databases, although subject to referral and selection biases, in general

support the framework of a risk-based approach to revascularization. For example, long-term survival with 97% follow-up for 9263 patients with CAD has been reported by the Duke Registry.[24] Over a spectrum of baseline risk, CABG was associated with improved long-term outcomes in comparison with medical therapy among patients in moderate- and high-risk strata, and PTCA was superior to medical therapy only among low-risk strata.[24] Compared with PTCA, CABG was associated with improved outcomes among high-risk strata (chiefly those with involvement of the proximal left anterior descending artery), and PTCA was superior to CABG among low-risk patients. Problems unique to observational studies such as determination of time zero and assignment of deaths occurring while awaiting revascularization point to the need for larger prospective RCTs of up-to-date therapies.

Methodological Limitations of Available Data

Invasive or surgical trials are complex, tend to be small compared with drug therapy trials, and are inherently open label. Such trials usually compare 2 active treatments, thereby decreasing the chances of detecting differences among arms (unless 1 procedure is harmful). Crossover to the other therapy further decreases the ability to detect differences and occurs with increasing frequency during the course of follow-up, necessitating consideration of therapeutic strategies rather than specific treatments. The most important limitation of the currently available data is the low statistical power to detect plausible differences in clinical outcomes, particularly death. This low statistical power is attributable to both the relatively low numbers of events (low-risk populations studied) and the relatively low numbers of patients recruited. Systematic reviews, preferably based on individual patient data and extended follow-up, can provide some redress. Generalizability of trial results has also been questioned, because a minority of screened patients are generally eligible, only some of whom ultimately consent and are enrolled into trials.[25] Larger, definitive trials comparing current medical, interventional, and surgical therapies, particularly in patients at moderate to high risk of events, are urgently needed.

Summary of Considerations for Myocardial Revascularization for Chronic Stable Angina Based on Currently Available Evidence

CABG Surgery Versus Medical Therapy

1. Mortality benefits of CABG surgery are proportional to baseline patient risk.
2. CABG surgery does not reduce the overall incidence of nonfatal myocardial infarction.
3. CABG is effective for symptom improvement.

Balloon Angioplasty Versus Medical Therapy

1. Balloon angioplasty is indicated for symptom improvement but not merely for the presence of an anatomic stenosis.
2. Balloon angioplasty does not prevent death or myocardial infarction.
3. Balloon angioplasty is associated with a greater need for subsequent CABG surgery.

Stents Versus Balloon Angioplasty

1. Stents are indicated for the treatment of arterial dissections with abrupt or threatened vessel closure after balloon angioplasty.
2. Stents decrease rates of angiographic restenosis repeat procedures but not those of death or myocardial infarction.

PCI Versus CABG

1. CABG surgery is likely preferred for high-risk patients such as those with left main, severe 3-vessel, or diffuse disease, severe ventricular dysfunction, or diabetes mellitus.
2. Both PCI and CABG provide good symptom relief.
3. Repeat procedures are required more frequently after PCI.

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