Aortic Aneurysm

Aortic aneurysms can be classified into thoracic & abdominal aortic aneurysm with different clinical features, diagnostic characteristics and management. If the growth occurs continuously, it can result in bursting of the artery and bleeding, a condition termed aortic dissection, which is considered a catastrophic fatal condition. Abdominal aortic aneurysms are generally caused due to infection, injury or atherosclerosis. Thoracic aortic aneurysms are caused due to injury, high blood pressure, inherited tissue disorders. Various risks factors are associated with aortic aneurysm including high cholesterol, atherosclerosis, high blood pressure, and smoking.

Definition of Aortic Aneurysm

Aortic aneurysm is referred to as condition of **bulge growth to more than one and half of aorta’s width involving the three layers of the vessel wall** including the intima, media, and adventitia. Abdominal aortic aneurysms are more prevalent in comparison to thoracic aortic aneurysms. Although the normal aortic diameter varies with various factors as age and gender, average diameters have been determined.
The aneurysm has two main morphologies

1. **Fusiform**, which is considered symmetrical circumferential dilatation of a part of the aortic wall.
2. **Saccular**, which is considered a localized outpouching of an aortic wall.

Pathophysiology of Aortic Aneurysm

Pathophysiology of aneurysms is multifactorial and complex in nature. However, disruption of elastic fibres of the aortic wall extracellular matrix is the main feature of abdominal aortic aneurysm.

Thoracic aortic aneurysm

Aneurysms of ascending thoracic aorta are **usually due to cystic medial**
degeneration which leads to weakening of aortic wall. Cystic medial degeneration usually occurs due to

- Aging
- Uncontrolled hypertension resulting in hyaline arteriosclerosis
- Hereditary connective-tissue disorders like Marfan syndrome which is an autosomal-dominant disorder resulting from mutation in one of the genes for fibrillin-1
- Ehlers-Danlos syndrome
- Familial thoracic aortic aneurysm syndrome

Abdominal aortic aneurysm (AAA)

It is multifactorial and associated with alterations in the biology of the arterial wall resulting in loss of wall strength due to various risk factors contributing in the development of AAA. Please see next for the risk factors.

Risk factors of Aortic Aneurysm

Thoracic aortic aneurysms are caused mainly due to injury, high blood pressure, inherited tissue disorders like Ehlers-Danlos syndrome or Marfan syndrome.
Various causes and associated risk factors are associated with increased risk of aortic aneurysm, especially the AAA, and include:

1. **Age-related** increase in risk of AAA, especially in elderly men.
2. AAA is considered more common in Caucasian populations, which is twice more common than black people.
3. **Smoking** is one of the most common risk factors of AAA as it's associated with atherosclerotic changes of the vessels wall preventing the normal nutrients from diffusion into its wall, therefore weakening the vessel wall with subsequent dilatation. **Once an aneurysm formed, continuous active smoking will cause progressive dilatation, expansion and risk of rupture.**
4. Risk of AAA is increased in families with history of AAA due to **genetic predisposition.**
5. **Patients having other large vessels aneurysms** (e.g., iliac, femoral, popliteal, carotid) are at risk of having AAA due to the same common pathological mechanisms.
6. **Aortic wall infection** can result in degeneration of a localized area of the aortic wall due to contiguous spreading from nearby infection or septic emboli from associated infective endocarditis.

### Clinical manifestations of Aortic Aneurysm

#### Thoracic aortic aneurysm

Most patients with thoracic aortic aneurysms are asymptomatic at time of presentation, and they might be discovered accidentally by chest X-ray showing widened mediastinum, CT scan for other purpose or echocardiography showing dilatation of the ascending aortic aneurysm with possible aortic regurgitation.

Symptoms of thoracic aortic aneurysms arise mainly from the compression of adjacent thoracic structures or vascular sequences.

