Percutaneous Angioscopy of Saphenous Vein Coronary Bypass Grafts

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Objectives. We compared the results of percutaneous angioscopy and angiography for detecting critical elements of surface lesion morphology in 21 patients undergoing balloon angioplasty of saphenous vein coronary bypass grafts.

Background. Angiography remains the standard for diagnosing and treating intravascular pathology associated with atherosclerotic coronary artery disease. It has been demonstrated that coronary angioscopy is more sensitive for identifying complex atherosclerotic plaques and intracoronary thrombi in native coronary arteries.

Methods. Angioscopy and angiography were performed before and after angioplasty of “culprit lesions” in bypass grafts. All but one of the patients had unstable angina. The mean age of the saphenous vein coronary bypass grafts was 10.1 ± 2.4 years (range 5 to 15).

Angiography remains the reference standard for the diagnosis and treatment of intravascular pathology associated with atherosclerotic coronary artery disease. Catheter-based treatments such as balloon angioplasty, atherectomy and intracoronary thrombolysis are heavily dependent on variables of angiographic lesion morphology to guide therapy. This is particularly true of stenotic saphenous vein coronary bypass grafts, in which angiographic morphologic features such as the location of a lesion within the body of the graft, diffuse lesions and intravascular filling defects have been associated with an increased risk of procedural complications (1–3).

We and others (4,5) have demonstrated that coronary angioscopy, the direct visualization of the endoluminal surface, is more sensitive than is angiography for the identification of complex atherosclerotic plaques and intracoronary thrombi in native coronary arteries. Angioscopy also yields information regarding subtle details of plaque morphology such as the presence or absence of pigmentation as well as specific details of the surface contour of atherosclerotic plaque (that is, smooth, ulcerated or friable) (6).

The purpose of this paper is to describe the angioscopic surface morphology of stenotic saphenous vein coronary bypass grafts and to contrast and compare these findings with angiographic data.

Results. Restenosis at a prior angioplasty site was present in seven patients. Intravascular thrombi were seen by angiography in 15 (71%) of 21 versus 4 (19%) of 21 grafts by angiography (p < 0.001). Dissection was identified by angiography in 14 (66%) of 21 versus 2 (9.5%) of 21 grafts by angiography (p < 0.01). The presence of friable plaque lining the luminal surface of the vein graft was detected by angiography in 11 (52%) of 21 versus 4 (19%) of 21 grafts by angiography (p < 0.05). There was no correlation between age of the bypass graft and the finding of friable plaque.

Conclusions. We conclude that angioscopy is superior to angiography for detecting complex lesion morphology in bypass grafts and that the presence of friable plaque does not preclude an uncomplicated angioplasty procedure.

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our Institutional Review Board, and informed consent was obtained from each patient.

Angioscopic equipment. The coronary angioscope (Advanced Cardiovascular Systems) is a 4.3F polyethylene catheter that closely resembles a balloon angioplasty catheter. The angioscope has four working channels, including one for inflation and deflation of the occlusion balloon (2.5- to 4.0-mm inflated diameter), a lumen to accommodate the 0.2-mm fiber optic image bundle, one channel for the illumination fibers and a guide wire lumen that permits the infusion of clear crystalloid to displace blood from the distal tip of the scope.

The tip of the angioscope can be directed or steered into coaxial alignment with the lumen of tortuous coronary arteries using a specially designed 0.014-in. (0.36 cm) guide wire with sinusoidal bends in the terminal portion. By withdrawal and rotation of the guide wire, the distal tip of the angioscope is deflected by the bends in the wire. Once the tip of the angioscope is aligned with the vessel lumen, the guide wire may be rotated to allow circumferential viewing of the vascular lumen.

The angioscope has two proximal connectors for coupling 11 illumination fibers to a halogen light source and a 2,000-element fiber-optic imaging bundle is connected to a color television camera. The angioscopic images are displayed on a color video monitor and recorded on 0.75-in. (1.9 cm) videotape.

