Thoracic aortic aneurysm: clinical, surgical and anesthetic consideration

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Abstract: Surgical repair of thoracic aortic aneurysm (TAA) is a complex procedure that poses many surgical, anesthetic and perioperative challenges. Its complexity resides not only in challenging surgical aspects such as the need for interrupting the cerebral perfusion, but also the requirement for meticulous monitoring strategy during the perioperative period. Aneurysms are usually defined as a localized dilation of an arterial lumen greater than 50% of its normal diameter. The majority of the patients with TAA are asymptomatic at the time of diagnosis. TAA are usually found incidentally after chest X-ray or other imaging studies. Most patients are hypertensive but remain asymptomatic until the aneurysm expands. The main presenting symptom is pain. Pain may be sharp and acute implying impending aortic dissection or rupture. The location of pain may indicate the area of aortic involvement. Early diagnosis and elective treatment of TAA is of great importance. Elective surgeries in specialized institution have the best results. Diagnosis by size and symptoms have recently been enhanced with new "non-size criteria" by evaluation of mechanical properties of the aortic wall, symptomatic athero-embolism and biomarkers. It is important to apply the type of treatment in a timely manner, considering the conservative, radical surgical open resection or placement of endovascular stent. Fig. 1, Ref. 19, Online full text (Free, PDF) www.cardiology.sk

Key words: thoracic aortic aneurysm – pain – surgical treatment

History, pathophysiology, presentation and first surgical treatment

Dilatation of the segment of an arterial vessel has been known since antiquity. "True" aneurysms were recognized as a true-dilatation of the entire aortic wall, and "false" derived from tears in the aortic wall.

The most common causes of aneurysms were atherosclerosis, genetic disorders of the connective tissue (Marfan syndrome, Ehler-Danlos syndrome and recently identified Loeys-Dietz syndrome), infection (syphilis) and trauma.

Patients with TAA are usually asymptomatic. Most patients are hypertensive: the first symptom is pain. The location of the pain may indicate the area of aortic involvement. Ascending aortic aneurysm is presented with anterior chest pain, while aortic arch aneurysm causes pain radiating to the neck. Descending thoracic aneurysms tend to cause back pain. Ascending aortic aneurysm may cause aortic regurgitation, with diastolic murmur and heart failure. Arch aneurysms may stretch the recurrent laryngeal nerves, with presentation of hoarseness. Descending thoracic aneurysms and thoracoabdominal aneurysms may compress the trachea or bronchial tree and cause dyspnea, stridor, wheezing and cough. Spinal cord compression may result in paraparesis or paraplegia. The most common complication of TAA is acute dissection or rupture (1, 2).

The surgical entry for treatment of aneurysms was palliative with very poor and devastating results. It was only in 1902 that Tuffier (3) in Paris ligated the saccular aneurysm of the ascending aorta. Later the surgical technique was attempted to prevent the rupture of the TAA by stimulating a peri-aortic fibrosis and wrapping the aorta in a cellophane

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film. Progress was slow and mortality was enormously high. Only a few cases were published. In December 1948 Albert Einstein, the world known scientist, underwent surgery for a large TAA by Niessen (4) in New York City. Niessen was able to wrap only a portion of the aneurysm with cellophane. Einstein died of a ruptured aneurysm six years later. His death, among others, initiated tireless work around the world to find effective techniques for surgical treatment of TAA. Introduction of the cardiopulmonary bypass in clinical practice (1953), developing of plastic material (Dacron, Teflon), improving anesthetic management and monitoring were additional factors contributing to the growth of aortic surgery.

Open surgery for aortic aneurysm

Abdominal aortic aneurysm

Dubost (5) in Paris performed the first successful resection of an abdominal aneurysm on March 29, 1951. He removed the aneurysm and for reconstruction utilized

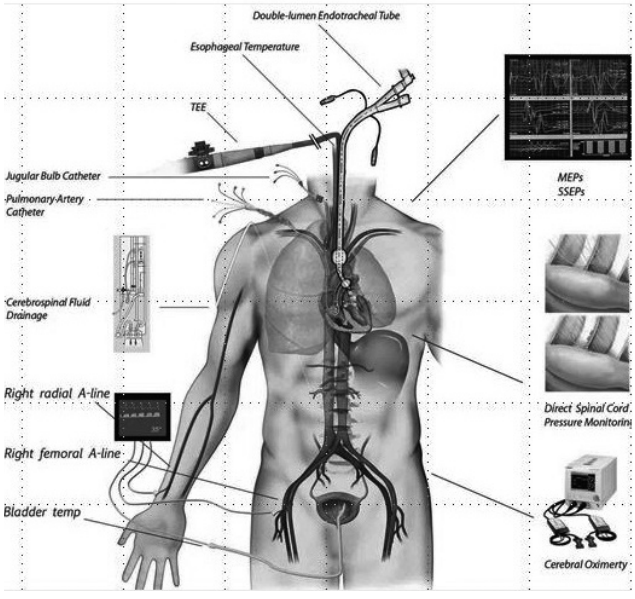

Figure 1 TAA repair

a 15 cm cadaver aortic homograft (harvested from the thoracic aorta of a 20-year-old girl). Dubost´s success was imitated by many surgeons, namely DeBakey, Cooley and Crawford from Houston, Texas and many European colleagues. DeBakey and Cooley (6, 7) reported seven patients operated on from 1952 –1953. A new era of aortic surgery had started (8).

Descending thoracic aortic aneurysm

DeBakey and Cooley in 1953 successfully resected a descending TAA using a "clamp-and-saw" technique and replaced it with a homograft. The aorta was also clamped for 45 minutes: there were no ischemic changes to the kidney and spinal cord. From additional experience they stated that clamping of the descending aorta should be limited to 60 minutes. They suggested using a shunt, or perfusion to protect against paraplegic complication (7).

