Transluminal Coronary Angioplasty During Saphenous Coronary Bypass Surgery

A Preliminary Report

EUGENE WALLSH, M.D., ANDREW J. FRANZONE, M.D., ROY H. CLAUSS, M.D., MICHAEL S. BRUNO, M.D., FELICIEN STEICHEN, M.D., SIMON H. STERTZER, M.D.

A previously described balloon tipped dilatation catheter has been used during revascularization surgery to dilate lesions which potentially could limit the runoff of the saphenous bypass grafts. A total of 34 lesions were dilated in 25 patients. Restudy of 12 patients (15 lesions) demonstrated positive results and no clinically significant complications. These preliminary results suggest an important role for transluminal coronary dilatation in the operative treatment of coronary artery disease.

From the Departments of Surgery and Medicine Lenox Hill Hospital, New York, New York

DIFFUSE OR SEGMENTAL, distal coronary occlusive disease may compromise coronary bypass runoff and jeopardize late graft patency. In order to improve coronary runoff in selected cases, distal stenotic segments were dilated with a specially designed dilatation catheter via the coronary arteriotomy site during bypass surgery. This report describes the technique and early results.

Materials and Methods

Each patient considered as a possible candidate for intraoperative coronary angioplasty was informed preoperatively of the availability and status of the technique. They were also encouraged to have coronary angiography prior to discharge.

A total of 34 obstructive lesions or segments were dilated in 25 patients undergoing aortocoronary saphenous vein bypass surgery. There were 23 men and two women between the ages of 45 and 70 (mean: 60 years). Twenty-six of the distal lesions were in left anterior descending coronary arteries and seven in right coronary arteries. The intraoperative dilatations were combined with standard procedures including: 40 coronary artery bypass grafts, two mitral valve replacements, and nine distal coronary endarterectomies with saphenous coronary bypass.

Surgery was performed using normothermic intermittent partial cardiopulmonary bypass with flow adjusted according to left atrial pressure. At operation, all hearts were permitted to contract in normal sinus rhythm. The aortocoronary saphenous vein graft was constructed using a previously described standard interrupted suture technique.[2]

The angioplasties were performed using a modification of the technique developed at the University of Zurich.[6] The catheter consisted of a specially designed miniature polyvinylchloride balloon* (Fig. 1). The balloons were 12–20 mm in length. They vary from 2.0 to 3.7 mm in external diameter when fully inflated. The balloon was inflated to six atmospheres of pressure for 15 seconds at each dilatation site, monitored by a pressure gauge.

After exploring the heart and confirming the preoperative angiography, an arteriotomy site was selected. The specially designed scored catheter was passed into the distal coronary artery ante and/or retrograde according to the lesion site. The catheter tip was always passed beyond the lesion. The balloon was then inflated sequentially back to the arteriotomy or only across the lesion if it appeared well localized angiographically. The balloon was actively deflated prior to changing dilatation site within the coronary. The dilatation catheter was never manipulated like an embolectomy catheter. The balloon catheter was then removed and the aortocoronary bypass completed

Reprint requests: Eugene Wallsh, M.D., Lenox Hill Hospital 130 East 77th Street, New York, New York 10021.

Submitted for publication: June 7, 1979.

* Schneider Medintag AG, Zurich, Switzerland.

