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Editorial Comment

Cardiopulmonary Support: The Risk and Benefits of Assisted Coronary Angioplasty*

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The addition of femoral-femoral cardiopulmonary bypass in the catheterization laboratory to support the high risk patient is a challenging new frontier for percutaneous transluminal coronary angioplasty. This new procedure is reported in this issue of the Journal in the form of an initial National Registry (1). Although their work is preliminary, the authors are to be congratulated for cooperating in this joint effort to obtain insight into subset suitability for the utilization of this unique invasive technique. This initial effort is reminiscent of the National Heart, Lung, and Blood Institute (NHLBI) registry started shortly after the introduction of balloon angioplasty (2). The general experience suggests that, as in any new therapeutic advance, risks must be weighed against benefits, and indications and contraindications need to be established clearly.

In this regard, the use of cardiopulmonary support is inappropriate in cases of borderline myocardial dysfunction or where hemodynamic instability would not be a serious consequence of angioplasty. This limitation is especially meaningful because of the 41% morbidity reported during the learning curve in using cardiopulmonary support (1). Extensive arterial and venous incursions and significant blood loss occur in a disquieting number of patients. Peroneal nerve injury also has been seen when percutaneous cannulation and decannulation are utilized (3).

Unresolved questions and problems. There are unresolved questions regarding the manner of introduction and removal of the cannulas. At present, several centers are evaluating cohorts with total-percutaneous, total-open (surgical) cannula introduction and removal or percutaneous cannula introduction with open removal in an effort to determine whether a statistical difference in success and, particularly, in complications exists among these three approaches. There may also be institutional differences, depending on the individual experience of the interventional cardiologists and the involvement of vascular surgeons. Moreover, with decreased cannula size, the percutaneous approach may become more attractive. Two observations are already apparent: 1) hemodynamically unstable patients requiring emergent treatment (e.g., those with full cardiac arrest or cardiogenic shock) should undergo percutaneous cannulation (4); and 2) in cases of hemodynamic collapse, the cardiopulmonary support system is far more effective than intraaortic balloon counterpulsation (5).

Of the many unanswered questions about coronary angioplasty and cardiopulmonary support, one is quite practical. Should patients with markedly depressed left ventricular function and multivessel coronary disease undergo dilation of all lesions at the same sitting (under cardiopulmonary support) or dilation of only the most important vessel—the coronary artery that supplies the greatest amount of ischemic myocardium? Because cardiopulmonary support cannulas should be removed soon after angioplasty, and abrupt closure of more than one artery might lead to catastrophic hemodynamic consequences, we recommend that only the most critical artery be dilated under cardiopulmonary support, the others staged (for later angioplasty), probably without cardiopulmonary support. In cases where the "last remaining vessel" is to undergo angioplasty under cardiopulmonary support, one should choose relatively ideal (discrete, subtotal) lesions that have a high statistical chance of angioplasty success (6–8). Obviously, the lower the incidence of abrupt closure after the removal of the cannulas, the safer the overall procedure, especially if left ventricular function is morbidly depressed. It has always been true of high risk angioplasty that the poorer the surgical risk, the more ideal the lesion should be for angioplasty. This is reemphasized in dealing with high risk patients having coronary angioplasty under cardiopulmonary support because, as the authors (1) point out, four of the seven patients who had abrupt reclosure after decannulation died.

Recent developments. Since this study was concluded (December 31, 1988), several additional observations have been noted.

1) A blood flow of 6 liters/min may not be necessary; most patients have adequate perfusion with three to four liters/min. Therefore, large cannulas could be replaced with smaller ones. With 18F (versus the initial 20F) cannulas, flows >4 liters/min can be maintained (without line cavitation) during the periods of dilation catheter balloon inflation, (9).

2) Rather severe underlying regional myocardial ischemia may develop during angioplasty despite cardiopulmonary

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support. In the absence of significant collateral circulation, increased cardiac output cannot entirely compensate for the regional ischemia during angioplasty. Myocardial lactate production and regional wall motion dysfunction have been demonstrated despite cardiopulmonary support during angioplasty balloon inflation.

3) In addition to cardiopulmonary support, the perfusion balloon has been used concomitantly to reduce regional myocardial ischemia during angioplasty (10). However, certain high risk patients (e.g., those with adequate collateral flow to the target artery) may be treated with the perfusion balloon alone, thereby avoiding the potential complications of cardiopulmonary support. The Registry experience (1) suggests that a left ventricular ejection fraction of ≤25% should be the cutoff point for use of cardiopulmonary support. In addition, the authors conclude that the mortality rate of cardiopulmonary supported angioplasty is high in patients >75 years of age or with left main stem disease, or both, but these are patients at high risk in any case.

Finally, the actual mechanism of myocardial protection during cardiopulmonary support is not entirely clear. How does the maintenance of peripheral organ perfusion help the ischemic myocardium to sustain ≥5 min of balloon inflation resulting in occlusion of a "last remaining vessel" in the presence of depressed left ventricular function? Is this due to preload reduction with associated decreased myocardial oxygen demand or somethiing even more complex?

Conclusions. Future investigation of cardiopulmonary support with coronary angioplasty should document various physiologic variables, such as mixed venous oximetry, cardiac indexes, systemic vascular resistance, quantitative assessments of myocardial ischemia (i.e., lactate), and the effect of adjunctive coronary perfusion balloons on these variables. These are some of the challenges that remain in order to understand better the hemodynamic nature of cardiopulmonary support, and to define more clearly the specific subset of patients in whom its deployment will be most valuable.

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