Ascending aortic aneurysm

For repair a cardio-pulmonary bypass was used and a short period of circulatory arrest, fibrillation was corrected with defibrillation and the patients tolerated the procedure well. Later in 1962 the first repair of ascending aortic aneurysm was performed. In 1968 Bentall and Bono developed the composite graft from Teflon tube and aortic valve. In the graft it was necessary to prepare holes for re-implantation of coronaries. To simplify the procedure over the years several techniques were developed to used valve-saving approach for replacement of the aortic root.

Aortic arch aneurysm

The main problem is a catastrophic cerebral ischemia due to a stoppage in cerebral circulation. Shunts, with a variety of brain perfusion with mild hypothermia, temporarily improved the results. Later the use of antegrade and retrograde perfusion was utilized for brain protection. Deep hypothermic circulatory arrest, following success in repair of congenital heart surgery in pediatrics, was introduced in 1975 by Griepp (9) for repair of aortic arch aneurysm.

Thoraco-abdominal aortic aneurysm

The natural history of descending and thoraco-abdominal aortic aneurysms without surgical repair is dismal. Most patients who need an operation are elderly and have significant comorbidities. The question is open type of surgery, versus endovascular intervention. Spinal cord injury is a devastating complication. Panthee and Ono (10) in a large review reported an overall incidence of paraparesis or paraplegia from 1% – 32% with open surgery and 1% – 19% with endovascular aortic surgery. Despite many different surgical adjuncts (11) for spinal cord protection, we have not been able to eliminate this devastating complication.

More recently, less invasive therapy for aortic different type aneurysms have been developed. The first endovascular repair of TAA was reported by Parodi in 1991.

Our experiences with TAA

The very difficult decision confronting both patient and physician upon the discovery of a TAA is whether surgery should be performed or not. Size guidelines, based on ex-

pert consensus, are often used as indications for surgery. In 1985, Griepp and coworkers (12, 13, 14) opened the Aortic Aneurysm Surveillance Program to follow our patients and evaluate the risk of surgery versus serial monitoring of aneurysm diameter, growth, volume and location, as well as risk factors for dissection or rupture. If acute surgery is not indicated, patients are entered into a program for serial follow-up. The program reviews all imaging studies and magnetic resonance imaging and assesses the extent of the aortic dilatation. An elective aortic intervention (open or endovascular) is recommended when the risk of aortic rupture outweighs the risk of surgery.

Once the decision for surgery has been made, the patients are assessed in a thorough preoperative evaluation. Our institution utilizes a multidisciplinary approach in a specialized Preoperative Evaluation Clinic for day admission cardiac and major vascular surgery patients. On the day of surgery the patient is admitted to the hospital, following the necessary routine clinical and administrative procedures, and the patient is escorted to the operating room. Preoperative antibiotic prophylaxis (Cefazolin, Vancomycin) is started according to protocol (14).

Anesthetic management

In the OR a standard ASA anesthesiologist (American Society of Anesthesiologists) monitors, using a 5-leads ECG and pulse oximeter. The invasive pressure monitoring systems are connected. Standard anesthesia technique for cardiac surgery is utilized. One lung anesthesia is applied when needed. Special neurological monitoring (SSEP, MEP) is used in indicated cases. Every patient has transesophageal echocardiography monitoring during the whole operation. Different techniques are utilized for the brain (deep hypothermic circulatory arrest, or retrograde/anterograde perfusion) and spinal cord protections (drainage of cerebro spinal fluid). Routine anesthetic and neurological monitoring in patients undergoing TAA repair is demonstrated in **Figure 1** (11, 14, 15, 16).

Results

From February 1999 to January 2007 our institution operated on 1,135 patients for open repair of TAA. Overall mortality (including cases with aortic dissection) was 6.4%. We divided patients into three age groups: age < 65 years (n = 365); 65 – 75 years (n = 420); age > 76 years (n = 345). Patients aged 76 years and older (oldest patient was 93 years old) had a higher mortality rate, but statistically did not reach significance (95%CI 0.56 – 3.1 and 0.7 – 4.6 respectively. Gender did not significantly affect death rate (17).

Patients with known Marfan's syndrome were observed in a different group. Cardiovascular manifestations of Marfan lead to high morbidity and reduced life expectancy, and surgical intervention is often indispensable (18, 19). In general, these patients are younger with minimal comorbidities. We undertook a retrospective evaluation of the patients with Marfan, with a retrospective evaluation of reoperations. Eighty-three Marfan patients (60 males, 23 females) underwent 155 operations in our institution. Twenty-eight patients had acute aortic dissection and two had aortic rupture. Mean age at initial surgery was 32 ± 13 years. We compared sixty-one patients whose surgery was elective (Group 1) to 22 patients with initial emergency operations (Group II). Operative mortality in Group I was 1.6%, versus 9.0% in Group II. Also significant differences between groups included reoperation, 1 versus 3. Survival at 5 and 10 years did not differ between groups. Our presented investigations have encouraged us to be aggressive in recommending early surgical interventions to patients with Marfan syndrome.

Conclusion

The last decade has witness a series of developments in improvements of surgical (open and endovascular) techniques, anesthesia, monitoring and perioperative care with decreasing morbidity and mortality. Age is not a contraindication for repair of aortic aneurysms (14).

Major new discoveries have provided valuable information into the understanding of the cellular and molecular mechanism of Marfan syndrome. The cumulative knowledge will translate into individualized and effective pharmacological intervention, allowing for tailored medical and surgical approaches to this serious disease (19).

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