Fusiform aneurysm of the ascending thoracic aorta

Aortic aneurysm: What is it and how is it treated? The aorta is the largest artery in the body and is a blood vessel that carries oxygen-rich blood from the heart to all parts of the body. The part of the aorta that runs through the chest is called the thoratic aorta, and since the aorta moves down through the abdomen, it is called the abdominal aorta. What is a thoratic aortic aneurysm? When the artery wall in the aorta weakens, the wall abnormally expands or bulges as blood is pumped through what causes the aortic aneurysm. Lumps or balloons can be defined as: Fusiform: A uniform shape that appears equally along the enlarged part and edges of the aorta. Sacicular aneurysm: A small, lop-sided blister on one side of the aorta that forms in the weakened area of the aorta wall. An aneurysm can develop anywhere along the aorta: Aneurysms that occur in the part of the aorta that runs through the abdomen (abdominal aorta) are called abdominal aortic aneurysms. Aortic aneurysms that occur in the chest area are called thoracic aortic aneurysms and may include the root of the aorta, ascending aorta, aortic arch or descending aorta. Aneurysms that include the aorta as it flows through the abdomen and chest are called thoracoabdominal aortic aneurysms. Who is affected by the aneurysm of the thoratic aorta? Thoratic aortic aneurysms affect approximately 15,000 people in the United States each year. Up to 47,000 people die each year on all types of aorta; over from breast cancer, AIDS, homicides, or motor vehicle accidents, making aortic disease a silent epidemic. Is the aneurysm of the thoratic aorta serious? A thorax aortic aneurysm is a serious health risk because depending on its location and size it can crack or dissect (tear), causing life-threatening internal bleeding. When detecting at times, thoratic aortic aneurysms can often be corrected with surgery or other less invasive techniques. Small aneurysms place one at increased risk for: Atherosclerotic plaque (fat and calcium deposits) formation at the site of the aneurysm clot (thrombus) can form in place and relax, increase the chance of stroke Increase the size of the aneurysm, causing it to squeeze into other organs, causing pain Autopsy of the aorta or tearing of the layers of the aorta, potentially fatal complication and medical emergency. The aneurysm ruptures because the artery wall thinner at this point is brittle and can burst under stress. Sudden rupture of the aortic aneurysm can be life-threatening and is a medical emergency What is an autopsy of the aorta? An aortic autopsy occurs when the layers of the aorta tear and separate from each other. The presence of an aortic aneurysm increases the risk of autopsy of the aorta, but autopsy of the aorta can also occur in people of normal aortic size. Aortal autopsy can occur suddenly, causing severe sharp, tearing pain in the chest or upper back. Yet, like all types of aneurysms, there may be no symptoms of the aorta Most often associated with high blood pressure, aortic autopsy forces the layers of the aorta wall apart through increased blood flow. If not treated in a timely manner, the autopsy of the aorta weakens the aorta and can lead to an aortic aneurysm by causing weakening of the area of the aorta bulge like a balloon, stretching the aorta. If you experience any symptom of a thoratic aortic aneurysm or autopsy, tell your doctor immediately. If not treated, these conditions could lead to fatal rupture. Symptoms of autopsy of the aorta The most common symptom: Severe chest pain (anterior, posterior or both). Uncommon symptoms: Abdominal pain, numbness or weakness in one or both legs, loss of consciousness, symptoms of stroke. If you have these symptoms, call emergency help (dial 9-1-1 in most areas). What causes thoratic aortic aneurysm? Thoratic aortic aneurysms are most often caused by atherosclerosis, hardening of the arteries that damages the walls of the artery. While your arteries are usually smooth on the inside as you age they can develop atherosclerosis. When atherosclerosis occurs, a sticky substance called atherommatous plaque accumulates in the walls of the arteries. Over time, excess plaque causes the aorta to solidify and weaken. Your risk of atherosclerosis increases if: You are a smoker have high blood pressure Have high cholesterol are obese Have a family history of cardiovascular or peripheral vascular diseases (narrowing of blood vessels) Some diseases can also weaken the layers of the aortic wall and increase the risk of thoratic aortic aneurysms, including: Marfan syndrome (genetic connective tissue disorder), Loeys-Dietz and other familial connective tissue disorders Other non-sucissive connective tissue disorders (characterized by a family history of aneurysms) Presence of bicuspid aortic valve infections Inflammatory disease Rarely, trauma such as severe fall or car accident can cause thoratic aortic aneurysm. As you get older, the risk of developing an aortic aneurysm increases. More men than women are diagnosed with a thoratic aortic aneurysm, and are often affected by the condition at a younger age. Recent research shows that a significant number of aneurysms have familial patterns or are inherited from previous generations. It is important to tell your doctor if there is a history of aortic aneurysm in your family to ensure that the best preventive examinations are completed. What are the symptoms of thoratic aortic aneurysm? Aneurysms of the thoratic aorta often go unnoticed, since patients rarely experience any symptoms. While only half of those with a thoratic aortic aneurysm complain of symptoms, possible warning signs include: Pain in the jaw, neck and upper back Chest or back pain Cough, spewing, or difficulty breathing Last reviewed by a Cleveland Clinic health care professional on October 1,2019. Get useful, useful and relevant health + wellness information enews The clinic is a nonprofit academic health center. Advertising on our site helps support our mission. We do not endud non-Cleveland Clinic products or services. Aortic aneurysm policies are occasionally evaluated and treated by doctors of many specialties. Indeed, while cardiac surgeons act on ascending aorta and arch and vascular surgeons manage abdominal aortic aneurysms, currently the responsibility often falls on cardiologists to oversee the medical care of patients with aortic disease of all types. However, although formally trained in cardiovascular medicine, most cardiologists pay their attention to the heart and its coronary arteries, and relatively few have experience in managing aortic diseases. Therefore, it is important that cardiologists acquire a sufficient knowledge base to be able to confidently evaluate and manage patients with aortic disease and know when it is advisable to refer them to surgery. To this end, the purpose of this review is to summarise the current understanding of thoratic and abdominal aortic aneurysms. Thoracic aortic aneurysmsThoracic aneurysms may include one or more aorta segments (aorta root, ascending aorta, arch, or descending aorta) and are classified accordingly (Figure 1). Sixty percent of thoratic aortic aneurysms include aortic root and/or ascending aorta, 40% include descending aorta, 10% engage arch, and 10% include thorate aorta (with some spanning >1 segment). Etiology, natural history and treatment of thoratic aneurysms vary for each of these segments. Figure 1. Anatomy of the thoratic and proximal abdominal aorta. (©Massachusetts General Hospital Thorate Aortic Center. It is used with consent.) Etiology