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The Role of the Lumbar Drain in Thoracic Endovascular Aorta Repair: Exploring the Indications for Pre-Placement Neuraxial Imaging

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THE ROLE OF THORACIC endovascular aorta repair (TEVAR) in the management of descending thoracic aortic pathologies is widely accepted. Some of the major complications of thoracoabdominal aortic aneurysm (TAAA) surgery are spinal cord ischemia (SCI) and paraplegia. A multitude of interventions have been used to reduce the risk of SCI, with placement of a lumbar drain for cerebrospinal fluid (CSF) drainage recommended as one of the most efficacious of these interventions. Considerations given to lumbar drain placement include timing of placement (prophy lactic placement preoperatively versus postoperatively) and whether placement should be routine in all TEVAR cases versus selective use in high-risk patients.

The need for brain imaging before placement of lumbar drains to mitigate potential herniation has not been well-reviewed. Although generally considered a safe procedure, drain placement can lead to potentially serious or even fatal outcomes in certain circumstances, especially in patients with occult elevations in intracranial pressure (ICP). The authors present a case conference in which the central conundrum was whether the need to obtain screening brain imaging before lumbar drain placement for TAAA surgery was indicated. Commentaries, both for and against routine use of brain imaging, are included, given the uncommon presentation of occult elevations of ICP without any clinical symptoms.

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CASE REPORT

A 62-year-old female with a history of severe peripheral vascular disease presented to the vascular surgery clinic with bilateral lower extremity claudication. Her other comorbidities included compensated congestive heart failure with preserved ejection fraction, hypertension, 20-pack years smoking history, and remote intravenous drug abuse. Further evaluation using computed tomographic (CT) angiogram demonstrated a mid-descending thoracic aorta 7-mm stenotic segment that was approximately 3.5 cm long.

The patient was scheduled for a balloon angioplasty of the stenotic descending aorta segment followed by TEVAR. It was believed that before placement of the endograft, the patient would benefit from placement of a lumbar spinal drain for spinal cord protection. Per the authors' institutional practice, lumbar spinal drains are placed by the neurosurgery service. The cardiac anesthesiologists manage the drains intraoperatively. Postoperatively, the neurosurgery service provides drain management while the patient is in the intensive care unit until the drain is removed. The patient did not report any prior history of neuropathology. However, before drain placement, the neurosurgery service requested that the patient undergo CT imaging of the head to rule out an occult Chiari malformation. A CT of the head was obtained, which was normal, and general anesthesia was induced uneventfully. The neurosurgery service then placed a lumbar spinal drain before the start of the procedure. Arterial and central venous lines were placed uneventfully. A balloon angioplasty of the stenotic segment and TEVAR were performed. The intraoperative course was complicated by retrograde aortic dissection with free mediastinal aortic perforation, which was managed with emergency secondary stenting of the aorta. The patient's postoperative course was uneventful with no neurologic deficits. The patient was discharged from the hospital on postoperative day 7.

DISCUSSION

Since the advent of the TEVAR procedure in 1994, its clinical application for management of pathologies in the descending thoracic aorta has become widely accepted.[1–4] SCI is one of the most serious complications of TAAA surgery.[5] The incidences of SCI and paraplegia after open TAAA surgery range from approximately 5% to 20%, depending on the extent of co-existing preoperative risk factors,[5,6] whereas the reported rates of paraplegia with TEVAR procedures are up to 8%.[7] Although the risk of SCI appears to be significantly less with TEVAR compared with open aortic repair, SCI after TEVAR remains a serious complication associated with significant morbidity and mortality.[8–11] A multitude of various interventions have been used to help reduce the risk of SCI, including intraoperative spinal cord function monitoring, left heart bypass, blood pressure augmentation, re-implantation of intercostal arteries, systemic hypothermia, neuraxial hypothermia, and prophylactic lumbar CSF drainage. Permissive systemic hypertension and CSF drainage are the 2 primary methods to preserve and augment spinal cord perfusion pressure as a means of mitigating the development of SCI.[5,12] Multiple reports highlight the benefit of lumbar drainage during TEVAR procedures in terms of obviating paraplegia risk, especially in high-risk patients (prior abdominal aortic procedures or long stent-graft length).[13–15] In contrast to the support for performing lumbar drainage during TEVAR, 2 observational studies—1 from 2011 (424 patients over 8 years) and the other from 2013 (381 patients over 10 years)—in which all patients were undergoing TEVAR procedures at single centers, demonstrated that the use of lumbar drainage did not affect the rate of spinal cord injury.[16,17] Given the low risk of SCI in TEVAR and the risks of CSF drainage, 2 approaches have evolved for the practice of CSF drainage in TEVAR: routine or selective lumbar drain insertion in high-risk patients.[18,19]

