Percutaneous Transluminal Angioplasty of Saphenous Vein Grafts for Medically Refractory Unstable Angina

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Objective. We attempted to answer the question, is balloon angioplasty a reasonable alternative to repeat coronary artery bypass graft surgery in patients with previous coronary bypass graft surgery, medically refractory unstable angina and vein graft lesions?

Background. Patients with medically refractory unstable angina need revascularization. Patients with previous coronary artery bypass graft surgery and medically refractory angina are at "high risk" for adverse outcomes with repeat coronary bypass graft surgery. Conversely, patients with angioplasty of old vein grafts are also at "high risk" for adverse outcomes.

Methods. Balloon angioplasty of 89 lesions in saphenous vein grafts was performed in 75 consecutive patients with medically refractory unstable angina. Of these 75 patients, 24 (32%) had myocardial infarct within 30 days, 23 (31%) had left ventricular ejection fraction <0.35, and 50 (67%) had major comorbidity. Patients underwent standard balloon angioplasty with aggressive use of intravenous and intracoronary heparin, urokinase, nitroglycerin, oral aspirin, calcium channel blocking agents and coagulation.

Results. Angiographic success (reduction of stenosis ≥50% without major complication) was seen in 84 of 89 lesions. Clinical success (angiographic success plus hospital discharge without major complication) was seen in 70 of 75 patients. During index hospitalization, two patients (3%) died, two (3%) had nonfatal infarcts, and one (1%) had emergency reoperation (coronary bypass graft surgery). In late follow up (3 to 66 months), 12 (20%) patients were lost to follow-up, 17 (23%) had repeat percutaneous transluminal coronary angioplasty, 2 (3%) had late bypass graft reoperation, 18 (25%) had late deaths, and 1 (<1%) had a heart transplant. Of the 41 patients alive after one or more angioplasties, 25 have little or no angina, and 16 have occasional or more angina. We compared long-term survival rates in these 75 patients with a cohort of patients with high risk, unstable angina from the Veterans Affairs Surgical Registry (2,570 patients). The 30-day survival rate was better in patients with coronary angioplasty (97% vs. 92%, p < 0.05), but by 6 months there was no difference, and by 5 years a trend toward a higher survival rate with coronary artery bypass graft surgery was seen.

Conclusions. Balloon angioplasty of saphenous vein grafts with aggressive adjunctive pharmacotherapy is a reasonable alternative to repeat coronary bypass graft surgery in patients with medically refractory unstable angina, previous coronary bypass graft surgery and saphenous vein narrowing.

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an alternative to reoperation in patients with medically refractory unstable angina and previous coronary artery bypass graft surgery.

Methods

Patient group. Between December 1986 and March 1993, 75 patients with unstable angina and at least one previous coronary artery bypass graft operation underwent saphenous vein graft balloon angioplasty. All patients had severe ischemic syndromes (Canadian angina classes III and IV) despite medical therapy. Thirty-six patients had reversible electrocardiographic changes of ischemia recorded at rest.

Angioplasty protocol. Coronary angioplasty was performed by standard technique (3). All patients were treated with aspirin (325 mg every day) and intravenous heparin or nitroglycerin, or both. Seventy patients (93%) consented to salvage coronary angioplasty, which specified that no surgical standby was available because of the surgeon’s perception of “prohibitive” risk (3). Intracoronary balloon augmentation was instituted because of hemodynamic instability in nine patients. Anatomic assessment of lesion severity was determined by visual inspection in two or more angiographic views. Intravenous heparin (10,000 U bolus with periodic additional boluses) was given to all patients. Adjunctive pharmacotherapy included 1) intracoronary nitroglycerin (>200 mg) in every patient; 2) intrasaphenous vein graft heparin (5,000 to 20,000 U) in 72 of 75 patients; 3) intrasaphenous vein graft urokinase (250,000 to 1 million U) in 16 of 75 patients; and 4) low dose warfarin (2 to 5 mg) throughout the hospital stay in 74 of 75 patients.

Definitions. Angiographic success was defined as a residual lumen narrowing <50%. Complications were defined as major if death, myocardial infarction or emergent coronary artery bypass grafting occurred during index hospitalization. Clinical success was achieved if stabilization of patient’s clinical status occurred, with eventual hospital discharge and no major complications during the index hospitalization. Late cardiac events were defined as death, myocardial infarction or repeat revascularization (coronary artery bypass graft surgery or coronary angioplasty).

