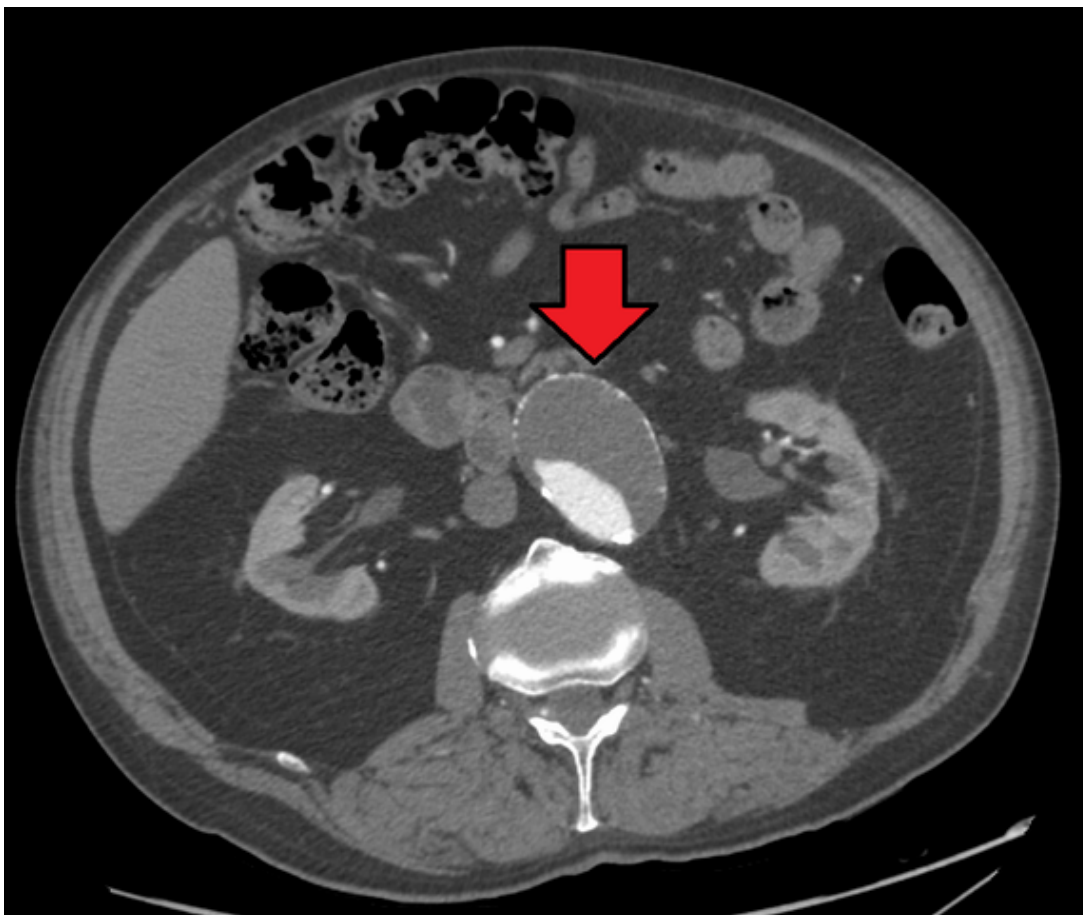


Aortic Aneurysm

[See online here](#)

An aortic aneurysm is the abnormal widening of part of the wall of the aortic artery, leading to abnormal bulging. This condition can occur with or without a cause. The aneurysm can be a localized or diffused dilation of aortic artery, usually to more than 50% of its normal size. Aortic aneurysms are classified as thoracic or abdominal, with different clinical features, diagnostic criteria, and management. If bulging occurs continuously, it can result in the bursting of the artery and eventually hemorrhage, a condition known as aortic dissection, which is a catastrophic fatal condition. Abdominal aortic aneurysms are generally caused by infection, injury, or atherosclerosis. Thoracic aortic aneurysms are caused by injury, high blood pressure, or inherited tissue disorders.



