Recovery of lost motor evoked potentials in open thoracoabdominal aortic aneurysm repair using intercostal artery bypass

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ABSTRACT

Ischemia of the spinal cord remains a disastrous complication in thoracoabdominal aortic aneurysm (TAAA) surgery. We report a case of open type I TAAA repair during which no motor evoked potentials were detectable for >1 hour after aortic cross-clamping. The creation of three intercostal artery bypasses restored spinal cord perfusion. As the patient showed only moderate clinical signs of spinal cord ischemia afterward, we underline the role of neuromonitoring to guide intercostal artery bypass implantation during TAAA surgery as the combined use of neuromonitoring and intercostal artery bypass implantation may prevent paraplegia in specific TAAA cases. (J Vasc Surg Cases and Innovative Techniques 2018;4:54-7.)

Svensson et al[1] reported an incidence of spinal cord ischemia of 16% after surgical repair of thoracoabdominal aortic aneurysm (TAAA). Different strategies, such as intraoperative assessment of motor evoked potentials (MEPs), have been established to reduce spinal cord ischemia damage.[2-5] Extensive reimplantation of intercostal arteries has been performed regularly in the past; a more differentiated procedure is recommended in publications of the last years. Based on the existing collateral network of the spinal cord, sacrifice of at least 8 to 12 intercostal arteries without decreasing spinal cord perfusion has been described.[6,7] While using intraoperative neurologic monitoring applying MEPs, the surgeon is able to adapt the surgical procedure during TAAA repair. If necessary, each segment of the aorta can be evaluated separately by repositioning of the aortic clamp, and intercostal artery revascularization can be performed if required.[5] We present an exceptional case with complete loss of MEPs after aortic cross-clamping for 1 hour with restoration after aortic reconstruction including three intercostal artery bypasses. The patient's written informed consent was obtained.

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CASE REPORT

A 66-year-old woman suffering from Crawford type I TAAA with a diameter of 8.1 cm was referred to our department for open repair (Fig 1). The computed tomography (CT) scan showed open vertebral and subclavian arteries; furthermore, the iliac arteries showed no relevant atherosclerotic stenosis. Thirteen pairs of intercostal and lumbar arteries could be found in the descending thoracic and abdominal aorta. The surgical procedure and the neurologic monitoring have been described before.[8] During the procedure, permissive hypertension with a mean arterial pressure (MAP) of 80 mm Hg was maintained to support spinal cord perfusion. Distal perfusion was maintained through left femoral access.

Thoracotomy was followed by laparotomy with limited incision of the anterior diaphragm and opening of the crus. Aortic clamping was possible distal to the left subclavian artery and below the superior mesenteric artery. Reconstruction started with the proximal descending aorta. Aortic cross-clamping in this segment did not affect the MEP amplitudes; two small bronchial arteries were sacrificed, whereas two intercostal arteries were cannulated using 3F Pruitt catheters (LeMaitre Vascular Inc, Burlington, Mass). A 22-mm Gelweave prosthesis (Vascutek, Inchinnan, United Kingdom) was anastomosed and reinforced with a vascular Teflon strip (Santec Medical, Großostheim, Germany). After repositioning of the distal aortic clamp between the celiac trunk and the superior mesenteric artery, the MEPs decreased significantly on both legs. Furthermore, based on the MEP curve assessment, a causal peripheral ischemia could be excluded. MAP was raised to 90 mm Hg, yet the MEP decrease continued for the next minutes. An 8-mm Dacron bypass (Vascutek) was implanted to include the two cannulated intercostal arteries in the aortic reconstruction.

Distal aortic clamping was intermittently released to optimize spinal cord perfusion. After repositioning of the distal aortic clamp, the aneurysm sac was opened; a backbleeding intercostal artery could be integrated in the distal aortic anastomosis. Just before the distal anastomosis was completed, MEPs could

Fig 1. Computed tomography (CT) angiography in the sagittal plane showing kinked type I thoracoabdominal aortic aneurysm (TAAA) with a maximum diameter of 8.1 cm.

not be detected anymore. Perfusion through the aortic reconstruction was released, but there was still no recurrence of the MEPs. Two small pairs of intercostal arteries with moderate backbleeding were identified; after endarterectomy of the calcified aortic wall, two 8-mm bypasses were implanted (Fig 2). Subsequently the MEPs were restored, finally reaching 100% at the end of the procedure (Fig 3). During the whole procedure, no increase of the cerebrospinal fluid pressure above 10 mm Hg was detectable.

