# Aortic arch in the shaggy aorta: challenges and solutions

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## Clinical vignette

An 83-year-old man was referred with an incidentally discovered aortic arch aneurysm. His past medical history was significant for hypertension, dyslipidemia, and prior stent implantation in the right common and internal carotid arteries. Computed tomography angiography demonstrated a 60-mm aortic arch aneurysm with a shaggy aorta involving the arch. Transthoracic echocardiography demonstrated normal cardiac function. Coronary angiography revealed two-vessel coronary artery disease, including an 80% tubular stenosis of the mid left anterior descending artery and a 90% discrete stenosis of the distal left circumflex artery. Accordingly, surgical aortic arch repair combined with coronary artery bypass grafting was planned using a brain circulation isolation technique.

## Surgical techniques

### Preparation

The patient is placed in the supine position to allow for median sternotomy. The right infraclavicular area is prepared and draped to facilitate exposure of the right axillary artery.

### Exposure

A right infraclavicular incision is made to expose the right axillary artery, followed by median sternotomy. Particular attention is paid to careful mobilization and exposure of the left common carotid and left subclavian arteries to allow subsequent clamping.

### Operation

After systemic heparinization, an 8-mm Dacron graft is anastomosed to the right axillary artery, and the arterial line is connected. Venous cannulation is established via the superior vena cava. The left subclavian artery is clamped. The left common carotid artery is then clamped, and an arteriotomy is performed distal to the clamp to permit insertion of a balloon-tipped perfusion catheter. Selective antegrade cerebral perfusion (sACP) is initiated, and cardiopulmonary bypass is simultaneously commenced via the right axillary artery.

Total circulatory arrest is initiated when the rectal temperature reaches 25 ℃. sACP is delivered through a perfusion line connected to a roller pump using a Y-connector, with one limb connected to the balloon-tipped perfusion catheter in the left common carotid artery and the other to the side port of the axillary arterial cannula. The proximal innominate artery is clamped. sACP flow is adjusted to maintain a target line pressure of 200 mmHg (1). The temperature of the perfusate used for sACP is maintained at approximately 25 ℃. The left subclavian artery is not routinely perfused unless the patient is considered to be at increased risk of spinal cord ischemia.

After the distal aortic anastomosis is completed,

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cardiopulmonary bypass is resumed. Any visible debris is meticulously removed while bypass flow is gradually increased. The remaining reconstruction is performed in the following sequence: left subclavian artery, proximal aortic anastomosis, release of the aortic cross-clamp, left common carotid artery, and finally the innominate artery.

### Completion

Coronary artery bypass grafting is performed as follows: a saphenous vein graft, originating as a free graft from the left subclavian artery graft, is anastomosed to the distal left circumflex artery, and the left internal thoracic artery is anastomosed to the left anterior descending artery. After meticulous hemostasis is confirmed, the patient is subsequently weaned from cardiopulmonary bypass.

## Comments

### Clinical results

The patient did not develop a postoperative stroke. He was extubated on postoperative day 1 and remained hemodynamically stable. Transfer to the general ward was delayed until postoperative day 4 because of bed unavailability. Injection laryngoplasty was performed on postoperative day 6 for left vocal fold palsy. Increasing left pleural effusion required percutaneous catheter drainage on postoperative day 12, which was removed 4 days later. The patient continued swallowing rehabilitation and was discharged on postoperative day 22 without further major complications.

### Advantages

In patients with a shaggy aorta, directing the ascending aortic cannula toward the aortic valve has been proposed as an alternative strategy; however, this approach does not completely eliminate the risk of embolization (2). To avoid ascending aortic cannulation, right axillary artery cannulation is frequently employed. Nevertheless, previous reports have suggested that blood flow from the right axillary artery to the ascending aorta and aortic arch may be more rapid than expected (3), and this strategy does not fully prevent embolization through the left common carotid artery.

The brain circulation isolation technique described herein was originally reported by Norihiko Shiiya in 2001 (4). This strategy enables isolation of direct aortic blood flow to both carotid arteries, thereby reducing the risk of cerebral embolization. Importantly, this technique offers a simple yet effective approach for preventing embolic stroke in patients with a shaggy aorta.

Furthermore, implantation of a conventional or frozen elephant trunk prosthesis helps separate circulating blood from atheromatous plaques in the proximal descending aorta. Careful attention is required when cardiopulmonary bypass is resumed to prevent embolization caused by dislodged debris. The sequence of reconstruction is also important. Performing the proximal aortic anastomosis before reconstruction of the brachiocephalic branches may reduce distal atheromatous embolization, as the heart resumes ejection of relatively atheroma-free blood.

### Caveats

Meticulous care is required during exposure of the left common carotid and left subclavian arteries. Excessive manual manipulation or pressure on a shaggy aorta may dislodge atheromatous debris and precipitate embolic stroke. Therefore, minimizing direct aortic manipulation is essential to mitigate this risk.

## Acknowledgments

This manuscript and video introduce the brain circulation isolation technique used at our center when performing aortic arch surgery in patients with a shaggy aorta.

## Footnote

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*Conflicts of Interest:* The authors have no conflicts of interest to declare.

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