Definition of Aortic Aneurysm

An aortic aneurysm is a bulging growth of more than one and half times the normal width of the aorta, involving the 3 layers of the vessel wall: the intima, media, and adventitia. Although the normal aortic diameter varies with factors such as age and gender, average

diameters have been established. Abdominal aortic aneurysms are more prevalent than thoracic aortic aneurysms.



"Fusiform Aneurysm" by Lecturio.



"Saccular Aneurysm" by Lecturio.

The aneurysm has 2 main morphologies:

1. **Fusiform: circumferential dilatation of part of the aortic wall**
2. **Saccular: localized outpouching of an aortic wall**

Pathophysiology of Aortic Aneurysm

Pathophysiology of aneurysms is multifactorial and complex; however, disruption of the elastic fibers of the aortic wall's extracellular matrix is the main feature of abdominal aortic aneurysms.

Thoracic aortic aneurysm

Aneurysms of ascending thoracic aorta usually occur **due to cystic medial degeneration of the aortic wall, eventually resulting in weakening of the aorta.**

Cystic medial degeneration usually results from the following risk factors:

- Aging
- Hyaline arteriosclerosis caused by uncontrolled aorta
- Hereditary connective-tissue disorders, like [Marfan syndrome](#) (an autosomal-dominant disorder caused by the mutation in one of the genes that creates fibrillin-1)
- [Ehlers-Danlos syndrome](#)
- A family history of thoracic aortic aneurysm

Abdominal aortic aneurysm (AAA)

Abdominal Aortic Aneurysm is multifactorial and associated with alterations in the biology of the arterial wall. Various risk factors cause these alterations, which result in the loss of wall strength and contribute to the development of AAA.

