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CARDIOLOGY Rounds™

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Coronary Angioplasty vs. Coronary Bypass Surgery

Results of BARI and Review of Literature

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Both percutaneous coronary angioplasty (PTCA) and coronary artery bypass graft surgery (CABG) are highly effective in reducing symptoms of angina as well as improving exercise capacity and quality of life in patients with coronary artery disease. Both procedures are superior to medical therapy for alleviating symptoms. Bypass surgery prolongs life compared with medical therapy in higher risk groups.

In the 1970's, three large multicenter trials were conducted comparing CABG and medical treatment. A meta-analysis was recently published[1], combining data from the three large studies and four smaller studies. The 10 year mortality data was available for 2649 patients. Mortality at 5 years was 10.2% for the CABG group, and 15.8% for the medical treatment group. By 10 years the mortality reduction remained statistically significant, but appeared to decline with time. Subgroup analysis showed the greatest benefit in patients with 3-vessel or left main disease, abnormal left ventricular function and more severe angina. Proximal LAD disease was also associated with mortality reduction following CABG.

The ACME trial[2] is the only randomized study to date comparing PTCA with medical therapy. Patients with stable angina, single-vessel coronary disease and positive stress test or thallium were randomized to receive PTCA or medical therapy. A total of 212 patients were randomized. The duration of angina-free exercise on the treadmill at 6 months was significantly longer in the PTCA treated patients. As well, a higher percentage of patients were free of angina after 1 month in the PTCA group. However, the benefit of PTCA was partly offset by a trend towards increased myocardial infarction and a significantly higher need for CABG in the PTCA group. The study lacked adequate power to assess mortality.

Including the BARI Study, there have been 9 randomized trials to date[3-11] comparing PTCA & CABG which are reviewed in detail (Table 1).

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PTCA vs CABG

There are many differences in patient population and design between the trials that must be taken into consideration when comparing the results. These include use of newer devices, such as stents and atherectomy (allowed in the RITA and CABRI trials but not the others), as well as incomplete revascularization (permitted as a treatment strategy in CABRI and the EAST trial as long as there was at least one lesion suitable for PTCA). The randomized patients in these trials represented a very selected subgroup, ranging from 3.0 to 17.0 percent of all patients screened.

In all trials of multi-vessel coronary disease, there was no difference in death or MI over the duration of follow-up. In the MASS and Lausanne studies and the subset of RITA patients with single-vessel coronary disease, there was an increased rate of MI with PTCA[12]. There were higher rates of MI with CABG in the GABI and BARI trials. All trials demonstrated the increased need for repeat revascularization in the PTCA-randomized patients. The difference was most evident in the first year, with 33.7% of the PTCA patients undergoing repeat procedures compared with 3.3% of the CABG patients. The need for repeat revascularization after PTCA in single-vessel disease was only marginally less than the rate for multivessel disease (30.5% vs 34.5% at 1 year, p=0.2). An important caveat to these findings is that in all the trials, including BARI, the criteria for subsequent revascularization was not well-defined a priori in the protocols.

There was a higher prevalence of angina after PTCA at 1 year in all trials except GABI, which found no difference. The difference between the treatment groups in rates of angina declined with time. By three years, the relative risk of angina with initial PTCA declined from 1.93 to 1.23. By five years, the EAST study showed no differences in the frequency of angina[15]. All studies showed increased use of antianginal medications in the PTCA group. However, these results must be interpreted with caution as many PTCA patients were discharged on calcium-channel antagonists prophylactically to prevent vasospasm.

A subgroup analysis of CABRI was performed on the cohort of 228 patients with complete occlusion of at least one vessel. Despite the fact that the patients who underwent PTCA were only partially revascularized, the difference between the treatment groups in this cohort was no different than that seen for the other CABRI patients. This surprising result suggests that complete revascularization may not be necessary to achieve the clinical outcomes seen in the other trials. The three large European trials included 122 diabetic patients (5% of total population). The mortality rates at 2 years for diabetic patients was 15.6% compared with 3.5% for CABG[14]. No mortality difference was seen for nondiabetics. Although the EAST study failed to show differences in mortality between diabetics and nondiabetics, the number of diabetics was much lower than in BARI.

