LECTURE

The Impact of Interventional Techniques on the Practice of Cardiology

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Abstract

Coronary angioplasty has dramatically influenced the current practice of cardiology. Introduced only 10 years ago, it is now widely used as a means of revascularizing symptomatic patients with coronary artery disease. It is currently considered the optimal therapy for nearly one half of patients needing a revascularization procedure. Recent studies suggest that the technique can be satisfactorily and effectively used in elderly patients, those with multivessel disease, as well as patients with recent myocardial infarctions. Despite these broadening indications, success rates have risen to more than 90% in most centers while mortality has remained low (1%). Angioplasty is still limited by restenosis or renarrowing of the dilated vessel that occurs in 25–35% of patients within the first six months. Repeat angioplasty is successful in almost all patients and can even be repeated on multiple occasions if necessary. Long-term follow-up shows a low incidence of subsequent death or non-fatal myocardial infarction with a majority of patients asymptomatic after five years. New techniques are now being developed to permit recannulization of chronically totally occluded blood vessels as well as reduce abrupt vessel closure and early restenosis. These techniques include laser angioplasty, atherectomy and intravascular stents. The growth and expansion of angioplasty has given the cardiovascular physician an important new treatment modality for symptomatic patients with coronary artery disease. Its impact on the practice of medicine will be felt for many years to come.

Key words: coronary artery disease, PTCA, laser angioplasty, atherectomy, prognosis

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Ten years ago, Dr. Andreus Guentzig first introduced coronary angioplasty. Since its inception, the field of interventional cardiology has grown dramatically and has made a significant impact in the practice of cardiology. Initially, it was restricted to a small number of patients with mild forms of obstructive coronary disease. Up until 1981, only 3,000 patients had undergone the procedure, however, by 1983, more than 40,000 procedures were done in the United States. During this past year more than 200,000 angioplasties were performed and optimistic estimates indicate that more than 500,000 PTCA's may be done by 1992. The reason for this growth is multifactorial, but in large part is due to improved equipment, greater operator experience and broadening indications.

Initial selection of patients was primarily restricted to patients with single vessel disease who had discrete sub-total non-calcified proximal coronary lesions. These restrictions were necessary because of the limited ability to direct the balloon with a fixed guidewire into distal vessels. In 1981, a number of modifications in balloon catheter design were introduced that allowed independent wire motion coupled with smaller and more trackable catheters that could negotiate tortuous and diseased vessels. In addition, angioplasty operators have gained valuable experience that now has permitted the use of the procedure in patients with multivessel disease. Evidence for this change in patients selection comes from the data of the National Heart Lung and Blood Institute, PTCA Registry, begun in 1977 to assess the early PTCA experience, 3,000 patients were collected between 1977 and 1981. It was voluntarily reopened in sixteen centers between 1985 and 1986 in order to track the changes in PTCA in the United States. During the initial registry period, more than 70% of patients had single vessel disease, compared to 46% in a more recent registry. While multi-lesion dilatations were unusual initially (9.5%) they have become much more common recently (40%). Currently, treated patients are older, have higher incidence of prior MI, prior by-pass surgery, congestive heart failure, diabetes and lower ejection fractions.

In spite of changes in patient selection, the success rate has significantly risen. At least one lesion was successfully dilated in 91% of the cases, and all lesions were successfully dilated in 82% of patients in the current angioplasty registry. This compares to 68% and 63% earlier. This higher success rate was associated with a lower need for emergency by-pass surgery (3.9% vs 6.0%) and an equivalent rate of non-fatal myocardial infarction (4.3% vs 5.1%) and death (1% vs 0.7%).

Using the current guidelines that now include single and multi-vessel disease, approximately 50% of patients presenting to our institution are candidates for revascularization, using the even more aggressive approach that attempts to dilate only the "culprit" lesion, presumably responsible for the patient's symptoms, more than 75% of patients referred for revascularization could receive an angioplasty rather than by-pass surgery. While the majority of the past growth of angioplasty can be accounted
for by the broader application in stable angina patients, there has also been tremendous growth in the use of angioplasty, in the setting of acute myocardial infarction. PTCA has now been shown to be as effective as thrombolytic therapy when used alone and early during the onset of symptoms. However, recent randomized trials now show that angioplasty need not be done immediately if the patient receives adequate thrombolytic therapy. Clinical trials are under way at the present time to determine if all patients who reach thrombolysis should undergo angioplasty of the infarct related artery during their initial hospital stay.4

