The “Sandblasting” Effect of Aortic Cannula on Arch Atheroma During Cardiopulmonary Bypass

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A 69-yr-old woman presented with dyspnea on exertion was found to have moderate-to-severe mitral regurgitation with moderate left ventricular dysfunction (estimated ejection fraction was 30%) and was scheduled for elective mitral valve repair. The patient had undergone uneventful coronary artery bypass graft surgery 7 months earlier. Her medical history was otherwise significant for hypertension and diabetes.

Intraoperative transesophageal echocardiography (TEE) confirmed moderate mitral regurgitation and showed diffuse atheromatous disease in the distal aortic arch with a maximal plaque height of 3 mm. Epiaortic scanning was not performed in this case. The mid-ascending aorta was cannulated under direct vision with a 17F Bio-Medicus® (Medtronic Inc, Minneapolis, MN) cannula. This is a straight, wirewound polyurethane cannula with a multiport tip and is usually chosen for femoral arterial cannulation. However, given the patient’s recent previous cardiac surgery and limited visibility of the ascending aorta, the surgeon (D.D.G.) opted for this particular cannula, which offers better flow with less aortic injury than a conventional 22F or 24F cannula. The improved flow characteristics come from the long segment of holes which put the cannula tip near the back wall. The location of aortic cannulation was not changed based on cannula type. After initiation of cardiopulmonary bypass (CPB), a new mobile atheroma was noted in the distal aortic arch, just distal to the tip of the aortic cannula (Fig. 1, see Video 1 available at www.anesthesia-analgesia.org). Although it is possible that this atheroma may have been missed by the pre-CPB routine TEE examination, the possibility of plaque disruption by CPB flow cannot be excluded. Both B-mode and color flow Doppler scans (see Video 2 available online) revealed that the jet stream of flow from the aortic cannula was directed toward the mobile atheroma. The surgical procedure was uneventful. Extracorporeal circulation was maintained at a nonpulsatile flow rate of 2–2.4 L·min⁻¹·m⁻². After discontinuation of CPB and removal of the aortic cannula, TEE examination of the aorta demonstrated the mobile atheroma at the same location, unchanged in character. Her postoperative recovery was unremarkable. There were no adverse postoperative neurological sequelae.

Adverse neurological outcomes have been correlated not only with atheroma in the ascending aorta, but also with those in the arch and descending aorta, and with carotid atherosclerosis (1). Aortic manipulation is usually implicated as being responsible for atheroma detachment and subsequent embolization. However, atheromata may also be detached by the “sandblasting” effect of high velocity aortic cannula flow during CPB that may be directed toward susceptible atheroma (2). Although type of cannula selected (curved versus straight; variable size) may not be associated with a higher incidence of cerebral emboli, location of cannulation (ascending aorta versus distal

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arch) may affect neurological outcome (3). The cannula selected in our case was 17 in. long and projected to a greater length into the aortic lumen than regularly used aortic cannulae, because it was seen by TEE in the distal arch. Effectively, cannulation in our case may be equivalent to distal aortic cannulation due to ultimate location of the cannula tip. Changes in aortic rotational flow have been documented during CPB and could explain the erosive effect of the high-velocity jet from aortic cannulae (4). In a recent report, Pybus described the potential mechanism for atheroma dislodgement due to rotational flow during CPB (5). Another possibility in the case we report is the development of an acute aortic dissection due to shear forces on an atheromatous aorta. We did not see an intimal tear during our case, making the diagnosis of aortic dissection highly unlikely. However, the plaque disruption that occurred during this surgery may have left the patient vulnerable to the future development of an aortic dissection from poorly controlled hypertension.

Intraoperative TEE images during our case demonstrated how a susceptible atheroma may be at risk of detachment due to this sandblasting effect. Thus, surgical neuroprotective strategies aimed solely at identifying ascending aortic atheroma may not be sufficient. Fortunately, the patient did not have a postoperative stroke. Epiaortic scanning may be useful not only with selection of aortic cannulation site, but also adjustment of angulation of the distal tip of the aortic cannula. These echocardiographic images highlight the potential of the juxtaposition of aortic cannula and distal arch atheroma in the etiology of postoperative organ dysfunction.

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