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Emergency One-Stage Hybrid Surgery

for Ruptured Aneurysm of the Distal Aortic Arch

Rupture of an aortic arch aneurysm is a life-threatening condition that requires emergency operation. For rupture of a distal arch aneurysm, we performed—with the patient under total circulatory arrest—an emergency total arch replacement with an elephant-trunk procedure, followed by one-stage antegrade stent-grafting. Prompt institution of cardiopulmonary bypass and total circulatory arrest has the advantage of lessening the risk of overt aortic rupture in this emergency situation. (Tex Heart Inst J 2013;40(3):343-6)

Rupture of an aneurysm of the aortic arch is a life-threatening condition that necessitates emergency surgery. Recent advances in the field of hybrid surgery have led many surgeons to choose a procedure less invasive than conventional open surgery, especially in cases of ruptured aneurysm of the arch.

This report was approved by the institutional research board and ethics committee at Sejong Heart Institute, Sejong General Hospital, and patient consent was waived.

Case Report

A 71-year-old man with hypertension presented at the emergency department of our hospital with ongoing back pain. He had experienced an initial loss of consciousness when the back pain had begun abruptly, 5 hours earlier, but he recovered soon after. His vital signs were relatively stable; he maintained a systolic blood pressure within the range of 70 to 110 mmHg. A chest radiograph showed a mediastinal widening. Chest computed tomography (CT) revealed an aneurysm involving the distal aortic arch and the proximal descending aorta. A periaortic mediastinal hematoma and a left hemothorax, which were consistent with aortic rupture, were observed (Fig. 1). The maximal diameter of the aneurysm was 65 mm.

We performed an emergency one-stage hybrid arch operation. After median sternotomy, we encountered a large number of mediastinal hematomas. Heparin (5,000 IU) was given intravenously before clamping of the brachiocephalic artery. An 8-mm Vascutek® Gelweave™ graft (Vascutek Ltd., a Terumo company; Renfrewshire, Scotland) was anastomosed to the proximal side of the brachiocephalic artery. After the anastomosis, the remaining dose of intravenous heparin (3 mg/kg) was administered. Using the arterial cannula connected to the extended graft and the single 2-stage venous cannula in the right atrium, we instituted cardiopulmonary bypass (CPB) (Fig. 2A).

Key words: Aorta, thoracic/surgery; aortic aneurysm, thoracic/surgery; aortic arch/surgery; aortic rupture/surgery; blood vessel prosthesis implantation/methods; endovascular procedures; stents

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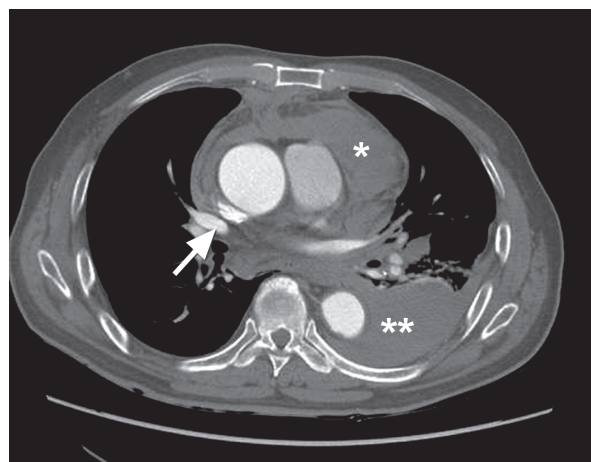


Fig. 1 Preoperative computed tomogram shows a distal arch aneurysm, measuring 65 mm in diameter, at the level of the right superior pulmonary vein (arrow).

Double asterisk = left hemothorax; single asterisk = mediastinal hematoma

At the nasopharyngeal temperature of 20 °C, hypothermic circulatory arrest was initiated. During that arrest, bilateral antegrade cerebral perfusion was performed. For myocardial protection, blood cardioplegic solution was infused intermittently through the ret-

rograde cannula every 15 to 20 minutes. A total arch replacement with an elephant-trunk procedure was performed using a 24-mm Gelweave 4-branch collared graft. The deeply seated left subclavian artery was ligated (Fig. 2B). In consideration of the urgent situation,