Cost analyses have been performed in several of the above trials. The results consistently show that the initial cost savings of PTCA over CABG are markedly reduced over time due to the need for repeat hospitalizations and procedures.

In the BARI study, diabetics were not a prespecified subgroup. However, the safety monitoring board found that patients with treated diabetes mellitus had a 15% improved survival with CABG compared with PTCA (p=0.002), and released a Clinical Alert on Sept. 21, 1995. The five-year survival of patients without diabetes were virtually identical, indicating that the trend towards improved survival with CABG was entirely accounted for by the diabetic population.

TABLE 1

Trial	# of pts	% of pts screened	% 1-VD	% 3-VD	% DM	Patient clinical status	F/U (yrs)	Outcome Comment (PTCA vs CABG)
Lausanne[3]	134	8%	100%	0%	12%	Documented ischemia CCS III-IV: 79% UAP:10%	2.5	Death: no difference MI: 12% vs 3% (p=0.09) Need for RR:25% vs 3% (p<0.01)
MASS[4]	142	?	100%	0%	18%	Stable angina ≥80% prox LAD	3.5	Death & MI:no differences Need for RR:29% vs 0% (4% in medical therapy group)
Toulouse[5]	152	?	0%	22%	?	?	2.8	Higher inhospital complications with CABG (24% vs 9%, p<0.05)
ERACI[6]	127	17%	0%	45%	7%	UAP:83%	1	Death and Q-wave MI:no difference Need for RR:32% vs 3.2% (p<0.001)
GABI[7]	359	4%	0%	18%	12%	CCS Class ≥ II Occluded vessels excluded	1	Higher inhospital MI, pneumonia with CABG Death & MI following discharge:no difference Freedom from angina at 1 yr:no difference
CABRI[8]	1054	3%	1%	41%	12%	Asymptomatic:7% CCS III-IV: 47% UAP:8%	1	Death & MI:no difference Angina: higher in PTCA, esp.females Need for RR:33.6% vs 6.5% (p<0.01)
RITA[9]	1011	6%	45%	12%	?	Asymptomatic:7% CCS III-IV: 57% Angina at rest: 59%	2.5	Death & MI:no difference Need for RR:36% vs 4% Arrhythmias & CHF more common after CABG Angina & meds:more after PTCA
EAST[10,15]	392	8%	0%	40%	23%	Asymptomatic:4.2% CCS III-IV: 77% IV NTG: 12%	5	Death & Q-wave MI:no difference Need for RR:61% vs 16% Angina at 5 yrs:no difference Large defect on Thallium: no difference
BARI[11,13]	1829	15%	2%	41%	25%	Positive GXT CCS III-IV: 16% UAP:55%	5	3% increased survival with CABG (p=NS) 2% increased MI-free survival with ACB (p=NS) 15% increased survival with CABG in DM pts (p=0.002)

Legend: 1-vd = single-vessel disease
3-VD = 3 vessel disease
F/U = follow-up
CCS = Canadian Cardiovascular Society angina class
UAP = unstable angina pectoris
MI = myocardial infarct
RR = repeat revacularization
GXT = graded exercise test
IV NTG = intravenous nitroglycerine
DM = Diabetes Mellitus
prox LAD = proximal left anterior descending artery

Summary

The nine multicenter randomized trials comparing PTCA and CABG show that in selected nondiabetic patients with multivessel coronary disease and anatomy suitable for either PTCA or CABG, there is no increased risk of death or MI at 5 years with an initial strategy of PTCA. The PTCA strategy does result in a greater need for subsequent revascularization procedures. However, 70% of patients can avoid CABG altogether over 5 years, with the great majority requiring only one additional PTCA. For many patients, the need for one or even two repeat PTCA procedures may be an acceptable trade-off to avoid the more invasive bypass surgery. Patients undergoing initial PTCA also have higher rates of angina and use of antianginal medications, but these differences are primarily in the first year and decline with time.

The increased mortality seen in diabetic patients undergoing PTCA is likely related to the fact that the diabetic patients in the trials were slightly older, and much sicker with more extensive coronary disease, worse left ventricular function, more congestive heart failure and hypertension. Further investigation is required to clarify the reasons for the difference, but patients with treated diabetes who have similar characteristics to the diabetic BARI patients should preferentially undergo CABG over PTCA unless there are other intervening circumstances. The initial cost-savings with the PTCA strategy is markedly reduced over time due to the need for subsequent hospitalizations, procedures and cardiac medication, but remains significant throughout follow-up.