and pathogenesis Neurysms of the ascending thoratic aorta most often arise from cystic medial degeneration, which appears histologically as a blackout of smooth muscle cells and degeneration of elastic fibers. Medial degeneration leads to weakening of the wall of the aorta, resulting in dilation of the aorta and the formation of an aneurysm. When such aneurysms include the root of the aorta, the anatomy is often referred to as anuloaorticectia. Cystic medial degeneration occurs normally to some extent with aging, but the process is accelerated by hypertension.1Marfan syndromeThe absence of cystic medial degeneration in young patients is classically associated with Marfan syndrome (or with other uncommon connective tissue disorders such as Ehlers-Danlos syndrome). Marfan syndrome is a herifiable autosomal dominant disorder caused by mutations in one of the fibrilline-1 genes, a structural protein that is the main component of elastin microfibrils. Mutations result in a decrease in the amount of elastin in the aortic wall and loss of the normally highly organized structure of elastin. As a result, the aorta exhibits significantly abnormal elastic properties that lead to a gradual increase in Thoratic aortic aneurysm syndromeCystic medial degeneration has also been observed in patients with ascending thoratic aortic aneurysms who do not have connective tissue disorders. In addition, it is now recognized that although cases of thoratic aortic aneurysms in the absence of connective tissue attacks can be sporadic, they are often familial and are now referred to as familial thoratic aortic aneurysm syndrome. In an analysis of their large database of patients with a thoratic aortic aneurysm Coady and colleagues3, they found that at least 19% of patients had a family history of thoratic aortic aneurysm and presented themselves at a significantly younger age than patients with sporadic aneurysms. Most pedigtrals suggest an autosomal dominant way of inheritance, but there is significant variability in expression and penetration disorders, so that some inherit and pass on the gene, but show no manifestation of the disease. Several mutations have been identified. Mutation to 3p24.2–25 may cause both isolated and familial thoratic aortic aneurysms, with histological evidence of cystic medial degeneration.4,5 Mutations have also been mapped to 2 other chromosomal loci (5q13–14 and 11q23.2-q24).1,6 The extent of genetic heterogeneity is likely to become more visible as more families with thoragen aortic aortic aneurysm are examined. It is also possible that this is in fact a polygenic condition, thus explaining the variable expression and penetentrance. As a result, it is currently not possible to carry out routine genetic screening of this syndrome. Bicuspid Aortic ValvesMases ascending thoratic aortic aneurysms are associated with the underlying bicuspid aortic valve. It was once thought that such aneurysms were due to poststenotic dilation of ascending aorta, but the data suggest otherwise. Nistri et al7 used echocardiography to evaluate young people with commonly functioning bicuspid aortic valves and found that 52% had theoretic dilation (44% at the tubular part of the ascending aorta and 20% at the sinus level [i.e. root]). Indeed, other studies have shown that the bicuspid aortic valve is associated with dilapidated aorta, regardless of the presence or absence of haemodynamically significant valve dysfunction.8 The underlying cause of aortic dilation associated with the bicuspid aortic valve was found to be the underlying cause of aortic dilation associated with the bicuspid aortic valve. In one study, 75% of those with bicuspid aortic valve undergoing aortic valve replacement surgery had biopsy-proven cystic medial necrosis ascending aorta, compared to only 14% of patients with tricuspid aortic valves undergoing similar surgery. They found that patients with bicuspid aorta had less fibrillin-1 than patients with tricuspid aortic valves, and the reduction in fibrilline-1 was independent of patient age or aortic valve function. Interestingly, lung artery samples of the same individuals showed a similar reduction in fibrilline-1 content among those who have bicuspid aortic valves. This could lead to some patients with bicuspid valve undergoing the Ross procedure developing a late dilation of the pulmonary auto graft (see later sections). In addition, in a recent study in patients with ascending thoratic aortic aneurysms, Schmid et al12 found that compared to tricuspid aortic valve control, aortic tissue aneurysms of those with bicuspid aortic valves showed more lymphocyte infiltration and smooth muscle cell apoptosis. This suggests that wall aneurysms associated with bicuspid aortic valves may be weaker than more typical aneurysms. Since half of those with bicuspid valves have aortic dilation, cardiologists should routinely picture ascending aorta in all bicuspid aortic valve patients. In many cases, this can be achieved by echocardiography. However, while the root of the aorta is easily visualized in most transthoracic echocardiograms, in many cases the middle of the ascending aorta is not. Consequently, if the ascending diameter of the aorta is not reported on the echocardiogram, it cannot be safely assumed that it has been visualised and has been found to have a normal mean. You could examine the images to specifically examine the ascending aorta, but if it wasn't visualized enough, one should instead get a computed tomography (CT) scan or magnetic resonance imaging (MRI) study to determine the diameter of the aorta. AtherosclerosisAtherosclerosis is a rare cause of ascending thoratic aortic aneurysm. On the contrary, atherosclerosis is the predominant etiology of the aneurysm of the descending thoratic aorta. These aneurysms usually arise only distally to the origin of the left subclavian artery. The pathogenesis of atherosclerotic aneurysms in the thoragen aortic may resemble abdominal aneurysms (see later parts), but this is not extensively studied. SyphilisSyphilis was once perhaps the most common cause of ascending thoratic aortic aneurysms, but in an era of aggressive antibiotic treatment, such luetic aneurysms are rarely seen in modern medical centers. The latent period from initial spirocheal infection to complications of the aorta is usually 10 to 30 years, although it can range anywhere from 5 to 40 years. During the secondary phase of the disease, spirochetes directly infect the aortic media, causing smoothing endarteritis of the vassal vasor, especially the proximal ascending thorax aorta. Destruction of collagen and elastic tissues leads to dilation of the aorta, fibrosis and calcification. Longitudinal wrinkles on the aortic wall produces a radiographic pattern of barking trees. Weakening the wall of the aorta leads to aortic dilation, resulting in aneurysms that can be fusiform, but are often sacicular. The ascending aorta is most often affected, but an aneurysm may include an arch or root. Ascending aortic disability often produces secondary aortic regurgitation, and inflammation in the aortic root can result in ostial coronary artery stenoses. Turner syndromeTurner syndrome is associated with a number of cardiovascular anomalies, including bicuspid aortic valve (present in one third of individuals) and aortic coarctation. Thoratic aortic aneurysms are also found and usually include ascending aortics. In a recent systematic study of adults with Turner syndrome, Elsheikh et al13 screened 38 asymptomatic women and found that 42% had dilated aortic root. Of these, 4 out of 38 (11%) had bicuspid aortic