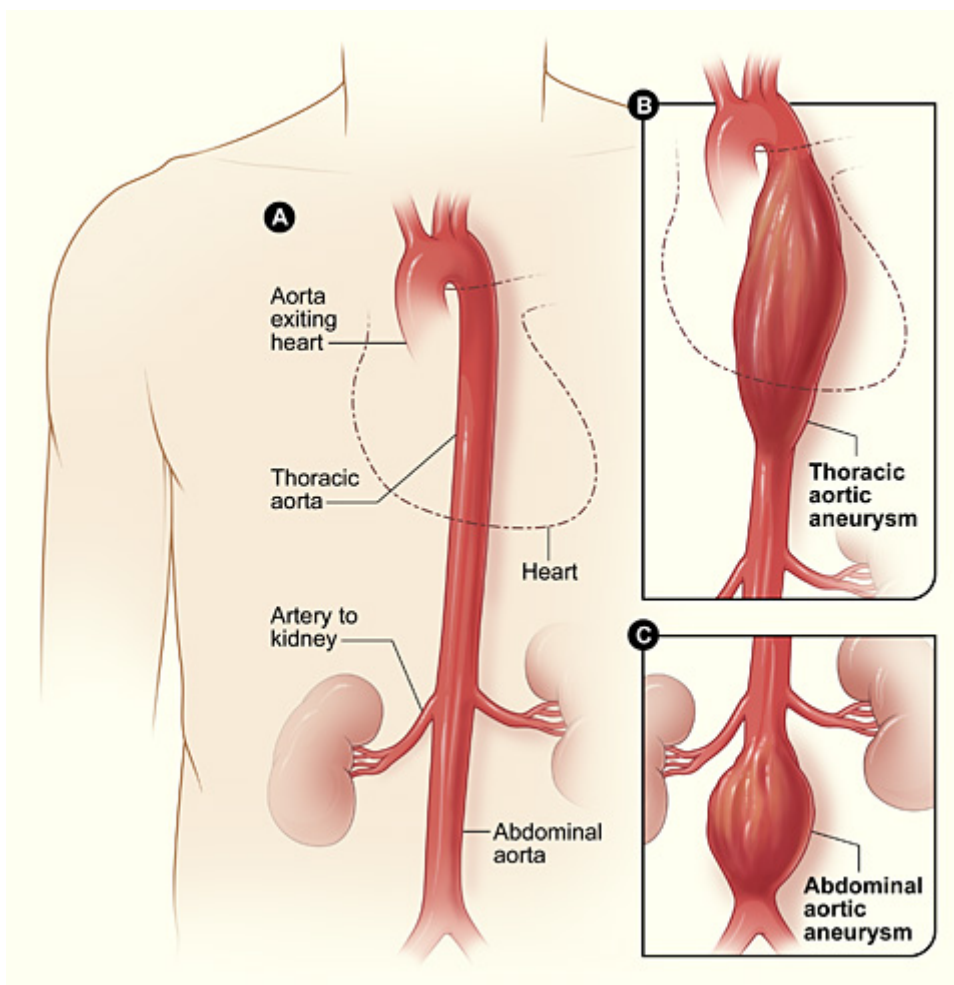


Image: "Diagram of aortic aneurysm Figure A shows a normal aorta. Figure B shows a thoracic aortic aneurysm (which is located behind the heart). Figure C shows an abdominal aortic aneurysm located below the arteries that supply blood to the kidneys." by the U.S. government. License: [Public Domain](#)

Risk factors of Aortic Aneurysm

Thoracic aortic aneurysms are caused mainly by injury, high blood pressure, and inherited tissue disorders, like Ehlers-Danlos syndrome or Marfan syndrome.

Risk factors associated with aortic aneurysm include the following:

1. **Age:** There is an increased risk of AAA with aging, especially in men over 65 years of age.
2. **Race:** The incidence of AAA in Caucasian populations is twice that of Black populations.
3. **Smoking** is one of the highest risk factors of AAA, as it is associated with atherosclerotic changes of the vessel's wall, preventing the normal nutrients from diffusing into the wall and weakening the vessel wall with subsequent dilatation.
Once an aneurysm is formed, continuous active smoking will cause progressive dilatation, expansion, and risk of rupture.
4. **Genetic predisposition:** The risk is high in families with a history of AAA.
5. **Patients that have other large vessel aneurysms** (e.g., iliac, femoral, popliteal, carotid) are at risk of developing AAA because of the same pathological mechanisms.
6. **Aortic wall infection** can result in the degeneration of a localized area of the aortic wall due to the spreading of the infection or to septic emboli from associated infective endocarditis.

Clinical manifestations of Aortic Aneurysm

Thoracic aortic aneurysm

Most patients with thoracic aortic aneurysms are asymptomatic. The condition might be discovered accidentally by a chest X-ray showing a widened mediastinum, a computerized tomography (CT) scan for another 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:

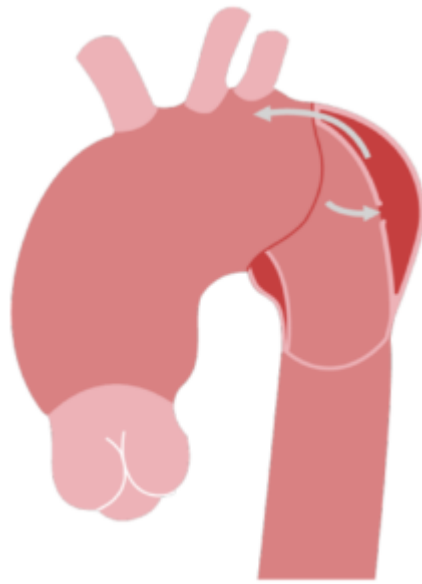
- Left recurrent laryngeal nerve compression causes hoarseness of the voice.
- Phrenic nerve compression causes hemidiaphragmatic paralysis.
- Compression of the tracheobronchial tree causes coughing, wheezing, dyspnea, and hemoptysis.
- Esophageal compression causes dysphagia.
- Superior vena cava compression causes superior vena cava syndrome.

Vascular sequences

1. Aortic regurgitation

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

2. Thromboembolic events



“Aortic Dissection” by Lecturio.

