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Case Report
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Reconstruction of the Left Subclavian Artery During Circulatory Arrest for Total Arch Replacement with Frozen Elephant Trunk

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Abstract

In recent years, the use of frozen elephant trunk for distal aortic arch aneurysms has become more common, facilitating total arch replacement. Specifically, when the distal anastomosis is located between the left common carotid artery and the left subclavian artery, the left subclavian artery can be reconstructed either through a bypass to the left axillary artery or creation of a fenestration in the stent graft system. In our case, a technique to securely and safely reconstruct the left subclavian artery was adopted by performing an anastomosis within the mediastinum during circulatory arrest before the distal anastomosis. This report describes this approach.

Keywords: Frozen elephant trunk; Total arch replacement; Left subclavian artery

Introduction

Open stent grafts for total arch replacement are now widely used in cases of thoracic aortic aneurysms, with favorable outcomes being reported [1]. When performing the distal anastomosis in total arch replacement between the left common carotid artery and the left subclavian artery (zone 2), methods for reconstructing the left subclavian artery have included extra-anatomical bypass to the left axillary artery or creation of a fenestration in the frozen elephant trunk for acute type A aortic dissection [2,3]. In Japan, the frozen elephant trunk, which combines an open stent graft with a vascular prosthesis, has become commercially available, and its use is expected to increase. Here, we report a method for performing the distal anastomosis at zone 2 using the frozen elephant trunk with a vascular prosthesis.

Methods and Results

The patient was an 82-year-old man. Twelve years ago, he underwent endovascular abdominal aortic repair for an infrarenal abdominal aortic aneurysm. Follow-up computed tomography revealed a saccular distal aortic arch aneurysm measuring 67 mm (Figure 1), and the patient was referred to our department for surgical treatment of this aneurysm. Accordingly, he underwent total aortic arch replacement using a frozen elephant trunk (Thoraflex Hybrid).

Cardiopulmonary bypass was established, and systemic cooling was performed to rectal and tympanic temperatures of 30 and 23°C, respectively, followed by lower body circulatory arrest. Selective cerebral perfusion was performed by inserting 14-Fr and 12-Fr cannulas into the brachiocephalic artery and left common carotid artery, respectively. The aortic arch was transected between the left common carotid artery and the left subclavian artery. During lower body circulatory arrest, the left subclavian artery was dissected distally, clamped, and transected, with its origin sutured and closed. The branch graft for the left subclavian artery on the Thoraflex Hybrid graft was trimmed, and an end-to-end anastomosis was performed between this graft branch and the left subclavian artery (Figure 2). Following the anastomosis, a 12-Fr cannula was inserted into the graft branch to augment the selective cerebral perfusion. After confirming hemostasis at the anastomosis site, the Thoraflex Hybrid (30/32 mm × 150 mm) was inserted into the aortic arch and deployed. Following the anastomosis of the aortic arch, the graft branches for the left subclavian artery were anastomosed, followed by proximal aortic anastomosis and reconstruction of the left common carotid artery. The reconstruction of the brachiocephalic artery marked the end of the surgery. The operation time was 3 h and 20 min, with a lower body circulatory arrest time of 50 min. The time required for the left subclavian artery reconstruction was 24 min.

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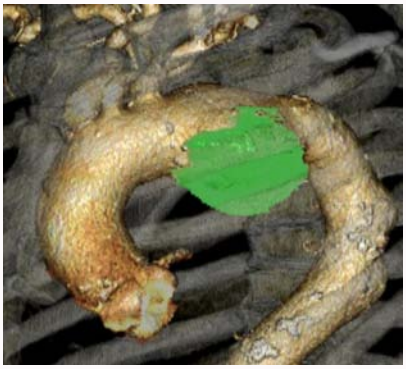

Figure 1: Three-dimensional preoperative computed tomography.

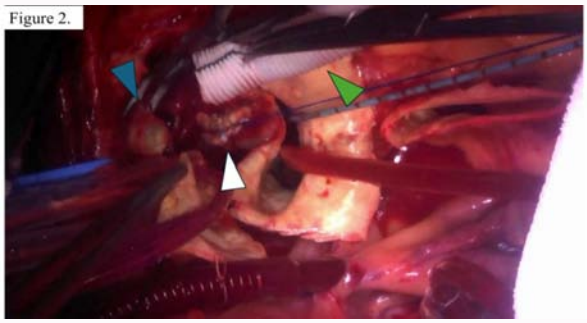

Figure 2: Intraoperative findings during the left subclavian artery. The blue, green, and white arrowheads indicate the clamped left subclavian artery, graft side branch, and closed origin of the left subclavian artery, respectively.

Discussion

Open stent grafts have been used for thoracic aortic aneurysms and acute aortic dissections, demonstrating favorable outcomes. When using open stent grafts for thoracic aortic aneurysms, the distal anastomosis is often performed between the left common carotid artery and the left subclavian artery (zone 2), shifting the challenging distal anastomosis of total arch replacement as proximally as possible. However, in such cases, the reconstruction of the left subclavian artery presents challenges, requiring either extra-anatomical bypass to the left axillary artery, fenestrated frozen elephant trunk technique [2], or reconstruction in a very deep and narrow field following the distal anastomosis.

Extra-anatomical bypass to the left axillary artery requires an additional incision site and use of a long prosthetic graft, which increases the risk of graft occlusion. The fenestrated open frozen elephant trunk technique is not a recommended usage as per the approved package insert. Furthermore, for acute type A aortic dissection, studies have indicated that endoleaks from the fenestrated portion have posed significant issues [4,5]. Furthermore, total arch replacement using the frozen elephant trunk in zone 2 often require longer open stent grafts. To minimize the risk of spinal cord injury, the use of long open stent grafts has been reported. To minimize spinal cord injury, ensuring reliable reconstruction of the left subclavian artery is essential. However, reconstruction using long grafts or performing surgery in unstable and constrained surgical fields may not align closely with the strategies aimed at reducing the risk of spinal cord injury.

As a safe and reliable method for left subclavian artery reconstruction, performing reconstruction during circulatory arrest, as in the presented approach, is a valuable option. However, with a conventional frozen elephant trunk, the formation of the distal anastomosis stump and anastomosis itself require significant time, potentially prolonging the circulatory arrest duration. In this context, the use of frozen elephant trunk with vascular prosthesis—combining a prosthetic graft and a stent graft—proved beneficial by simplifying the distal anastomosis and thereby allowing for the reconstruction of the left subclavian artery during circulatory arrest. We performed this procedure in nine cases, including the present case. Four of these cases were surgeries for acute type A aortic dissection. In these cases, the average durations of lower body circulatory arrest and left subclavian artery reconstruction were 57 ± 9 and 26 ± 4 min, respectively. This duration of circulatory arrest is acceptable and allows for reliable anastomosis of the left subclavian artery. This method is applicable to thoracic aortic aneurysm and acute aortic dissection cases. Therefore, we consider this method particularly useful when using a frozen elephant trunk with a vascular prosthesis.

Conflict of Interest

Nothing to disclose.

Informed Patient Consent

Informed consent was obtained from the patient for this report.

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