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Original Article

Contemporary Single-Center Experience With Prophylactic Cerebrospinal Fluid Drainage for Thoracic Endovascular Aortic Repair in Patients at High Risk for Ischemic Spinal Cord Injury

Michael Mazzeffi, MD, MPH, MSc[*,1], Ezeldeen Abuelkasem, MD[†], Charles B. Drucker, MD[‡], Richa Kalsi, MD[‡], Shabab Toursavadkohi, MD[‡], Donald G. Harris, MD[§], Peter Rock, MD, MBA[*], Kenichi Tanaka, MD, MSc[*], Bradley Taylor, MD, MPH[‖], Robert Crawford, MD[‡]

[*]*Department of Anesthesiology, University of Maryland School of Medicine, Baltimore, MD*
[†]*Department of Anesthesiology, University of Pittsburgh School of Medicine, Pittsburgh, PA*
[‡]*Department of Surgery, University of Maryland School of Medicine, Baltimore, MD*
[§]*Division of Vascular Surgery, Department of Surgery, University of Wisconsin School of Medicine, Madison, WI*
[‖]*Division of Cardiothoracic Surgery, Department of Surgery, University of Maryland School of Medicine, Baltimore, MD*

Objective: To review rates of permanent paraplegia and lumbar drain-related complications in patients undergoing thoracic endovascular aortic repair (TEVAR) surgery with prophylactic cerebrospinal fluid (CSF) drainage at the authors' institution.
Design: Retrospective cohort study.
Setting: Tertiary care, academic medical center.
Participants: Patients who underwent TEVAR with a high risk for ischemic spinal cord injury and prophylactic lumbar CSF drainage over a 5-year period.
Interventions: None.
Measurements and Main Results: One hundred and two patients underwent TEVAR with lumbar CSF drainage. Thirty-day mortality was 5.9%, and the rate of permanent paraplegia was 2%. Drain complications occurred in 4 (3.9%) patients, but no patient experienced permanent injury related to CSF drainage. Two patients in the cohort had complete resolution of paraplegia with increased CSF drainage and mean arterial blood pressure increases aimed to increase spinal cord perfusion pressure by 25%. A third patient experienced improvement in lower extremity strength but remained paraplegic, and a fourth patient demonstrated no improvement in symptoms. The 6 patients taking clopidogrel experienced no bleeding complications, and there were no apparent risk factors for bleeding in the 5 patients who had bloody drain output or in 1 patient who developed an epidural hematoma.
Conclusion: Prophylactic CSF drainage was associated with low paraplegia and drain-related complication rates. These data further support the safety of prophylactic CSF drainage in patients undergoing TEVAR with a high risk for ischemic spinal cord injury.

Key Words: aortic surgery; anesthesia; neuroprotection; lumbar drain

PROPHYLACTIC CEREBROSPINAL FLUID (CSF) drainage has emerged as an important adjunct for spinal cord protection during thoracic endovascular aortic repair (TEVAR)

[1]*Address reprint requests to* Michael Mazzeffi, MD, MPH, University of Maryland School of Medicine, 22 South Greene St., S11C00, Baltimore, MD 21201.
E-mail address: mmazzeffi@som.umaryland.edu (M. Mazzeffi).

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surgery. By lowering intrathecal pressure, CSF drainage helps improve spinal cord perfusion pressure (SCPP). In a recent systematic review and meta-analysis that included 10 studies, CSF drainage was shown to decrease the risk of ischemic spinal cord injury (SCI) after TEVAR by approximately half.[1] However, ischemic SCI is relatively infrequent after TEVAR, occurring in 3% to 6% of patients, and some studies have suggested that the role of CSF prophylactic drainage is less definitive.[2]

CSF drainage with a lumbar drain also is associated with serious complications, including lumbar epidural hematoma, direct SCI from trauma, or intracranial subdural hemorrhage from excessive CSF drainage.[3,4] In one large cohort of more than 700 patients from the University of Wisconsin, 10% of patients had bloody CSF during drainage, and nearly half of them had intracranial bleeding.[5] In another cohort of 62 patients, 2 patients (3.2%) had a drain-related complication, one of which had a poor neurologic outcome.[6]

The goal of the present study was to review consecutive cases of prophylactic lumbar CSF drainage in TEVAR patients at the authors' center and determine the incidence of drain-related complications. In addition, the authors sought to determine whether there were apparent risk factors for drain-related complications. The authors hypothesized that drain-related complications would be infrequent and unrelated to predictive variables such as patient age, use of antiplatelet drugs, or platelet count at the time of drain placement or removal.