**Compression of adjacent thoracic structures**

- Left recurrent laryngeal nerve compression Hoarseness of the voice.
- Phrenic nerve compression Hemidiaphragmatic paralysis.
- Compression of tracheobronchial tree Cough, wheezes, dyspnea, hemoptysis.
- Esophageal compression Dysphagia.
- Superior vena cava compression Superior vena cava syndrome.

**Vascular sequences**

1. Aortic regurgitation

AR may occur as a **result of aortic root dilatation with subsequent distortion of the annulus.** This may lead to heart failure manifestations, such as dyspnea, orthopnea and paroxysmal nocturnal dyspnea due to pulmonary venous congestion, especially if associated with hypertension as result of the increased afterload.

2. Thromboembolic events
Blood stagnation within the aneurism may result in **thrombus formation, with subsequent embolization** into different body organs causing thromboembolic manifestations.

The **most serious presentation of the thoracic aortic aneurysm occurs with aortic dissection and rupture into the intrapleural space or intrapericardial space**. After rupture or dissection of thoracic aortic aneurysms, individuals may feel sudden, sharp and severe pain in the upper back and abdomen. Furthermore, the individuals may go into a state of hypotension and shock, mostly hypovolemic shock.

**Abdominal aortic aneurysm (AAA)**

Most individuals of AAA show no symptoms, and it is only discovered with routine screening, physical examination or diagnostic imaging modalities for evaluation of other purposes. Although AAA is often asymptomatic, it may result in some characteristic clinical features, such as:

- **Pulsatile abdominal mass** that detected accidentally on routine physical examination.
- **Abdominal pain** that maybe attributed to another abdominal cause, and therefore a wide variety of differential diagnosis should be considered.
Differential Diagnosis of AAA

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<td>• Ovarian torsion</td>
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Intermittent pain and discomfort in the abdomen which lasts up to 2—4 days, along with symptoms of abnormal defecation and bloating which are associated with irritable bowel syndrome. However, crampy abdominal pain with bloody or non-bloody diarrhoea is associated with inflammatory bowel disease. Pain in the periumbilical position along with nausea, anorexia and emesis is associated with appendicitis.

Abdominal examination, CT scans, ultrasound examination and angiography can help in correctly diagnosing the condition.

Once the **abdominal aortic aneurysma ruptures**, it can result in

- sudden severe pain in the back and lower abdomen,
- vomiting,
- nausea,
- problems with urination,
- constipation,
- light-headedness,
- increased heart rate while standing and
- sweaty skin.

Internal bleeding due to abdominal aortic aneurysm rupture can result in shock which is fatal if not treated immediately.

AAA can also present with **thromboembolic events** due to embolization of thrombus into various organs presenting with

- stroke,
- acute LL ischemia,
- mesenteric vascular occlusion (MVO) or
- blindness.

AAA may present also with constitutional symptoms as a result of presence of
- Infected or inflammatory aneurysm.
- Disseminated intravascular coagulation (DIC).

Symptoms of fever, malaise, chronic abdominal pain and weight loss may suggest underlying inflammatory aneurysm, which affects about 5—10 % of patients with AAA.

Extensive large AAA may present with DIC manifestations resulting in either thromboembolic or hemorrhagic manifestations.

**Other less common presentations of AAA**

- Acute myocardial infarction as a result of massive loss of blood.
- Heart failure as result of AV fistula between the aorta and inferior vena cava.
- Upper GIT bleeding may occur as result of ortoduodenal fistula.

**Diagnosis and clinical investigations of Aortic Aneurysm**

**Patient History**

Patient history with chest or back pain, constipation, abdominal distension should be considered for further tests and examination. Aortic aneurysm should be in the differential diagnosis in presence of the previously described clinical manifestations.

**Physical examinations**

Thoracic aortic aneurysm should be suspected in presence of aortic regurgitation murmur or sudden onset of heart failure signs and symptoms.

Abdominal aortic aneurysm should be suspected in presence of unusual, strong pulsatile upper abdominal mass.

