Percutaneous Transluminal Angioplasty of Stenotic Coronary Artery Bypass Grafts: 5 Years’ Experience

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In a 60 month period (January 1981 to December 1985), 82 patients (79% male with a mean age of 60 years) had 83 saphenous vein grafts and 5 internal mammary artery grafts with a total of 101 stenotic sites treated with percutaneous transluminal coronary angioplasty. The mean time between bypass surgery and angioplasty was 51.2 months. The procedure was technically successful in 85% of patients, 86% of grafts and 85% of the sites attempted. In these cases, the mean diameter stenosis was reduced from 77 ± 14 to 27 ± 20% (p < 0.001), the mean pressure gradient from 49 ± 16 to 7 ± 6 mm Hg (p < 0.001). Emergency coronary artery bypass graft surgery was necessary in one patient (1.2%) whereas myocardial infarction occurred in three patients (3.6%). There were no hospital deaths.

Clinical follow-up was obtained in all 82 patients. Before angioplasty, 23% were in Canadian Cardiovascular Society functional class II, 60% in class III and 17% in class IV. With a mean clinical follow-up period of 21.4 ± 2.3 months, 71% are in class I, 17% in class II and 12% in class III. There were two deaths, 3 months or more after angioplasty, one probably due to graft closure. So far, angiographic follow-up (at 7.9 ± 2.1 months) has been available in 26 patients. Ten patients (with 10 grafts) exhibited graft restenosis; six of them have had second successful repeat angioplasty. Among the many variables analyzed, statistically significant predictors of success were a higher measured balloon/graft ratio (p < 0.001), smaller diameter graft (p < 0.001), and shorter lesion length (p < 0.01). The only predictor of complication was diffuseness of disease in the graft (p < 0.05). The statistically significant predictors of recurrence were the residual stenosis after the initial angioplasty (p < 0.01) and the measured balloon/graft ratio (p < 0.01).

Angioplasty of coronary artery grafts appears to be a feasible and efficacious procedure with a low complication rate. The technique is a satisfactory alternative to repeat surgery in selected patients.

(J Am Coll Cardiol 1987;9:8-17)
widened considerably (18,19). The use of this procedure has become safer as well as more successful.

This report summarizes our experience using angioplasty as the revascularization technique for stenotic saphenous vein and internal mammary grafts in patients with angina relatively refractory to medical management.

Methods

Data acquisition. All cases of percutaneous transluminal angioplasty of saphenous vein and internal mammary artery bypass grafts performed at the San Francisco Heart Institute between January 1981 and December 1985 inclusive (60 months) were retrospectively reviewed. The clinical information was obtained by consulting the medical record files as well as by contacting the patients or their referring physicians, or both. The details of each procedure were collected by review of the catheterization laboratory protocols. Angiographic data were obtained from the coronary arteriograms before and after dilation, and at follow-up when available.

Two ratios were generated from the angiographic data. The "measured balloon/graft" ratio was defined as the measurement of the inflated balloon diameter at maximal inflation pressure (at the site of the lesion). The largest measurement in the various projections was used. A second ratio, which will be called "expected balloon/graft" ratio, was derived from the commercially listed balloon size and the measured graft diameter.

All of the dilation catheters used in this study were from USCI (United States Catheter and Instrument Co., Inc.). The balloons in all cases but one were of polyvinyl chloride, a product with known compliance characteristics at various inflation pressures (that is, balloon diameters are larger at higher inflation pressures) (20,21). Measurements were performed using electronic calipers and a computer-assisted system (A2D Protocol 110 I, Programmable Digital Caliper, Hewlett-Packard, Inc.), calibrating to zero and to the diameter of the angioplasty guiding catheter (8F = 2.67 mm). Pre- and postangioplasty percent diameter stenosis and lesion length were measured in three angiographic views, the computer calculating the mean of these results.

