The Heart Surgery

EDITORIAL

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Coronary Artery Bypass Grafting in the Presence of Atheromatous or Calcified Aorta: On-Pump or Off-Pump?

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Moderate or severe atherosclerosis of the ascending aorta occurs in as many as 13% of the patients undergoing coronary artery bypass grafting (CABG) [Wareing 1992]. Although the etiologic mechanisms of adverse neurologic outcomes following CABG are diverse, data from the literature have conclusively shown that dislodgment and embolization of atherosclerotic material from the ascending aorta during surgical manipulations represents by far the most common pathogenic mechanism of perioperative stroke [Roach 1996, Murkin 1999]. As a result, it is not surprising that the adoption of conventional methods of coronary artery grafting in the presence of severe aortic disease substantially increases the risk of adverse neurologic outcome [Wareing 1992].

Although severe aortic atherosclerosis and calcific degeneration of the aorta may be occasionally encountered in younger patients, these incidences increase linearly with age [Wareing 1992]. The actuality of these considerations is particularly important in light of the fact that over one third of the patients undergoing CABG in recent years are age 70 years and older, as shown by the Society of Thoracic Surgeons National Database [STS 1998].

The management of patients needing CABG in the presence of aortic calcification or severe aortic atherosclerosis has traditionally included meticulous preoperative and intraoperative screening. The reason for doing so has been to identify those patients at increased risk of dislodging atherosclerotic material from the diseased ascending aorta [Rokkas 1998] and finding a variety of surgical techniques as an alternative to conventional myocardial revascularization. Modifications of the operative strategy include: avoidance of cannulation of the diseased ascending aorta; cannulating the distal transverse arch or other sites (innominate artery, femoral artery) [Davila-Roman 1991, Mills 1991, Sabik 1995, Baribaeu 1998, Leyh 1999]; avoidance of aortic cross clamping by using hypothermic fibrillatory arrest [Mills 1991, Baribaeu 1998, Leyh 1999]; avoidance of lateral occlusion-clamping by using a single period of aortic occlusion [Salerno 1982]; and construction of proximal anastomoses on inflow sites other than the diseased ascending aorta (innominate artery, subclavian artery, axillary artery, descending thoracic aorta) [Weinstein 1980, Davila-Roman 1991, Leyh 1999].

Alternatively, graft replacement of the ascending aorta or aortic débridement and endarterectomy have been proposed as definitive modalities of treatment in conjunction with coronary revascularization [Culliford 1986, Wareing 1992, Stern 1999]. Although such techniques, used alone or in combination, have been reported to reduce the risk of dislodgment of atherosclerotic material and consequently embolic stroke, they are generally associated with mortality rates significantly greater than those of conventional CABG in the same age–matched patient populations.

Furthermore, none of these techniques totally eradicate the risk of dislodgment of aortic debris and perioperative stroke, as none of them entirely eliminate manipulation of the diseased ascending aorta. In this regard, there has been convincing evidence to suggest that embolization from the ascending aorta may result from a variety of surgical maneuvers such as aortic cannulation, cross-clamping, and lateral occlusion-clamping [Culliford, 1986, Bal-El 1992]. In addition, dislodgment of atherosclerotic material may also occur as a result of the jet of perfusate from the aortic cannula on the diseased aortic wall ("sandblast effect") [St. Amand 1999]. Similarly, femoral cannulation and retrograde perfusion of the descending thoracic aorta and transverse arch in the presence of severe atherosclerotic disease may also result in embolic stroke [Price 1970, Martin 1982].

In view of these considerations, it appears obvious that although these techniques have merit in decreasing the

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incidence of the perioperative stroke to some extent, they do not completely eliminate it and are still associated with substantial mortality rates. In this perspective, the only strategy potentially capable of eliminating the risk of stroke in CABG patients presented with aortic calcifications or severe atherosclerotic disease should include complete avoidance of any type of aortic manipulation in combination with avoidance of cardiopulmonary bypass (CPB) altogether. While avoiding CPB eliminates the need for aortic cannulation and cross-clamping, lateral occlusion-clamping for construction of proximal anastomoses may be avoided by using alternative inflow sites for coronary grafts. Although the innominate artery has been proposed as the alternative inflow source in the presence of the calcified aorta [Weinstein 1980, Suma 1989, Baribeau 1998, Leyh 1999], there has been evidence to suggest that this vessel is likely to be affected by severe atherosclerotic disease when the ascending aorta and the aortic arch are diseased [Davila-Roman 1991, Tobler 1988].

As a result, although the use of the innominate artery as an inflow site for coronary grafts in off-pump coronary surgery may be advantageous in certain situations, such as coronary reoperations [Ricci 2000], its use should be avoided in cases of degenerative aortic disease due to the risk of cerebral embolization from a diseased innominate artery [Terada 1997, Ricci 2000]. In contrast, vein coronary grafts or arterial conduits can be connected to the left internal mammary artery (LIMA) in a T or Y configuration, as originally proposed by Mills and Tector [Mill 1991, Tector 1994]. Although concerns have been raised regarding the capacity of the LIMA to provide adequate flow to more than one coronary territory, several reports from the literature have shown that this vessel may considerably increase its flow reserve when anastomosed to multiple coronary beds [De Paulis 1999, Wendler 1999].

In conclusion, total myocardial revascularization via median sternotomy can be safely accomplished as a result of recent technological advances and the introduction of a new generation of mechanical stabilizers. In the presence of severe atherosclerotic and calcific disease of the ascending aorta, this technique can be modified advantageously. By using the LIMA as a pedicled graft to revascularize the LAD territory and connecting additional coronary grafts to the LIMA itself in a Y configuration, cardiopulmonary bypass and manipulation and instrumentation of the diseased ascending aorta can be avoided. Although long-term results of this technique are not yet available, hemodynamic studies have clearly shown that the LIMA is capable of supporting adequate flow to multiple coronary territories.

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