



Unilateral Low Extremity Paraplegia after Thoracic Endovascular Aortic Repair for Aortic Arch Aneurysm

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Spinal cord ischemic injury and consequently permanent paraplegia remain the most devastating complications after open and endovascular thoracic or thoracoabdominal aortic aneurysm repair. Hemodynamic stability, which depends on a network of blood vessels around the cord, is most important not only during but also after stent-graft deployment to prevent spinal cord injury. Despite the use of various strategies to prevent spinal cord ischemia, including aggressive revascularization of the subclavian artery and cerebrospinal fluid drainage, this condition remains inevitable and difficult to predict before an operation. We present a rare case of a patient who presented with unilateral paraplegia that developed after thoracic endovascular aortic repair for aortic arch aneurysm and our subsequent salvage strategy.

Key words: Aortic arch aneurysm, endovascular repair, spinal cord injury, paraplegia

INTRODUCTION

Surgical repair of aneurysms of the thoracic and thoracoabdominal aorta may carry a risk of spinal cord injury (SCI) at various incidences, based on the extent of the aneurysms. It has been reported that the overall risk of paraplegia after thoracic and thoracoabdominal aortic aneurysms repair (TAA/TAAA) is 16%. According to the Crawford classification, SCI occurred in 15%, 31%, 7%, and 4% of patients with types I, II, III, and IV aneurysm, respectively.¹ In addition to stroke, SCI is one of the most feared complications of TAA or TAAA repair and thoracic endovascular aortic repair (TEVAR). Patients with postoperative SCI have a mortality rate three times that of patients without SCI.²

TEVAR is emerging as a less invasive alternative to open surgical repair for TAA/TAAA as it diminishes the magnitude of repair-associated injury by avoiding thoracotomy and aortic cross-clamping and minimizing perioperative end-organ ischemia and insults to the respiratory system. Recent studies have reported encouraging results in terms of technical success

and mid-term outcomes compared with traditional open repair.³ Although morbidity and mortality rates are lower with TEVAR, the occasional case of SCI still occurs with an unclear underlying pathophysiology. Here, we report on a patient with thoracic arch aneurysm who underwent TEVAR and developed SCI that was presented as unilateral low extremity paraplegia.

CASE REPORT

A 72-year-old man who had undergone an emergent operation for type A aortic dissection about 8 years before admission was evaluated for chronic cough and chest discomfort. His previous operation included reconstruction of the ascending aorta with debranching to the innominate artery. A computed tomography (CT) scan demonstrated marked tortuosity and atherosclerosis, a saccular aneurysm over the aortic arch and proximal descending aorta with a maximal diameter of about 8.7 cm, and mural thrombus formation [Figure 1a and b]. The patient's medical history was significant for hypertension and previous lacunar infarction over the left

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corona radiata, bilateral basal ganglion, and right cerebellum. The physical examination was unremarkable, and peripheral perfusion was normal.

After right common carotid-to-left common carotid arterial bypass with an 8 mm polytetrafluoroethylene (PTFE) graft, TEVAR with zone 1 landing was performed through the right femoral artery by surgical dissection. The aortic aneurysm was repaired using three endovascular stent grafts (42 mm × 216 mm, 42 mm × 135 mm, and 42 mm × 162 mm, Zenith TX2, Cook Medical, Bloomington, IN, USA), and one distal bare-metal stent graft (30 mm × 147 mm, Zenith TX2, Cook Medical, Bloomington, IN, USA) that extended from the aortic arch to the beginning of the abdominal aorta [Figure 2a and b], followed by ligation of the proximal left carotid artery and coil embolization of the left subclavian artery (LSA). The level of coverage by the stent graft was over the T7–T8 level. The procedure was uneventful, and the patient's hemodynamic status remained stable during the operation. No endoleak was noted on the final aortography, and systolic blood pressure was maintained at around 120–140 mmHg.

On the 2nd day postintervention, the patient developed weakness over both lower extremities, with significantly reduced muscle power over the left low extremity compared to the right side. However, the patient's sensory function was intact, and he remained alert. A brain CT scan revealed negative findings. Under the impression of SCI, salvage with left carotid-to-LSA bypass was performed with a 6 mm PTFE graft as well as a lumbar cerebrospinal fluid (CSF) drainage. A high-dose steroid was also administered. Muscle power over the right lower limb recovered gradually after salvage therapy and was normal after 1 week. However, unilateral paraplegia remained over the left lower extremity after aggressive rehabilitation for 1 year.

DISCUSSION

SCI is the most dreaded complication of TAA/TAAA repair whether performed by open or endovascular surgery.^{2,4} It has

been assumed that injury arises primarily as a consequence of two mechanisms. In open surgical repair, perioperative hemodynamic instability has been associated with the occurrence of SCI.² In endovascular repair, the hemodynamic-related derangements are generally reduced since it does not require aortic cross-clamping.^{2,5} However, the intercostal arteries covered by the stent graft cannot be reimplanted, thus potentiating the risk of SCI. Due to different mechanisms, many cases of SCI after TEVAR have an incomplete or delayed presentation as compared with open aortic surgery.