Angioscopic procedure. The saphenous vein coronary bypass graft with the target lesion was selectively intubated with an 8F coronary angioplasty guiding catheter, and 10,000 U of heparin was administered. Baseline angiography was performed in a minimum of two orthogonal views. The angioscopic wire was advanced across the stenosis and placed in a distal segment of the graft or native coronary artery. The angioscope was then advanced over the guide wire to a location several millimeters proximal to the stenosis. The occlusion balloon was inflated with a mixture of radiopaque contrast medium and saline solution to 1 to 3 atm of pressure, and warm Ringer's lactate solution (2 to 10 ml) was infused through the guide wire lumen to clear blood from the field of view. The angioscopic guide wire was manually rotated and withdrawn into the angioscope while viewing until the lumen and lesion were visualized. The guide wire was then rotated to obtain a circumferential view of the culprit lesion. The duration of the occlusion time was 30 to 45 s per imaging attempt. We intentionally did not cross the stenosis with the angioscope before balloon angioplasty was performed to avoid "Dottering" the lesion.

After imaging, the angioscope was exchanged for an angioplasty balloon catheter, and balloon dilation of the culprit lesion was performed. After angioplasty, the angioscope was reinserted and balloon dilation of the culprit lesion was performed. After angioplasty, the angioscope was reinserted and advanced to the dilated segment of the vein graft and into the distal vessel, and imaging was performed. Finally, the angioscope and guide wire were withdrawn and postangioplasty angiography was performed in a minimum of two views corresponding to the baseline angiographic views.

Angiographic lesion morphology. The angiographic criterion for intravascular thrombus was the appearance of a radiolucent filling defect within the lumen of the vein graft. A dissection was identified by the appearance of a linear contrast stain within the wall of the graft. Friability of the graft was determined from the baseline angiogram by the angiographic appearance of a graft with an irregular or serrated lumen border. Percent lumen diameter stenosis before and after percutaneous transluminal coronary angioplasty was determined by electronic calipers comparing the lumen diameter of the stenosis with nearest proximal normal-segment segment of the graft. The cineangiograms were reviewed by an experienced angiographer (C.J.W.) without knowledge of the angioscopic or clinical information.

Angioscopic lesion morphology. Angioscopic criteria for intraluminal thrombi included the appearance of red material firmly adherent to the vessel wall or a globular red mass suspended within the lumen of the vein graft. Dissections appeared as mobile, whitish fronds of tissue adherent to the vessel wall, or as deep crevices (plaque fractures) extending into the wall of the graft. Friability of the graft was determined from the images obtained before angioplasty and was defined as the presence of fragmented and loosely adherent plaque lining the vessel wall. The angioscopic videotapes were reviewed by an experienced angioscopist (S.R.R.) without knowledge of the angiographic or clinical information.
Statistical analysis. Where appropriate, values are expressed as the mean value ± SD. Continuous variables were analyzed with the Student t test and categoric variables were compared by chi-square analysis. A probability value of < 0.05 was accepted as evidence of a significant difference.

Results

Angioplasty results. All 21 patients had successful angioplasty procedures that reduced the culprit stenosis by >20% with a residual diameter stenosis of <50% without a complication. No patients had clinical or angiographic evidence of distal embolization after angioplasty. During angiographic viewing, some patients had transitory ECG evidence of ischemia or chest pain, or both, that resolved with deflation of the angioplasty balloon and restoration of flow.

Intracoronary thrombi. Combining data obtained before and after angioplasty, angiography demonstrated the presence of intravascular thrombi (Fig. 1) in 15 (71%) of 21 grafts as opposed to only 4 (19%) detected by angiography (p < 0.001) (Fig. 2). The incidence of intracoronary thrombi detected by angiography did not differ between the restenosis graft lesions (71%; 5 of 7) and the primary graft lesions (71%; 10 of 14). There was no correlation between the age of a bypass graft and the presence of thrombus.

