

# Aortic Arch Endarterectomy Associated with On-Pump Cardiac Surgery in Patients with a Mobile Arch Atheroma

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We describe aortic arch endarterectomy performed concomitantly with on-pump cardiac surgery in 2 patients with grade V arch atherosclerosis. In both patients, transesophageal echocardiographic findings led to the diagnosis of severe arch atherosclerosis associated with a mobile atheromatous plaque in the aortic arch. The severe arch atherosclerosis was managed with endarterectomy under deep hypothermic circulatory arrest. In patients with severe grade V atherosclerosis in the aortic arch, performing endarterectomy simultaneously with primary cardiac surgery may be justified as a way to reduce the risk of peripheral embolism, including cerebrovascular accidents, with minimal additional surgical risk.

*Key words:* 1. Aorta  
2. Atherosclerosis  
3. Embolism  
4. Endarterectomy  
5. Circulatory arrest

## Case reports

### 1) Case 1

A 72-year-old man with a history of hypertension and smoking presented to the emergency department with sudden-onset dyspnea. He had stage 4 chronic kidney disease. Transthoracic echocardiography showed severe aortic valve regurgitation associated with vegetation on the prolapsed non-coronary cusp, as well as aortic root dilatation (4.3 cm). During transesophageal echocardiography, which was performed to more accurately examine the cardiac valve pathology, an irregularly protruding atheroma was found to be associated with a mobile atherosclerotic plaque in

the aortic arch (Fig. 1). Enhanced computed tomography (CT) was not performed because of the patient's advanced renal disease. Coronary angiography showed an intact coronary artery system. Cardiopulmonary bypass was performed, with arterial perfusion through the right axillary artery using an anastomosed 8-mm graft and 2 direct vena cava cannulations, and the patient was cooled to 20°C (bladder temperature). During the cooling period, the aortic valve was exposed through a transverse aortotomy above the sino-tubular junction. The right coronary cusp had a linear defect due to endocarditis, and 2 other leaflets were prolapsed. The aortic valve was excised. Systemic circulation was stopped at a blad-

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der temperature of 20°C, and unilateral antegrade cerebral perfusion of 600 mL/min was performed with occlusion of the base of the innominate artery and arterial perfusion through the right axillary artery. A transverse arch aortotomy revealed an irregularly protruding atheroma (Fig. 2A, B), with underlying muddy necrotic materials, in the aortic arch. The friable atherosclerotic intima was removed, the underlying muddy atheromatous materials were aspirated, and the calcified plaques were detached from the arch wall and around the os of the cerebral ves-

sels (Fig. 2C, D). After the internal wall of the arch was cleaned, the arch incision was closed with double rows of continuous 4-0 Prolene sutures. During rewarming, a 21-mm pericardial valve was placed with interrupted, pledgeted 2-0 Dacron mattress sutures. The circulatory arrest time was 31 minutes, and the cardiopulmonary bypass time was 203 minutes. The patient was taken off cardiopulmonary bypass without event. Extubation was possible on postoperative day 2 and the patient had no gross neurological deficits. The patient was maintained on intravenous heparin until extubation was performed, and warfarin was commenced with a target international normalized ratio of 2.0. The patient was discharged on postoperative day 20.

Three months after the first operation, the patient received left carotid artery stenting because of dizziness secondary to carotid artery stenosis. He returned to normal activities and remains well at 14 months after surgery. Written informed consents were obtained from the patient.

## 2) Case 2

A 77-year-old man presented to a peripheral hospital with sudden-onset chest pain. Coronary angiography showed severe 3-vessel coronary artery disease. Grade V arch atherosclerosis, with a mobile plaque in the lesser curvature of the distal aortic arch, was diagnosed with both transthoracic and

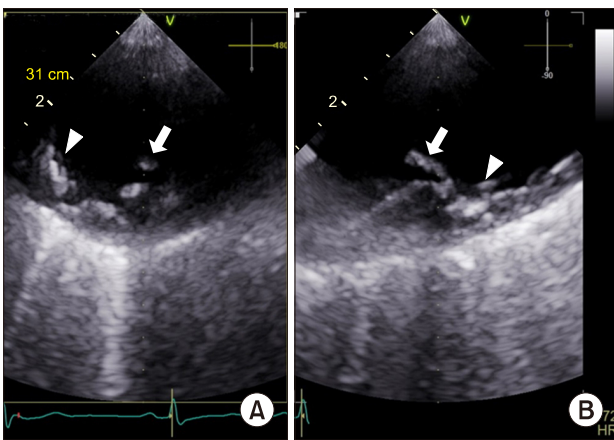


Fig. 1. (A, B) Transesophageal echocardiograms (short-axis and long-axis views) demonstrating a mobile atherosclerotic plaque (white arrows) and irregularly protruding atheromas (arrowheads) in the aortic arch.

