Left Subclavian Artery Revascularization for Delayed Paralysis after Thoracic Endovascular Aortic Repair

Eisaku Nakamura, MD, PhD, Kunihide Nakamura, MD, PhD, Koji Furukawa, MD, Hirohito Ishii, MD, Yukie Shirasaki, MD, Nobuhiko Ichiki, MD, Kazuhiro Higuchi, MD, Daichi Sakurahara, MD, and Tomoka Hamahiro, MD

Spinal cord ischemia (SCI) is a devastating complication following thoracic endovascular aortic repair (TEVAR). A man with a ruptured thoracic aortic aneurysm (TAA) was transferred to our hospital. Emergency TEVAR, with left subclavian artery (LSA) coverage, was performed for the ruptured TAA. On postoperative day two, the patient had incomplete paralysis in his legs, presumably caused by SCI. We performed LSA revascularization (LSAR) to provide blood supply to the spinal cord; his paralysis improved and almost resolved after surgery. To our knowledge, this is the first report on LSAR’s efficacy for delayed paraplegia due to SCI.

Keywords: delayed paralysis, thoracic endovascular aortic repair, left subclavian artery revascularization

Introduction
Thoracic endovascular aortic repair (TEVAR) is an established treatment for thoracic aortic aneurysm (TAA). Spinal cord ischemia (SCI), an extremely devastating complication, occurs in patients undergoing TEVAR for TAA. However, its causes are multifactorial and not fully understood. Various approaches to prevent SCI after TEVAR have been reported in the literature. The left subclavian artery (LSA) provides blood supply to the spinal cord via the vertebral artery. Left subclavian artery revascularization (LSAR), following LSA coverage, has proven useful.1) However, a meta-analysis showed a non-significant increase in SCI risk without LSAR1); thus, the need for routine LSAR for LSA coverage is still debatable. Furthermore, the need for LSAR after TEVAR is also unclear and controversial.1) We herein report a case in which LSAR was effective for delayed paraplegia due to SCI.

Case Report
A 77-year-old man with massive hematemesis presented to another hospital’s emergency department. Emergency gastroscopy revealed no bleeding sources in the stomach or duodenum. Chest radiography showed a giant TAA (Fig. 1A). Contrast-enhanced computed tomography (CT) revealed a TAA (112 mm in diameter) close to the LSA (Fig. 1B), pulmonary hemorrhage, and obstructed left internal and external iliac arteries. The aneurysm may have caused hemothysis from stabbing into the lungs; therefore, he was referred to our hospital for surgery. At the time of arrival, his blood pressure was 112/60 mmHg and his heart rate was 78
beats/min. Laboratory data revealed mild anemia (hemoglobin: 11.2 g/dL). He was diagnosed as having ruptured TAA because of his hemoptysis, and an emergency TEVAR was performed immediately. The descending thoracic aorta was stented with two grafts (GORE TAG®; W. L. Gore & Associates, Inc., Flagstaff, AZ, USA) inserted through the right femoral artery. The proximal stent was 45 mm in diameter and 200 mm long; the distal stent was 45 mm in diameter and 150 mm long. LSA coverage was required to achieve an adequate proximal seal. Additionally, LSA coil occlusion was performed.

The patient was extubated after TEVAR. Neurological deficits were not observed. Postoperatively, the mean blood pressure remained above 90 mmHg in the intensive care unit. On postoperative day two, he showed weakness of the right lower limb muscles with gradual, incomplete paralysis of both lower limbs. At that time, there was no decrease in blood pressure. An emergency CT was performed to determine the cause of paralysis, but the aneurysm was completely shielded (Figs. 2A and 2B). Additionally, LSA coil occlusion was performed.