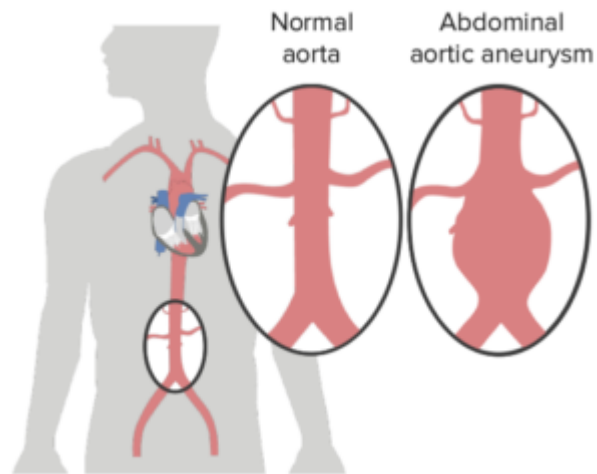
Blood stagnation within the aneurysm may result in the development of a **thrombus, with subsequent embolization** into different body organs eventually leading to thromboembolic manifestations.

The **most serious presentation of the thoracic aortic aneurysm is aortic dissection that ruptures into the intrapleural space or intrapericardial space.** After rupture or dissection of thoracic aortic aneurysms, the patient may feel a sudden, sharp, and severe pain in the upper back and abdomen. Eventually, the patient may go into a state of hypotension and shock (usually hypovolemic shock).

Abdominal aortic aneurysm (AAA)

Most patients with AAA show no symptoms, and the condition 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

- a **pulsatile abdominal mass** that is detected accidentally on a routine physical examination,
- **abdominal pain** that may be attributed to another abdominal cause; therefore, a wide variety of differential diagnoses should be considered.



“Abdominal Aortic Aneurysm” by Lecturio.

Differential Diagnosis of AAA

Gynecologic causes	Gastrointestinal causes	Urologic causes
<ul style="list-style-type: none"> • Ovarian torsion 	<ul style="list-style-type: none"> • Acute gastritis • Appendicitis • Gallstones • Large-bowel obstruction • Small-bowel obstruction 	<ul style="list-style-type: none"> • Urinary tract infection

Intermittent pain and discomfort in the abdomen that lasts up to 2-4 days, along with symptoms of abnormal defecation and bloating, can be associated with irritable bowel syndrome; however, crampy abdominal pain with bloody or non-bloody diarrhea is also associated with inflammatory bowel disease. Pain in the periumbilical position, along with nausea, loss of appetite, and emesis can be associated with appendicitis. Abdominal examination, CT scan, ultrasound examination, and angiography can help accurately diagnose the condition.

The rupture of an abdominal aortic aneurysm can result in the following symptoms:

- Sudden, severe pain in the back and lower abdomen
- Vomiting
- Nausea
- Urinary problems
- Constipation
- Lightheadedness
- Increased heart rate while standing
- Sweaty skin

The ruptured abdominal aortic aneurysm may result in internal bleeding, leading to shock, which can be fatal if not treated immediately.

AAA can also be present with **thromboembolic events** due to embolization of a thrombus into various organs. The following symptoms may be seen:

- Stroke,

- Acute LL ischemia,
- Mesenteric vascular occlusion (MVO)
- Blindness.

AAA may also present with constitutional symptoms as a result of the presence of

- an infected or inflamed aneurysm.
- disseminated intravascular coagulation (DIC).

Symptoms of fever, malaise, chronic abdominal pain, and weight loss may suggest an 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 blood loss,
- heart failure as a result of an arteriovenous fistula between the aorta and inferior vena cava,
- upper gastrointestinal bleeding as a result of aorto-duodenal fistula.

Diagnosis and clinical investigations of Aortic Aneurysm

Patient History

A patient with a history of chest or back pain, constipation, and abdominal distension should be considered for further tests and examination. An aortic aneurysm should be the differential diagnosis in the presence of such clinical manifestations.

Physical examinations

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

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

Investigations

ESR tests and blood cultures

Erythrocyte sedimentation rate (ESR) tests and blood cultures will demonstrate elevated ESR levels and positive blood cultures, which occur with inflammatory aortic aneurysms.

Chest X-rays

Chest X-ray examination from routine check-ups can reveal an aneurysm, which appears as a protruding shadow from the ascending aorta. Thoracic aortic aneurysms are diagnosed by chest X-ray and characterized by tracheal deviation or enlargement of the aortic knob, although smaller aneurysms are not detected by chest X-rays.

