

# Thoracic Endovascular Aortic Aneurysm Repair (TEVAR)

Worawong Slisatkorn, M.D.\*, Chumpol Wongwanit, M.D.\*, Thanongchai Siriapisith, M.D.\*\*\*, Pansak Laksanabunsong, M.D.\*, Somchai Sriyoscharti M.D.\*

\*Department of Surgery, \*\*Department of Radiology, Faculty of Medicine Siriraj Hospital, Bangkok 10700, Thailand.

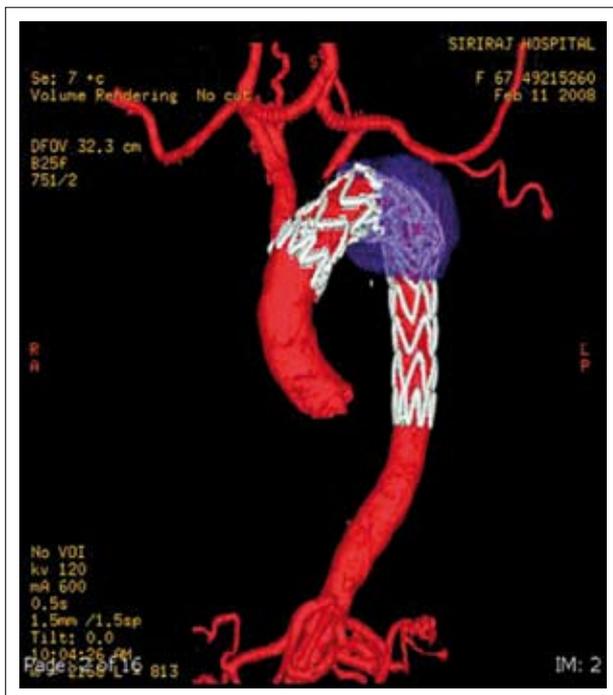
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The thoracic aortic diseases carry various pathologies such as atherosclerosis, degenerative aneurysm, aortic dissection, traumatic transection or rupture, penetrating atherosclerotic ulcer and infected aneurysm which may be life-threatening and necessitate urgent treatment. Currently there is a change in treatment paradigm. Thoracic endovascular aortic aneurysm repair (TEVAR) has become widespread for use as a treatment option and a solid alternative in serious comorbidities' patients (Fig 1). The advantages of endovascular surgery are less invasive surgery,

smaller incision (Fig 2), less operative blood loss, lower major postoperative complications and shorter intensive care and hospital length of stay.

Thoracic aneurysms constitute about 20% of all aortic aneurysms. The incidence is 6 per 100,000 patient-years<sup>1</sup>. The five year survival rate for untreated thoracic aneurysms is only 13% and for patients with degenerative aneurysms 3-year survival is 35%<sup>2</sup>. The growth rate is exponential with larger aneurysms growing at greater rates; at 0.12 cm/y for aneurysms greater than 5.2 cm. in diameter<sup>3,4</sup>. The time that elapses between aneurysm formation and rupture is influenced by aneurysm size and growth rate, hypertension, smoking, history of chronic obstructive pulmonary disease, presence of pain, etiology and age. The size of the aortic aneurysm remains the most important determinant of the likelihood of rupture. Rupture is more likely to occur in a thoracic aortic aneurysm exceeding 5 cm. in diameter<sup>5-8</sup>. The annual risk of rupture has been estimated to be 2% for aneurysm <5 cm. in diameter, 3% for aneurysm between 5 cm. and 6 cm. and 7% for aneurysms in



**Fig 1.** The thoracic stent graft covered the aortic arch and descending aorta in distal aortic arch aneurysm repair. The adjunctive carotid-carotid bypass and left common carotid- left subclavian artery bypass were demonstrated.



**Fig 2.** A small left groin incision for thoracic endovascular aortic aneurysm repair.

excess of 6 cm.<sup>9</sup> The overall risk for rupture during a 5-year period is 80%.

### Clinical presentation

The majority of patients with thoracic aortic aneurysms are asymptomatic. When a thoracic aortic aneurysm causes symptoms, patients most often report chest or back pain, which may be a sign of impending rupture. Occasionally, they may present with symptoms related to a local mass effect or erosion such as respiratory compromise, dysphagia, hemoptysis, hoarseness of voice.

