Con: Patients at Risk for Spinal Cord Ischemia After Thoracic Endovascular Aortic Repairs Should Not Receive Prophylactic Cerebrospinal Fluid Drainage

Robert S. Isaak, DO,* and William Furman, MD†

Over the past 2 decades, there has been a significant increase in the number of patients undergoing endovascular repair of aortic aneurysms (EVAR) and a shift away from open repairs.1 When vascular surgeons introduced the EVAR procedure, they typically only repaired infrarenal segments of the aorta. Over time, they became more facile with endovascular procedures, and stent-graft technologies evolved. This led to yet another shift away from open aortic surgery, this time toward patients having thoracic endovascular aortic repairs (TEVAR) for aneurysms that encompassed greater extents of the aorta, including thoracoabdominal aneurysms. Although the devices and surgical techniques used for EVARs and TEVARs may seem similar, TEVAR patients are at higher risk for complications, especially neurologic complications.

One of the most significant neurologic complications of thoracic aortic repair is postoperative spinal cord injury (SCI). The incidence of SCI, characterized by paraplegia or paresis of the lower extremities, is reported to be 2.4% to 40% after open thoracic aortic surgery.2,3 and 4.3% to 8% after TEVAR.7,8 The most recent 2010 American College of Cardiology Foundation and American Heart Association (ACCF/AHA) guidelines on “Diagnosis and Management of Patients with Thoracic Aortic Disease” addressed strategies to reduce the incidence of SCI.9 The guidelines endorsed cerebrospinal fluid (CSF) drainage for the purpose of spinal cord protection for both open and endovascular repair of the descending aorta. This was cited as a class I recommendation for CSF drainage, based on “B” level of evidence, “for patients at high risk of spinal cord ischemic injury.” This recommendation was based on 2 referenced studies and 1 meta-analysis that claimed (without basis) to make the case for CSF drainage during open thoracic aortic procedures.5,10,11 The cautious reader might conclude that these studies did not actually make the case for CSF drainage during TEVAR and may find it very difficult indeed to understand how or why this recommendation ever was extended from open surgery to include thoracic endovascular repair.

The 2002 study by Coselli et al10 only examined patients undergoing open repair of modified Crawford extent I or II thoracic aortic aneurysms. Each of the 144 patients in this study received moderate heparinization, left heart bypass, permissive mild hypothermia, and had reimplantation of what the surgeon identified as critical intercostal arteries. Seventy-six patients were randomized to receive CSF drainage, and 69 patients did not receive CSF drainage. The authors found an 80% risk reduction for SCI in the group that received CSF drainage (p < 0.03 by Fisher’s exact test), supporting the belief that CSF drainage can improve neurologic outcomes in open thoracic aortic surgery but providing no insight regarding TEVAR.

Safi et al examined 1,004 consecutive patients undergoing open thoracoabdominal aortic aneurysm repair at a single institution between 1991 and 2003.3 All patients received nearly identical anesthetic management and surgical care, the only difference being that 74% of the patients received “adjunct” therapy consisting of distal aortic perfusion along with CSF drainage, and the remaining 26% received neither distal aortic perfusion nor CSF drainage. When “adjunct” therapy was not provided, the incidence of SCI was 6.8%; it was significantly lower at 2.4% in the “adjunct” therapy group. The authors concluded that CSF drainage along with distal aortic perfusion resulted in a decreased risk of SCI in open aortic surgery. This study also provided no insight into outcomes after TEVAR.

The final study cited as contributing to the recommended guidelines was a meta-analysis performed by Khan et al11 in 2004 that did not conclude that CSFD clearly was beneficial in open thoracic aortic surgery. This review examined CSF drainage in open descending thoracic and thoracoabdominal aortic aneurysm repairs and, like the previous 2 studies, did not address TEVAR patients. The authors found only 3 studies, including a total of 287 patients, which met inclusion criteria for their analysis, and concluded that “There are limited data supporting the role of CSFD in thoracic and thoracoabdominal aortic aneurysm surgery for the prevention of neurologic injury.” These same authors repeated this meta-analysis in 2012.
and came to the exact same conclusion. To restate their conclusions, CSFD is of uncertain value in open thoracic aortic procedures. No comment was offered regarding TEVARs.

Hence, upon closer analysis, the recommendation favoring CSF drainage in TEVAR patients included in the ACCF/AHA guidelines appears difficult to endorse. It was based on 2 studies that failed to examine patients who underwent TEVAR and 1 meta-analysis that actually questioned the recommendation for CSFD in open thoracic aortic procedures. How can this possibly be the basis of a Class I recommendation, and why would anyone be motivated to follow such a recommendation?

