Embolization in Atherosclerotic Vascular Disease

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Embolization occurs during cardiovascular procedures as well as during the natural course of vascular disease. The consequences of embolization range from stroke and myocardial infarction to renal insufficiency and foot ulceration. Large-scale studies have demonstrated the effectiveness of pharmacological intervention in preventing microvascular obstruction. Recently some small studies have demonstrated the usefulness of mechanical emboli prevention devices during angioplasty and stenting.

A number of clinical studies have demonstrated microvascular obstruction in both the coronary and cerebrovascular beds. After an acute myocardial infarction, contrast echocardiography has demonstrated that up to 25% of patients with normal epicardial flow have decreased tissue level perfusion. These findings have been corroborated using MRI studies demonstrating that microvascular obstruction was associated with a worse clinical prognosis after acute myocardial infarction. Transcranial Doppler monitoring during carotid stenting procedures has demonstrated that essentially all patients undergoing carotid stenting have evidence of particulate embolization of the middle cerebral artery. This also occurs during carotid endarterectomy.

Several studies of coronary intervention including CAVEAT and EPISTENT reported higher than expected rates of CKMB elevation which were not adequately explained by side branch occlusion. The best explanation for these infarctions was microembolization to the distal coronary bed.

Coronary artery bypass surgery has a significant incidence of cognitive deficits and stroke. Transcranial Doppler studies have demonstrated that cerebral embolization occurs in all cases and there is a positive correlation between the embolic burden and the degree of brain injury. Most emboli occurred at the time of aortic cross-clamping, initiation of bypass, removal of cross clamping and resumption of cardiac function. Various biochemical markers including the S100 protein have been found to be elevated in these patients and there is some correlation with the degree of cognitive deficit.

Several pharmacological agents have been shown to reduce the incidence of microvascular obstruction in the setting of coronary artery intervention. Neumann and colleagues demonstrated that in patients having an acute MI, who either received Abciximab or heparin, coronary blood flow was markedly improved in the patients receiving abciximab as assessed by Doppler wire. In the large EPISTENT trial there was a 55% reduction in large periprocedural MIs when patients were treated with abciximab during coronary stenting. This reduction in MI translated into a 57% one-year mortality reduction. It is hypothesized that abciximab served to protect the microvasculature which resulted in fewer watershed zone infarctions which are prone to ventricular arrhythmias and could lead to sudden death. Obviously these pharmacological agents are not expected to reduce the amount of embolic debris and probably reduce the degree of platelet aggregation in the microcirculation. Similarly in a recently completed study of 130 carotid stent patients, the group receiving abciximab had a periprocedural stroke incidence of 1.6% while the control group had a stroke incidence of 8%.

Pharmacological agents may serve to reduce the impact of emboli on the microvasculature but ideally the emboli would never be allowed to reach the microvasculature. Towards this goal, a variety of mechanical devices have been developed in the last few years to prevent embolization. These can be grouped into the occlusive category and non-occlusive category. Within the occlusive group there are two categories: distal flow arrest and proximal flow arrest. The distal flow arrest type of devices are embodied by PercuSurge, which is a hollow guidewire with a balloon which is inflated distal to the lesion preventing embolization with aspiration of the artery at the end of the procedure prior to balloon deflation. The proximal flow arrest devices are typified by the ArteriA device which is a guide catheter with a doughnut shaped balloon around the outside of the guide catheter which occludes the artery proximal to the lesion thus causing reversal of the blood flow through the lesion and washing the embolic debris into the guide catheter. Both of these techniques require an intact collateral circulation and thus cannot be used in all patients. The non-occlusive type of devices are all filters and a variety of geometries and materials have been used for these filters. Typically they are umbrella shaped devices which cross the lesion in a collapsed state and then are expanded distally. They are typically made from polyurethane and have pores of approximately 100-micron diameter which allow perfusion to the brain or the heart. At the end of the procedures the filters are collapsed and the trapped debris is removed from the circulation. A number of large studies are being undertaken in coronaries, saphenous vein grafts, and the carotid arteries to evaluate these mechanical devices. Whether there is a synergistic effect between pharmacological agents and mechanical devices remains to be seen. It does appear clear, however, that these new approaches have substantially approached the morbidity and mortality of cardiovascular procedures.