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Case Report

# Prophylactic Lumbar Cerebrospinal Fluid Drainage after Anesthesia Induction in High-Risk Crawford Type I Thoracoabdominal Aortic Aneurysm Repair: A Case Report

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## ABSTRACT

Spinal cord ischemia (SCI) remains a devastating complication of thoracic endovascular aortic repair (TEVAR), particularly in extensive aneurysms such as Crawford type I. Cerebrospinal fluid drainage (CSFD) is widely used to augment spinal cord perfusion pressure (SCPP); however, the optimal timing of CSFD placement (preoperative vs post-induction) remains controversial. A 61-year-old male with Crawford type I (maximum diameter 7 cm), history of cerebral infarction, NSTEMI, and hypoalbuminemia was scheduled for elective TEVAR using the chimney technique. After general anesthesia induction, CSFD was placed at L3-L4 (target CSFP 8-12 mmHg, rate 10-15 mL/h). TEVAR proceeded smoothly with stable hemodynamics (MAP 85-100 mmHg); the drain was removed on postoperative day 2 (48 h) without complications. Neurological status was normal, without PDPH, paraplegia, or infection.

This case shows that placing CSFD after induction can be a feasible and safe procedure of a multimodal neuroprotection strategy for high-risk TEVAR. Post-induction CSFD is an alternative to preoperative CSFD placement without compromising spinal cord protection. Further studies are needed to clarify the optimal timing and patient selection for CSFD in TEVAR.

## Introduction

Thoracic endovascular aortic repair (TEVAR) has revolutionized the management of thoracic and thoracoabdominal aortic aneurysms, with perioperative mortality significantly lower than open surgical approaches, approximately 2-5% vs. 5-20% [1]. Spinal cord ischemia (SCI) is the most dreaded complication of TEVAR procedures, with an incidence of 3-10% in elective TEVAR and 20% in extensive cases such as Crawford type I or II [2]. Spinal cord ischemia typically results in permanent paraplegia or paraparesis. Extensive stent graft (>200 mm), the location involving T9-L1, chronic hypertension, history of stroke, and vascular comorbidities that reduce anterior spinal artery collaterals are the Major risk factors for SCI [2-3].

The pathophysiology of SCI after TEVAR is includes embolic events, reduced spinal cord blood flow, and elevated cerebrospinal fluid or intraspinal pressure [2]. Cerebrospinal fluid drainage (CSFD) via lumbar catheter may reduce the risk of SCI by lowering cerebrospinal fluid pressure and improving spinal cord perfusion. Preventive Cerebrospinal fluid drainage is recommended for patients at high risk of SCI undergoing extensive TEVAR in the 2012 joint EACTS/ESC position

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statement. Recent meta-analyses demonstrate significant benefits of CSFD placement in high-risk TEVAR [4].

In Crawford type I cases, where the aneurysm involves the aortic arch to the superior abdominal aorta, preoperative lumbar drain placement is crucial for SCPP optimization [2-3]. This case report describes the lumbar drainage protocol in perioperative TEVAR management in an elderly patient with a history of cerebral infarction.

## Case Report

A 61-year-old male was scheduled for elective TEVAR with the chimney technique for the left subclavian artery. The patient had a history of intermittent chest pain that first appeared several weeks prior, accompanied by headache and right-sided body weakness for approximately 1 month before hospital admission. Coffee-ground vomiting had occurred previously, but during preoperative evaluation, the patient had a nasogastric tube in place with no blood production or recurrent vomiting.

The patient had history of hypertension for 8 year, a non–ST-elevation myocardial infarction (NSTEMI) in 2017 without coronary intervention, and a cerebral infarction 1 month before admission. The patient was conscious, alert, and fully oriented. Neurological examination revealed right-sided hemiparesis. He was hemodynamically stable and breathing spontaneously at 20 breaths/min, with an oxygen saturation of 96% on room air.

Hemoglobin level of 12.4 g/dL, leukocyte count of 6,630/µL, platelet count of 346,000/µL, normal coagulation parameters, hypoalbuminemia (2.89 g/dL), and a creatinine level of 1.43 mg/dL. Arterial blood gas analysis on room air showed a pH of 7.42, $PaCO_2$ of 35 mmHg, $PaO_2$ of 72 mmHg, $SaO_2$ of 96%, and a $PaO_2/FiO_2$ ratio of 342, consistent with adequate gas exchange. Findings on non-contrast head CT are subacute infarct of the left internal capsule, a chronic lacunar infarct in the right basal ganglia, cerebral atrophy, diffuse arteriosclerosis, and evidence of hypertensive encephalopathy.

A Crawford type I thoracoabdominal aortic aneurysm was identified on CTA of the thoracoabdominal aorta, with fusiform dilatation extending from the aortic arch to the abdominal aorta proximal to the origins of both renal arteries. Duplex ultrasonography confirmed adequate femoral and brachial arterial lumens for endovascular access. Given the extensive planned aortic coverage and the associated risk of spinal cord ischemia following TEVAR.

Lumbar cerebrospinal fluid drainage was selected as part of the spinal cord protection strategy. The patient was counseled regarding the purpose of lumbar drainage and the potential complications, including headache, bleeding, and infection.

The patient underwent elective TEVAR with left subclavian artery (LSA) chimney-graft placement on May 28, 2025. Following induction of general anesthesia and endotracheal intubation, a lumbar drain was inserted at the L3–L4 interspace with the patient in the lateral decubitus position and minimal lumbar flexion. Using strict aseptic technique, a 14-G catheter was introduced through a paramedian approach. Free cerebrospinal fluid (CSF) flow was confirmed, and the initial CSF pressure was below 12 mmHg.

