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Case Report

A Case of Thoracic Endovascular Aortic Repair Using Carotid Access with Axillary–Carotid Bypass for Descending Aortic Aneurysm in a Patient with Aortoiliac Occlusive Disease

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The authors report a 71-year-old male with descending thoracic aortic aneurysm and multiple risk factors (aortoiliac occlusive disease, obesity, ascending aorta dilatation, and history of left ventriculoperitoneal shunt for hydrocephalus) who was treated with thoracic endovascular aortic repair (TEVAR) via left common carotid artery (LCCA) access and left axillary–carotid artery (Ax–CA) bypass; this approach shortened the LCCA clamp time during the procedure. The patient was discharged without any complications. TEVAR via LCCA access with left Ax–CA bypass is a useful and safe procedure for patients in whom conventional femoral artery access is not feasible.

Keywords: antegrade thoracic endovascular aortic repair, left carotid artery access, axillary–carotid artery bypass

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Introduction

Thoracic endovascular aortic repair (TEVAR) is widely used for the management of thoracic aortic aneurysms (TAAs). However, access to the thoracic aorta can occasionally be difficult because of the need for delivery sheath of large sizes,[1,2] and aortoiliac occlusive diseases make standard femoral access impossible. In cases where standard femoral access was not available, alternative access sites such as the abdominal aorta, ascending aorta, neck vessels, and left ventricular apex were selected.[1–7] However, comorbidities such as obesity, history of multiple thoracic and abdominal surgeries, and aortic atherosclerosis hinder TEVAR, leaving neck vessels as the only option.[6] Although left common carotid artery (LCCA) is a major access site among the neck vessels, cerebral ischemia might occur by clamping LCCA during TEVAR, and stroke might develop following LCCA declamping due to debris from the LCCA damaged by the delivery sheath. Therefore, a left axillary–carotid artery (Ax–CA) bypass before LCCA access for TEVAR is added to shorten the LCCA clamp time. We herein present a case of TEVAR in a patient with TAA using a novel procedure including LCCA access with left Ax–CA bypass.

Case Report

A 71-year-old male with a history of left ventriculoperitoneal (VP) shunt for hydrocephalus from bacterial meningitis, Y grafting for abdominal aortic aneurysm, and bilateral above-knee amputation was referred to our hospital. Enhanced computed tomography (CT) revealed a saccular aneurysm measuring 68 mm in diameter in the middle of the descending aorta, which was a candidate for TEVAR (**Fig. 1a**). The patient was severely obese, with an ascending aorta of 45 mm in diameter and a calcified

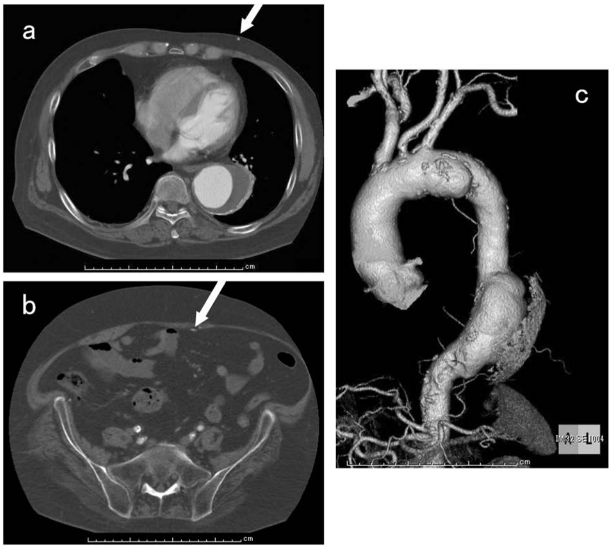

Fig. 1 (**a**) Preoperative computed tomography (CT) shows a saccular aneurysm (maximum diameter, 68 mm) in the descending thoracic aorta and ventriculoperitoneal shunt (arrow). (**b**) Preoperative CT shows stenosis of bilateral iliac arteries and ventriculoperitoneal shunt (arrow). (**c**) Preoperative three-dimensional-volume-rendering CT angiography shows descending aortic aneurysm, small distal arch aneurysm, and neck vessels.