Follow-up. All patients were followed up by return clinic visits, telephone contact or chart review for clinical symptoms, need for repeat revascularization or death. Because patients were all eligible veterans from Denver’s catchment area, catheterization, angioplasty and surgical records of our hospital were screened to identify subsequent procedures in these patients.

Surgical risk assessment. Coronary artery bypass graft surgery survival data have been collected by the Department of Veterans Affairs Cardiac Risk Assessment Program since April 1987 in a program to assess preoperative surgical risk (7). These data have resulted in a logistic regression prediction model based on 11 risk variables (previous heart surgery, cardiomegaly, age, serum creatinine, presence of peripheral vascular disease, presence of chronic obstructive pulmonary disease, recent myocardial infarction, New York Heart Association functional class, current diuretic use, intravenous nitroglycerin use, preoperative balloon pump use) that estimate expected surgical mortality. These variables have been used to predict the expected surgical risk for the patients with saphenous vein graft coronary angioplasty in this report had they underwent coronary artery bypass graft surgery. This value can be compared with that for observed angioplasty mortality.

Coronary artery bypass graft surgery control group. Patients with unstable angina who underwent bypass surgery were extracted from the Veterans Affairs Cardiac Risk Assessment Program Registry on the basis of the presence of at least one of the following six high surgical risk factors: previous coronary artery bypass graft surgery, age >70 years, myocardial infarction within 30 days, left ventricular ejection fraction <0.35, intravenous nitroglycerin required, intraaortic balloon pump required. A total of 2,570 patients were found who underwent coronary artery bypass surgery between April 1, 1987 and December 31, 1988. Survival data for these patients were obtained from a second data file (Beneficiary Identification Records Locator Subsystem) by matching social security numbers. Experience suggests that most deaths would appear in this data set but that some deaths due to coronary artery bypass surgery would be missed.

Statistical considerations. Observed angioplasty short-term mortality was compared with predicted coronary artery bypass surgery mortality, and chi-square analysis was used to test for differences at the 5% level of significance. Follow-up 5-year survival was evaluated by the Kaplan-Meier product limit estimates for years 1 to 5 after index treatment. This was done for the 75 patients with saphenous vein graft coronary angioplasty and for the coronary artery bypass graft surgery control group extracted from the Veterans Affairs Cardiac Risk Assessment Program Registry.

Maximal likelihood estimates of yearly survival and standard errors were obtained for censored data to compare survival in the saphenous vein graft coronary angioplasty and coronary artery bypass graft surgery control groups. Differences in survival were tested by a Student t test using 5% statistical significance.

Results

Clinical characteristics. Patient age and graft age mean values and distributions are presented in Table 1. The graft age averaged over the 75 patients differed little from the mean age averaged over the 89 lesions (8.2 vs. 8.1 years).

Angiographic results. Angiographic success for 89 dilated lesions is summarized in Table 2. Angiographic evidence suggested saphenous vein graft thrombus in 47 patients (63%) and consisted of either intraluminal defects with surrounding dye, jagged edges with overhanging margins or occlusions with dye penetration.
Clinical results and complications. Clinical success rates for the 75 patients with angioplasty are summarized in Table 2. One of the 72 patients discharged from index hospitalization underwent coronary artery bypass graft surgery; 70 patients were discharged without either myocardial infarction or coronary artery bypass graft surgery; 71 patients experienced relief from their angina symptoms; and 34 of 37 patients who underwent treadmill testing had a negative result for symptoms. Angioplasty was initiated in 10 patients during shock hemodynamic status (pulmonary capillary wedge pressure >20 mm Hg; systolic blood pressure >100 mm Hg), and 9 required intracoronal balloon counterpulsion. All 10 procedures were clinically successful, and all 10 patients were discharged. Five lesions abruptly occluded during the procedure. One patient underwent uncomplized emergent surgery; two patients had successful initial revascularization; and two patients sustained an acute infarction.