Was there any published high-level evidence that addressed the question of CSFD and outcomes in TEVAR patients? Regrettably, the answer is no. There were no published prospective randomized trials comparing patients, with and without prophylactic CSF drainage, who underwent TEVAR procedures. Likewise, there were no published prospective studies comparing prophylactic CSF drainage initiated before surgery with drainage starting at the time of development of signs of SCI in the postoperative period. As a result of this lack of evidence and physiologic theory, a recommendation to use CSF drainage in TEVAR patients could have been based only on data from a combination of retrospective case series (with their inherent biases), creative extrapolation of potentially irrelevant evidence from open thoracic aortic procedures, and theoretical over-reaching in an attempt to apply physiologic principles of spinal cord perfusion. This does not provide a strong basis for medical decision making.

The physiologic over-reach that often is argued is a bit troubling. TEVAR procedures are, in fact, physiologically different from open procedures. During an open repair of the thoracic aorta, a cross-clamp temporarily impedes blood flow to the intercostal arteries responsible for supplying the anterior portion of the spinal cord. During this period of aortic clamping, CSF is removed to achieve a CSF pressure of 60 mmHg. Ultimately, though, blood flow is restored to the intercostal arteries later in the procedure after the aortic cross-clamp is removed. The theory behind placing a lumbar drain and decompressing the CSF space is to maximize spinal cord perfusion pressure, or at least prevent the CSF pressure from being the effective downstream outflow pressure. This would thereby maximize spinal cord blood flow within the context of the existing circulatory performance of the patient’s cardiovascular system. This is not the case during a TEVAR, in which no cross-clamp is applied to the aorta and there is no temporary reduction of arterial blood flow that subsequently can be restored. Flow to the intercostal arteries can be impeded when a stent graft is deployed over the orifices of intercostal arteries supplying the spinal cord, but this is not reversible because the stent is never removed and the occlusion is never relieved. As a result of these significant differences, there is no logical physiologic basis upon which to predict a benefit from temporarily reducing CSF pressure via drainage before and after the deployment of the stent graft during a TEVAR. Furthermore, there are no data showing it works.

There are several patient factors believed to increase the risk of SCI after TEVAR, presumably by compromising spinal cord perfusion pressure. Some of these factors are present in patients before surgery and include previous aortic surgery or severe atherosclerosis of the aorta. Others, such as operative injury to the external iliac artery and injury or occlusion of the left subclavian artery or hypogastric artery, arise as a consequence of the surgery itself. Because spinal cord perfusion pressure is equal to mean arterial pressure (reference range: 70-110 mmHg) minus the greater of central venous pressure (CVP) or CSF pressure (reference range 8-15 mmHg), the most important modifiable factor for maintaining flow to the spinal cord is the mean arterial pressure. Therefore, the most significant step in SCI risk factor modification under the control of the anesthesiologist is the prevention of hypotension in the perianesthetic period.

Practice patterns related to CSF drainage during TEVARs vary considerably. This lack of consensus supports the author’s view that there is no true efficacy of CSFD in this setting. Some institutions routinely establish prophylactic CSF drainage before stent graft deployment if the stent is expected to cover the origin of any of the intercostal arteries between T8 and L1. Others do so for any TEVAR patient who has had a prior procedure with coverage between T8 and L1, independent of the location of the planned stent graft deployment for the current procedure. In contrast, several published case series have described the establishment of CSF drainage only after a postoperative neurologic deficit is recognized. Typically, drainage is maintained for 2 to 3 days postoperatively, with CSF pressures kept below 12 mmHg. CVP measurement, however, is not consistently used. As a result, 10 or 12 mmHg is selected arbitrarily as the target for CSF pressure reduction. The logic behind this is faulty, as there is no reliable way to know if the CVP is ≥10 mmHg in an individual patient and no compelling reason to believe it would be that high in any specific case.

Finally, it is worth noting that the placement of a lumbar drain and CSF drainage are not without risk. The list of potential complications includes several that are potentially life threatening, such as intracerebral hemorrhage from intracerebral hypotension, neuraxial (including subarachnoid, subdural, and epidural) hematomas, and meningitis. One review of 230 patients receiving CSF drains for repair of thoracoabdominal aortic aneurysm found a mortality rate of 11% that was attributed directly to the presence of a CSF drain. Other complications that can result from CSF drains include catheter fractures, local area skin infections, CSF leaks, mechanical failures, and abducens nerve palsy.

To sum up the case against CSF drainage, the authors have made the following observations:

1. The studies cited in the ACCF/AHA guidelines in support of the recommendation for CSF drainage in patients at high risk for SCI after TEVAR actually did not address patients having TEVAR procedures. One of these articles even questioned the benefit in open procedures.
2. There are no high-quality outcomes data showing efficacy in TEVAR patients.
3. There is no physiologic reason to believe CSFD should be efficacious.
4. There is no consensus among practitioners who provide care to TEVAR patients.
5. The application of the technique is flawed by not being able to reduce CSF pressure below CVP reliably (because CVP normally is not measured and commonly is overestimated).

6. Between 1 in 20 and 1 in 50 patients develops significant and potentially life-threatening complications. This rate is far too high to accept for a procedure that has little or no demonstrable benefit.\(^4\)

**REFERENCES**