0003-4932/80/0200/0234 $00.70

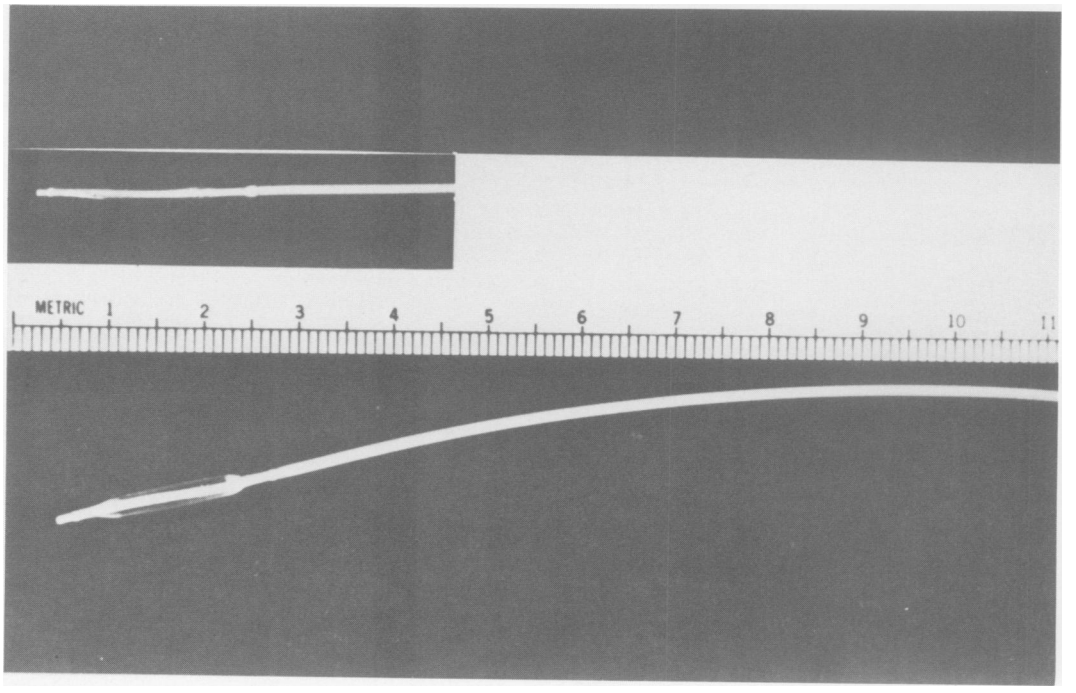

FIG. 1. A prototype miniature inflated balloon catheter for intraoperative coronary dilatation. Insert demonstrates deflated balloon segment.

with an intracoronary shunt technique previously described.[2]

All dilated segments contained an angiographically demonstrable obstructive lesion. On inspection and palpation, the lesions were either isolated or contained within a diffuse atheromatous segment.

Results

There were no deaths in this series. No infarcts were produced as determined by new Q wave or specific cardiac enzyme determinations. No rhythm disturbances were produced by the dilatation. Fracturing of a plaque with a visible hematoma or dissection was never encountered during dilation.

Forty-eight per cent of the patients (12/25) were restudied angiographically between the seventh and twelfth postoperative days. This group contained 44% (14/34) of the dilated lesions.

Eighty per cent (12/15) of these areas were patent and showed increased angiographic luminal diameter (Figs. 2 and 3). This included eight left anterior descending and four right coronary arterial segments. A single right coronary arterial lesion was unchanged angiographically. Two dilated anterior descending obstructions were found to be within closed coronary artery segments proximal to the anastomosis. These areas were heavily and diffusely obstructed prior to the coronary bypass surgery. Any causal relationship between their closure and the dilatation of the segments could not be determined. All saphenous coronary bypass grafts were patent.

Discussion

The insertion of catheters or graduated probes into coronary vessels during aortocoronary bypass surgery has been done to facilitate identification of vessel lumens, assure accuracy of suture placement, and simplify small vessel anastomoses.[2,3,8,9] This can be done at low risk to the patient. The catheters used during this study were originally designed by Dr. Andreas Gruntzig of the University of Zurich. In September of 1977, he performed the first percutaneous transluminal coronary dilatation.[6] This dilation was performed using a long rigid guiding catheter passed from the femoral artery. Through this, a soft flexible balloon tipped dilatation catheter of approximately 1.0 to 1.5 mm in diameter (deflated) was passed subselectively into the coronary artery. The balloon dilatation technique was based on the earlier work of Dotter and Judkins using progressive coaxial catheter dilatation in peripheral vessels to compress stenotic atheroma.[1]

The dilation catheter used in this study is a modified version of the original Gruntzig catheter. Other prototype polyvinylchloride balloon dilating catheters were also used.†

This study is an extension of the collaborative effort to evaluate percutaneous transluminal coronary angioplasty in the treatment of obstructive coronary atherosclerosis. A common scientific protocol for the percutaneous technique has been established be-

† Elecath Corporation, Rahway, NJ.

