

Tear of Joy or Sorrow: Endovascular Stent Grafting for Thoracoabdominal Aorta

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Surgery for thoracoabdominal aorta actually began before the era of cardiopulmonary bypass. In the mid-1950s, Ellis et al.,¹⁾ Etheredge et al.,²⁾ and DeBakey et al.³⁾ opened a field of surgery for throacoabdominal aorta using allograft. In 1965, DeBakey reported their results as 26% mortality in 42 patients with thoracoabdominal aortic aneurysms who underwent the extra-anatomical reconstruction of the thoracoabdominal aorta without using a cardiopulmonary bypass. Crawford et al.⁴⁾ modified and simplified the operation, such as “in situ” reconstruction of the thoracoabdominal aorta using the inclusion technique, reducing hospital mortality to 8% by 1978. After using a simple proximal aortic clamping, they⁵⁾ classified the thoracoabdominal aortic aneurysm into four categories according to its extension and demonstrated that early mortality and postoperative neurological deficit were 10.7% and 28.3%, especially, in extent II aneurysm. The progress of thoracoabdominal aortic surgery has mainly been achieved by the sons of Crawford. Svensson et al.⁶⁾ demonstrated the efficacy of intraoperative monitoring of the cord function using motor- or sensory-evoked potentials and intrathecal papaverine to prevent cord ischemia. Coselli et al.⁷⁾ reported an enormous surgical series of thoracoabdominal aorta with an exceptionally good result. Safi et al.⁸⁾ showed a greater improvement of surgical results for thoracoabdominal aorta using the adjunct, such as the distal bypass, cerebrospinal fluid drainage, and crystalloid fluid infusion into the kidneys. The European followers^{9,10)} also reported excellent clinical results of the thoracoabdominal aortic disease. We owe much of our knowledge regarding aortic aneurysm to our “sitting on the shoulders” of predecessors. However, surgery for thoracoabdominal aorta still remains a mountain to be conquered in the field of cardiovascular surgery. The incidence of postoperative spinal cord complications is re-

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ported to be 5% to 10%, even resulting from experienced hands; however, postoperative paraplegia occurs more frequently in the real world, especially in patients with Crawford type II extension aneurysm, higher age, and renal dysfunction. Moreover, frequent occurrence of postoperative bleeding, renal failure, gastrointestinal problems such as ischemic colitis, and respiratory failure have greatly compromised the recovery of patients. The registry of the Japanese Association for Thoracic Surgery reported that the hospital mortality of surgery for thoracoabdominal aorta was 17.4% in 528 patients during 2005.¹¹⁾ The U.S. multicenter registry in 2001 disclosed that early mortality after thoracoabdominal aortic surgery was 20%!¹²⁾

The anatomy of spinal cord circulation was hardly known until recently. Progress in radiological imaging, such as magnetic resonance imaging or computed tomography, has elucidated details of spinal cord circulation.¹³⁾ The well-known artery of Adamkiewicz had been one of postmortem entity, but nowadays surgeons are informed of not only the exact location of the Adamkiewicz artery, but also the collateral blood supply to the cord preoperatively. This evolution enables easier, simpler, and faster reconstruction of the intercostal arteries during thoracoabdominal aortic surgery.

Cumulative clinical experience has provided better understanding of the intraoperative hemodynamics of the spinal cord. Although some brave surgeons¹⁴⁾ are still using a “clamp-and-sew” or “clamp-and-pray” technique, the application of distal perfusion and the avoidance of proximal or distal hypotension enhanced blood supply to the cord via internal iliac, vertebral, intercostal, and lumbar arteries. Prevention of the blood-steal phenomena from the orifice of the intercostal arteries in the opened aorta maintains blood-pool reserve in the spinal cord. Animal experiments of cerebrospinal fluid drainage by Miyamoto et al.¹⁵⁾ in 1960 and recent randomized trials¹⁶⁾ proved its efficacy for reducing spinal cord ischemia. Sequential clamping of the intercostal arteries has been considered effective for enhancing the ischemic tolerance of the spinal cord. Intraoperative measurements of the motor-

evoked spinal cord potentials provide an exact and instantaneous vital state of the cord.¹⁷⁾ Regional or systemic hypothermia of the cord is also theoretically believed to be protective.¹⁸⁾ Numerous pharmacological agents, such as papaverine, naloxene, corticosteroids, oxygen radical scavenger, prostaglandin, excitatory amino acid antagonist, and even “a nonspecific flu medicine” have been tried. Intraoperative protection of the abdominal viscera using selective perfusion, crystalloid infusion, or hypothermia has been successfully achieved.

On the other hand, the recent advance of endovascular catheter-based technology (TEVAR: thoracic endovascular aortic repair) has realized “minimally invasive” treatment for the thoracoabdominal aortic lesions. Generally, the incidence of paraplegia was averaged to 3% in endovascular intervention for extensive descending aorta, which is superior to the open surgical procedure. Ishimaru et al.¹⁹⁾ has reported that the incidence of spinal cord complications was 2.0% among patients who had endovascular stent grafting to the descending aorta or thoracoabdominal aorta. The U.S. multicenter randomized trial²⁰⁾ of endovascular stent grafting and open surgery for an extensive aneurysm of the descending aorta demonstrated a better result in intervention than surgery did. Using a branched endovascular stent graft, Roselli et al.²¹⁾ reported a remarkable low incidence of the early mortality (1.3%) and postoperative paraplegia (2.7%) in 73 cases. Muhs et al.²²⁾ also reported an excellent early result of hospital death as one out of 38 patients, 2.6%, and midterm results of 13% mortality within 1 year. There was no cord complication in their series. Although in a limited number of patients, the hybrid therapy for thoracoabdominal aorta, such as endovascular stenting and extra-anatomical bypass for the visceral arteries, has gained reasonable success.²³⁾ The contra-indications to the TEVAR definitely do exist in patients with chronic aortic dissection, tortuous aorta, thrombi rich aorta, small peripheral arteries (which exclude stent access), and shock state as a result of aneurysm rupture. Also, the long-term results of TEVAR are not optimal. Nevertheless, many cardiovascular surgeons are looking at the achievement of TEVAR in thoracoabdominal aorta with a bitter-jealous admiration. The medicine world is aiming to be less invasive to the patients, and this trend is inevitable. Some innocent pessimists tend to think that shrewd cardiologists and radiologists will overtake surgeons in treating patients with aortic aneurysms. However, the disease itself is best treated by personnel who know the disease best. We surgeons have been trained to manage patients with aortic

aneurysms, and we know the aneurysm better both externally and internally more than other medical counterparts. Also, we have been taking care of aneurysm patients on a daily basis for a long time. Only we are able to treat patients who have had complications caused by TEVAR, such as perforation, rupture, dissection, occlusion, and esophageal or bronchial fistula. We must evolve and thrive for new technology to adapt ourselves to a new paradigm in treating patients with thoracoabdominal aorta. We must educate and train our young people to open a new frontier in the new field of surgery. There is no time for nostalgic crying for the good old days. Things are not what they used to be, and the times are changing rapidly.

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