### Diagnosis

Diagnosis modalities for thoracic aortic diseases include chest radiography (Fig 3), computer tomography angiography (CTA) (Fig 4), magnetic resonance imaging (MRI), transesophageal echocardiography (TEE), intravascular ultrasound (IVUS), and angiography. CTA provides detailed information about the size, location, aortic true and false lumens, extent of aortic disease and mediastinal structures involvement. It's a very useful option for aortic investigation and is significant in pre-operative endovascular planning. MRI offers advantages over CT regarding ionizing radiation and nephrotoxic contrast media avoidance. However, it is a time consuming examination and may not be continuously available. TEE offers excellent visualization of the ascending and descending aorta. The proximal and distal aortic arch view is limited by tracheal shadowing. It is invasive and operator-dependent.

### Management

Surgical intervention is recommended if the sac diameter reaches 6 cm. for an asymptomatic aneurysm, and immediate treatment is recommended for symptomatic aneurysms, regardless of diameter. The standard treatment has been open surgery (Fig 5). Elective surgery has an associated mortality incidence of 10-20%. Major complications include stroke (3-21.7%)<sup>10</sup>, spinal cord paralysis (2.6-13%), and renal failure (4-37%)<sup>11</sup>.

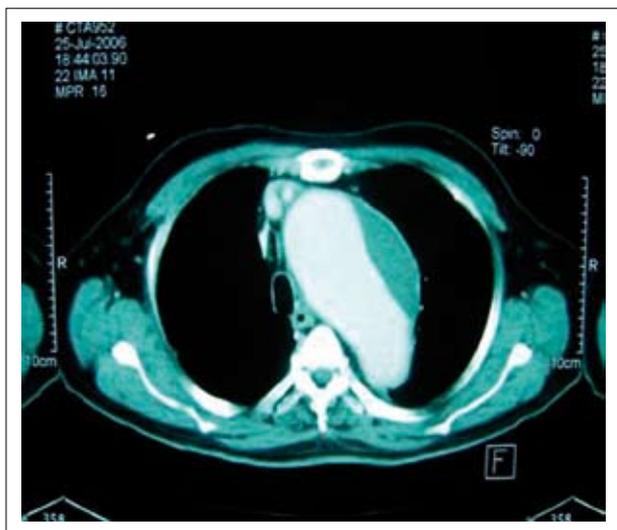
Volodos reported the first thoracic endovascular stent grafting in 1991<sup>12</sup> while the first clinical series was published by the Stanford group in 1994<sup>13</sup>. The aim of TEVAR is to prevent rupture by exclusion of the



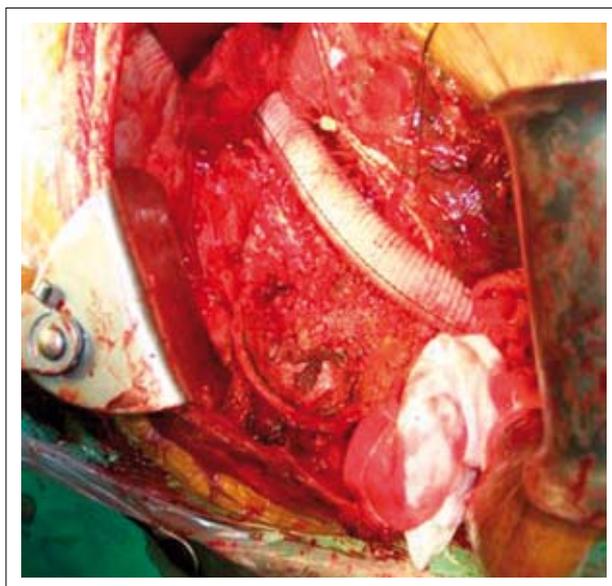
**Fig 3.** A Chest film of the patient with thoracic aortic aneurysm.

aneurysm sac to decrease pressure stress on the wall. In recent years, endovascular aortic aneurysm repair has shown great promise especially for the descending aortic aneurysm. Bavaria et al published an early outcome of endovascular stent grafting of descending thoracic aortic aneurysms in low risk patients compared to open surgical repair regarding significantly less perioperative death (2.1% vs 11.7%), spinal cord ischemia (3% vs 14%), respiratory failure (4% vs 20%), shorter hospital stay (7.4% vs 14.4%) and ICU stay (2.6% vs 5.2%)<sup>14</sup>.

Data from the EUROSTAR Thoracic Registry<sup>15</sup> by a total of 54 different European institutions, covered 581 thoracic aortic disease patients, and demonstrated 90% complete technical success, with a 30 days mortality rate of 13% (n=67). Neurological complications occurred in a total of 54 (9%) patients. These included 18 (3%) intracranial strokes and 15 (2.5%) spinal cord injuries.



**Fig 4.** A CTA demonstrated thrombus filled in the aortic arch aneurysm.



**Fig 5.** Left postero-lateral thoracotomy incision for the open surgical repair of descending aortic aneurysm.

Arterial complications were encountered in 61 (10%) patients. An endoleak was noted on the completion angiogram in 54 (9%) patients. There were 40 (7%) type I endoleaks and 14 (2%) type II.