valve and 11 out of 38 (29%) Hypertension. This population is at increased risk of aortic dissection and rupture. Indeed, those with both bicuspid aortic valve and aortic dilation may be at particularly high risk, given that both bicuspid aortic valve and Turner syndrome are strong risk factors for aortic dissection. As a result, it has been recommended that all women with Turner syndrome undergo a complete cardiac evaluation and echocardiographic or MRI scan at least every 5 years to detect potential aortic dilation.14Aortic arteritisTakayasu is the arteritis-most pronounced arteritis that affects aorta-is a chronic inflammatory disease of unknown etiology. The disease affects women much more often than men, and the average age at the time of diagnosis is 29 years.15 It usually causes obliterative luminal changes in the aortic and other arteries involved. However, in 15% of cases, aortic dilation can occur and lead to an aneurysm. These can arise either in the acute inflammatory (early) stage of the disease, or in the sclerotic (late) stage of the disease. Therefore, the finding of a thoratic aortic aneurysm in a young woman with symptoms of a systemic inflammatory process should increase the consideration of the disease. Giant-cell arteritis usually affects temporal or crayon arteries, but can also affect the aorta and produce aneurysms. In a long-term cohort of 169 patients in Olmstead County with giant cell arteritis, 30 (18%) aortic aneurysm (18 thoratic and 16 abdominal). Unfortunately, there were no clinically useful predictors of aortic involvement. Ankylous spondylitis is associated with inflammation of fibrocartilage, and it is hypothesis that inflammation is directed at tissues rich in fibrillary-1.17 Thus, it can be the cause of an aneurysm ascending aorta.18Aortic autopsyChronic autopsies of the aorta tend to break down over time. The affected walls of the aorta were weakened at the beginning of treatment (which led to an autopsy) and after autopsy the outer wall of the false lumen further weakened because its inner half (intimacy flap) was disassembled. As a result, persons with chronic aortic dissecation are at high risk of developing an aneurysm and should be closely monitored using surveillance imaging studies. TraumaNonpenetrating traumatic aortic injuries usually occur as a result of slowing down the injury. Most often, trauma leads to partial or complete reloading of the descending thoratic aorta at the level adjacent to the left subclavian artery. Most of those with aortic transocation die within an hour, and others undergo aortic repair during their initial hospitalization. However, in 1% to 2% of such patients, traumatic aortal transection is not diagnosed at the beginning, and patients can continue to develop chronic pseudoaneurysms at this site. These aneurysms are different in that they are usually sacicular (rather than the more common fusiform shape), relatively discrete, and located immediately distal on the left subclavian artery.19 Over time they tend to calcify. Clinical manifestationsSome patients with thorax aortic aneurysms are asymptomatic at the time of diagnosis, since aneurysms are usually discovered incidentally in imaging studies (chest x-ray, CT scan, or echocardiogram) ordered for other indications. An aortic aneurysm or ascending aorta can produce secondary regurgitation of the aorta, so a diastolic murmur can be detected during physical examination or, less often, patients may have congestive heart failure. When thoratal aortic aneurysms are large, patients may suffer from local effects such as bronchitis or mainstem bronchus (causing coughing, dyspnea, wheezing, or recurrent pneumonitis), compression of the esophagus (causing dysphagia), or compression of a recurrent bulging nerve (causing hoarseness). Rarely, chest or back pain may occur when an aneurysm is not distinguished due to direct compression of other intrathoracic structures or erosion into the adjacent bone. The dreaded consequence of a thoratic aneurysm is an aortic dissection or rupture (often referred to as acute aortic syndrome), which is potentially fatal. Typical symptoms of acute aortic syndrome include the sudden onset of severe pain in the chest, neck, back and/or abdomen. Diagnosis and SizingOften, thoratic aortic aneurysms are evident in chest x-ray films and are characterized by the expansion of mediastinal silhouettes, enlargement of the aortic knob, or tracheal

deviation. However, minor aneurysms and even some large ones may not produce any abnormalities in chest x-ray films. One should be careful when interpreting a radiological report that describes the abnormal silhouette of the aorta as an ecstatic aorta. Ectasia is formally defined as dilation of the vessel, but commonly radiologists use the term to describe the tortuosity of the thoracic aorta, which often occurs with later age (see discussion). In fact, based on the chest x-ray film itself, one can not typically whether the enlarged silhouette of the aorta represents an agonising aorta or the presence of an aneurysm. As a result, if a chest x-ray film shows an enlarged aorta silhouette, one should have a low threshold for ordering tomography imaging studies (eg, CT scan) to define aorta anatomy. Contrast-enhanced CT scans and MR angiography are preferred ways of defining aortic (and branch blood vessel) anatomy, both accurately detecting and resizing thoracic aortic aneurysms (Figure 2). However, a specific aortic anatomy can dictate which imaging study is optimal. For example, when aneurysms include the root of the aorta, MR is preferable to ct scanning because CT images root less well and are less accurate in size of its diameter. Figure 2. Contrast-enhanced CT scans showing a 7.5×8.3 cm ascending thoracic aortic aneurysm. And indicates ascending; D, descending. Caution should be exercised when displaying the agonising thorax aorta, which is common in the elderly, when measuring the diameter of the aorta in axial images; such images may be cut through the aorta axis outside the axis, resulting in a false-large diameter (Figure 3A). One option is to reconstruct the axial data into 3-dimensional images (i.e. CT angiography), with which it is then possible to measure the agonizing aorta in the right cross-section to obtain an exact diameter (Figure 3B). An alternative is MR angiography (Figure 4), which frames the thoratic aorta in multiple planes and therefore easily allows measurement on the axis. Figure 3. A, standard axial image from a contrast-enhanced CT scan showing what appears to be an oval-shaped descending thoratic aortic aneurysm, appears to measure up to 8.0×5.2 cm in diameter (arrows). B, Three-dimensional reconstruction in the left ante oblique view of the same CT scan showing that the descending aorta is agonizing and was subsequently cut off from the axis (dotted arrow) on the axial CT scan. The actual maximum diameter of this aortic segment was only 5.6 cm (fixed arrow). Figure 4. MR angiogram showing a 4.7 cm ascending thoratic aortic aneurysm. Transthoracic echocardiography is effective in the imaging of the root of the aorta (Figure 5) and is therefore often used to evaluate patients with Marfan syndrome. However, it does not consistently visualize the middle or distal ascending aorta well, nor does it visualize the descending aorta. Therefore, other than those with Marfan syndrome, transthoracic echocardiography should generally not be used for diagnosis and size of thoracic aortic aneurysms. Although transedophageal echocardiography can visualise the entire thoragen aorta well, due to its semi-invasive