The grafts were divided into five anatomical sites: the proximal anastomosis (Fig. 1), the proximal, mid and distal third of the graft shaft and the distal anastomosis (Fig. 2 and 3). The distribution of the lesions at these various sites is displayed in Table 1.

Clinical patient profiles. Bypass graft angioplasty was attempted in 82 patients, 65 male and 17 female, with an age range of 38 to 78 years (mean 59.7). A total of 83 saphenous vein grafts and 5 internal mammary artery grafts with 101 stenotic sites were dilated. Sixty-eight patients underwent angioplasty at one site, nine at two sites and five at three sites. The right coronary artery was the insertion site for 18 of the "target" saphenous vein grafts, the left circumflex for 21 saphenous vein grafts and the left anterior descending artery for 49 grafts (42 saphenous vein, 5 internal mammary artery and 2 Sewell grafts). All the patients had disabling angina relatively refractory to medical therapy and an abnormal treadmill stress test if they were able to exercise. Symptomatic status was classified according to the Canadian Cardiovascular Society Functional Classification criteria (22); 23% were in class II, 60% in class III and 17% in class IV before angioplasty. Insulin-dependent diabetes mellitus was found in 21% of patients, elevated serum triglycerides in 35% and elevated serum cholesterol in 22%. Sixty-five percent of patients were smokers at the time of angioplasty. The mean period since bypass surgery was 51.2 ± 40 months (range 2 to 144); of the 82 patients, 50 (61%) had had their bypass surgery 12 months or more before coronary angioplasty. The mean duration of symptoms at the time of the procedure was 6.7 ± 9 months (range 1 to 60).

All patients were maintained on their original medical therapy until the angioplasty. Twelve to 24 hours before the procedure, they were started on a regimen of aspirin (325 mg daily) and dipyridamole (50 to 75 mg orally) three times a day. All patients were given a premedication regimen including secobarbital sodium and a calcium channel blocker (usually nifedipine, 10 mg orally). A bolus of 10,000 units of heparin was administered after the cannulation of the entrance artery (femoral or brachial) and supplemented as needed based on the duration of the angioplasty.

Angioplasty technique. All the angioplasty procedures were performed by one of three experienced physicians utilizing the femoral (52 grafts) or brachial (32 grafts) techniques, or both (4 grafts), as described elsewhere (19,23). Various femoral guiding catheters were used to achieve the most stable position in the orifice of the graft (19). The most commonly used femoral guiding catheters were a right Judkins or left venous bypass style for saphenous vein-left anterior descending and saphenous vein-left circumflex grafts, and a right venous bypass, multipurpose (King), Stertzer femoral or Arani style for the saphenous vein-right coronary artery graft. Guiding catheter selection was determined by the configuration and orientation of the saphenous vein graft and the diameter of the ascending aorta (19). All five internal mammary artery graft lesions involved the distal anastomosis of the left internal mammary and the left anterior descending artery. Four of these procedures were performed using an internal mammary artery guiding catheter from the femoral approach and one by way of the left brachial artery employing a Stertzer brachial guiding catheter.

The size of the balloon catheter was selected to match as closely as possible the diameter of the saphenous vein graft or the internal mammary artery graft when dilating the proximal anastomosis and graft shaft lesions. The diameter of the native vessel was the determinant of balloon size for
distal anastomotic lesions. The dilation catheter balloons were inflated to achieve as full expansion as possible within the pressure limits of the balloon. The duration of inflation was determined by the longest inflation period tolerated without signs of severe ischemia. Multiple inflations were performed to obtain optimal angiographic results and to reduce the transstenotic pressure gradient to less than 15 mm Hg. The pressure gradient across the lesions before and after angioplasty was obtained with a dilation catheter system utilizing standard pressure transducers.