Perhaps the greatest limitation of angioplasty is restenosis that continues to average 30 to 35% in most centers.5 The majority of patients present with recurrent angina at 3 to 4 months after PTCA and redilatation has shown to be highly effective and associated with a low risk of complications. Clinical studies have shown that male gender, unstable angina, diabetes, hypercholesterolemia, cigarette smoking, multi-vessel disease, ostial, left anterior descending or right coronary lesions and lesions of the by-pass grafts are most likely to develop restenosis. While the mechanism of restenosis is unknown, it seems likely that it is due to the traumatic damage that occurs following angioplasty. As we have previously shown, angioplasty results in severe damage to the vessel wall with splitting of the neo-intimal plaque and stretching the vessel.6 There is an immediate accumulation of platelets that is directly related to the degree of vascular damage. Experimentally, anti-platelet regimens can significantly reduce the incidence of restenosis by preventing platelet accumulation. However, disappointingly, aggressive therapy with anti-platelet drugs or anti-coagulants, as well as calcium antagonists have not altered the incidence of restenosis in clinical trials. Thus current research is more actively investigating the stimulus for smooth muscle cell migration and proliferation in the role of monocytes and macrophages in this process.

If a patient does not develop restenosis, or is successfully redilated, the patient's long-term outcome is excellent, particularly, with single vessel disease.7,9 The overall five year survival of patients entered in the NHLBI, PTCA registry was 92% and 78% of the patients were asymptomatic at five years. This is also supported by the excellent long-term outcome of the 169 patients initially studied by Dr. Gruentzig. Actuarial event-free survival (freedom from death, MI or by-pass surgery) was 79% at six years and 67% of the patients were asymptomatic. The one year, event-free survival in patients with multi-vessel disease is also excellent (78%) with 70% of the multi-vessel patients asymptomatic at one year.13 Reports from many centers now reaffirm that angioplasty can be successfully and safely applied to patients with multi-vessel disease. Whether this form of therapy is better than by-pass surgery, it has not yet been shown by any randomized trial, however, three large multi-center clinical trials are now underway in the United States to examine this question.

Angioplasty is currently limited in its ability to treat patients with chronic total
occlusion (greater than 3 months duration) or patients with diffuse coronary disease. Abrupt vessel closure immediately following angioplasty and restenosis also pose significant problems and add to the morbidity and mortality of the technique. In an attempt to overcome these limitations, many investigators have turned to alternative devices. These have included laser, atherectomy devices and intravascular stints. Direct laser transmitted through fiber-optic fibers vaporizes the atherosclerotic plaque. By removing the plaque and creating a smooth surface, it is hoped that restenosis might be less and acute thrombotic occlusion that causes abrupt closure reduced. Likewise, laser thermal angioplasty vaporizes tissue through heart at a distal metallic tip. Animal studies and clinical experience in peripheral disease using laser thermal angioplasty suggest that acute and chronic complications are less frequent. In addition, laser energy or thermal energy can penetrate total coronary occlusions and thermal angioplasty has been successful in opening vessels and peripheral vessels that otherwise would have to be treated by by-pass surgery. The experience in the use of laser angioplasty in the coronary circulation is too limited at the present time to assess its potential. However, the hope is that it may well demonstrate the same benefits that have been shown in the peripheral circulation.

Atherectomy devices remove the atherosclerotic plaque mechanically. Some do so by slicing off the protruding atheroma and removing it in an enclosed housing, while other devices pulverize the plaque with a rapidly rotating drill. Experience in peripheral vessels demonstrate that these devices are feasible and effective, yet no information is currently available to evaluate their effectiveness in the coronary circulation.

Intravascular stints or metallic expandable coils placed during angioplasty have recently been used in Europe and preliminary reports indicate they are highly effective in reducing restenosis. In addition, they have been effective in managing patients who develop abrupt vessel closure due to vascular dissection. The major complication of these devices has been thrombotic occlusion, necessitating prolonged anti-coagulation. Again, experience is limited, however, the potential in treating angioplasty complications seems great.

The future of angioplasty and other interventional techniques is extremely bright and it is not unreasonable to expect that coronary angioplasty and related techniques will become the primary therapy for the majority of symptomatic patients not adequately treated with medical therapy. It also seems likely that by-pass surgery will continue to flourish, but be reserved for patients in whom angioplasty is not possible or has been demonstrated to be unsatisfactory.

References