Abdominal ultrasound

Abdominal ultrasound is used to detect abdominal aortic aneurysm and is the standard method for monitoring and screening for this condition. Aortic dilation of greater than 1.5 is associated with an aneurysm.

Men age 60 or older with a family history of AAA should undergo abdominal ultrasound evaluation for possible underlying AAA. Men who are 65–75 years old and have a history of current or previous smoking should also undergo assessment for AAA.

Transthoracic echocardiography

Transthoracic echocardiography is an effective diagnostic tool for aortic root imaging and is usually used to evaluate patients with Marfan syndrome. The method is semi-invasive and therefore not a preferred method for imaging, as it may miss the diagnosis.

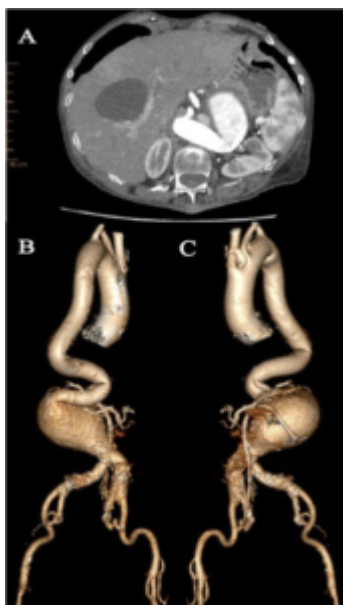


Image: "Preoperative CTA and 3-dimensional reconstructions. (A) Preoperative CTA showed the infrarenal AAA with tapered neck and severe angulation in axial view. (B, C) 3-dimensional reconstructions confirmed severely tortuous descending aorta and infrarenal AAA with really hostile neck. Aneurysmal dilatation and severe calcification of bilateral iliac arteries and tortuosity of left aortoiliac access were observed." by Zeng Q, Huang L, Huang X, Peng M. License: [CC BY 4.0](https://creativecommons.org/licenses/by/4.0/)

MR angiography and Contrast-enhanced CT scanning

Magnetic resonance angiography (MRA) and contrast-enhanced CT scanning are preferred for detecting the size and presence of thoracic aortic aneurysms.

MRA is an option when images are in multiple planes, as it allows on-axis measurements.

Contrast-enhanced CT scan is used for generating a 3D image of the aorta and has the benefits of spatial resolution, reproducibility, and speed for detecting AAA.

Tissue Doppler Imaging (TDI)

Another ultrasonographic technique called tissue Doppler imaging (TDI) allows the measurement of wall motion along the arterial segment. AAA commonly leads to changes

in aortic wall properties and therefore can be detected using TDI.

Treatment of Aortic Aneurysm

Aortic aneurysms can either be treated **medically or surgically, based on the size and 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 the aneurysm by controlling the risk factors and enhancing the quality of life.

The diameter of an abdominal aortic aneurysm is the best predictor for the risk of rupture. The risk of rupture increases when the aneurysm increases from 5 cm to 6 cm in size.

General measures

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 modifications should also be considered. Patients and their families should be educated on the risks associated with aortic rupture and its symptoms. Physical stress on the aorta has a large effect on acute aorta rupture or dissection; thus, patients should be **restricted from heavy weight lifting or competitive athletics**.

Patients should be advised to appear for **regular follow-up imaging tests**, like magnetic resonance imaging (MRI) or CT scans, for effective long-term management, as continuous monitoring of the size of the 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 monitoring with imaging is acceptable when there is no growth of the aneurysm.

A follow up at 3-6 months should occur if there is a significant increase in the size of the aneurysm.

Patients should be referred to rehabilitation programs for cardiovascular disease, which are designed for acute phases during hospitalization, the early stage after discharge, 1-2 months after onset, and more than 2 months after the onset of an aneurysm.

Medical treatment

Asymptomatic thoracic aortic aneurysm

Asymptomatic thoracic aortic aneurysms are initially treated medically with aggressive control of 2 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, are considered very effective in controlling blood pressure and heart rate, especially in patients with Marfan syndrome, by the following mechanisms:

- Reducing the rate of aortic dilatation
- Decreasing wall shear stress
- Decreasing left ventricular contractility

Asymptomatic abdominal aortic aneurysm (AAA)

Conservative treatment is recommended for asymptomatic infrarenal abdominal aortic aneurysm < 5.5 cm, rather than surgical repair, as the risk of aneurysmal rupture is lower when the diameter is less than 5.5 cm. Patients with AAA should receive statins and aspirin to decrease the risk of cardiovascular events, as AAA is considered a coronary heart disease equivalent.