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Discussion

TEVAR is increasingly performed for TAA because of low in-hospital mortality and low postoperative morbidity. However, severe complications, such as paraplegia, occasionally occur despite various SCI prevention strategies. Post-TEVAR SCI occurs in up to 10.3% of patients, most of whom never return to leading a normal life. Therefore, protective measures to reduce SCI in TEVAR are very important. Currently, there are two hypotheses to explain SCI’s occurrence: inadequate collateral blood supply to the spinal cord and atheroembolism of aortic plaque material in the segmental artery. However, SCI’s precise pathogenesis remains unclear.1) Additionally, multiple post-TEVAR risk factors for SCI occurrence have been identified. Therefore, it was very difficult to completely prevent SCI after TEVER.

Maintaining collateral circulation to the spinal cord to prevent SCI is critical,1,2) although other prevention measures have been reported.3) The LSA provides blood flow to the vertebral artery, which is connected to the anterior spinal artery.4) The 2009 American Society of Vascular Surgery practice guidelines recommended routine, preoperative LSAR for elective TEVAR patients undergoing LSA coverage.5) However, according to a recent meta-analysis, there is no significant difference in the rate of SCI between patients with and without LSAR.1,6) In addition, LSAR itself carries a 10%–12% chance of complications (including brachial plexus, vagus nerve, left recurrent nerve, and thoracic duct injuries; neck hematoma; subclavian dissection; and stroke).1) Some studies have suggested performing LSAR in a limited patient population, such as patients with prior left mammary artery coronary bypass, those with a left side arterio-venous fistula for renal dialysis, and left-hand dominant patients.1,6,7) However, the need for routine LSAR after TEVAR is uncertain.1) Our patient had some risk factors (extensive aortic coverage, LSA coverage, and hypogastric artery obstruction) related to the lack of a collateral blood supply network; in accordance
with current practice guidelines, LSAR was essential for maintaining spinal cord viability. Nevertheless, we did not perform LSAR on the same day due to the case’s emergent nature. Immediately after surgery, no neurological deficits were observed, and the patient was kept under observation.

Most SCI cases after TEVAR have a delayed onset (>24h). In our patient, incomplete paralysis was noted on postoperative day two. In delayed SCI, it is also important to maintain adequate blood pressure through collateral circulation of the spinal cord. Estrella et al. proposed a treatment protocol for delayed SCI that included CSFD, oxygen delivery, and patient status. They emphasized that delayed SCI could be reduced by preventing complications such as delayed postoperative hypotension and CSFD malfunction. In our patient, blood pressure was strictly controlled, and it was difficult to perform CSFD; therefore, only LSAR was performed. Our patient’s paralysis after TEVAR was also resolved by LSAR. Most previous reports focused on whether to perform prophylactic LSAR during TEVAR. Therefore, whether LSAR is necessary for delayed SCI is unclear. However, considering the mechanism of our patient’s recovery, we believe the increased collateral blood flow due to LSAR was important for treating delayed SCI. Although few patients with SCI completely return to baseline function, patients with delayed SCI are more likely to have functional improvement. It may have been possible for our patient to recover neurological function without LSAR. However, we believe that LSAR should be considered when LSA coverage has been performed and when there is extensive total aortic coverage and hypogastric artery occlusion.

Several other effective neuroprotective strategies during TEVAR have been developed, including specific anesthetic approaches, maximized oxygen delivery, optimized hemoglobin, mild hypothermia, maintaining cerebrospinal fluid and spinal cord perfusion pressures, neuromonitoring, procedure staging, LSAR, minimally invasive coil embolization, temporary aneurysm sac perfusion, and novel implantation sequences for branched/fenestrated stents. A multimodality approach is crucial for reducing the incidence of SCI after TEVAR.

Conclusion

We present a novel report on LSAR’s efficacy for delayed paraplegia due to SCI. After emergency TEVAR with LSA coverage was performed for the ruptured TAA, the patient had incomplete paralysis in his legs, presumably caused by SCI. We performed LSAR to provide blood supply to the spinal cord; the patient’s paralysis improved and almost resolved after surgery. LSAR should be considered when LSA coverage has been performed and in cases of extensive total aortic coverage and hypogastric artery occlusion.

Disclosure Statement

None declared.

Author Contributions

Study conception: EN, KN
Data collection: EN, HI
Analysis: all authors
Investigation: all authors
Writing: EN
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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