In 2010, the American multisociety thoracic aortic guidelines recommended prophylactic lumbar CSF spinal drainage to prevent SCI after TEVAR in high-risk patients (Class I Recommendation; Level of Evidence B).[20] In 2014, the European thoracic aortic guidelines recommended CSF drainage in high-risk patients undergoing TEVAR (Class IIa Recommendation; Level of Evidence C).[21] The patient presented in this case conference did not exhibit preoperative high risk for SCI, given that the planned TEVAR involved a short thoracic aortic segment in a patient with no prior aortic intervention.[18–21] The complicated intraoperative course with dissection, perforation, and more extensive aortic coverage likely raised her risk for SCI considerably and therefore strengthened the rationale for perioperative CSF drainage.[5,12,20,21]

A number of clinical trials have evaluated risk stratification to guide perioperative timing of CSF drainage for TEVAR. In 2010, Zoli et al demonstrated that the extent of segmental artery sacrifice was the most powerful predictor for SCI, with a 1.2% risk for SCI when fewer than 8 segmental arteries were compromised, reinforcing the idea that the collateral spinal arterial network has extensive reserve.[22,23] In 2013, Hanna et al demonstrated the safety and efficacy of a selective approach to CSF drainage in TEVAR, limiting this technique to patients with prior aortic interventions and planned long-segment aortic coverage.[16] A recent systematic review (trials from 1991 to 2011, n = 4,936) demonstrated the current poor quality of the evidence base and was unable to establish a role for prophylactic CSF drainage in TEVAR.[24] Further high-quality trials are required to define the indications for prophylactic lumber drains in TEVAR, taking into account that SCI is uncommon in contemporary practice.[24]

Keith et al took a different approach, with a perioperative protocol that reserved lumbar CSF drainage for patients with SCI after TEVAR.[25] Out of 278 cases reviewed between 2000 and 2010, only 16 (16/278, 0.58%) had documented SCI, confirming the rare incidence of this complication in TEVAR. With a selective approach, 10 of 16 (62.5%) SCI patients required postoperative CSF drainage; 7 of these 10 patients (70%) had a favorable clinical response, 3 (30%) experienced complete and 4 (40%) experienced partial resolution of their SCI. In contrast, SCI resolved in 4 of the 6 (66.7%) patients who did not undergo CSF drainage, with no resolution in the remaining 2 patients.[25] Significant predictors of SCI in this series included the length of thoracic aortic coverage ($p = 0.036$) and the existence of infrarenal aortic disease ($p = 0.026$). The investigators concluded that a selective approach as outlined in their protocol was reasonable and safe. The clinical utility of CSF drainage in emergency TEVAR also has been demonstrated in the literature.[26–28]

Complications associated with lumbar drains can be categorized into the following 2 groups: those associated with drain insertion and those associated with catheter and collection system maintenance (including the consequences of excess CSF drainage). As is the case with any instrumentation of the neuraxis, there is potential risk for direct nerve root or spinal cord injury, epidural or spinal hematoma,[29] and infection.[30] Due to the use of a relatively large-bore needle for catheter placement, the possibility of inadvertent loss of excess CSF after dural puncture exists, especially when the procedure is performed with the patient in the upright position. The catheter itself also may lead to a nerve-related injury.

There are also a number of complications related to maintenance and management of a lumbar drain. The catheter and drainage collection present potential infectious risks,[31] the catheter may fracture in the intrathecal space,[31] and the catheter or collection system may become occluded.

Another major issue with lumbar drainage is excess CSF drainage, which may occur due to a number of reasons. First, the location for calibration of the transducer to zero may contribute to excess CSF removal. The optimal location for transducer zeroing has been discussed for the tragus, the right atrium, and the point of insertion. If the lumbar location is chosen, this may lead to overestimation of CSF pressure and resultant excess CSF being drained.[5] Other causes of excess CSF removal include inadvertent excessive drainage volume due to collection system mismanagement or catheter disconnection from the collection system itself. Regardless of the cause, excess CSF drainage may lead to intracranial hypotension, which potentially can result in significant morbidity and mortality.[32] Intracranial hypotension leads to the descent and stretching of all intracranial contents, including many structures of the posterior fossa. Even small CSF volume removal for diagnostic lumbar puncture (LP) has been shown to lead to a caudal shift of the brain, cerebellar tonsil decline, and ventricle dilation.[33] Reductions in spinal fluid volume and the associated intracranial hypotension may lead to the well-described post-dural puncture headache, which aside from pain may be associated with autonomic instability, abducens nerve palsy, visual field defects, vertigo, vomiting, and tinnitus.[34,35] Intracranial hypotension also is associated with acute intracranial hemorrhage and subdural hematoma formation.[29] The risk of subdural hematoma development likely is related to the total volume and rate of CSF drainage.[36] Tearing of dural bridging veins or rupture of cortical veins during excess drainage or brain shrinkage have been postulated as part of