### TEVAR: Siriraj experience

From December 2005 to December 2007, 59 patients with thoracic aortic diseases were operated by an endovascular stent grafting technique. The mean age of patients was 65 years (range 22 to 94 years). There were 43 (73%) males and 16 (27%) females. Seventeen percent of patients had an American Society of Anesthesiologists (ASA) Risk Score of 4 or 5, which signified that they were considered to be unfit for open surgery due to serious comorbidities. Seventy eight percent of the patients were hypertensive, 13% had stroke history, 22% had ischemic heart disease, 25% had a peripheral arterial disease and 20% had chronic obstructive pulmonary disease.

The patients were categorized into five groups:

1. Degenerative thoracic aortic aneurysm (N=33, 56%)
2. Aortic dissection (N=9, 15%)
3. Traumatic rupture of the thoracic aorta (N=4, 7%)
4. Penetrating atherosclerotic ulcer (N=6, 10%)
5. Infected aortic aneurysm (N=7, 12%)

The aortic arch was involved in 9 (15%) patients, the proximal descending aorta in 45 (76%) patients, the mid descending aorta in 36 (61%) patients and the distal third in 23 (39%) patients. The mean maximum diameter of the aneurysm was 62.9 mm. (SD 18 mm, range 37-120 mm.). Of the aortic dissection group, 3 (33%) had acute Stanford type B dissection and 6 (67%) had chronic Stanford type B dissection.

Emergency procedures were performed in 30 (51%) patients and 11 (19%) patients had a ruptured aneurysm. The following commercially available, Communauté Européenne (CE) – approved devices were used:

1. Valiant (Medtronic/AVE) (N=37)
2. TAG (W.L. Gore & Associates) (N=19)
3. Zenith TX2 (Cook) (N=3)

A single graft was deployed in 32 (55%) of cases, two were deployed in 24 (42%) and three in 2 (3%). General anesthesia was employed in 56 (95%) of the patients. The femoral artery was used to be an access vessel in 50 (85%) of the patients. Adjuvant extra-anatomic bypass was undertaken in 17 (29%) of patients. These included 8 aorto-carotid-subclavian artery bypasses, 5 carotid artery bypasses, 3 left subclavian artery bypasses and 1 visceral artery bypass. The cerebrospinal fluid was drained if the patient had previous abdominal aortic surgery or the entire descending thoracic aorta was covered to prevent postoperative spinal cord ischemia and 10 (17%) patients had preoperatively spinal drainage.

### Outcome

Complete operative technical success was achieved in 58 (98%) of patients. There was one technical failure due to problem in passing a stent graft through a tortuous aorta. No intraoperative death was encountered. The mean and median operative times were 162 and 120

minutes (range 60-480 minutes). Thirty (51%) patients required one day in the intensive care unit postoperatively and three (5%) did not. The mean and median duration of hospital admission were 15 and 12 days respectively (range 3-93 days). There were 5 (8.5%) deaths, 3 caused by severe pneumonia with sepsis, 1 due to severe brain damage after intraoperative conversion and the other one was caused by a bleeding cardiac tamponade.

Arterial complications were observed in 5 (8.5%) patients. These included rupture of the aorta, iliac artery and arm ischemia related to the left subclavian artery covering.

Neurological complication was noted in 6 (10%) patients. Of these 2 were associated with a bypass operation of the disease vessels, 2 were related to catheter and stent graft manipulation, one developed ischemic stroke a week later and the other one was the patient who was immediately converted to open surgery. Transient spinal cord ischemia was detected in one patient.

An endoleak was noted on the completion of aortogram in 16 (28%) patients. There were 2 (3.4%) type I endoleaks, 13 (22%) type II endoleaks and 2 (3.4%) type III endoleak. One type III endoleak patient was converted to open surgery a week later due to hemoptysis and the other one was successfully managed by ballooning.

The type II endoleak in 6 out of 13 (46%) patients disappeared at 3 months postoperatively followed by CT scan.

## CONCLUSION

The early results of TEVAR at Siriraj Hospital demonstrated a high complete technical success (98%) with low hospital mortality (8.5%) and an acceptable rate (10%) of neurological complication. A variety of thoracic aortic diseases can be treated by endovascular stent grafting. This procedure can be accomplished in high risk patients such as ruptured aneurysm, and old age patients with serious comorbidities. The total incidence of endoleaks on completion of the procedure was 28%, most of them were type II endoleaks while 46% spontaneously resolved at 3 months. However, the durability of endovascular treatment in thoracic aortic pathologies remained to be established.

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