nature, it is not preferred for routine imaging of those who have stable (non-detecting) thoracic aneurysms. Figure 5. Transthoracic echocardiogram, in parasternal long-axis view, demonstrate the enlarged aortic root (4.4 cm) and ascending aorta (4.2 cm). While the root of the aorta is well visualized, the ascending aorta is smaller than is often the case with trans-october imaging. Rv the right chamber; LV, left ventric room; and LA, left atrium. Natural historyRode history of thoratic aortic aneurysms has not been well defined. One reason is that the etiology and location of the aneurysm can affect its growth rate and propensity to dissect or rupture. The second reason is that it is rare, in an era of modern imaging and aneurysm size, to actually allow known aneurysms to grow until rupture, because surgery is usually performed when the aneurysms are only large enough to be considered a significant risk of rupture. Although some patients with large aneurysms do not undergo surgery, they are usually elderly or have important co-morbidities, thereby increasing their mortality, regardless of the aneurysm. Based on long-term data from Yale Davies et al20, it found that the average growth rate for all thorax aneurysms was 0.1 cm/year. The growth rate, however, was greater for aortic descending aneurysms versus ascending aorta, was greater for autopsy aneurysms versus undeparted ones, and was greater for those with Marfan syndrome versus those without. The initial size is an important predictor of the rate of growth of the thorac aneurysm. However, even checking the initial size of the aneurysm, there are still substantial differences in the individual aneurysm growth rate,21, which makes it difficult to predict growth prospectively for a given aneurysm. Therefore, it is necessary to monitor all aneurysms with regular monitoring to monitor growth. In terms of aneurysm size and risk of rupture or dissection, in its Davies et al20 series found an annual rate of 2% for aneurysms <5 cm, 3% for aneurysms 5 to 5.9 cm and 7% for aneurysms ≥6 cm in diameter. Therefore, the risk appears to suddenly increase, since the thorax aneurysm to reach a size of 6 cm.ManagementSurgical TreatmentOptimal timing of surgical repair of thoratic aortic aneurysm remains somewhat uncertain, due to limited data on their natural history. For most ascending thoracic aortic aneurysms, surgery is indicated on average ≥5.5 cm. Among those with an increased operative risk (eg, elderly people or those with co-morbidities), we will usually raise the threshold to 6 cm or more before recommending surgery. Conversely, in patients who are at increased risk of aortic dissection or rupture (e.g. Marfan syndrome or bicuspid aortic valve), an ascending repair of the aorta is often recommended, when the aneurysm reaches only 5 cm and in selected cases (in patients at particularly high risk), with an even smaller diameter.22 In addition, when patients with bicuspid valve require aortic valve replacement surgery, we recommend prophylactic replacement of ascending aorta, if its diameter is 4 cm or greater, given that we now recognize that these patients would otherwise remain at high risk for subsequent aortic autopsies. For most descending thoratic aortic aneurysms, we recommend surgery with an aorta diameter of 6 cm or larger. Ascending thoratic aorta mortality rate of elective surgical corrections of ascending aortal aneurysms in large centers is 3% to 5%. Thoratic repair of the aorta requires cardiopulmonary bypass surgery (there is no possibility of off-the-pump and the aneurysm is generally resected and replaced with a prosthetic graft dacron tube of appropriate size. When an aneurysm involves the root of the aorta and is associated with significant aortic regurgitation, one usually performs composite aortic repair (Bentall procedure) using a graft tube with a prosthetic aortic valve sewn to one end. The valve and graft are sewn directly into the aortic anulus, and the coronary arteries are then reimplanted into the dacron aortic graft (Figure 6). Figure 6. A composite aortic graft repairs an aneurysm involving the root of the aorta and the ascending thoratic aorta. Coronary arteries are felled like buttons, and the aneurysm is resected to the level of the aortic anulus, with the victim of a native aortic valve. The prosthetic flap is attached directly to the Dacron graft, and this composite graft is sewn directly to the annula. The native coronary buttons are then reimplanted into graft. (©Massachusetts General Hospital Thorate Aortic Center. It is used with consent.) Alternatively, if the leaflets of the aortic valve are structurally normal and the aortic regurgitation is secondary to root dilation, a replacement of the valve-sparing root may be performed (Figure 7). This technique, advanced by Dr Tirone David, involves excising the cavities of Valsalva in aorta sparing leaflets, sewing dacron graft to the base of the aortic anulus and reconfiguting the aortic valve leaflets within the graft to restore their normal anatomical configuration.23 If successful, this procedure will avoid the need to replace the prosthetic valve and the associated long-term risks and reduce the risk of re-valve surgery. In a series of 151 patients with aortic root aneurysm aneurysms who underwent valve-sparing surgery, David et al23 found that after 8 years of follow-up, 67% had mild or no aortic regurgitation, while only 2% developed severe aortic regurgitation. Figure 7. Valve-sparing procedure to repair an aneurysm involving the root of the aorta and ascending thoratic aorta. Aortic cavities are cut out, but flaps leaflets are not. The leaflets are then placed in the lumen of the Dacron graft, which is then sewn directly into the aortal anula. The valve leaflets are then re-installed at the bottom of the graft to restore competence. (©Massachusetts General Hospital Thorate Aortic Center. It is used with consent.) Some younger patients have an enlarged aorta root, but due to internal valve dysfunction, the aortic valve cannot be spared. For those who want to avoid the prosthetic valves needed with a composite aortic graft, one option was a pulmonary auto graft, also known as the Ross procedure. In this procedure, the aortic valve and the patient's root are cut out. The patient's own lung root is then carved and transplanted aortic position. In turn, the lung root is replaced by cryopreserved pulmonary (or aortic) homograph. Although conceptually attractive, the procedure was not without complications. One of its main limitations is the development of late dilation of the auto graft root, which is especially problematic in those who have had preoperative dilation of the root of the aorta. In one series of 91 patients, the incidence of pulmonary auto graft dilation was 61% after 5 years in patients with prior aortic aneurysm, compared to 27% among those who did not have a previous aortic aneurysm (i.e. those who had surgery only for aortic valve disease).24 When complete aortic/valve root replacement is required, another alternative to compound graft is the use of cryopreserved aortic (cadaveric aorta and proximal ascending aorta). After the procedure, however, there is a late structural value damage and can lead to subsequent reoperation. In addition, it appears that that deterioration of the aortic valve progresses faster in younger patients than in elderly patients, making homograft less likely to serve as a durable, lifelong prosthesis.25Arch aneurysmSurgical replacement of aortic arch aneurysms is particularly challenging and carries a significant risk of neurological