After extubation in the intensive care unit, sensitivity of the lower extremity showed no impairment, and the patient was able to move her feet, yet a loss of strength of the thigh muscle was observed. A consulted neurologist confirmed spinal cord ischemia with paresis of the hip flexors on both sides within 24 hours after treatment. Magnetic resonance imaging of the spine revealed no signs of spinal cord ischemia and showed open intercostal artery bypasses (Fig 4). The intrathecal catheter could be removed after 72 hours without further pathologic neurologic findings. The patient completed a neurophysiologic rehabilitation after discharge from the hospital. At 12 months postoperatively, she was able to move without any support; still, climbing stairs and getting up from a lying position remained difficult. No further problems regarding the spinal cord perfusion or any other postinterventional complications could be observed. A CT scan performed in November 2017 showed a patent aortic prosthesis, whereas all intercostal artery bypasses were occluded.

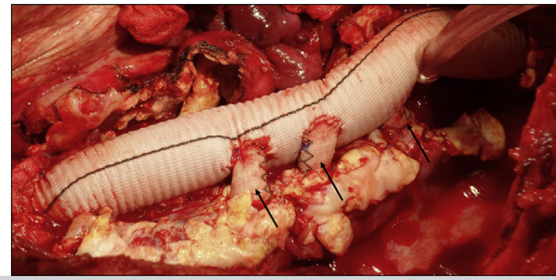

Fig 2. Type I thoracoabdominal aortic aneurysm (TAAA) repair using 22-mm Gelweave prosthesis (Vascutek, Inchinnan, United Kingdom). Three intercostal artery bypasses are indicated.

DISCUSSION

Assessment of MEPs during TAAA surgery has been clearly demonstrated to diminish spinal cord ischemia in several studies and meta-analysis.[9-11] Without the use of intraoperative neuromonitoring by means of MEP measurement, no online information about spinal cord function is available during surgery. Based on clinical experience, a decline of at least 50% or 75% is regarded as expression of critical spinal cord ischemia as it may correlate with postprocedural paraplegia.[12,13]

In this regard, the MEP findings of the presented case are puzzling. Although the signals disappeared for >1 hour, the patient was able to walk and showed only moderate signs of spinal cord ischemia. Obviously, the consequent use of all possibilities to protect the spinal cord from ischemic damage during TAAA surgery, including arterial hypertension, control of the intrathecal pressure, and distal aortic perfusion, kept the spinal cord perfused at a level allowing maintenance of morphologic but not functional integrity of the spinal cord gray matter. Presumably, the collateral network of the spine perfusion demonstrated its clinical relevance.[14] Retrospective studies reveal a nonsignificantly reduced probability of spinal cord ischemia if intercostal artery revascularization is used during TAAA repair.[15] Further studies describe an inadequately high rate of intercostal artery bypass implantation during TAAA surgery as a result of nonadequate neurologic monitoring and poor comprehension of the collateral network of the spine.[7,16] Etz et al[7] described the possibility of sacrificing up to 15 intercostal and lumbar arteries during open TAAA surgery using MEPs and somatosensory evoked potentials as neurologic monitoring. Wynn et al[15] even believe that the consequent use of spinal cord protection including an MAP above 80 mm Hg may obviate the use of intercostal artery revascularization during TAAA surgery.

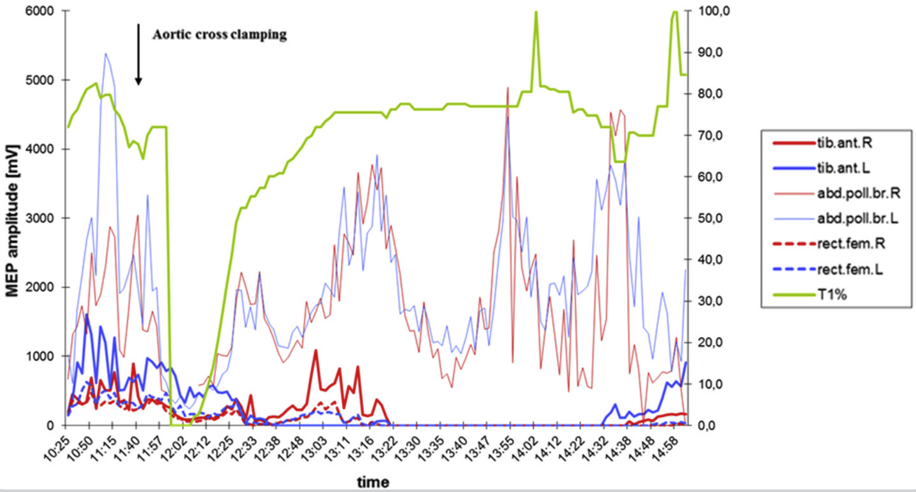

Fig 3. The report of the motor evoked potentials (*MEPs*) shows a significant decrease of the potentials starting 5 minutes after aortic cross-clamping. After implantation of three intercostal artery bypasses, a complete recovery of the signals could be assessed.