Recently published reports indicate that the incidence of SCIs that have resulted in paraplegia/paraparesis after TEVAR is 3%–5% as sacrifice of the critical intercostal arteries is inevitable by a stent graft.⁶ There was a broad range in the incidence of SCI, with an average of 4.5% in 7309 patients (range, 0%–10.3%), making this technique inferior to open surgery.⁶ SCI remains a multifactorial problem that results from complex interactions between several factors: perfusion and oxygen delivery, local metabolic rate and oxygen demand, reperfusion injury, and failure to maintain microcirculatory flow.⁷ Common risk factors for spinal cord ischemia include: aneurysm extension and location (affecting thoracic or lumbar blood supply) and perioperative hypotension. Therefore, maintenance of higher than normal arterial blood pressure during and after surgery, drainage of CSF, and revascularization of important blood supply highly related to spinal cord artery (LSA, intercostal and lumbar spinal arteries, and hypogastric and sacral arteries) are useful concepts to keep in mind for spinal cord protection.⁸

To extend the safe landing zone in distal arch aneurysm, TEVAR with zone 2 landing or even zone 1 landing with LSA coverage is sometimes necessary as presented in this case. However, this process may compromise the proximal collateral circulation to the spinal cord, including the vertebral



Figure 1: (a) Axial and (b) coronal views of contrast-enhanced computed tomography of the chest demonstrate a large saccular aneurysm over the aortic arch



Figure 2: (a) Pre- and (b) post-thoracic endovascular aortic repair aortography of case discussed here

and internal thoracic arteries. It has been reported that simple coverage of LSA is a risk factor of spinal cord ischemia.^{9,10} However, recent published papers suggest that LSA coverage was generally acceptable, and routine revascularization was not necessary in the majority of zone 2 TEVAR.¹¹ According to a meta-analysis on the morbidity and mortality during zone 2 TEVAR, LSA coverage was associated with a nonsignificant increase in the risk of spinal cord ischemia.¹² Although there is still a controversy in this issue, the European Registry on Endovascular Aortic Repair still emphasizes the need to preserve the LSA.¹³ In particular, reconstruction of the LSA is requisite for a case to have other SCI high-risk factors with a long stent-graft treatment.¹²

The rationale for CSF drainage is that a hypothetical decrease in intrathecal pressure may increase medullary blood perfusion and thus minimize potential spinal cord ischemia. In open TAA/TAAA repair, lumbar CSF drainage is widely used, and some randomized controlled trials have examined its benefits.¹⁴ However, the utility of this adjunct is still controversial in TEVAR. No randomized studies are available, and a wide variety of protocols for lumbar CSF drainage has been used. A recent systemic review of SCI and CSF drainage after TEVAR reported a crude incidence of SCI of 3.89%, with a lower rate of routine prophylactic drainage (3.2%) than without prophylactic drainage (3.47%) and selective prophylactic drainage (5.6%).¹⁵ However, this study presented unadjusted risks without accounting for differences in patients and procedural factors between groups. In addition, although there are potential benefits of CSF drainage as an adjunct to open surgical repair or TEVAR, major and minor complications including subdural hematoma, epidural hematoma, intracranial hemorrhage, headache, meningitis, nerve injury, and CSF leak have been reported.^{16,17} From our perspective and that of other institutions, the placement of lumbar CSF drainage should be restricted to select patients such as those who have had previous abdominal aortic aneurysm repair, anticipated coverage of T8–L1 segment, and compromised collateral circulation and those with symptomatic SCI who did not have a drain placed preoperatively.⁶ Although the therapeutic effects of CSF drainage were noted in the management of SCI after open TAA repair, the precise impact of CSF drainage in the setting of TEVAR is still debated.¹⁸

Unilateral lower extremity paralysis is an unusual presentation of SCI and was previously reported in coil embolization of an internal iliac artery aneurysm.¹⁹ To the best of our knowledge, there is no published literature reporting unilateral paraplegia after TEVAR and its salvage treatment. Two potential pathophysiologic processes that could have caused the complication have been presented in this case. The first is distal embolization during the procedure since there

were lots of mural thrombi found on CT scan, and the second is ischemia resulting from interruption of blood flow as a result of inevitable long-segment coverage of the descending aorta.

CONCLUSION

SCI could happen after TEVAR surgery and should be avoided because of its association with early mortality, increased health-care cost, and other significant socioeconomic consequences. Adequate preoperative evaluation is important for risk prediction. By preoperative imaging, we are able to preview the collateral blood supply of the spinal cord. Aggressive revascularization of the subclavian artery is important. The benefit of prophylactic CSF drainage has no proven efficacy in TEVAR surgery but could be prophylactic when used in carefully selected high-risk patients. While neurologic deficit has been observed after TEVAR, CSF drainage should be performed immediately, as it may provide functional recovery, as shown in this case.

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Conflicts of interest

There are no conflicts of interest.

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