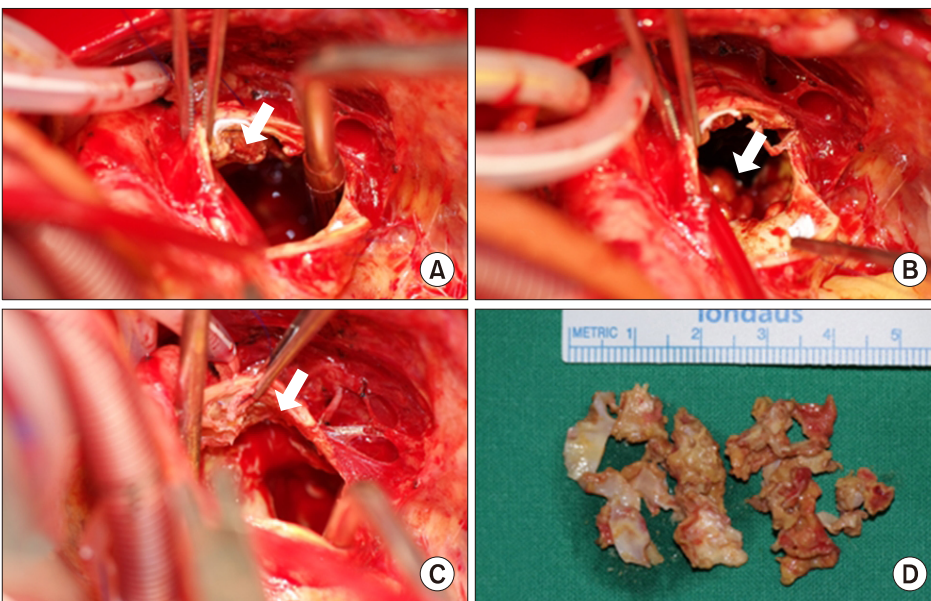


Fig. 2. (A, B) Irregularly protruding atheromas (white arrows) in the aortic arch; (C) arch wall cleaned by endarterectomy around the innominate artery os (white arrow); and (D) friable atherosclerotic plaques removed from the aortic arch.

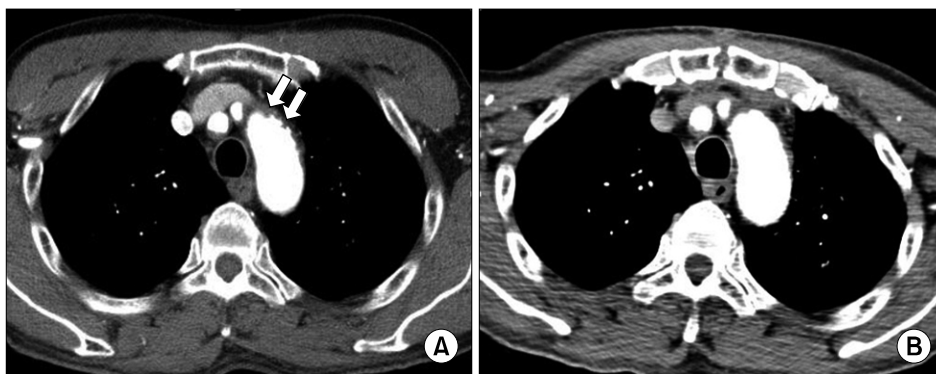


Fig. 3. (A, B) Computed tomography angiograms showing an irregular internal wall in the aortic arch (arrows).

transesophageal echocardiography. CT angiograms showed an irregular internal wall in the aortic arch (Fig. 3A). The patient was transferred to our department for coronary artery bypass surgery and arch endarterectomy.