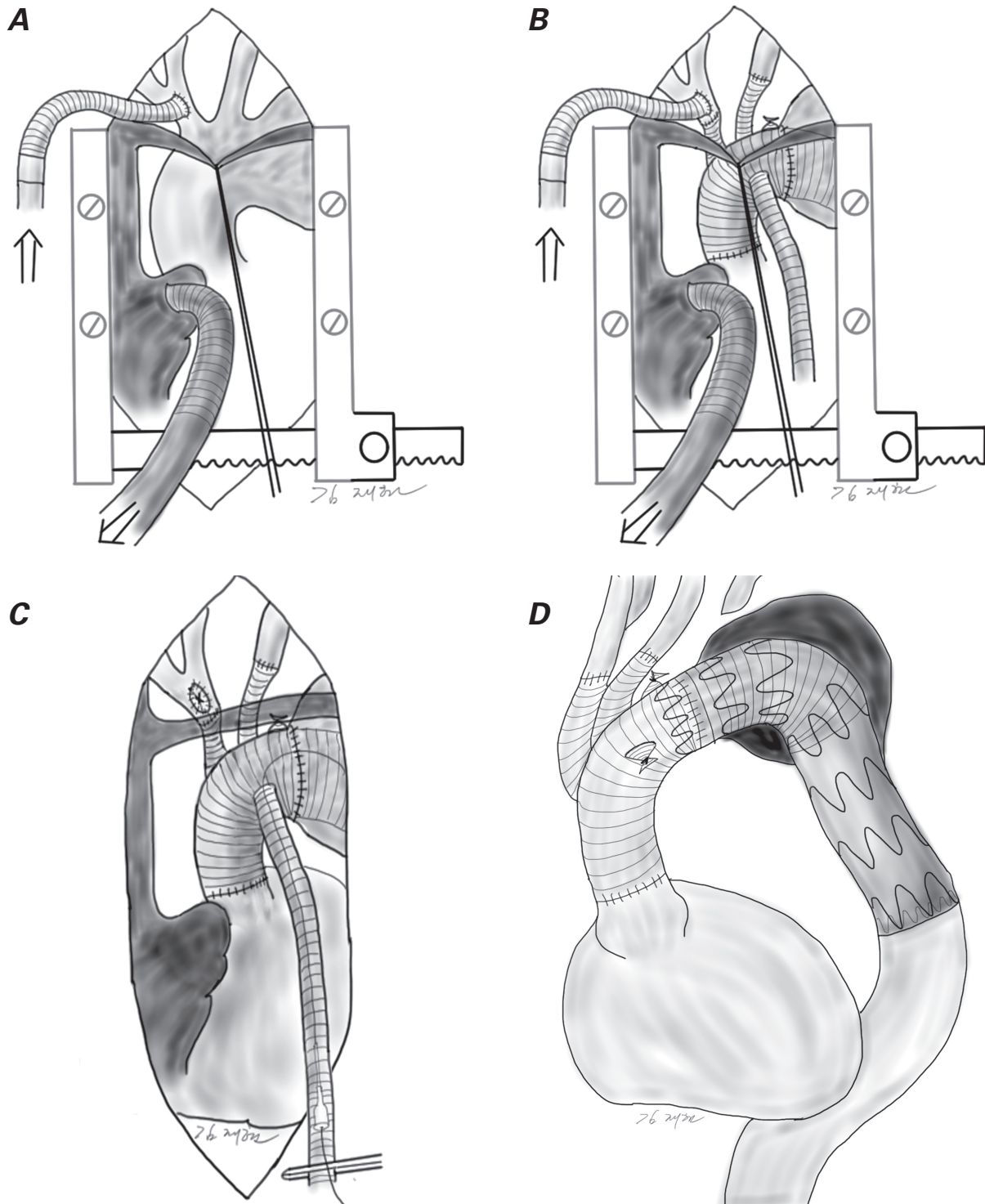


Fig. 2 Schematic drawings after each stage of the operative sequence. **A**) Cannulation for cardiopulmonary bypass (arterial cannula to the brachiocephalic artery, venous cannula from the right atrium); **B**) view after total arch replacement with elephant trunk graft; **C**) antegrade deployment of the thoracic stent-graft after weaning from cardiopulmonary bypass; and **D**) completion of the hybrid arch operation.

we did not perform a carotid–subclavian artery bypass. The CPB time, cardiac ischemic time, and total circulatory arrest times were 191, 149, and 42 minutes, respectively.

After weaning the patient from CPB, we partially reversed the heparin with protamine. Thoracic endovascular repair was performed using the remaining 10-mm branch of the 4-branch graft as a conduit (Fig. 2C). A 30 × 30 × 200-mm Valiant® Thoracic Stent Graft (Medtronic Vascular, Inc.; Santa Rosa, Calif) was deployed antegrade. A C-arm fluoroscope was used to guide the wire and the stent-graft. The proximal landing zone was marked with a radiopaque material sutured onto the graft. A Reliant® Stent Graft Balloon (Medtronic Vascular) was used for the ballooning of the stent. The stent was seated proximally on the elephant trunk and was landed distally on the T7 level. After its deployment, the conduit graft was ligated and resected. Heparin was fully reversed with protamine (Fig. 2D).