**Investigations**

**ESR tests and blood cultures**

ESR tests and blood cultures demonstrates elevated ESR and positive blood cultures which occur in inflammatory aortic aneurysms.

**Chest X-rays**

Plain chest X-ray examination from check-ups can detect aneurysms and appear as a protruding shadow from the ascending aorta. Thoracic aortic aneurysms are diagnosed from chest X-ray and characterised by tracheal deviation or enlargement of aortic knob while smaller aneurysms are not detected by chest X-rays.

**Abdominal Ultrasound**

Abdominal ultrasound is considered for detection of abdominal aortic aneurysm. It is the
standard method for monitoring and screening of abdominal aorta aneurysms.

Aortic dilation of greater than 1.5 is associated with aneurysm.

Men 60 years or older with family history of AAA in parents should undergo abdominal U/S evaluation of possible underlying AAA. Men who are 65—75 years old and have history of current or previous smoking should undergo assessment for AAA.

**Transthoracic Echocardiography**

Transthoracic echocardiography is an effective diagnostic tool for aortic root imaging and is usually used for evaluation of patients with Marfan syndrome.

The method is semi-invasive in nature and therefore not a preferred method for imaging as it **may miss the diagnosis**.

**MR angiography and Contrast-enhanced CT scanning**

MR angiography and Contrast-enhanced CT scanning are preferred for detecting the size and presence of thoracic aortic aneurysms.

MR angiography is an alternative where images are in multiple planes and therefore allows on-axis measurements.

Contrast-enhanced CT is used for generating a 3D image of the aorta which demonstrates a combination of spatial resolution, reproducibility and speed for detection of AAA.

**Tissue Doppler Imaging (TDI)**
Another ultra-sonographic technique referred as Tissue Doppler Imaging (TDI) allows measurement of wall motion along the arterial segment.

AAA commonly leads to changes in aortic wall properties and therefore can be detected using these techniques.

**Treatment of Aortic Aneurysm**

Aortic aneurysms can either be treated medically or surgically based on size & location of the aneurysm, the maximal diameter and the associated conditions such as Marfan syndrome. However, it is important to prevent growing, rupture or dissection of aneurysm by controlling of the risk factors and enhancing the quality of life.

It is generally accepted that the diameter of abdominal aortic aneurysm is the best predictor for risk of rupture.

It is very clear that the risk of rupture increases when the aneurysm increases from 5 cm to 6 cm in size.

**General measures**

The patients treated for aneurysm should be advised on effective management of blood pressure. Routine daily activities should be continued with minimal restrictions along with minimal exercise.

Lifestyle modification of the patients should be considered. Patients and their family should be educated on the risks associated with aortic rupture or dissection and its symptoms. Stress on the aorta plays a big role in acute aorta rupture or dissection thus, patients should be restricted on heavy weight lifting or competitive athletics.

Patients should be advised to appear for regular follow-up imaging tests like MRI or CT for effective long-term management, as continuous monitoring of the size of aneurysm is important for further treatment and management.

**Diagnostic imaging must be repeated and compared** to the initial images at:

- 6—12 months: for aneurysms 4.0 to 5.4 cm in diameter
- 2—3 years: for aneurysms 3.0 to 4.0 cm,
- Every 5 years: for aneurysms 2.6 to 2.9 cm

Yearly interval monitoring with images is accepted when there is no growth of the aneurysm.

Follow up at 3—6 months should be done if there is significant increase in the size of the aneurysm in comparison to the previous size.

Patients should be recommended to attend rehabilitation programs for cardiovascular diseases which are designed for acute phases during hospitalisation, early stage after discharge and 1—2 months after onset and for patients with more than 2 months after the onset of aneurysm.

**Medical treatment**

**Asymptomatic thoracic aortic aneurysm**

Asymptomatic thoracic aortic aneurysms are initially treated medically with aggressive
control of two main factors:

1. Blood pressure
2. Heart rate

The main aim is to slow the progression and the expansion of the aortic aneurysm size, thereby lowering the risk of rupture or dissection of the aneurysm.