damage from embolization of atherosclerotic debris or from global ischemic injury during circulatory arrest. To replace the enlarged arch with a prosthetic graft tube, the brachiocephalic vessel must be removed from the arch before its resection and then re-into the graft tube arch after its mutual position. Traditionally this included removing and then re-deploying brachiocephalic blood vessels en bloc during hypothermic circulatory arrest. However, many surgeons have now adopted a newer surgical technique using a multilimbed prosthetic arch graft, to which each arc vessel is individually anastomosed (Figure 8), which reduces the duration of hypothermic circulatory arrest and the frequency of embolism. Figure 8. Repair aneurysms involving ascending thoratic aorta and arch using a multilimbed prosthetic graft. (©Massachusetts General Hospital Thorate Aortic Center. It is used with consent.) Three methods of brain protection were used for aortic arch surgery. The traditional method was to use a deep hypothermic circulatory arrest with the arrest of cerebral perfusion. Subsequently, retrograde cerebral perfusion through the superior dowry cava cannula was introduced as an adjunct for cerebral protection during hypothermic arrest. It was believed that this technique would improve outcomes by adding nutrients and oxygen to the brain and flushing particulate matter from the cerebral and cervical arteries that would otherwise embolize. However, systematic studies of retrograde cerebral perfusion showed no improvement in results. In this method, perfusion is inserted directly into the cerebral vessels to connect the brain during all except short periods of surgery. In fact, the use of multilimbed, prosthetic aortic graft has made such selective antegrade brain perfusion easier and more effective. Previously available data suggest that selective antegradal cerebral perfusion significantly reduces the incidence of temporary neurological dysfunction, although its impact on stroke risk remains unclear. Fortunately, several methods have been introduced to reduce the likelihood of paraplegia; these include regional hypothermic protection of the spinal artery by epidural cooling during surgery, drainage of cerebrospinal mucus, re-implantation of patent critical intercopic arteries, use of intraoperative somatosensor potential monitoring and maintenance of distal aortic perfusion during surgery using atriosemoral (left heart) bypass of the distal aorta. Using these supplements, the incidence of paraplegia fell from a historical rate of 13% to a 17% rate of 5% to 6% in most modern series. Optional surgical repair of descending thoratic aortic aneurysm is also associated with mortality ranging from 5% to 14%. Importantly, a recent study of surgical repair of aortic chest aneurysms found that surgical mortality was significantly higher in low-volume hospitals and in low-volume surgeons compared to high volume and high volume surgeons.28Figure 9. Correction of descending thoratic aortic aneurysm. (© Massachusetts General Hospital Thoracic Aortic Center. It is used with consent.) An alternative approach to repairing descending thorate aneurysms is the use of transluminally located endovascular stent-graft (Figure 10). This technique has the advantage of being much less invasive than surgery, with potentially fewer postoperative complications and lower morbidity. Ellozy et al29 recently reported a number of 84 patients who receive endovascular stent-grafts to treat descending thoratic aortic aneurysms. The primary technical success was achieved in 90%, and the successful elimination of the aneurysm was achieved in 82%. However, serious procedural or device-related complications occurred in 38%, including procedural binding failure (8%), distal connection failure (6%), mechanical device failure (3%), periprocedural death (6%) and late rupture of the aneurysm (6%). More encouraging was the fact that only 3% suffered from persistent neurological complications. Compared to open surgical repair, endovascular stent-notching appears to have acceptable perioperative morbidity and mortality, but it is clear that technical improvements are needed before it can become a routine treatment for such an aneurysm. On the it is best reserved for those who have an ideal aorta anatomy, or those who are otherwise poor surgical candidates. Figure 10. Minimally invasive repair descending thoratic aortic aneurysm using transluminally located endovascular stent-graft. The unpacked stent is advanced and placed through an aneurysm. The proximal part is extended and anchored, and then the distal part is extended and anchored. The covered stent then serves as a conduage for blood flow while excluding the aneurysm aorta from circulation. Aneurysm of the bag then thrombosis. (©Massachusetts General Hospital Thorate Aortic Center. It is used with consent.) Staged RepairSome patients requiring surgical repair have aneurysms that include multiple aortic segments (ascending, arch, and/or descending thoratic aorta). Trying to repair both ascending and descending segments in one operation is challenging and risky. Therefore, most centers will address these complex situations by performing staged procedures, with the repair of one aortic segment (ascending or descending) first to be followed later by a second surgery. The order of surgical repair is dictated by an individual's specific aortic anatomy–for example, depending on which aortic segment is most at risk of rupture and where the surgeon can expect to place the aorta cross-clamp. In some cases, however, the lack of an adequate neck (a relatively undilated segment of the proximal descending aorta) makes it difficult to perform such a staged procedure. In such cases, an alternative staged surgical approach known as the elephant strain technique is used.30 The first part of the operation is most similar to the standard ascending aneurysm and the overall repair of the arch. However, the distal end of the arc of the aortic graft is a few centimeters longer than the original arch, so after anastomosis is made on the proximal descending aorta (only the distal left subclavian artery), the excess length of the graft is left protruding distal in the lumen descending thoratic aortic aneurysm. In the second stage of this procedure, the descending or thoracoabdominal aortic aneurysm is corrected by a standard left thoracotomym. However, the surgeon cross-clamps the distal end of the existing elephant trunk (rather than clamping the enlarged native aorta), and the proximal end of the new descending aortic graft is now anastomosed at the free distal end of the elephant trunk. Medical managementLlertion therapies available to slow the growth of thoratic aneurysms and reduce their risk of dissection or rupture are quite limited. In a randomised study in adults with Shores et al31 Marfan syndrome, it found that treatment with propranolol (versus no β-blocker therapy) for 10 years resulted in significantly slower aortic dilation rates, fewer aortic events and lower mortality. Unfortunately, whether these benefits can actually be extrapolated to non-Marfan populations with aneurysm remains unknown. Nevertheless, it is mechanically logical that medical therapy to reduce dP/dt and control blood pressure would be beneficial for the treatment of all patients with thoratic aortic aneurysms. In addition, due to the safety β of blockers, there is no disadvantage of the anticipated treatment provided it is well tolerated. There is some early experimental evidence to suggest that oxidative stress may play a role in the pathogenesis of