The left hemothorax, which had been caused by rupture of the aneurysm, was drained 3 days after the operation. Through the left chest tube, 1,000 cc of dark blood was drained initially. The postoperative course of treatment was uneventful. Extubation and ward transfer occurred on postoperative days 1 and 3, respectively. A one-week course of antibiotics for a mild pneumonic infiltration of the right lung further extended the patient's hospital stay until postoperative day 20.

The last CT image, taken 4 months after the operation, showed a well-seated thoracic stent without endoleak or stent migration (Fig. 3).

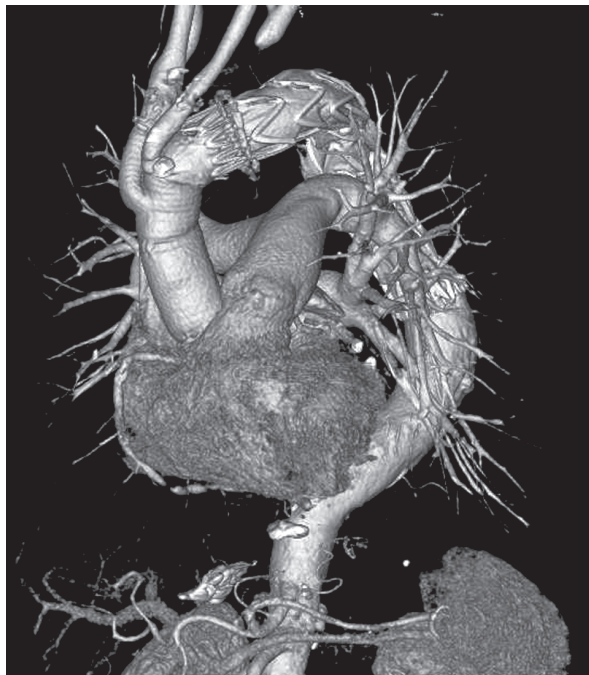


Fig. 3 Follow-up computed tomogram at 4 months shows a well-seated stent-graft with no endoleak.

Discussion

Conventional surgical repair of a ruptured aneurysm of the thoracic aorta carries high morbidity and mortality rates.¹ However, thoracic endovascular stenting procedures have shown encouraging outcomes for the treatment of ruptured aneurysms of the thoracic aorta.^{2,3}

When a ruptured thoracic aneurysm involves arch vessels, emergency hybrid surgery can be an alternative to open surgery. One type of hybrid operation, the arch-debranching procedure complemented by thoracic endovascular stenting, can circumvent the need for CPB.^{4,5} However, that alternative carries the risk of overt rupture, because it is performed under the conditions of heparinization and uncontrolled blood pressure. To reduce the risk of total aortic rupture while opening the sternum, some investigators have used temporary femorocarotid bypass.^{6,7} Temporary femorocarotid bypass can be applied in a small number of very limited situations, but it is a time-consuming procedure that still carries the risk of overt rupture during its performance.

Total arch replacement with an elephant-trunk graft, complemented by thoracic stenting—the so-called “frozen elephant-trunk procedure”—carries risks related to the use of CPB and total circulatory arrest.^{4,5} However, data collected from meta-analyses^{5,8} have revealed results that are equivalent to those of the debranching type of hybrid operation. For repair of a ruptured arch aneurysm, the frozen elephant-trunk procedure can maintain blood pressure at less than 80 mmHg: CPB is begun immediately after sternotomy, thereby preventing overt aortic rupture.

For the patient whose case we describe here, we deployed the thoracic stent-graft after weaning him from CPB, because we did not have a suitable stent-graft for the frozen elephant-trunk procedure. In addition, we avoided the risk of aortic injury or rupture that would have accompanied blind deployment of the stent-graft under total circulatory arrest. Moreover, nitinol-based stent-grafts preclude ballooning on landing zones when the patient is under deep hypothermia, a disadvantage that could lead to endoleak after the initial procedure. Although concerns regarding overt aortic rupture after weaning from CPB could be raised, we assumed that the 8- to 10-cm length of elephant trunk would cover the ruptured aneurysmal arch and prevent overt rupture before thoracic stent-grafting could be accomplished.

Conclusion

Emergency total arch replacement with elephant-trunk placement and one-stage thoracic stenting can be an option for the treatment of ruptured aneurysms of the aortic arch. The risks and benefits of CPB and total circulatory arrest should be evaluated on the basis of each patient's condition.

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