The results of these studies highlight the importance of patient preference. Because there is no difference in mortality or myocardial infarction in selected nondiabetic patients with suitable anatomy, the decision of PTCA or CABG rests on whether the possibility of avoiding invasive cardiac surgery is justified by the increased risk of recurrent angina, slightly lower functional status and the need for repeat revascularization procedures. Such decisions can only be made after careful consideration of the individual patient's values, perceptions and preferences.

Both interventional cardiology and cardiac surgery are constantly evolving and improving with technological advances. The use of intracoronary stents has been shown to reduce the rate of restenosis, and further developments in adjunctive therapy, local delivery therapy and optimal stent deployment will likely result in improved outcomes. Bypass surgery without sternotomy has been performed on selected patients in some centers. Thus comparisons between the two intervention strategies will need to be evaluated on an ongoing basis as new techniques and devices are adapted.

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Upcoming Scientific Meetings

3-4 May 96
Atlantic Canada Cardiovascular Conference
Halifax, Nova Scotia, Canada
(Dalhousie University School of Medicine)
Tel.: 902-494-1560

6-8 May 96
Annual Meeting of The British Cardiac Society
Glasgow, Scotland
(British Cardiac Society)
Tel.: 44 1 71 383 3887

15-18 May 96
North American Society of Pacing and Electrophysiology (NASPE) 17th Annual Scientific Sessions
Seattle, Washington, USA
(North American Society of Pacing and Electrophysiology)
Tel.: 508-647-0100

15-16 May 96
7th International Symposium on Ischaemic Heart Disease
Toledo, Spain
(Hospital Universitario de Getafe Carretea)
Tel.: 44 1 273 732727

15-18 May 96
American Society of Hypertension 11th Annual Scientific Meeting
New York, New York, USA
(American Society of Hypertension)
Tel.: 212-644-0650

26-29 May 96
4th International Congress on Heart Failure – Mechanisms and Management
Jerusalem, Israel
(World Congress on Heart Failure Organizers, Inc.)
Tel.: 310-657-8777

29 May - 1 June 96
Cardiology for the Primary Care Physician
Charleston, South Carolina, USA
(American College of Cardiology)
Tel.: 301-897-5400

30 May - 1 June 96
4th International Symposium on Thrombolytic Therapy in Acute Ischaemic Stroke
Copenhagen, Denmark
(DIS Congress Service Copenhagen)
Tel.: 45 44924492

Abstracts of Interest

The Impact of the Completeness of Revascularisation on Adverse Cardiac Events at 1 year Follow-Up in 1021 CABRI Patients

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Background. The Major Adverse Cardiac Events (MACE: death, myocardial infarction (MI), CABG and PTCA) at 1 year follow-up of the Coronary Angioplasty Bypass Revascularisation Investigation (CABRI) were previously reported. Overall results: no significant difference in survival and MI rate, but a significantly higher re-intervention rate in patients randomised to PTCA relative to CABG. We studied the effect of completeness of revascularisation on MACE at 1 year follow-up.

Methods.Patients randomised to PTCA, were divided in 4 groups: (I) complete revascularisation (procedural result: 0 vessel disease (VD), n = 154), (II) nearly complete (1 VD, n = 210), (III) nearly incomplete (2 VD, n = 75) and (IV) incomplete revascularisation (2 or 3 VD unchanged, n = 94). Kaplan-Meier event-free survival curves were calculated.

Results. One year results (%) and log-rank p-values are reported in table.

Event	I	II	III	IV	p-value
Death	95	97	95	96	0.6
Death, MI	92	94	93	90	0.4
Death, MI, CABG	87	84	75	59	0.0001
Death, MI, CABG, PTCA	69	64	47	49	0.0001

Conclusion. (1) The completeness of revascularisation was not predictive of survival or MI. (2) The re-intervention rate is a function of the (in)completeness of revascularisation.