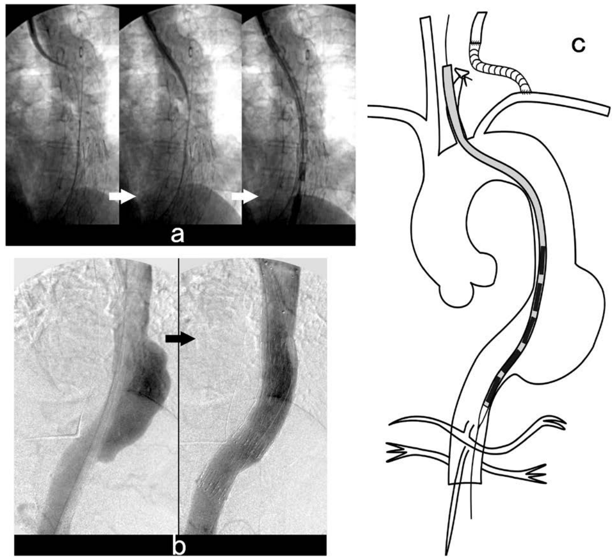

Fig. 2 (**a**) Intraoperative angiography shows the large sheath inserted into the descending thoracic aorta via the left carotid artery. (**b**) Intraoperative angiography shows the stent graft deployed into the descending thoracic aorta. (**c**) Intraoperative schema. Left axillary–carotid artery bypass is used to deliver the stent graft to the descending aorta.

external iliac artery of less than 5 mm (**Fig. 1b**). His left VP shunt passed subcutaneously from the left thoracic side to the abdominal region. Therefore, surgery with left thoracotomy and laparotomy was extremely difficult.

Not only conventional descending aortic replacement with left thoracotomy, but also TEVAR via iliofemoral artery, abdominal aorta, ascending aorta, and left ventricular apex was considered challenging. Among the neck vessels, the brachiocephalic artery and left subclavian artery were too steep to deliver the stent graft to the descending aorta. Conversely, the LCCA, which was leading to the descending aorta (**Fig. 1c**), was considered as an alternative access site for TEVAR. However, there was a possibility that the patient would not be able to tolerate the long duration of LCCA clamp due to the hypoplasia of the right vertebral and right middle cerebral arteries. Furthermore, his LCCA was 6.0–8.0 mm in diameter and showed atheromatous change, and thus was not large enough to allow the insertion of a delivery sheath with an outer diameter of 7.7 mm; doing so could possibly result in LCCA damage and cerebral embolization of debris after the LCCA declamping. Conversely, LCCA stenosis was a potential long-term complication. Therefore, left Ax–CA bypass before LCCA access was planned for TEVAR, with the aim to shorten the LCCA clamp time, followed by LCCA ligation after the procedure.

The procedure was done under general anesthesia in an operating room equipped with a Siemens Arcadis Avantic mobile angiography system (Siemens Medical, Munich, Germany). The left axillary and left carotid arteries were exposed through a small left subclavicular and anterolateral neck incision. The LCCA stump pressure at the time of LCCA clamping was 57 mmHg, which was equal to the diastolic systemic blood pressure. Simple clamping of the LCCA was performed because an LCCA stump pressure above 50 mmHg is considered to be generally safe for procedures requiring common carotid artery clamping such as carotid endarterectomy. Bypass grafting from the left axillary artery to the distal portion of the LCCA was performed using a Gore-Tex Intering Vascular Graft (diameter, 7 mm; W. L. Gore and Associates, Flagstaff, AZ, USA). Proximal anastomosis was end-to-side, distal anastomosis was end-to-end, and the LCCA was ligated proximal to the anastomosis.

A guidewire was advanced with a pig tail catheter from the proximal portion of the ligated LCCA to the descending aorta, captured with a snare catheter introduced from the left femoral artery, and pulled through the left femoral artery. The access route was stretched and linearized easily by tugging the guidewire carefully, indicating that stent-graft insertion could proceed safety. Despite the presence of a very small saccular aneurysm in the distal portion of the aortic arch, it protruded less than 7 mm into the lumen, with no tendency to expand; therefore, rupture of the aneurysm or dissection of the aortic arch was deemed unlikely. After the incision of the LCCA, a Zenith TX2 Pro-Form stent graft (outer diameter 7.7 mm;

Fig. 3 Postoperative three-dimensional-volume-rendering computed tomography angiography showing the absence of endoleaks and complete exclusion of the aneurysm.