Methods

Patients

The institutional review board at the University of Maryland, Baltimore, approved the study. Consecutive adult patients who underwent TEVAR with a lumbar drain placed for prophylactic CSF drainage between November 1, 2011, and December 31, 2015, were included in the study. The study period was selected based on the availability of electronic medical records, which allowed the authors to reliably record study variables, and because surgery and anesthesia practices were consistent during this period. Eligible patients were identified using current procedural terminology codes for TEVAR. Patients who had a lumbar drain placed were identified using the surgeon's surgical report. For all patients, the following data were collected: age, sex, hypertension, diabetes mellitus, coronary artery disease, cerebral vascular disease, chronic kidney disease, end-stage renal disease requiring dialysis, dyslipidemia, active tobacco use, chronic obstructive pulmonary disease, history of TEVAR, history of endovascular aortic repair, history of open abdominal aortic aneurysm repair, estimated blood loss during surgery, starting mean arterial blood pressure (MAP), lowest MAP during surgery, vasopressor use during surgery, total days of CSF drainage, and 30-day mortality.

In addition, details were collected about lumbar drain placement and removal, including the following coagulation parameters: international normalized ratio (INR), activated partial thromboplastin time, platelet count, and antiplatelet drug use. Furthermore, data on drain-related complications and paraplegia after surgery were recorded.

CSF Drainage Protocol

The decision to perform CSF drainage was made by the attending vascular surgeon in consultation with the attending anesthesiologist. Lumbar drains were placed in patients undergoing TEVAR who were deemed to be high risk for ischemic SCI. Low-risk TEVAR patients do not have lumbar drains placed at the authors' center. High-risk patients were those with ≥ 15 cm of aortic coverage, previous endovascular aortic repair or TEVAR, and poor pelvic perfusion or an occluded abdominal aorta. These criteria were based on previously reported risk factors in the literature, which suggest that patients with large aortic coverage area and previous aortic surgery may be at particularly high risk for ischemic SCI after TEVAR.[7,8] Lumbar drains were placed by anesthesiologists with expertise in cardiothoracic or vascular anesthesiology or by anesthesiology trainees under their direct supervision. Drains were placed using anatomic landmarks and in rare cases fluoroscopic guidance. All patients underwent motor and somatosensory evoked potential monitoring during their surgery. Figure 1 summarizes the CSF drainage guidelines used during the study period.

Heparin management during TEVAR was performed to achieve an activated clotting time of 250 to 300 seconds. During surgery CSF was drained continually when CSF pressure exceeded 10 mmHg. However, no more than 15 mL of CSF per hour was routinely drained. At the time of graft implantation, up to 20 mL per hour of CSF could be drained if evoked potential monitoring demonstrated abnormalities or if SCPP fell below 80 to 90 mmHg. After completion of surgery, CSF was drained continually in patients when the CSF pressure exceeded 10 mmHg; the goal SCPP was 80 to 90 mmHg. Again, care was taken to drain no more than 15 mL of CSF per hour unless the patient had new-onset paraplegia. In cases of new paraplegia, up to 20 mL per hour could be drained to increase SCPP by 25% in concert with targeted MAP increases. In patients without complications, drains were removed on the 2nd to 5th postoperative day, depending on the patient's overall course and coagulation profile. In patients who had new-onset paraplegia that resolved, drains were capped approximately 24 hours after symptom resolution and were removed 24 hours later if the patient's neurologic examination remained stable.

Study Outcomes

The primary study outcome was any lumbar drain-related complication including the following: central nervous system bleeding, ischemic SCI, drain entrapment, or drain fracture. Sequelae, including permanent paraplegia, were described for all patients with a drain-related complication.

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