After successful balloon angioplasty, the patients were monitored for 24 hours and, if stable, were discharged on aspirin and dipyridamole. They were kept on this regimen for at least 6 months. In two cases involving total occlusion

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**Figure 1.** Coronary angiograms. A and B, Left lateral projection of saphenous vein graft to left anterior descending coronary artery showing severe stenosis (arrow) at the proximal anastomosis (A) before and (B) after angioplasty. Note attenuation of filling of the left anterior descending artery before angioplasty. C and D, Left lateral projection showing balloon inflated on lesion (C) at 15 atm (15A) showing indentation (arrow) and (D) 19 atm (19A) showing full expansion of balloon (PE PLUS balloon, USCI).
A technical aspect. The mean maximal inflation pressure was 9.5 ± 2.2 atmospheres (range 5 to 19) with a mean maximal inflation time of 52 ± 18 seconds (range 25 to

**Figure 2.** Coronary angiograms. Left anterior oblique projection of sequential saphenous vein graft to diagonal and left anterior descending arteries showing mid-graft stenosis (closed arrow) and a second stenosis (open arrow) at the distal anastomotic site (A) before and (B) after angioplasty. Note attenuation of flow into the left anterior descending artery before angioplasty.

of the saphenous vein graft, the patients were discharged on warfarin instead of aspirin. In addition, nitrates (oral or topical) and a calcium channel blocker (nifedipine, 10 mg four times a day) were used for at least 3 months after angioplasty. Clinical follow-up was obtained in all the cases.

**Figure 3.** Coronary angiograms. Left lateral projection of internal mammary artery graft to the left anterior descending artery with severe stenosis (arrow) at distal anastomosis (A) before and (B) after angioplasty.

**Technical aspects.** The mean maximal inflation pressure was 9.5 ± 2.2 atmospheres (range 5 to 19) with a mean maximal inflation time of 52 ± 18 seconds (range 25 to
An average of $4 \pm 2$ inflations (range 1 to 9) were performed per patient. The mean percent diameter stenosis before angioplasty was reduced from $77 \pm 14$ to $27 \pm 20\%$ ($p < 0.001$), the mean pressure gradient from $49 \pm 16$ to $7 \pm 6$ mm Hg ($p < 0.001$). The mean lesion length was $5.7 \pm 4$ mm and the average graft diameter was $3.4 \pm 0.7$ mm (range 2.2 to 5.0). The mean diameter of the native vessels distal to the anastomosis of the graft was $2.4 \pm 0.4$ mm (range 1.5 to 4.5). Recently, baseline and hyperemic coronary flow reserve using digital subtraction angiography and color mapping techniques have been performed before and after angioplasty (24).

### Results

#### Initial findings

Technical success was defined as reduction in the initial percent diameter stenosis of 35% or more and reduction in the transstenotic pressure gradient to 15 mm Hg or less with no complications requiring coronary artery bypass surgery or resulting in myocardial infarction. In 70 (85%) of the 82 patients all graft and lesion sites were successfully dilated; in 76 (86%) of the 88 grafts all sites were successfully dilated; and in 86 (85%) of the 101 sites technical success was achieved. In all five internal mammary artery-left anterior descending artery grafts, the distal anastomotic site stenosis had successful angioplasty. There were 12 unsuccessful or complicated cases: a) three patients had complications, two with distal embolization, one with total occlusion; b) in six patients there was failure to cross the stenosis; c) in the other three cases, although inflation of the balloon to the maximal pressure limits was achieved, there was insignificant change in the stenosis after angioplasty. These latter three cases were performed before the availability of the “high pressure” balloon and in these instances the measured balloon/graft ratio was below 0.8/1.0.

Despite the use of relatively high pressure (mean = 9.5 ± 2.2 atm) during inflation, many balloons were not fully expanded when measured at peak pressure. These were all standard pressure (< 10 atm) balloon catheters. In one instance, a high pressure balloon catheter was available, and was inflated to 19 atm. The balloon was still indented at 15 atm (Fig. 1C) but fully expanded at 19 atm (Fig. 1D).