Surgical intervention

Surgery is recommended in cases when the **aneurysm is rapidly increasing in size**.

The 2 types of surgery for repairing aortic aneurysms include:

1. open chest or abdominal repair,
2. endovascular repair.

The open chest repair or open abdominal surgery is the standard type of surgery for the treatment of aortic aneurysms. The surgery involves making a major incision in the chest or the abdomen and requires the use of general anesthesia 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:

1. Symptomatic thoracic aortic aneurysms.
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 AAA is considered the **best method of preventing aortic rupture**, either by open surgery or endovascular surgery. The indications for elective AAA repair include surgical candidates with

- AAA > 5.5 cm.
- rapidly expanding AAA.

- AAA associated with a peripheral arterial aneurysm or peripheral artery disease.

Endovascular Aneurysm Repair (EVAR)

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

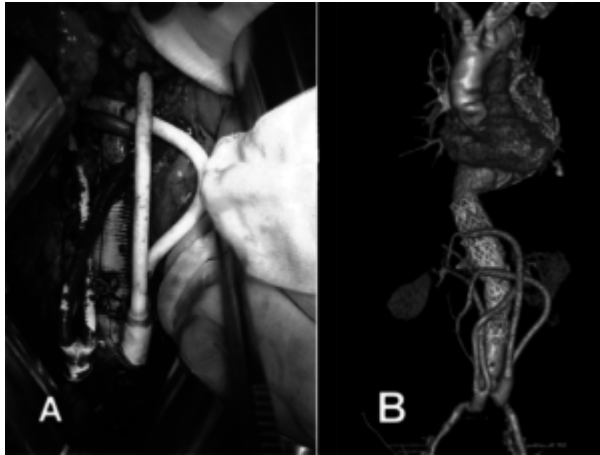


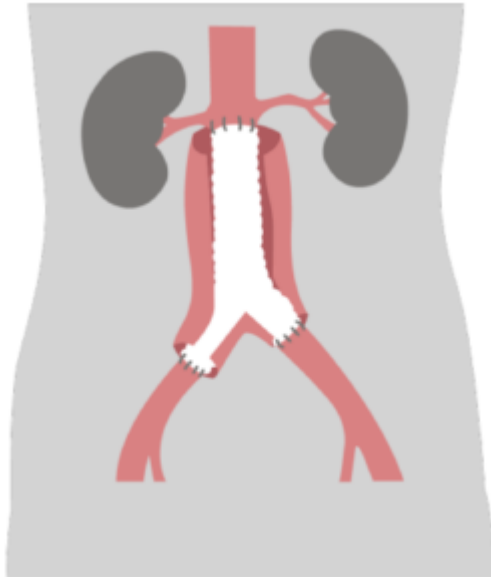
Image: "(A) Intraoperative view. (B) Early angio CT scan showing the implanted stent-grafts and the patency of all prosthetic bypass." by Mannacio V, Mottola M, Ruggiero D, D'Alessio A, Surace GG, Di Tommaso E, Amato B, Iannelli G. License: [CC BY 2.0](https://creativecommons.org/licenses/by/2.0/)

1. Advantages

This method also demonstrates various short-term benefits which include:

- Reduction of blood loss,
- Minimum hospital stays,
- Rapid recovery and
- Minimal complications due to its less invasive nature.

2. Procedures



“Surgical Repair (synthetic graft of woven Dacron)” by Lecturio.

Endovascular repair of aneurysm **does not involve the 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 the abdomen or chest.

The procedure uses general anesthesia and is performed using an X-ray of the artery. A catheter is inserted into the groin and threads the graft to the aorta affected by the aneurysm. The graft is expanded after being inserted into the aorta and fastened to it. This ensures a stable flow of blood and prevents rupturing of the aneurysm.

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