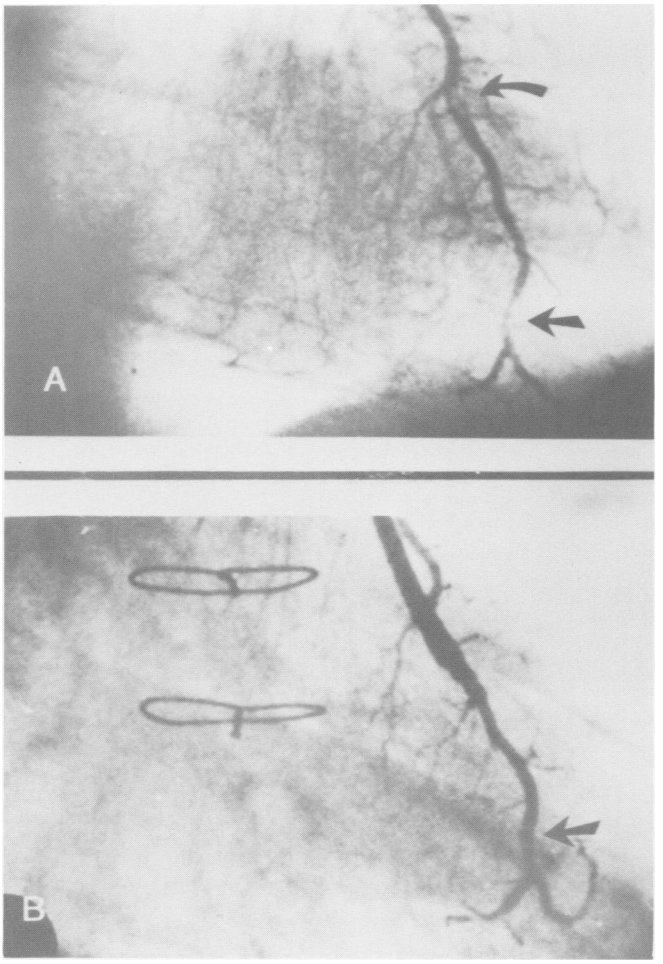

FIG. 2. (A) Preoperative angiographic study of the left anterior descending coronary artery. The curved arrow indicates the proximal lesion. The short straight arrow indicates the distal obstruction. (B) Postoperative angiographic study of the saphenous coronary bypass to the above vessel. The arrow indicates the balloon dilated distal area.

tween Dr. Andreas Gruntzig at the University Hospital in Zurich, Switzerland, Dr. Richard Myler at St. Mary's Hospital in San Francisco, Dr. Simon Stertzer at Lenox Hill Hospital in New York City, and Dr. Martin Kaltenbach at the University of Frankfurt, West Germany. Since part of the protocol calls for some form of antithrombotic regimen, all coronary dilatation patients were placed on dipyridamole and aspirin early in the postoperative period.[5,7,10]

In the present study, the lesions dilated were in the distal anterior descending and right coronary arteries. In those patients restudied, there was angiographic evidence of luminal enlargement. One lesion in the midportion of the right coronary artery was unchanged. This lesion appeared discrete in the preoperative angiograms. Clinically, the lesion was part of a diffusely calcified and sclerotic segment. In other areas, the presence of calcium did not prevent luminal dilatation. It is of interest that no calcified plaques were grossly fractured.

The distal right coronary artery branches, that is, the posterior descending coronary and atrioventricular groove branches, were more diffusely calcified than the distal left coronary system. When the main right coronary artery and its distal branches are uniformly diseased, it has been our practice to electively perform a distal endarterecomy with bypass.[11] We have been unable to consistently pass the dilatation catheter from the main right coronary artery into the terminal branches. Additional technical difficulties encountered in the reported group of patients were inability to consistently advance the catheter across a tortuous anterior descending coronary vessel and inability to pass the catheter retrograde in the anterior descending coronary in its passage behind the pulmonary artery. The two reported closures of dilated

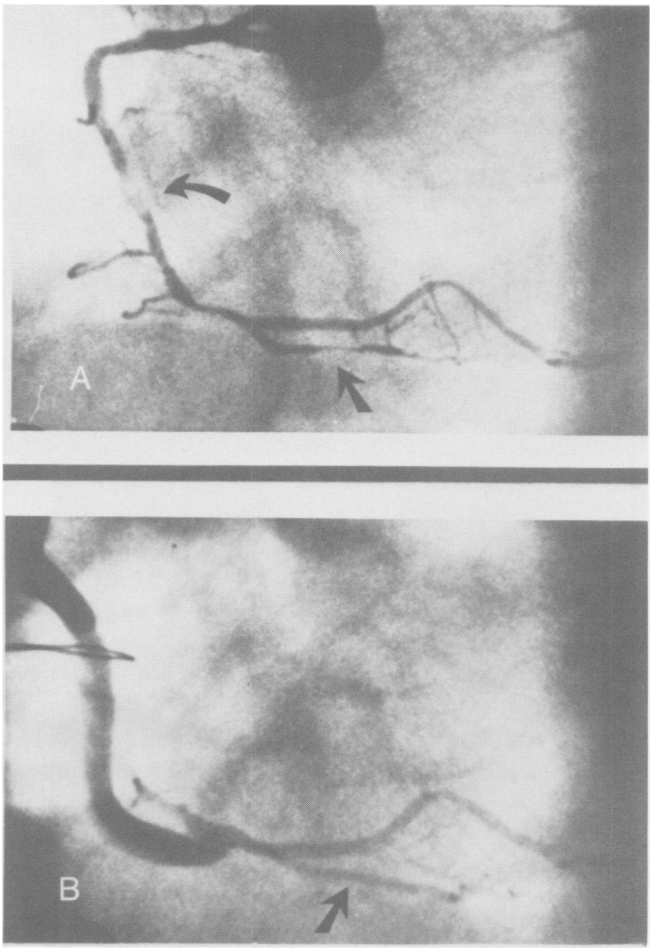

FIG. 3. (A) Preoperative angiographic study of a dominant right coronary artery. The curved arrow indicates a block in the mid-A–V groove portion of the main right coronary artery. The short straight arrow indicates obstruction in the atrioventricular groove branch of the right coronary artery. (B) Postoperative angiographic study of the saphenous coronary bypass to the distal right coronary artery. The arrow indicates the balloon dilated distal area.

segments seen on restudy were encountered in areas just at the pulmonary outflow tract. The possibility of intimal dissection contributing to this closure cannot be excluded. No clear indication of intimal flap damage was present during surgery.