#### Definition and predictors of success

Clinical success was defined as technical success in all the grafts and lesions, no complications requiring emergency coronary artery bypass surgery or resulting in myocardial infarction and an improvement in at least one functional anginal class (and improvement in exercise testing with nuclear scintigraphy if available). In this series of 82 patients, 70 had a technically and clinically successful angioplasty in all grafts and stenotic sites. In the 12 unsuccessful cases, the patients were treated medically or with repeat coronary artery bypass surgery.

Patient age and sex, anginal class and duration, diabetes, hypercholesterolemia, smoking history, graft age, native vessel grafted, native vessel diameter, lesion site in graft and percent diameter stenosis and pressure gradient before and after angioplasty were not statistically significant predictors of success. By univariate partial correlation analysis controlling for the percent diameter stenosis before angioplasty, predictors of angiographic (technical) success included a higher measured balloon/graft ratio ($p < 0.001$), higher expected balloon/graft ratio ($p < 0.001$), smaller graft diameter ($p < 0.001$) and shorter lesion length ($p < 0.01$). Using multiple regression analysis, the measured and expected balloon graft ratios (both $p < 0.01$) were the only predictors of success. A measured ratio over 1.1:1.0 was associated with the lowest residual percent diameter stenosis after angioplasty (Fig. 4).

#### Complications

Three patients (3.6%) had either distal coronary embolization (two) or abrupt closure (one) after angioplasty resulting in evidence of myocardial infarction (new Q waves in the electrocardiogram and creatine kinase-myocardial brain fraction of 6% or more). One of these patients (1.2%) underwent emergency coronary artery bypass surgery with embolic debris flushed from the native vessel at the time of surgery (Fig. 5). No hospital deaths occurred in this series. The incidence of major cardiac events (myocardial infarction, emergency coronary artery bypass surgery or death) was 3.6%. In addition, two patients had

### Table 1. Saphenous Vein/Internal Mammary Artery Graft Angioplasty: Distribution of Anatomic Sites, Follow-up and Recurrence of Stenosis

<table>
<thead>
<tr>
<th>Site</th>
<th>Initially No.</th>
<th>Initially %</th>
<th>Follow-Up No.</th>
<th>Follow-Up %*</th>
<th>Recurrence No.</th>
<th>Recurrence %†</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proximal anastomosis</td>
<td>14</td>
<td>14</td>
<td>9</td>
<td>64</td>
<td>3</td>
<td>33</td>
</tr>
<tr>
<td>Shaft</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Proximal third</td>
<td>16</td>
<td>16</td>
<td>10</td>
<td>63</td>
<td>2</td>
<td>20</td>
</tr>
<tr>
<td>Middle third</td>
<td>22</td>
<td>22</td>
<td>7</td>
<td>32</td>
<td>2</td>
<td>29</td>
</tr>
<tr>
<td>Distal third</td>
<td>6</td>
<td>6</td>
<td>4</td>
<td>67</td>
<td>1</td>
<td>25</td>
</tr>
<tr>
<td>Distal anastomosis</td>
<td>43</td>
<td>42</td>
<td>13</td>
<td>30</td>
<td>2</td>
<td>15</td>
</tr>
<tr>
<td>Total</td>
<td>101</td>
<td>100</td>
<td>43</td>
<td>42</td>
<td>10</td>
<td>23</td>
</tr>
</tbody>
</table>

*Percent of initial sites restudied angiographically (for example, 9 of 14 = 64%); †percent of restudied sites (for example, 3 of 9 = 33%).
a minor complication: one had transient heart block and the other an episode of ventricular tachycardia that responded to an intravenous bolus injection of lidocaine.

Patient age, sex, anginal class and duration, diabetes mellitus, hypercholesterolemia, smoking history, graft age, graft or native vessel diameter, balloon size, native vessel grafted, site of lesion in graft, percent diameter stenosis or pressure gradient before and after angioplasty were not statistically significant predictors of procedural complications. By univariate analysis, the only significant predictor of complications was the presence of diffuse atheromatous disease in the grafts (p < 0.05). These grafts were all surgically placed 4 years or more before angioplasty.