atherosclerotic thoratic aortic aneurysms and that perhaps statin therapy and angiotensin II receptor blocker therapy may have a potential protective effect.32,33 However, much more research is needed before any therapeutic consequences can be worked out. When β-blocker therapy is maximised (or if β blockers are contraindicated or intolerant), any persistent hypertension should be treated with other antihypertensive agents, in order to reduce blood pressure to a low normal range, eg, systolic pressure of 105-120 mm Hg. White-coat hypertension is not uncommon in patients undergoing an aneurysm evaluation, and therefore it may be difficult for a doctor to determine whether in-office blood pressure is truly representative. As a result, it is often useful for the patient to use automatic shoulder blood pressure cuffs to regularly monitor his or her response to treatment, thereby confirming that blood pressure is within the prescribed range. Although most aortic disection appears to occur spontaneously, it is known that a minority occurs when determining strenuous isometric exertion. Aerobic exercise is generally safe provided the patient does not have a hypertensive response to exercise. As a result, the patient should want to engage in intense aerobic exercise (e.g. running or cycling), it is reasonable to obtain a treadmill exercise test-based β-blockers and/or other basic antihypertensive-assess the physiological response to exercise and ensure that systolic blood pressure does not rise above 180 mm Hg.Patients should be informed of the typical symptoms of acute aortic autopsy. In addition, patients should be advised that if they sometimes feel a sudden onset of significant chest, neck, back or abdominal pain, they should be immediately referred to the emergency room for evaluation. They should be warned of the risks if they choose to wait hours or days to see if symptoms spontaneously disappear. In addition, patients should be instructed to inform the emergency physician of the existence of thoracic aortic aneurysms and to explicitly explain that their doctor recommends an urgent CT scan of the chest (or transedophageal echocardiography or MRI if CT is contraindicated) to exclude acute aortic dissection or rupture. This can lead to department of the doctor, who would otherwise consider aortic autopsy in differential diagnosis to the image of the aorta immediately. As detailed, several etiologies of thoratic aneurysms, including bicuspid aortic valve,10 may be familial. Since thorax aneurysms are typically asymptomatic, the only way to detect their presence among other potentially affected family members is with formal screening. A screening echocardiogram may be appropriate in relatives of those who have Marfan syndrome or bicuspid aortic valve. For all other etiologies (including idiopathic aneurysms), CT scans or MRI are preferred, since the imaging of the ascending aorta is crucial. It should be recognized that the presence of aortic aneurysm can be a marker of more diffuse aortic disease than up to a quarter of those with thoratic aortic aneurysms have simultaneous abdominal aortic aneurysms. Therefore, in order to exclude the presence of other aneurysms, it is necessary that all patients diagnosed with thoratic aneurysm undergo at least one initial imaging study, which includes the abdominal aorta. This can be achieved easily by CT scan or MRI. Serial ImagingPatients should be monitored by serial imaging studios for follow-up. When the aneurysm of the thoratic aorta is first detected, it is usually not possible to determine the growth rate. Therefore, it is appropriate to obtain a repeated imaging study 6 months after the initial study. If the aneurysm is unchanged in size, then it is reasonable to get an imaging study on an annual basis in most cases. In patients without Marfan syndrome or acute aortitis, thoratic aortic aneurysms tend to grow relatively slowly, so annual imaging is sufficient for monitoring. However, should there be a significant increase in the size of the aorta from one study to another, the interval between studies should be reduced to 3 or 6 months (according to the average aorta). For surveillance imaging messages to be useful, they must contain averages of affected aortic segments; general descriptions, such as there is an ascending aortic aneurysm or descending thoratic aorta is widespread, are insufficient. To quantify the growth of an aneurysm over time, maximum aortic averages must be compared. In addition, caution should be taken when relying entirely on the conclusions reported by the reader. Some readers may indicate: There is a 5-cm ascending thoratic aortic aneurysm that does not change compared to the previous examination. However, if, for example, the previous diameter of the aorta was 4.8 cm and previously it was only 4.6 cm, the conclusion that the aneurysm is unchanged is misleading because it cannot illuminate the true pattern of progressive growth of the aneurysm. In addition, it is ideal to have serial imaging studies conducted in the same center with the same technique, so a direct comparison can be made between comparable images. Finally, individual readers can measure the average of the aorta differently, so even if the report states that average has changed, this does not necessarily mean that the aorta has actually grown in size from one study to another. In fact, in a recent systematic assessment of inter-hearing variability, 8 experienced readers interpreted CT scans of aortic aneurysms and between them the average difference was 4 mm when measuring the maximum diameter of the aorta.35 As a result, the only way to be absolutely sure whether the aorta diameter has changed is for a given reader to compare similar images from sequential studies and then perform each set of measurements in person. Abdominal aortic aneurysmsAbdominal aortic aneurysms are much more common than thoratic aortic aneurysms. Age is an important risk factor, and the incidence of abdominal aortic aneurysm increases rapidly after the age of 55 in men and 70 in women. The prevalence of abdominal aortic aneurysms is ≈5% in men aged ≥65 years examined by ultrasound.36Etiology and pathogenesisSmoking is a risk factor, which is most associated with abdominal aortic aneurysm, followed by age, hypertension, hyperlipidemia and atherosclerosis.37 Sex and genetics also affect the formation of an aneurysm. Men are 10 times more likely than women who have abdominal aortic aneurysms of 4 cm or higher.38 Those with a family history of abdominal aortic aneurysms have an increased risk of 30%.39 and their aneurysms tend to occur at a younger age and carry a greater risk of rupture than sporadic aneurysms. Unfortunately, no gene errors have yet been detected. The strength of the aortic wall lies in the elastane and collagen of its extracellular matrix. As a result, the degradation of these structural proteins weakens the wall of the aorta and allows the development of an aneurysm. Classically, atherosclerosis was considered the underlying cause of abdominal aortic aneurysm: The infrarenal abdominal aorta is most affected by the atherosclerotic process and is similarly the most common site of abdominal aneurysm formation. However, current research suggests that genetic, environmental, hemodynamic and immunological factors all contribute to the development of aneurysms. There is histological evidence of inflammatory infiltrates in the wall of the aortic aneurysm, and such inflammation was implicated in the degradation of the extracellular matrix. Matrix metalloproteinases are enzymes that are produced