ZTEG-2P-30-140-PF; Cook Medical, Bloomington, IN, USA) was delivered smoothly to the descending aorta with the tug-of-wire technique and deployed to the distal side of the aneurysm (**Fig. 2a**). Similarly, a second Zenith TX2 Pro-Form stent graft (outer diameter 7.7 mm; ZTEG-2P-32-140-PF; Cook Medical Bloomington, IN, USA) was delivered and deployed to the proximal side of the aneurysm. TAA was successfully excluded (**Fig. 2b**). After removal of the delivery system, the LCCA was ligated proximal to the incision (**Fig. 2c**).

The patient was discharged without any complications after a 10-day hospital stay. Postoperative CT scan confirmed the correct positioning of the stent graft, exclusion of the aneurysm with no endoleaks, and a patent left Ax–CA bypass graft (**Fig. 3**). At follow-up 5 years after the surgery, TAA was found to have shrunk, the Ax–CA bypass graft was patent with aspirin treatment, and the patient had no neurological symptoms.

Discussion

The standard access for TEVAR is the transfemoral approach because it is minimally invasive. Several reports described alternative TEVAR access sites such as abdominal aorta, ascending aorta, neck vessels, and left ventricular apex in patients with unfavorable iliac anatomy.

In patients with obesity, post-multiple thoracic and abdominal surgeries, and aortic atheromatous changes, TEVAR via axillary artery or carotid artery has advantages including reduced invasiveness.[6] Axillary access is another option for TEVAR, although axillary arteries are usually very tortuous and slightly narrow to deliver the stent graft into the descending aorta,[3] which renders the procedure potentially very challenging. The LCCA access was selected in the current section as it enabled the most direct access to the descending aorta among the neck vessels. Based on our experience, imaging of the LCCA, aortic arch, and descending aorta by three-dimensional-volume-rendering CT or magnetic resonance imaging (MRI) is recommended to detect unfavorable angulation.

The LCCA approach may lead to stroke due to hypoperfusion resulting from the long clamp time during TEVAR, cause injury via the delivery sheath, and embolus formation after the LCCA declamping, all of which must always be held in mind.[2–4] There are no recent reports of transcarotid access for TEVAR with Ax–CA bypass. Conversely, a series of 96 cases was reported in 2016, in which the transcarotid approach without Ax–CA bypass was used for transcatheter aortic valve replacement. The overall stroke/transient ischemia attack rate in that series was relatively high at 6.3%.[8] In the current case, the left Ax–CA bypass was performed before TEVAR, and the proximal LCCA was ligated to avoid prolonged hypoperfusion and embolization due to LCCA manipulation. The rate of stroke ranges between 2.0% and 3.4% with left Ax–CA bypass for conventional TEVAR via femoral artery access, which is lower than that reported with the transcarotid approach for transcatheter aortic valve replacement, with excellent graft patency.[9,10]

The typical duration of femoral artery clamp during conventional TEVAR is approximately 40 min or more, and a similar time frame is expected with the LCCA approach. However, the LCCA clamp time was 10–20 min in the current case undergoing the left Ax–CA bypass approach. With the left Ax–CA bypass, the LCCA blood flow is maintained during TEVAR and the surgeon can concentrate on the process without concerns regarding the clamp time. Nevertheless, evaluation for potential stenosis of the intracranial arteries and communication along the circle of Willis by MRI is necessary.

In the current case, Ax–CA bypass with proximal LCCA ligation was chosen despite the associated potential risk of chronic graft occlusion for the following reasons. First, this approach requires several LCCA clamps and resuturing of the anastomosis to remove the bypass graft. Second, Ax–CA bypass is a widely used approach in TEVAR with stable long-term patency. Finally, the LCCA showed atheromatous changes which could lead to LCCA stenosis in the future.

In antegrade TEVAR, the stent graft is deployed in a reversed manner from its original design in consideration of the blood flow. In addition to the difficulty in controlling the proximal side of the landing zone due to the reversed blood flow, coaxial deployment in Zone 2 or 3 is also challenging. Therefore, the presence of a distal arch aneurysm with a short proximal landing zone is a contraindication for antegrade TEVAR. Deployment of a stent graft in a reversed fashion can result in postoperative endoleaks, which constitute a high risk in the long term. Therefore, frequent follow-up CT is necessary in these cases.[1,7)]

Conclusion

We herein presented a case of successful TEVAR requiring a novel approach by LCCA access with left Ax–CA bypass in a patient in whom access via the femoral artery, iliac artery, and aorta was not feasible.

Disclosure Statement

The authors have no conflicts of interest to declare.

Author Contributions

Critical review and revision: all authors
Final approval of the article: all authors
Accountability for all aspects of the work: all authors

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