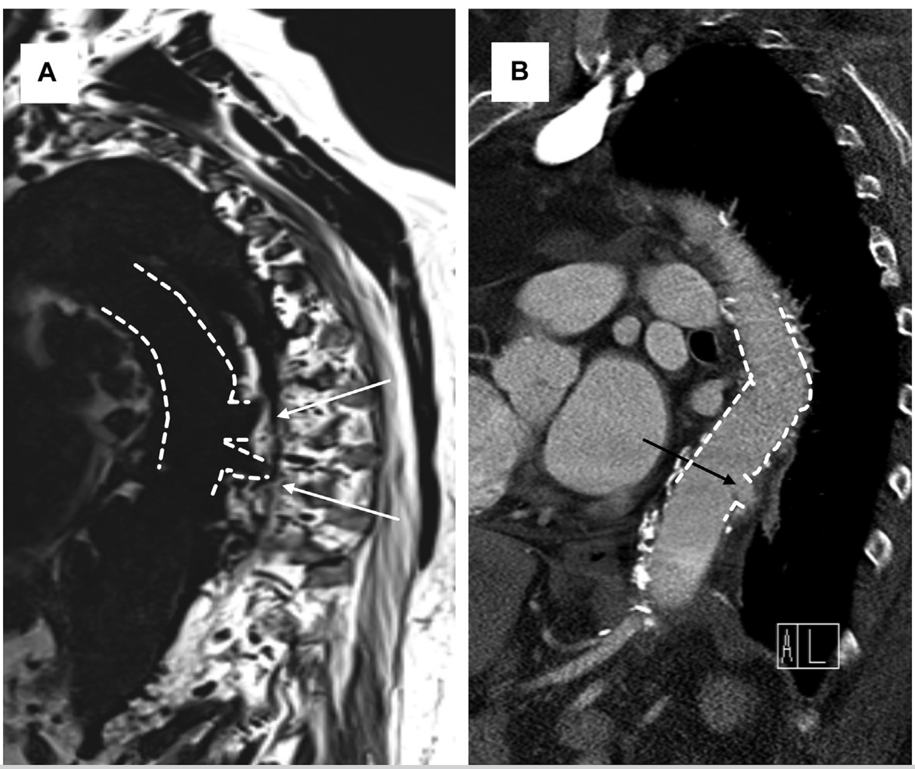

Fig 4. A, Postoperative magnetic resonance imaging of the spine. The patent intercostal artery bypasses are indicated. **B,** Postoperative computed tomography (CT) scan 12 months after surgery. The occluded intercostal artery bypass is indicated.

In this case, a multimodal concept to protect the spinal cord from ischemic damage was used. Still, only the implantation of three intercostal artery bypasses was able to restore the MEP signals and proper spinal cord perfusion correspondingly. Vascular surgeons who use the technique of intercostal artery revascularization routinely describe the safety and feasibility of the procedure, which is associated with a low rate of spinal cord ischemia after type II TAAA repair.[17,18] The MEP-triggered reimplantation of the internal carotid artery during open TAAA surgery is the standard method in our department. However, if internal carotid arteries are dominant on preoperative CT scans and show intense backbleeding intraoperatively, reimplantation will also be performed.

As the long-term patency of intercostal artery bypasses is moderate, an occlusion 12 months postoperatively is not unusual.[19]

Finally, this case underlines the stringent necessity of neurologic monitoring to protect the spinal cord during TAAA surgery. Furthermore, the technique of intercostal artery revascularization demonstrates its clinical value. Without the implantation of intercostal artery bypasses in this case, paraplegia would have been the fatal consequence. Hence, we consider the MEP-controlled intercostal artery revascularization an essential part of open TAAA repair.

CONCLUSIONS

Neurologic monitoring applying MEPs is essential to assess spinal cord function during TAAA surgery. Intercostal artery revascularization is crucial to maintain spinal cord perfusion and can be guided by MEP monitoring.

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