Comparative 5 year Incidence of Ischemic Events for PTCA and CABG in the Bypass Angioplasty Revascularization Investigation (BARI)

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The Bypass Angioplasty Revascularization Investigation (BARI) examined the hypothesis that an initial revascularization strategy of percutaneous transluminal coronary angioplasty (PTCA) compared to coronary artery bypass graft (CABG) surgery in pts with multivessel coronary disease does not compromise clinical outcome during 5 year follow-up. Between August, 1988 and August, 1991, 914 and 915 pts were randomly assigned to CABG or PTCA at 18 medical centers. Ascertainment of ischemic cardiac events were based on serial ECG analysis, cardiac enzyme data, clinical history, and classified at the St. Louis University Core laboratory. The events were classified as myocardial infarction (MI) if any of the following events occurred: (1.) a grade 2 Minnesota code Q-wave progression, (2.) new left bundle branch block with abnormal cardiac enzymes or (3.) abnormal cardiac enzymes and chest pain ≥ 20 minutes or worsening of ST-T wave abnormalities. Events were classified as ischemic but noninfarct if the above criteria were not met, cardiac enzymes were normal, and the pt had chest pain ≥ 20 minutes, required a hospital visit, and had the new occurrence of ST-T wave abnormalities. Kaplan-Meier estimates were used to determine the 5 year cardiac ischemia event-free survival rates in the PTCA and CABG groups. The rates were examined in a priori subgroups of unstable angina (69% of the population), severe chronic stable angina (16%), and mild or no angina but severe ischemia on noninvasive testing (15%). The rates were examined in pt subsets stratified by number of diseased vessels and left ventricular ejection fraction, and presence or absence of proximal left anterior descending stenosis ≥ 50%, hypertension, diabetes, and congestive heart failure. Results will be presented.

Clinical Outcome and Costs of CABG and PTCA in the GABI Study Over 2 Years Follow-Up

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In the German Angioplasty Bypass-Surgery Investigation (GABI) 359 patients (pts) with symptomatic multivessel disease (MVD) were randomized to CABG (n=177) and PTCA (n=182) during 1986 and 1991. There was no difference between the two treatment modalities with respect to the efficacy on angina pectoris relief at 1 and 2 years follow-up (7% vs. 10% CCS ≥ 3). However, reinterventions in PTCA pts were more frequent (44% vs. 6%, $p < 0.001$) and 21% pts crossed over to CABG during the first year. In the second year, the reintervention rate was only 4% (CABG) and 5% (PTCA). Initial and follow-up costs were compared according to the current price index. Procedural costs were calculated based on 50 pts undergoing MVD-CABG and 28 pts undergoing single or MVD PTCA. Costs of MVD-PTCA were $8.200 (82% material, 13% personnel, 5% rooming) and of CABG $19.200 (58% material, 37% personnel, 6% rooming). Averaged costs per patient during follow-up:

	CABG ($)	PTCA ($)
1st hospitalization	19500	9900
6 months	19600	12600
1 year	19700	14600
2 years	20300	15500

Conclusions: CABG and PTCA in MVD are equally effective in reducing angina over 2 years. Initial costs of PTCA are 49% lower. Due to reinterventions in the first year, costs increase to 76% of CABG costs after 2 years.

Is Five-Year Mortality Different for Treatment by Choice vs. Random Assignment in the Bypass Angioplasty Revascularization Investigation (BARI)?

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BARI recruited 4110 patients with multivessel coronary artery disease requiring revascularization who were suitable for either CABG or PTCA. Consent for random treatment assignment was obtained from 1829 patients; another 2013 preserved the right to chose their treatment but agreed to be followed in a registry, and 268 refused to participate. Within 3 months of study entry, CABG was the initial procedure for 32% of registry patients, PTCA for 58%, and the remaining 10% were maintained on medication only.

	Tx by Random Assignment	Tx by Choice
Age ≥ 65	39%	40%
Female	27%	26%
African American	6%	4%
Post HS Education	29%	40%
Prox/Mid LAD	76%	69%
# Lesion > 50%	3.1	3.0
% Myocardium Jeopardized	61.1	59.2
Hx MI	55%	51%
Hx CHF	9%	5%
Unstable Angina	64%	61%

The 5-year mortality for patients in the BARI trial will be compared to the BARI registry adjusting for differences in patient characteristics between the groups.

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