**Follow-up.** Of the 70 patients in whom angioplasty was performed successfully, 26 so far have had angiographic restudy at a mean of 7.9 ± 2.1 months after angioplasty. Of the remaining 44 patients, 21 have not yet passed their 6 month postangioplasty follow-up and therefore (by protocol) have not yet had repeat angiography. The remaining 23 patients, who are more than 6 months postangioplasty, have so far refused angiographic restudy because they are clinically asymptomatic, have negative (normal) exercise studies, or both. In our experience, postoperative patients, unless symptomatic after angioplasty (or, for that matter, after coronary bypass surgery) are more difficult to convince to have repeat angiography, no doubt because they have already had several prior invasive procedures.

In the 26 patients with postangioplasty angiographic documentation, all anatomic sites were represented in the follow-up and there was no statistically significant difference in their distribution (Table 1). Restenosis was defined as a decrease of 50% or more of the luminal diameter gain at the time of angioplasty. Of these 26 patients, 16 had all lesions patent and 10 had evidence of recurrence in at least one site. In these 26 patients, 43 grafts had been dilated: 33 grafts were patent and 10 showed evidence of recurrence in at least one site. The patients with patent grafts had normalization (or significant improvement) in exercise (treadmill) testing and no evidence of reversible ischemia by nuclear scintigraphy. In the 10 patients with recurrence, 7 had no change in clinical classification and had exercise
testing abnormalities similar to their preangioplasty test results. The other three patients with recurrence had improvement in their anginal class (class I or II) as well as exercise testing results. These three patients had double graft (or vessel) angioplasty with recurrence in only one graft; they have been continued on medical therapy. Of the seven patients with angiographic recurrence and subjective and objective evidence of ischemia, six have had a second successful angioplasty and one had uncomplicated elective repeat coronary bypass surgery.

**Predictors of graft restenosis at follow-up.** The patient age, sex, anginal class or duration, diabetes mellitus, hypercholesterolemia, hypertriglyceridemia, smoking history, graft age, graft diameter, native vessel grafted, percent diameter stenosis before or pressure gradient before or after angioplasty were not statistically significant predictors of recurrence. Also, it was noteworthy that in our study the site of stenosis in the graft was not a statistically significant predictor of restenosis (Table 1). When using a stepwise multiple regression analysis, the percent diameter stenosis immediately after dilation was a strong predictor of the percent diameter stenosis at follow-up (p < 0.01). Using the same analysis, the interaction of a high percent diameter stenosis immediately after angioplasty and a low measured balloon/graft ratio was also a strong predictor of restenosis at follow-up. In further statistical analyses using restenosis status as the outcome variable, there was a trend in which higher percent diameter stenosis after angioplasty was related to higher incidence of recurrence (p = 0.07) (Fig. 6), and lower "measured balloon/graft" ratio was significantly related to higher incidence of recurrence (p < 0.01) (Fig. 7).

**Functional status and survival.** In this series of 82 patients, with a mean clinical follow-up of 21.4 ± 2.3 months, 71% are in angina class I, 17% in class II and 12% in class III. Eighty patients (97.6%) are alive at the present time. There have been two late (more than 3 months after angioplasty) deaths, one related to graft occlusion. Of the 82 patients, 66 have had angioplasty as their definitive procedure (including the 6 repeat angioplasties) for an overall success (so far) of 80%.

**Discussion**

Several years ago, many considered that the risk of performing coronary angioplasty in postoperative patients was prohibitive. There were higher morbidity and mortality rates in the National Heart, Lung and Blood Institute PTCA Registry (25,26) in patients who had previously undergone coronary bypass surgery. In addition, there was a concern that there would be distal coronary embolization in saphenous vein graft angioplasty, and early results in this cohort reported a high incidence of restenosis.