Surgical risk assessment. The risk for 30-day coronary artery bypass surgery death was computed for each of the 75 patients with saphenous vein graft on the basis of the Veterans Affairs Cardiac Surgical Risk Assessment Program. Individual risk values ranged from 3% to 42%, with a mean value of 18%, which is equivalent to 13.5 expected deaths (0.18 x 75) had these 75 patients undergone coronary artery bypass graft surgery. This expected number is considerably greater than the observed two deaths (3%), and the difference was statistically significant (chi-square 12.0, p < 0.05). Late clinical results are summarized in Table 3.

Table 3. Late Clinical Results

<table>
<thead>
<tr>
<th>Event</th>
<th>No. of Ps</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ps discharged from index hospital</td>
<td>73</td>
</tr>
<tr>
<td>Ps lost to follow-up</td>
<td>14</td>
</tr>
<tr>
<td>Late deaths</td>
<td>16</td>
</tr>
<tr>
<td>Total deaths</td>
<td>20 (27%)</td>
</tr>
<tr>
<td>Requiring pts</td>
<td>41</td>
</tr>
<tr>
<td>Late CABG</td>
<td>2</td>
</tr>
<tr>
<td>Transplantation</td>
<td>1</td>
</tr>
<tr>
<td>Late PTA</td>
<td>17</td>
</tr>
<tr>
<td>Minimal or no angina</td>
<td>2541</td>
</tr>
<tr>
<td>Medically controlled angina</td>
<td>1641</td>
</tr>
</tbody>
</table>

CABG = coronary artery bypass surgery; PTA = percutaneous transluminal coronary angioplasty; Ps (pts) = patients.
Table 4: Survival Rate Estimates After Index Procedure

<table>
<thead>
<tr>
<th>Month</th>
<th>PTCA</th>
<th>CABG</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1.000</td>
<td>1.000</td>
</tr>
<tr>
<td>1</td>
<td>0.973</td>
<td>0.930*</td>
</tr>
<tr>
<td>6</td>
<td>0.933</td>
<td>0.885</td>
</tr>
<tr>
<td>12</td>
<td>0.876</td>
<td>0.848</td>
</tr>
<tr>
<td>18</td>
<td>0.810</td>
<td>0.593</td>
</tr>
<tr>
<td>24</td>
<td>0.777</td>
<td>0.541</td>
</tr>
<tr>
<td>30</td>
<td>0.724</td>
<td>0.517</td>
</tr>
<tr>
<td>36</td>
<td>0.741</td>
<td>0.517</td>
</tr>
<tr>
<td>42</td>
<td>0.677</td>
<td>0.497</td>
</tr>
<tr>
<td>48</td>
<td>0.677</td>
<td>0.497</td>
</tr>
<tr>
<td>54</td>
<td>0.765</td>
<td>0.497</td>
</tr>
<tr>
<td>60</td>
<td>0.755</td>
<td>0.497</td>
</tr>
<tr>
<td>66</td>
<td>0.748</td>
<td>0.497</td>
</tr>
<tr>
<td>b</td>
<td>0.907</td>
<td>-0.032</td>
</tr>
<tr>
<td>R²</td>
<td>0.965</td>
<td>0.995</td>
</tr>
</tbody>
</table>

*P < 0.05. b = death/person-years of follow-up. CABG = coronary artery bypass graft surgery; PTCA = percutaneous transluminal coronary angioplasty; R² = 99.7%.

curve S(t) = \exp(-b \times t) where t = years after surgery. This corresponds to a yearly survival rate (95% confidence interval) of

S(PTA) = \exp(-0.000) = 98% (91% to 97%);

S(CABG) = \exp(-0.032) = 97% (96% to 97%).

Discussion

In this highly selected group of patients with coronary artery bypass graft surgery and medically refractory unstable angina, angioplasty and adjunctive intracoronary pharmacotherapy of old saphenous vein grafts was a reasonable alternative to reoperation. Patients with coronary artery bypass graft surgery who present with unstable ischemic syndromes frequently are older, have had a previous or recent myocardial infarction and, often, significant comorbidity that places these patients at high risk for reoperation. In the Veterans Affairs system, where results of all coronary artery bypass operations performed in 45 centers are monitored, reoperation is associated with ~5% mortality (7). This operative mortality is higher than in non-Veterans Affairs facilities but reflects the true risk for the veteran population. In our study, the projected 30-day coronary artery bypass mortality rate was predicted at 18% for these 75 patients had they undergone reoperation in our hospital. Although our initial 30-day mortality rate for angioplasty was 3% and compares quite favorably to that predicted for repeat surgery (18%), the long-term mortality rate for angioplasty was significant at 27% for a 3-month to 3-year follow-up period. However, our study group in general had a relatively guarded long-term prognosis given the fact that 34% had a left ejection fraction ≤0.35, and 67% had major comorbidity (Table 1).