During cardiopulmonary bypass through the right axillary artery using an 8-mm graft, the bladder temperature was lowered to 18°C via a 2-stage right atrial venous cannula. During the cooling time, 2 vein grafts were anastomosed to the obtuse marginal branch and the distal right coronary artery. After the systemic circulation was stopped at a bladder temperature of 18°C, unilateral antegrade cerebral perfusion was performed through the right axillary artery perfusion line with clamping of the base of the innominate artery. Through a transverse arch incision, the friable atherosclerotic intima was removed, along with the underlying necrotic materials and calcified plaques. After the internal arch wall was cleaned, the arch incision was closed. During rewarming, the left internal mammary artery graft was anastomosed to the left anterior descending artery, and aortic anastomoses of the 2 vein grafts were performed under tangential clamping of the ascending aorta. The circulatory arrest time was 29 minutes, and the cardiopulmonary bypass time was 197 minutes. Extubation was performed on day 1 with no gross neurological deficits. The patient was discharged on post-operative day 18 and he remains well 12 months after surgery. Written informed consents were obtained from the patient.

## Discussion

The severity of aortic atherosclerosis is classified as grade I (no intimal thickening), grade II (intimal

thickening 1–3.9 mm without atheroma), grade III (atheroma <4 mm), grade IV (intimal thickening or atheroma >4 mm), and grade V (any mobile or ulcerated atheroma) [1]. Transesophageal echocardiography is the modality of choice for the diagnosis of aortic atheromas [2], although CT, magnetic resonance imaging, and intraoperative epiaortic ultrasound are complementary. A study that including prospective cohorts evaluated with transesophageal echocardiography [3] established the presence of aortic arch atheroma (especially plaques >4 mm or mobile plaques) as a risk factor for cerebrovascular disease, and as a high risk factor for recurrent stroke [4]. The presence of aortic plaques proximal to the descending thoracic aorta is an established risk factor for ischemic stroke, and it has been linked to a 2.5- to 9-fold increase in stroke risk in case-control studies [5].

Most patients who undergo arch thromboendarterectomy have peripheral arterial embolization secondary to a friable thrombus situated in the aortic arch [6]. A previous study indicated that in patients who require on-pump cardiac surgery, high-grade arch atherosclerosis should be concurrently managed with the main cardiac surgery [6]. Preoperatively, our patients did not yet have symptoms or signs caused by peripheral embolization, although they had mobile atheromas in the arch. If arch endarterectomy had minimal surgical risk, it could be valuable for preventing future embolization in cases where the entire arch wall consists of superimposed thrombi and friable atheromas. During cardiopulmonary bypass, standard aortic cannulation for arterial perfusion should be avoided to prevent systemic embolization from friable atheromas in the aortic arch. Hypothermic circulatory arrest is useful for the management of

arch atheroma, as in surgery for acute aortic dissection, aortic arch replacement, pulmonary thromboendarterectomy, and aortic valve replacement in patients with a porcelain aorta. Elective operative management and circulatory arrest may be considered as the best option for primary cardiac surgery and arch endarterectomy. A few studies have reported that aortic thromboendarterectomy for patients with grade IV and V aortic plaques at the time of aortic valve replacement or coronary artery bypass grafting had an acceptable risk and a low recurrence rate [7]. After arch endarterectomy, there may be concerns about delayed aortic dissection or dilatation. However, the atherosclerotic arch wall is quite different from the thinner and weaker wall in cases of thoracic or abdominal aortic aneurysms. In our patients, the cleaned arch had a hard porcelain wall, which was not flexible; however, it was strong, since it was able to handle the blood pressure.

Aortic hemiarch or total arch replacement can be another treatment option for patients who have high-grade aortic arch atherosclerosis, although a longer total circulatory arrest time would be expected. However, for patients with various comorbidities (e.g., chronic kidney disease, chronic obstructive pulmonary disease, or other conditions), minimizing the circulatory arrest time is important for the patients' postoperative recovery. Therefore, aortic arch endarterectomy is preferable for those patients instead of arch replacement.

In conclusion, few reports have investigated endarterectomy of grade VI and V aortic arch atherosclerosis as a way to prevent systemic embolization. In our experience, the procedure was not complex, and was performed without surgical complications. Transthoracic or transesophageal echocardiography and, sometimes, CTs are the methods of choice for diagnosing severe grade V arch atherosclerosis, which appears as irregular, thick, loose atherosclerotic intima with a mobile plaque in the aortic arch. In patients who require on-pump cardiac surgery, such as aortic valve replacement or coronary bypass surgery, arch endarterectomy under deep hypothermic circulatory arrest can be performed simultaneously with minimal additional surgical risk.

### Conflict of interest

No potential conflict of interest relevant to this article was reported.

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