Pathophysiology And Therapeutics Of Myocardial Ischemia: Proceedings Of The A. N. Richards Symposium

Improved Regional Myocardial Blood Flow, Left Ventricular Unloading, and Infarct Salvage Using an Axial-Flow, Transvalvular Left Ventricular Assist Device

A Comparison With Intra-Aortic Balloon Counterpulsation and Reperfusion Alone in a Canine Infarction Model

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Background. It has been suggested that left ventricular unloading at the time of reperfusion provides superior infarct salvage over reperfusion alone. The purpose of this study was to show that the Hemopump transvalvular axial-flow left ventricular assist device provides superior left ventricular unloading, ischemic zone collateral blood flow, and infarct size reduction compared with intra-aortic balloon counterpulsation and reperfusion alone.

Methods and Results. Eighteen dogs were instrumented with regional myocardial function sonomicrometers in the ischemic and control zones. The left anterior descending coronary artery just distal to the first diagonal branch was instrumented with a silk snare and Doppler flow probe. Additionally, pressure catheters were placed in the left atrial appendage, left ventricular apex, and ascending aorta for hemodynamic measurements. Regional myocardial blood flow was determined by using 15-μm radioactive microspheres. Measurements were made in the control state, immediately after coronary occlusion, at 1 and 2 hours after coronary occlusion, with reperfusion, and 1 hour after reperfusion. In treated animals, left ventricular assistance was maintained during the entire period of occlusion and reperfusion. The Hemopump was associated with a significant decrease in left ventricular systolic and diastolic pressure, whereas mean arterial pressure was maintained. Intra-aortic balloon counterpulsation resulted in no significant changes in left ventricular systolic pressure and a modest decrease in left ventricular diastolic pressure. Regional unloading as assessed by sonomicrometers was significant in the Hemopump animals and absent in the balloon pump animals. Absolute regional myocardial blood flow in the ischemic zone increased slightly ($p=0.002$) in the Hemopump animals and did not change in the balloon pump animals. Infarct size expressed as percentage of the zone at risk was 62.6% in the control animals, 27.22% in the balloon pump animals, and 21.7% in the Hemopump animals.

Conclusions. Mechanical unloading of the ventricle during ischemia and reperfusion appears to result in significant infarct salvage compared with reperfusion alone. The Hemopump appears to provide superior left ventricular systolic and diastolic unloading compared with intra-aortic counterpulsation in a canine model. (Circulation 1992;85:1152–1159)

Key Words • myocardial infarction • coronary disease • reperfusion injury • left ventricular assist device

The concept of salvage of ischemic myocardial tissue by reperfusion therapy has been suggested by animal[1] and human[2] studies. Some investigators have reported that the level of collateral flow to the bed at risk determines ultimate infarct size[3]; others have suggested that the amount of collateral flow and degree of functional recovery are not correlated.[4]

An additional possible benefit of reperfusion therapy is the concept that late reperfusion may not salvage left ventricular (LV) tissue or function but may limit infarct expansion.[5] Additionally, reperfusion may induce further myocardial damage; however, there is no clear consensus regarding the extent or possible modification of this problem.[6] Recent interest has focused on the actions of free radicals and use of free radical scavengers at the time of reperfusion. Unfortunately, at the present time, these studies have yielded conflicting results possibly because of differences in models and agents used.[7,8]

With the development of interventional techniques for salvaging ischemic myocardium, mechanical support of

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