**Initial success rate.** In our series of coronary graft angioplasty, we report a primary success rate of 85%. In contrast to previous reports (27–29), the degree of residual saphenous vein graft stenosis in our series was not influenced by the location of the lesion in the graft. Structural changes seen in the grafts (30–32) and used to support the variation in the success rate at various sites (33) did not appear to play a significant role in our patients. The difficulties in fully distending the diseased segment of the graft, however, was of primary importance. The only significant predictors of immediate success by multivariate analysis were the measured and expected balloon/graft ratios. We believe that the failure of the balloon to reach its expected diameter at the site of the lesion would be best solved by the use of high pressure balloons (for example, USCI PROFILE PLUS or PE PLUS balloons which are made of polyethylene terephthalate, a substance with high pressure tolerance and low compliance). These balloons can achieve full inflation even with "harder" atherosclerotic plaques (that is, those with a higher percentage of fibrous and/or calcific material).
Morbidity and mortality. The previously noted higher complication rate of patients who were postoperative or had graft angioplasty (25,26) has been countered by recent studies that showed a low incidence of morbidity (27,29,33–36). Our series is comparable with other published data in that regard, showing a major cardiac event incidence of 3.6%. The low morbidity and mortality reported are most likely related to technologic improvements (19) in the last few years as well as to increasing experience of those physicians who perform angioplasty. Incidentally, it is of interest to compare this angioplasty data with the results from surgical centers reporting morbidity and mortality in repeat coronary bypass operations (8–11). In these centers, there were perioperative myocardial infarction incidences of 2 to 12% and mortality rates of 1 to 17%.

Distal coronary embolization of an atheroma was reported by Aueron and Gruentzig (37). In two of our patients, both of whom had diffusely diseased grafts that were at least 4 years old, distal embolization was noted (one proved at surgery). Therefore, we strongly urge avoiding angioplasty in older grafts that show angiographic evidence of diffuse disease (Fig. 5); if medical management cannot control the angina in these patients with diffuse disease in old grafts, then we recommend surgery rather than angioplasty as a second line of therapy.

The need for emergency bypass surgery occurred in only one patient in our series. Yet, we firmly believe that emergency revascularization surgery after unsuccessful graft angioplasty represents a more significant challenge to the cardiovascular surgical team. Surgeons with extensive experience with myocardial revascularization and, in particular, emergency surgery after unsuccessful angioplasty should be at standby for these cases. It may be advisable to utilize an intraaortic balloon pump in patients in whom abrupt closure of a dilated graft occurs after angioplasty (38). This may be especially important in patients who have had prior cardiac surgery, because chest wall and pleuropericardial fibrosis may delay reexposure of the heart during the second (emergency) operation. The intraaortic balloon pump may effectively stabilize the patient during this critical period. Fortunately, this was only necessary in one of our patients.

Follow-up results: graft restenosis. Our clinical follow-up results compare favorably with previously reported saphenous vein graft angioplasty studies (34–36) and also to reports of patients submitted to reoperation for coronary artery disease (8–11). However, the true restenosis “rate” in our series is not precisely known. Only 53% of the 49 successfully treated patients who have reached their 6 month postangioplasty period have had follow-up angiography. Yet, even if we use as the denominator only those patients who have had angiographic documentation postangioplasty, our recurrence rates were 38% for the 26 patients and 23% for the 43 grafts. This would probably be the “worst case” restenosis rate. On the other hand, it would not be fair to state that we had a 14% (10 of the 70 successful cases) restenosis rate, because 21 patients have not passed through the 6 month “window of recurrence” (39,40). In addition, 23 patients who are more than 6 months postangioplasty have so far refused restudy because they are asymptomatic and have improved exercise studies. But “silent” recurrence has been reported in 5 to 14% of cases after angioplasty (39,41). Also, it should be noted that re-recurrence will affect our restenosis incidence as well as the cost-effectiveness of this technique compared with repeat coronary bypass surgery (42).