Beta-blockers, such as Propranolol is considered very effective in controlling the blood pressure and heart rate especially in patients with Marfan syndrome, by the following mechanisms:

- Reducing the rate of aortic dilatation.
- Decreasing the shearing stress.
- Decreasing the left ventricular contractility.

**Asymptomatic abdominal aortic aneurysm (AAA)**

Conservative treatment is recommended in asymptomatic infra-renal abdominal aortic aneurysm <5.5 cm rather than surgical repair as the risk of aneurismal rupture becomes high when the diameter exceeds the 5.5 cm.

It is appropriate, for patients with AAA receive Statins and Aspirin to decrease the risk of cardiovascular events, as it is considered coronary equivalent.

**Surgical intervention**

Surgery is recommended in cases where aneurysm is increasing in size rapidly. Two types of surgery are known for repairing the aortic aneurysms which include:

1. Open chest or abdominal repair, and
2. The endovascular repair.

The open chest repair or open abdominal surgery is the standard type of surgery for treatment of aortic aneurysms. The surgery involves a procedure of making a major incision in the chest or the abdomen. The surgery requires use of general anaesthesia while the aneurysm is removed from the affected area. The aorta section is replaced by a graft made from Teflon or Dacron.

**Thoracic aortic aneurysm (AAA)**

Prophylactic surgical repair of the thoracic aortic aneurysm is recommended to prevent the mortality of aneurysm rupture.

The indications of surgical repair are:

2. Rapid growth rate (≥10 mm/year) in aneurysms <5 cm in diameter.
3. Evidence of dissection.
4. Ascending thoracic aortic aneurysm >4.5 cm at the same time of aortic valve surgery.
5. Aortic diameter of 5—6 cm for ascending aortic aneurysm.
6. Aortic diameter 6—7 cm for descending aortic aneurysm.
7. Aortic diameter ≥7 cm in high-risk patients.
Abdominal aortic aneurysm (AAA)

Elective repair of the AAA is considered the **best method of prevention of aortic rupture**, either by open surgery or endovascular surgery.

The indications of elective AAA repair include good risk surgical candidates with:

- AAA >5.5 cm.
- Rapidly expanding AAA
- AAA associated with peripheral arterial aneurysm, or peripheral artery disease.

Endovascular Aneurysm Repair (EVAR)

The procedure of endovascular aneurysm repair emerged in 1990s as an alternate method for treatment of aneurysm. However, this quickly gained an important role in clinical management of aortic aneurysm. Various studies have shown equivalent efficacy and safety of EVAR when compared to the conventional method of open surgical repair.

![Image](https://via.placeholder.com/150)

**Image:** “(A) Intraoperative view. (B) Early angio CT scan showing the implanted stent-grafts and the patency of all prosthetic bypass.” by Mannacio V, Mottola M, Ruggiero D, D’Alessio A, Surace GG, Di Tommaso E, Amato B, Iannelli G. License: [CC BY 2.0](http://creativecommons.org/licenses/by/2.0)

1. **Advantages**

This method also demonstrates various short-term benefits which include

- reduced blood loss,
- minimised hospital stays,
- rapid recovery and
- minimal complications due to its less invasive nature.

2. **Procedures**
Endovascular repair of aneurysm does not involve removal of the aneurysm. In this procedure, the aorta is strengthened by inserting a graft. Catheters are inserted into the arteries and the graft is placed at the affected aorta. This procedure does not involve opening of the abdomen or the chest.

The procedure uses general anaesthesia. A catheter is inserted into the groin and threads the graft to the aorta affected by the aneurysm. The complete procedure is performed using X-ray of the artery.

The graft is expanded after the insertion in the aorta and fastened to it. This ensures a stable flow of blood and prevents rupturing of the aneurysm.

References


NIH. 2011. What are the signs and symptoms of an aneurysm? Available at: https://www.nhlbi.nih.gov/health/health-topics/topics/arm/signs


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