

Spinal cord protection and related complications in endovascular management of B dissection: LSA revascularization and CSF drainage

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Introduction

The endovascular repair of thoracic aorta (TEVAR) has significantly decreased the overall incidence of neurologic complications when compared with open surgery. Nevertheless, the risk of paraplegia remains an important concern, with rates ranging from 2% up to 8% (1). Risk factors for spinal cord ischemia following TEVAR include prior abdominal aortic aneurysm (AAA) repair, prolonged hypotension, severe atherosclerosis of the thoracic aorta, occlusion of the left subclavian artery (LSA) or hypogastric arteries, and more extensive coverage of the thoracic aorta by the graft (1).

Different strategies have been developed over time to protect the spinal cord from ischemic insult during thoracic aortic repair (2) (see *Table 1*). LSA revascularization and cerebral spinal fluid (CSF) drainage are the two more invasive preventive maneuvers applied in TEVAR for treating type B dissection which may be associated with relevant pitfalls.

Pitfalls and safeguards

LSA revascularization pitfalls

Since the effective contribution of the LSA to spinal cord vascularization is difficult to estimate due to anatomical variability, its revascularization may be not always necessary and should be performed selectively. Most authors agree on absolute indications to LSA revascularization in patients presenting with specific clinical situations, including left internal mammary artery-coronary bypass, dominant left vertebral artery, isolated left cerebral hemisphere, and

functioning left upper extremity artery-venous dialysis fistula or bypasses. A selective revascularization approach has also been suggested based on ischemic risk stratification, such as in the presence of extensive aortic coverage, prior aortic surgery, or an occluded hypogastric artery (3). LSA revascularization may be associated with several complications, which are summarized in *Table 2* (4).

LSA revascularization safeguards

Recommendations to avoid such complications focus on two aspects: a justified indication, and a careful and skillful surgical technique to avoid injuries to adjacent structures when a left subclavian-carotid transposition or bypass grafting is performed. Because the surgical outcome is strongly related to volume and experience, highly experienced surgeons should be in charge of these surgical preventive procedures.

CSF drainage pitfalls

Spinal fluid pressure (SFP) normally approximates central venous pressure, and spinal cord perfusion pressure is the difference between mean arterial pressure and SFP. Thoracic endograft deployment produces an acute rise in both central venous pressure and SFP. This increase in SFP decreases spinal cord blood flow. For this reason, CSF drainage is recommended in selected TEVAR cases which have a high risk of spinal cord ischemia (*Table 3*), as part of a multimodality approach for the prevention of neurological complications.

Changes in spinal fluid volume and pressure affect

Table 1 Suggested strategies for spinal cord protection during TEVAR

Preoperative
Assessment of collateralization
Main medullary artery identification
Intraoperative
Left subclavian artery revascularization
Spinal perfusion pressure monitoring
Cerebral spinal fluid drainage
Increase of hemoglobin levels
Increase of mean arterial pressure
Evoked potentials monitoring
Local or systemic hypothermia
TEVAR, endovascular repair of thoracic aorta.

Table 2 Potential complications related to LSA revascularizations

Hemi-diaphragm palsy
Lymphocele, lymphorrhea
Graft or vessel bleeding
Graft or vessel thrombosis
Graft infection
Wound dehiscence or infection
Cerebrovascular accident
LSA, left subclavian artery.

intracranial mechanics and can produce deleterious clinical effects. When spinal fluid is removed, SFP drops, producing intracranial hypotension. This can cause acute intracranial (intraparenchymal, subdural, or subarachnoid) bleeding due to the enlargement and rupture of venous sinuses or cortical veins and caudal brain displacement.

In addition, besides the particular complications associated with lumbar puncture or neuraxial anesthesia (i.e., bleeding puncture, headache, infection), in patients necessitating a CSF monitoring and draining catheter, brain bleeding complications (*Table 4*) are the most serious events which can occur (5). There are several risk factors for brain bleeding related to CSF drainage (*Table 5*).