Dissection. Dissection was seen either before or after angioplasty in 14 grafts (66%) by angiography versus 2 grafts (9.5%) by angiography (p < 0.01) (Fig. 2). No patients had angiographic evidence of dissection before angioplasty, whereas seven patients had intimal tears seen with angiography before angioplasty. After angioplasty, 2 dissections (9.5%) were seen with angiography, whereas 11 (52.3%) were seen with the angioscope (Fig. 3). The presence of dissection did not correlate with the age of the bypass graft.

Friability. Graft friability was detected by angioplasty (Fig. 4) in 11 grafts (52.3%), with only 4 (19%) by angiography (p < 0.05). Graft age did not correlate with the presence of graft friability. Pigmentation of the plaque was present in 10 (71%) of 14 primary lesions versus 4 (57%) of 7 restenosis lesions (p = NS). Angioscopy confirmed the presence of a friable plaque in three of four grafts identified by angiography. The graft incorrectly identified as friable by angiography had a
complex lesion with a white fibrotic nonshaggy-appearing intimal lining by angioscopy.

**Discussion**

Our data demonstrate the ability of angioscopy to detect features of lesion morphology that are frequently not seen by angiography in saphenous vein coronary bypass grafts. This observation is consistent with prior studies (7–9) in native coronary arteries in patients with unstable angina or non-Q wave myocardial infarction that have shown relative insensitivity of angiography for detecting intraluminal pathologic features such as intracoronary thrombus and plaque rupture. Angiography has also been reported (10–12) to lack precision in documenting the presence of thrombus or dissection in patients undergoing coronary angioplasty. The sensitivity of angiography for any surface morphology will depend on the magnitude of the finding. It is quite easy to understand...
the insensitivity of angiography for mural thrombi or superficial dissections that may be easily visualized by angioscopy but not detected by angiography. In our patients angioscopy proved to be more accurate than angiography in detecting the presence of intraluminal thrombi, dissection; and friability of the endoluminal surface. This superior sensitivity of angioscopy over angiography for identifying intraluminal morphology is consistent with results obtained in native coronary arteries (4,5).

The angiographic appearance of friable lesions or diffuse disease in saphenous vein coronary bypass grafts has been suggested to be a relative contraindication to balloon angioplasty because of the increased risk of distal embolization of atherosclerotic material (2,3). Histologic studies (13-15) of saphenous vein bypass graft stenoses demonstrate the progression from fibrointimal proliferation in early graft lesions (<1 year old) to the development of typical atherosclerotic plaque in grafts >3 years old. These plaques differ very little in their composition from native coronary artery atherosclerotic lesions with the exception that the plaques may be larger in saphenous vein grafts and, because of their bulk, may be more likely to cause clinically significant embolization during angioplasty (13). There are reports (1,3,13,16) that angioplasty of saphenous vein bypass grafts >3 years old (atherosclerotic versus fibrointimal lesions) has been associated with increased risk of distal embolization. However, other investigators (17-21) have not confirmed the increased association of angioplasty complications with any specific angiographic lesion morphology in bypass grafts or an association of older vein grafts with an increased risk of procedural complications.

This uncertainty regarding the risk of embolization and the questionable ability of angiography to identify a high risk subgroup for bypass graft angioplasty may be related to the insensitivity of angiography for detecting friable lesions, as we have shown. None of our patients, including the 11 patients with demonstrable friability of the lumen surface by angioscopy, experienced embolization associated with angioplasty of these older vein grafts. Furthermore, we could not demonstrate that the presence of a friable surface correlated with the age of the bypass graft.

Summary. We have demonstrated that the incidence of intravascular thrombi, dissection and plaque friability are underestimated by angiography in saphenous vein bypass grafts. We have also shown that the angioscopic identification of friable plaque does not preclude an uncomplicated angioplasty procedure; and that in these older grafts there is no correlation between their absolute age and the presence of friable plaque. To determine whether the angioscopic appearance of plaque can predict in which grafts atheroembolism is more likely to occur will require study of a larger number of patients.

References