Restenosis rates of 50% were reported by El Gamal et al. (36) and Reeder et al. (43). Dorros et al. (44) reported 50 and 53% recurrence rates at the proximal anastomotic and graft shaft sites, respectively, and only 18% restenosis rate at the distal anastomotic site. Douglas and coworkers (28) noted the same discrepancy in restenosis rates, with the lowest incidence occurring at the distal anastomotic site. This site variation in recurrence was not corroborated in our study (Table I). However, none of these studies, or, for that matter, ours, had 100% follow-up angiographic documentation. Each recurrence site “cell” was small in these series, as well as in ours, reducing the power of statistical evaluation, making conclusions less reliable.

Nevertheless, one might implicate various pathologic phenomena (30–32,35,45,46) at different sites in the graft. Furthermore, Hollman (35) also noted a higher recurrence rate (as well as acute embolic events) in older grafts. He suggested that this may be related to changing graft disease with age. Early changes in vein grafts are those of intimal hyperplasia (47). In patients with normal lipids, unique ath erosclerotic changes develop after about 3 years (earlier in hyperlipidemic patients) (45). Foam cells may erode through the graft intima and the entire atheromatous plaque may be more friable and more likely to embolize than those seen in the native coronary arterial circulation.

Perhaps the higher residual stenosis after angioplasty reported at the proximal anastomotic site (26,44) may explain the higher recurrence rates previously noted. In our series, however, there was no significant difference in postangioplasty percent diameter stenosis at the various sites in the grafts. The measured balloon-graft ratios were the only statistically significant predictor of immediate (technical) success and long-term results (Fig. 4 and 7).

Prior reports (28,34,44) as well as our data suggest that a significant residual stenosis after angioplasty may affect the long-term patency (Fig. 6). Higher postangioplasty residual stenoses may be due to atheroma that are “hard” (high percentage of fibrous or calcific material) or due to the use of a balloon that is too small relative to the graft diameter. The use of high pressure balloons will certainly permit more effective compaction of “hard” lesions. Furthermore, it would appear that using balloons large enough to achieve balloon/graft ratios of at least 1.1:1.0 may achieve
more optimal initial technical results and, perhaps, increase long-term patency. It should be emphasized, however, that there may be an increased risk of dissection with indiscriminate oversizing of balloons in relation to grafts or native coronary arteries. Therefore, oversizing balloons should be avoided with eccentric lesions on sharp curves in native coronary arteries or grafts (48).

Finally, we suggest that because of problems associated with identifying recurrence “rates” in series with less than 90% angiographic follow-up, “risk” of recurrence may be a more meaningful concept. In this context, risk means the likelihood, as predicted by certain factors, of recurrence of stenosis in a particular patient (for example, patients with lower balloon/graft ratio at baseline may be at higher risk for recurrence). Therefore, risk refers to the cohort of patients who present for angiographic follow-up and is less affected by the number of patients in the original sample.

Conclusions. Saphenous vein and internal mammary artery graft stenoses can be successfully treated with the coronary angioplasty technique. An 85% initial success rate is reported along with an emergency bypass incidence of 1.2%, myocardial infarction incidence of 3.6% and major cardiac event rate of 3.6%. No hospital deaths occurred. These initial results compare favorably with similar angioplasty studies and with the results of reoperation for saphenous vein grafts stenosis. Careful selection of appropriate patients, avoiding those with diffusely diseased older grafts, will further enhance the success rate and decrease the complication rate. The problem of recurrence following native coronary angioplasty has been described in detail elsewhere (41,49–52), but graft angioplasty may offer particular insights into this problem because of the different pathologic processes in saphenous vein grafts. Higher pressure balloons and efforts to achieve slightly larger balloon/graft ratios may lead to a decrease in recurrence rates. Also certain pharmacologic regimens may favorably affect the recurrence rate after graft angioplasty (53,54).

With identification of those factors responsible for success, complications and recurrence, coronary angioplasty may well be the treatment of choice in symptomatic patients with saphenous vein or internal mammary artery graft stenosis.

References