CSF drainage safeguards

It is very important to identify any risk factor listed in *Table 5*. The presence of any coagulation disorders as well

Table 3 Indications for CSF drainage in TEVAR for type B dissection repair

Extensive coverage of descending thoracic aorta including T8-T12
Previous abdominal aorta repair
Poor collateral network (subclavian or hypogastric occlusions)
Immediate postoperative paraplegia
CSF, cerebral spinal fluid; TEVAR, endovascular repair of thoracic aorta.

Table 4 Potential complications related to CSF drainage

Intracranial bleeding
Spinal bleeding
Hemorrhagic spinal liquid
Headache
CSF, cerebral spinal fluid.

Table 5 Risk factors for CSF drainage complications

Total intraoperative drained volume >150 mL
High central venous pressure
Cerebral atrophy
Previous head trauma
Chronic subdural hematoma
Presence of cerebral aneurysm
Cranial arteriovenous malformations
Cranial vault abnormalities
Coagulation disorders
CSF, cerebral spinal fluid.

as antiplatelet or anticoagulant therapy must be taken into account. To avoid bleeding complications, antiplatelet treatment should be stopped at least 5 days before surgery and the catheter should be removed at least six hours after last low molecular weight heparin dosage.

Continuous and controlled CSF monitoring and drainage should be used. No more than 10 mL/hour should be drained and SFP should be maintained at 10-12 mmHg, avoiding any inadvertent catheter obstruction.

As a general rule, the main goal is to reach a control SFP with the minimum volume of spinal fluid drainage in order to minimize intracranial bleeding complications. During the postoperative phase, the catheter must be kept in place

for 24-72 hours, carefully maintaining spinal cord perfusion pressure above 70 mmHg. If bloody liquid is observed through the catheter, drainage must be stopped; coagulation parameters should be checked and corrected if necessary. Additionally, spinal and head computed tomography or magnetic resonance scans should be performed in patients with bloody spinal fluid, as well as in all patients with abnormal neurologic signs.

The spinal catheter can be removed after a period of 12 hours, with stopped drainage in order to check for any neuro-deficit and correct the coagulation parameters. Besides CSF drainage, important adjuvant perioperative preventive measures which should be taken include maintaining mean blood pressure above 80 mmHg and hemoglobin level above 10 g/dL.

To avoid complications related to management of the CSF catheter, a dedicated and automated CSF pressure and drain monitoring system, the *LiquoGuard*[®] (Möller Medical GmbH & Co KG, Fulda, Germany) has been recently proposed (6). This has a transducer and a console which measures CSF pressure, connected to a peristaltic tube pump which drains CSF continuously, according to pre-established parameters and limits for CSF pressure (hourly drainage speed, maximum and minimum CSF pressure, maximum amount to be drained per hour). *LiquoGuard*[®] facilitates detection of catheter leakage and helps avoid catheter occlusions by ensuring a continuous and controlled CSF flow. Moreover, the *LiquoGuard*[®] sensor unit is easily taped and adjusted to the lumbar catheter level, by using a specially designed fixation device, for maximal patient comfort and mobility. This system permits a continuous pressure-controlled CSF flow with a high level of patient and nurse compliance, with on-line and off line recording capabilities.

Comments

Both LSA revascularization and CSF drainage are recommended as the most prominent maneuvers to prevent paraplegia, the most dramatic complication in thoracic

aorta repairs. However, both need to be applied in selected patients who may benefit the most from them and who justify the implicit and potential serious complications. To minimize such pitfalls, both techniques should be carefully performed. Concerning CSF drainage, beyond the technique itself, anesthesiologists and nurses must pay special attention on CSF pressure and drained volume, mean arterial pressure and coagulation monitoring. Recent specific tools, such as *LiquoGuard*[®], make CSF pressure and monitoring easier.

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