Cerebrospinal fluid drainage was titrated to maintain a CSF pressure of 8–12 mmHg, with a maximum drainage rate of 10–15 mL/h. This was integrated with spinal cord perfusion pressure monitoring, targeting a MAP greater than 90 mmHg with vasopressor support as required. TEVAR was completed uneventfully without conversion to open surgery. During the 4-hour procedure, hemodynamic stability was maintained, with MAP ranging from 85 to 100 mmHg. Cerebrospinal fluid pressure remained below 10 mmHg, and a total of approximately 200 mL of CSF was drained.

Hemodynamics were stable without vasopressors, laboratory results showing albumin stabilization after the surgery. The lumbar drain was removed on postoperative day 2 after CSFP stabilized at less than 12 mmHg, cumulative drainage was less than 400 mL/24 h, and there were no signs of neurological deficit or infection. No complications such as hematoma, infection, overdrainage, or SCI occurred.

## Discussion

Spinal cord ischemia remains one of the most alarming complications following TEVAR, particularly in extensive aortic coverage such as Crawford type I aneurysms, where collateral perfusion from intercostal and lumbar arteries may be significantly compromised. The pathophysiology of SCI is multifactorial, involving reduced arterial inflow due to segmental artery coverage, perioperative hypotension, and increased cerebrospinal fluid pressure (CSFP), all of which ultimately decrease spinal cord perfusion pressure (SCPP) [1-2]. Optimization of SCPP represents the cornerstone of neuroprotection during TEVAR (SCPP = MAP – CSFP).

Cerebrospinal fluid drainage can enhance spinal cord perfusion pressure (SCPP) by lowering cerebrospinal fluid pressure (CSFP). In high-risk patients undergoing thoracic or thoracoabdominal aortic repair, CSFD is used as part of a multimodal spinal cord-protection strategy. Recent systematic reviews and meta-analyses have demonstrated that preventive CSFD, particularly when combined with aggressive blood pressure augmentation, can significantly decrease the incidence of SCI in high-risk TEVAR [3-4]. European Society of Cardiology (ESC) and European Society for Vascular Surgery

(ESVS) recommend CSFD in patients at high risk for SCI [5].

However, although the use of CSFD for spinal cord protection is widely recognized, the optimal timing of catheter insertion remains uncertain. Traditional practice often preoperative placement to enable baseline CSF pressure monitoring and prompt drainage if intraoperative hypoperfusion occurs [6]. Preoperative insertion can cause patient discomfort and create logistical challenges. It may also delay the procedure, particularly if catheter placement is difficult or traumatic. In contrast, post-induction CSFD placement may provide several practical benefits. Placement after general anesthesia can improve patient comfort and facilitate catheter insertion under controlled procedural conditions. It may also streamline the operative workflow, which can be especially advantageous in urgent cases or complex hybrid procedures. Post-induction insertion allows CSF-pressure monitoring to be integrated promptly with invasive hemodynamic monitoring, facilitating early optimization of spinal cord perfusion pressure once anesthesia has been established [6-7].

The use of CSFD remains controversial, particularly with regarding to routine versus selective use. Although prophylactic CSFD may benefit in selected high-risk patients, routine use in all TEVAR procedures is not supported because the benefit may not outweigh the risk of drain-related complications. Spinal or epidural hematoma, intracranial or subdural hemorrhage, infection, cerebrospinal fluid leak, and post-dural puncture headache are potential complications in CSFD procedure. In a recent systematic review and meta-analysis of thoracic and thoracoabdominal endovascular procedures, Reported complication rates range from approximately 0.8% to 1.5% for major hemorrhagic events and up to 10% for post-dural puncture headache [3-4]. Therefore, current practice trends favor a risk-stratified approach, reserving CSFD for patients with extensive aortic coverage, prior aortic surgery, or compromised collateral circulation [8]. In the present case, multiple high-risk features supported the use of CSFD as part of a multimodal neuroprotective strategy. Maintenance of CSFP within 8–12 mmHg and MAP above 90 mmHg ensured adequate SCPP throughout the perioperative period, consistent with current guideline recommendations [1,5].

In this high-risk patient, the absence of postoperative neurological complications supports the feasibility of post-induction CSFD when used alongside strict hemodynamic optimization as part of a multimodal spinal cord-protection strategy. Staged aortic repair, optimization of hemoglobin to maintain oxygen delivery, controlled blood-pressure augmentation or permissive hypertension, and intraoperative neuromonitoring with somatosensory evoked potentials (SSEPs) and motor evoked potentials (MEPs) are several adjunctive may be used to reduce the risk of SCI. [9-10]. Although neuromonitoring was not utilized in this case, its integration may further enhance early detection of spinal cord hypoperfusion and guide intraoperative management. This case shows the emerging evidence that spinal cord protection should be individualized and guided by physiological principles. It also suggests that the timing of CSFD placement may be adapted to the clinical setting, provided that appropriate patient selection, continuous monitoring, and rigorous hemodynamic optimization are maintained [1, 6].

## Conclusion

This case report shows the success of preventive lumbar drainage post-anesthesia induction in preventing spinal cord ischemia in high-risk Crawford type I TEVAR, with optimal neurological outcomes without complications. The multimodal approach, including target CSFP <12 mmHg, MAP >90 mmHg, and 48-hour duration, provides favorable outcomes in patients with comorbidities.

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