by smooth muscle and inflammatory cells, and several of these proteinases may be involved in the formation of abdominal aortic aneurysms. Indeed, some of the matrix metalloproteinosis can degrade elastin and collagen. Levels of some matrix metalloproteinosis are significantly increased in the walls of the aneurysm compared to controls. In addition, several other proteinases, including plasminogen activators, serine elastases and catepsins, may contribute to the formation of the aneurysm. Clinical manifestationsMomly abdominal aortic aneurysms are asymptomatic and are discovered incidentally on routine physical or in imaging studies ordered for other indications. When symptoms arise, pain is a typical complaint. Pain is usually found in the hypogastrium or lower back and is usually stable and agonizing, lasting hours to days. Actual rupture is associated with the sudden onset of back pain along with abdominal pain and tenderness. Most patients have a palpable, pulsating abdominal mass, and many are hypotensive and appear critically ill.Physical ExaminationA few aneurysms can be detected for physical examination as a pulsating mass ranging from xiphoid to pimples. However, the sensitivity of physical examination is limited, and even large aneurysms can be difficult or impossible to detect in people who are overweight or obese.40 The size of an aneurysm is usually overrated during physical examination, so even normal aorta can sometimes feel enlarged. Diagnosis and sizeSome diagnostic imaging methods are available for detection and serial monitoring of abdominal aortic aneurysms. Abdominal ultrasonography is perhaps the most spulsic way to screen for aneurysms. Its main advantage is that it is relatively inexpensive and non-invasive and does not require the use of a contrast agent. Compared to ultrasonography, CT scanning has the advantage of being able to better define the shape and extent of the aneurysm, as well as the local anatomical relationships of visceral and renal vessels. It is also better than ultrasonography when displaying suprarenal aortic aneurysms. Disadvantages include its cost and the use of ionizing radiation and intravenous contrast media. However, although CT is less practical than ultrasonography as a screening tool, its high accuracy in the size of an aneurysm makes it an excellent modality for serial monitoring of changes in aneurysm size. It is important to note that CT measurements of aneurysm size tend to be larger than ultrasonic measurements averaging 3 to 9 mm, by size of the aneurysm.41.42 CT angiography (3-dimensional depiction of the aorta and its branches) is particularly useful in that it provides a more comprehensive assessment of the anatomy of the abdominal aorta and renal aneurysms, mesenteric and ilialic arteries (Figure 11). Figure 11. Contrast-enhanced CT scans with 3-dimensional reconstruction demonstrate a 5.6 cmfrarenal abdominal aortic aneurysm. The image has been rotated in space so that one is viewing the posterior aspect of the aneurysm. The kidneys, spleen and liver are also visualized. In those for whom contrast-enhanced CT scanning is contraindicated (eg, renal insufficiency or allergy), MR angiography is an alternative to a comprehensive evaluation of aortic aneurysm. Due to the image quality provided by both CT and MR angiography, traditional catheter-based contrast aortography is currently rarely used in the assessment of abdominal aneurysms. Screening In the last decade, great attention has been paid to the potential usefulness of routine screening adults for the presence of abdominal aneurysms. The largest and most enomous controlled study to date comes from the aneurysm multicenter screening study group,36, in which a sample of 67,800 men (ages 65 to 74) was randomized to an invitation to an ultrasound scan or to a control group that was not offered screening. Those with an aneurysm were monitored for a series of ultrasound scans for an average of 4 years and the operation was considered when the average reached ≥5.5 cm. In the control group there were 65 aneurysm-related deaths versus 113 deaths, which resulted in an estimated risk reduction of 42%. Calculating the cost of a life-year gain requires factoring in many financial variables, and differences in assumptions about costs (e.g. screening, surgery and hospitalization) and cost savings (e.g. avoiding emergency surgery for aortic rupture) greatly impact conclusions about cost effectiveness. As a result, estimates of life-year earned costs range from as low as $110,743 to as high as $57,000.36 with screening of 700 to 1,000 subjects needed to prevent 1 death. Although the exact cost of a life-year gain remains uncertain, it still seems that screening is grossly cost-effective. Indeed, in a recent consensus statement, a number of U.S. vascular specialists have recommended screening all men aged 60 to 85, all women aged 60 to 85 years with cardiovascular risk factors and both men and women >50 years with a family history of abdominal aortic aneurysm.44National historyThe main risk posed by abdominal aortic aneurysm is rupture and its high associated mortality. In one large study with ruptured aneurysms, 25% died before reaching the hospital, another 51% died in hospital without undergoing surgery, and of those who underwent surgery, the operative mortality rate was 46%, bringing overall 30-day survival to just 11%.45 The goal then is for patients to undergo elective aortic repair-with mortality of only 4% to 6%-when aneurysms are considered a significant risk of rupture. The risk of rupture increases with the size of the aneurysm. The UK Small Aneurysm Trial found that for aneurysms <4cm, 4 to 4.9cm and 5 to 5.9cm, the annual risk of rupture was 0.3%, 1.5% and 6.5% respectively for aneurysms of 6cm or higher, although it is not possible to estimate the exact risk. Although abdominal aneurysms are less prevalent in women than in men, when ruptures are present 3 times more often and with a smaller diameter of the aorta (diameter 5 versus 6 cm). Rupture is also more common in current smokers and in those with hypertension.45 Rapid rate of expansion predicts a rupture of the aneurysm. Although the average rate of expansion of the abdominal aortic aneurysm is expected to be close to approximately 0.4 cm/y, the rate of expansion in the population is highly variable. The initial size of the aneurysm is the best predictor of the rate of growth of the aneurysm, with larger aneurysms faster than small ones. Figure 12 graphically summaries the growth rate of the aneurysm, as determined in several longitudinal series. A promising new technique for predicting the fate of the abdominal aortic aneurysm is the analysis of stress on the wall. 3-dimensional reconstruction of the aortic aneurysm is carried out using CT angiography, and wall stress is then determined by the final element of analysis and blood pressure. In a recent analysis of 103 patients, Fillinger et al46 found that the sensitivity and specificity of maximum wall stress were better than the maximum aortic diameter for predicting the risk of aortic rupture. Although this technique has yet to be refined and better studied, it holds the promise to become an important tool in determining the timing of aorta repair. Figure 12. Growth rate of small abdominal aortic aneurysms vs. aneurysm size. Fixed lines indicate growth rate adjusted from 5 longitudinal series (a=Brown PM et al45; b=Lindholt JS et al54; c=Stonebridge PA et al57; d=Vardulaki KA et al58; and e=Santilli SM et al59). The dashed line represents an approximation of the average expected growth