Coronary angioplasty appears to be effective because an increased intraluminal diameter is achieved by the controlled injury resulting from compression of collagenous atheromata by pressure exerted against the intimal surface. Although some intimal damage is inevitable in this process, a dilatation carried out within the true lumen of the diseased artery assures patency, since the intra arterial pressure maintains the integrity of the flow.

In this series, there has been no intimal flap dissection that would interrupt flow and occlude the runoff. In addition to benign postoperative courses, these patients showed no evidence of extravasation, dissection, or distal embolization on angiographic restudy. Complications occurring during the procedure itself should have been made obvious by employing a technique with a beating heart and partial cardiopulmonary bypass support. In addition, millipore filter experiments carried out by Gruntzig and Myler in the operating room on peripheral vessels failed to demonstrate significant plaque embolization.[4] Although the mechanism of coronary dilatation using a balloon catheter sometimes involves compressing collagen containing atheromata, it is clear that in lesions with eccentric obstructive material, part of the dilating process involved the stretching of the non-atheromatous wall. How much this normal wall aleteration contributes to the overall increase in luminal size was not clear.

The long-term effectiveness and patency of these dilatations in improving distal coronary bypass graft runoff remains to be evaluated. The one year follow-up results of percutaneous transluminal angioplasty are however, encouraging and may reflect on the patency of the intraoperative dilatations.

It is conceivable that contrast coronary angiography available in the operating room might extend the usefullness of the technique. However, current experience indicates that most lesions are easily observable on the surface of the vessel. In addition, the lack of complications of coronary angioplasty in this study does not indicate a need for operative angiography.

At present, our only indication for intraoperative balloon dilatation is the presence of an angiographic stenosis that is accessible to the catheter and obstructive to distal runoff. The single contraindication to intraoperative dilatation is based upon work with percutaneous coronary dilatation in the catheterization laboratory. It is the avoidance of dilatations at bifurcations which risk closures of a branch by compression of atheromatous material into the adjacent vessel orifice.

Determining the role of coronary angioplasty in the operating room will require larger numbers of cases followed for long periods of time. However, the initial impression of its effectiveness, combined with the low incidence of its complications, encourages us to continue to evaluate this operative tool.

Acknowledgment

The authors would like to express their gratitude to Mr. Carl Manela for his technical assistance.

References

1. Dotter CT, Judkins MP. Transluminal treatment of arteriosclerotic obstruction. Description of a new technique and a preliminary report of its application. Circulation, 1964; 30: 654–662.
2. Franzone AJ, Wallsh E, Stertzer SH, et al. Reduced incidence of intraoperative myocardial infarction during coronary bypass surgery with use of intracoronary shunt technique. Am J Cardiol 1977; 39:1017.
3. Gros JB, Brantigan CO. Use of a Fogarty biliary catheter to create a bloodless field for saphenous vein-coronary artery anastomosis. J Thorac Cardiovasc Surg 1975; 69:105–106.
4. Gruntzig A, Myler RK. Unpublished data.
5. Gruntzig AR. Transluminal dilatation of coronary artery stenosis. Lancet 1978; i:263.
6. Gruntzig AR, Myler RK, Hanna ES, Turina MI. Transluminal angioplasty of coronary artery stenosis. Circulation (abstr) 1977; 56:84.
7. Gruntzig A, Myler RK, Stertzer SH, et al. Coronary percutaneous transluminal angioplasty: preliminary results. Circulation (abstr) 1978; 58:56.
8. Ludington LG, Kafrouni G, Peterson MH, et al. Technique for using soft, flexible catheter stents in aortocoronary vein bypass operations. Ann Thorac Surg 1976; 21:328–332.
9. Parsonnet B, Gilbert L, Gielchinsky I. Graduated probes for coronary bypass surgery. J Thorac Cardiovasc Surg 1974; 68:424–427.
10. Stertzer SH, Myler RK, Bruno MS, Wallsh E. Transluminal coronary artery dilatation. Prac Cardiol 1979; 5:25.
11. Wallsh E, Weinstein G, Franzone AJ, Stertzer SH. The use of distal right coronary artery endarterectomy and saphenous coronary bypass to decrease total grafts and extend operability in patients with coronary artery disease. *In* Norman JC, (ed). Coronary Artery Medicine and Surgery. Concepts and Controversy. Englewood Cliffs, Appleton-Century-Crofts, 1975. p. 590.