In an effort to provide a more comparable control than projections, we surveyed the Veterans Affairs Surgical Registry for patients meeting our criteria of medically refractory rest angina and high surgical risk. The high surgical risk group includes either age >70 years or left ventricular ejection fraction <0.35 or intravenous nitroglycerin therapy at time of surgery or intraaortic balloon pump at time of surgery or recent (30 days) myocardial infarction or post-crownary bypass graft surgery. This defines the 2,570 veterans who were followed up by means of the Beneficiary Identification Records Locator System and from which we derived the observed coronary artery bypass graft surgery deaths shown in Table 4. Because every analysis of Veterans Affairs Surgical Registry data has shown that post-crownary bypass is the highest of these six high risk factors, the angioplasty group is unequivocally at higher risk than the bypass surgery group (all patients in the angioplasty group had bypass surgery). Our data suggest that the short-term survival rate was better after angioplasty, but over a longer time there was no difference.

Reservations concerning angioplasty in patients after coronary artery bypass graft surgery. Angioplasty of old vein grafts can be complicated by thrombosis, embolization and dissection and has been associated with higher rates of abrupt occlusion and late restenosis (8-17). Previous reports have recommended alternative treatment strategies in such patients (8,17). The patients studied in this report were also at risk for abrupt occlusion and complications because all patients had refractory, unstable angina (21-24). Restenosis rates were also higher in this subgroup. Furthermore, a recent review of the published world data recommends caution 1) with regard to angioplasty of totally occluded veins; 2) in angioplasty of vein graft lesions that are likely to lead to shock with occlusion; and 3) with grafts ≥4 years old if repeat bypass surgery is a viable option (8). We agree with that position, but our data support extending the application of angioplasty in selected patients with these characteristics, especially in patients who are at increased risk for reoperation.

Role of adjunctive intracoronary pharmacotherapy. All patients in this study received adjunctive intracoronary therapy consisting of heparin, urokinase and nitroglycerin. To date there are no data that indicate that intracoronary heparin prevents acute occlusions or restenosis in vein grafts. We routinely and safely administered intracoronary heparin in all patients after angioplasty on theoretic grounds, but we have no objective data to support its use. Intracoronary urokinase has been effective in recanalization of occluded or diffusely diseased vein grafts (19,20). Residual thrombus after angioplasty may also predispose patients to subacute occlusion and restenosis (34). We routinely administered intracoronary urokinase for vein lesions that appeared irregular or hazy or contained obvious filling defects. Our reported angiographic and clinical success rates in these high risk patients for short-term complications may reflect in part the liberal use of adjunctive intracoronary pharmacotherapy.
Angioplasty in patients in shock after coronary artery bypass surgery. We report the results in 10 patients in clinical shock who underwent emergent angioplasty of vein graft lesions. This subgroup had the most unstable condition of our patients, and all had a prohibitive surgical risk. In all these patients, successful vein graft angioplasty resulted in clinical stabilization and hospital discharge, which was the primary goal of surgery in this subgroup.

Study limitations. The present study is retrospective and observational in design, and therefore direct comparative statements between angioplasty and repeat coronary bypass surgery cannot be made with regard to this patient series. We did not attempt to routinely repeat coronary angiography to assess restenosis rates and vein graft patency, and we therefore cannot comment on restenosis rates and their relation to clinical outcomes.

Conclusions. Our data suggest that vein graft angioplasty with conventional balloons and aggressive adjunctive pharmacotherapy is usually clinically successful. In patients with an extremely unstable condition (shock), totally occluded or long, complex lesions in old grafts, we report high rates of relief of symptoms, hemodynamic stability and hospital discharge. Angioplasty is an effective treatment strategy for patients with medically refractory unstable angina after bypass surgery and at high risk for operative mortality. A randomized trial is needed to determine which patient subsets are better served by angioplasty or repeat coronary bypass surgery.

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References