rate compared to size based on these series. (©Massachusetts General Hospital Thorate Aortic Center. It is used with consent.) ManagementSurgical TreatmentAneurysm size is the primary indicator for correcting asymptomatic aneurysms, and following 2 recent large-scale trials, there is now a reasonable consensus regarding the appropriate average aneurysm that requires surgery. UK Small Aneurysm Trial47 and Aneurysm Detection and Management (ADAM) Veterans Affairs Cooperative Trials48 randomised patients with small aortic aneurysms (diameter 4 to 5.5cm) either had early elective surgery or regular imaging monitoring, and both found no difference in survival between the 2 groups. Test results indicate that surgery is not indicated, in most cases, for asymptomatic aneurysms <5.5 cm. However, one important limitation is that that these 2 study populations consisted almost exclusively of men and because the risk of a rupture of the aneurysm is greater and occurs on a smaller average in women than in men, it is assumed that these results are not generalised to women.33 However, the recently published set of guidelines assumes that these results are not generalised to women.33 However, a recently published set of guidelines assumes that these results are not generalised for women.33 However, the recently published set of guidelines assumes that these results are not generalised for women.33 However, the recently published set of guidelines assumes that these results are not generalised to women.33 However, the recently published set of guidelines assumes that these results are not generalised to women.33 However, the recently published set of guidelines assumes that these results are not generalised to women.33 However, the recently published set of guidelines assumes that these results are not generalised to women.33 However, the recently published set of guidelines assumes that these results are not generalised to women.33 However, the recently published set of guidelines assumes that these results are not generalised to women.33 However, the recently published set of guidelines assumes that these results are not generalised to women.33 However, the recently published set of that these results are not generalised. The Joint Council of the American Association for Vascular Surgery and the Society for Vascular Surgery agreed with the 5.5 cm threshold for the average male patient, but recommended that women undergo elective repair at a smaller aorta diameter of 4.5 to 5 cm. Several studies have shown that mortality inversely is related to the volume of the surgeon. In fact, in a recent analysis, both the high volume of the surgeon and the high volume of the hospital were both associated with lower mortality rates than low-volume providers and that surgeons specializing in vascular surgery had lower mortality rates than nonspecialized surgeons with the same aorta volume.50A A less invasive alternative to open surgery to repair abdominal aortic aneurysms is the use of percutaneously implanted, expanding endovascular stent-grafts. After the deployment of the stent-graft is used to bridge the area of the aneurysm, thereby excluding it from circulation while allowing the blood flow of the aorta to continue distal through the prosthetic stent-graft lumen. First, only 30% to 60% of abdominal aortic aneurysms are anatomically suitable for endovascular repair. After implementation, the rate of successful implantation of stent-graft ranged from 78% to 94%. One of the main technical difficulties associated with the technique of stent-graft, which has yet to be overcome, is the frequent occurrence of endo leaks, which occur in 10% to 20% of cases49 and are perceived angiographically as a persistent contrast flow into the aneurysm sac due to the non-exclusion of an aneurysm from the circulation of the aorta. If left untreated, these endo leaks can potentially leave the patient at continued risk of spreading or rupturing an aneurysm. In a follow-up study of results after 12 months or longer among beneficiaries >1000 stent graft recipients, EUROSTAR investigators reported that almost 10 % of patients per year required secondary interventions, suggesting that caution should be exercised in the widespread application of endovascular aneurysm repair.51 In addition, the long-term outcome of endovascular repair compared to conventional surgical repair is currently unknown. Therefore, the use of stent-grafts for endovascular repair of abdominal aortic aneurysms was generally limited to elderly patients and patients at high operational risk. Medical ManagementAs with thoratic aortic aneurysm, β-blocker therapy is considered important to reduce the risk of abdominal aortic aneurysm expansion52 and rupture. Change in risk factor is essential: Hypercholesterolaemia and hypertension should be controlled and cigarette smoking discontinued. An aneurysm too small to merit surgery should be monitored with regular surveillance imaging to monitor their size. Based on the current size of the aneurysm and its predicted growth rate (as shown in Figure 12), it is possible to estimate how quickly an aneurysm can grow to a large enough size to merit repair and therefore recommend appropriate intervals for resaturation. The schedule of tracking samples is summarised in Table.53-56 In a recent analysis of the growth of brady et al53 aneurysm growth, he estimated that following such a re-screening algorithm, the possibility of an aneurysm reaching >5.5 cm between screenings would be limited to <1 %. When monitoring the growth of a ≥4 cm in diameter, CT scanning may be preferable to ultrasound because ct size is more accurate. Proposed intervals for monitoring the imaging of abdominal aortic aneurysms vs. baseline Aorta Mean presence of aneurysm, cmReimage Aorta in * In addition to planning repeated monitoring imaging, it is also necessary to consider referral of a vascular surgeon. that for abdominal aorta diameters <2.5 cm, rescreening is generally considered unnecessary. Data derived from references 53–56.2.5–2.95 y3.0–3.43 y3.5–3.92 y4.0–4.41 y4.5–4.96 mo5.5.9 Conclusions 0–5.53–6 mo*Conclusions Where aortic aneurysms are uncommon, many other cardiovascular diseases, the fact that that they may be life-threatening and that even large aneurysms may not produce symptoms, makes this all the more important for doctors to be vigilant when assessing patients at risk. As aneurysms are often first detected in an imaging study commissioned for other indications, any suggestion of an enlarged aorta should encourage follow-up by an appropriate specialized imaging study. Fortunately, modern imaging techniques–especially CT and MRI–now make the size and tracking of the aneurysm relatively easy. In the future, genetic screening may also play a role in screening those with a family history of thoratic aortic aneurysms. Ideally, expanding clinical awareness of aortic aneurysms and methods of diagnosis will help reduce the morbidity and mortality associated with this condition. Indeed, doctors who understand the principles of medical and surgical treatment of aortic aneurysms can conveniently determine when they should manage patients with medication and serial imaging studies (to monitor the aneurysm size and growth rate) and when to refer to a cardiotopic or vascular surgeon. Finally, while open surgical repair remains the standard approach to treating most large aortic aneurysms, it is likely that endovascular stent-notching will take on an increasingly important role as the technique is further refined. Footnotes

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