Indications for thoracoabdominal aortic surgery

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The thoracoabdominal aorta involves varying portions of the thoracic and abdominal aorta. However, problems embracing the thoracoabdominal aorta might already start at the level of the aortic root, the ascending aorta, or the aortic arch, as is often the case in postdissection thoracoabdominal aortic aneurysms (TAAAs). Proximal aortic dissection (ie, DeBakey type I) by definition extends into the more distally located aortic segments.

Classification of aortic pathology, whether aneurysm or dissection, is of the utmost importance because operative risks, surgical approach and strategy, and, of course, the extent of the repair are dependent on the type of TAAA. TAAAs were first classified by Crawford and colleagues¹ into 4 types and are shown in Figure 1. Type I aneurysm involves the aorta distal to the left subclavian artery and extends down to the proximal suprarenal abdominal aorta. A type II aneurysm is the most extensive, and it involves the descending thoracic aorta distal to the left subclavian artery and extends into the infrarenal abdominal aorta. A type III aneurysm starts in the descending thoracic aorta below the level of T6 and extends below the renal arteries. A type IV aneurysm starts at the diaphragm (not above) and involves the complete abdominal aorta, and its approach is similar to that of the other types.

Also, aortic dissections should be classified according to the Stanford classification, DeBakey classification, or both^{2,3} to analyze and compare outcomes, results of surgical intervention, and follow-up. In at least 25% of cases, but probably more, dissection results in future aneurysmal dilatation, finally ending as so-called postdissection aneurysms.

Repair of the thoracoabdominal aorta is a major surgical challenge, with a high morbidity and a significant mortality. Therefore it is warranted in all elective situations to assess the effect of surgical intervention by evaluating the pulmonary, cardiac, renal, and neurologic risks. It is possible to calculate the risk of rupture by using equations, including certain risk factors.⁴ In the elective context there is enough time to prepare and optimize all organs at risk: cessation of smoking, use of bronchodilators and respiratory exercise

training, evaluation of cardiac status (transthoracic echocardiography, persantine thallium scintigraphy, and, in the case of previous percutaneous coronary intervention or coronary artery bypass grafting, a renewed coronary angiogram), delaying intervention until renal function is optimized or restored (especially after intravenous contrast load after computed tomographic [CT] scanning or angiography). This is important because mortality is higher in patients with cardiac dysfunction and increases to as high as 50% in patients requiring postoperative hemodialysis.⁵

When discussing the operative indications for thoracoabdominal aortic surgery, one should clearly distinguish between acute and chronic indications based on a combination of symptoms and pathology.

ACUTE INDICATIONS

Acute Aortic Dissection

Uncomplicated acute distal aortic dissection or intramural hematoma (Stanford type B or DeBakey type III) is not an indication for surgical intervention or endovascular repair and requires only aggressive medical treatment. However, if complications occur, such as malperfusion, rupture, rapid expansion, or intractable pains, emergency surgical intervention or endovascular repair becomes mandatory. Malperfusion should be defined as severe ischemia of the limbs, spinal cord, intestines, or kidneys, and this can be addressed noninvasively by means of percutaneous endovascular techniques, although the creation of a re-entry through an open surgical thoracoabdominal approach certainly remains a valuable option.

Rupture can be impending (meaning imminent or threatening) or actual (meaning certain or undeniable and proved at surgical intervention), and in the latter case this will become evident based on hemodynamic instability, hypovolemic shock, and hemothorax on chest radiographs or CT scans. It should be emphasized that a moderate pleural unilateral or bilateral effusion is a common finding after acute dissection and does not by itself constitute a surgical indication. Rapid expansion is probably a less comprehensible conundrum. If the thoracoabdominal aorta grows faster than 1 cm/y,⁶ necessitating at least 2 consecutive CT scans with a certain time interval, there is a clear indication for surgical intervention, although not on an emergency basis. If the aorta expands quickly in a short period of time, as is often the case early after acute dissection, contained rupture, or when related to mycotic aneurysm, again surgical intervention should not be delayed too long. Intractable pain and uncontrolled hypertension remain very disputable indications, certainly in an era in which

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FIGURE 1. Four types of thoracoabdominal aortic aneurysms as described by Crawford and colleagues.¹

analgesics and antihypertensive treatment with a wide variety of potential drugs are at our disposal.

Considering graft replacement of an acutely dissected thoracoabdominal aorta, one should realize that this attempt might be extremely difficult because of the friability of the aortic layers. In addition, the risk of paraplegia or paraparesis is much higher in patients undergoing operations for acute dissection (19%) than in patients with chronic dissection (2.9%).⁷ This is why limited repairs, such as restricting graft replacement to the thoracic aorta, performing a fenestration for malperfusion, or using percutaneous endovascular techniques, might strongly be advocated in these particular circumstances. Only rarely is repair of the complete thoracoabdominal aorta required in acute distal aortic dissection because of rupture in this location or the presence of a pre-existing aneurysm.

Chronic Aortic Dissection and Aneurysms

If a patient known to have a TAAA (degenerative or postdissection) shows signs of rupture, rapid expansion (>1 cm/y), or intractable pain, an emergency repair should be performed.

Aortobronchial or Aortoesophageal Fistula

Although aortobronchial or aortoesophageal fistula is more likely related to previous aortic surgical intervention, such as after coarctation repair (so-called secondary fistulas), in rare circumstances it can be associated with a thoracic aortic aneurysm or even a TAAA (so-called primary fistula). In these dramatic circumstances it is a huge adventure to replace the entire thoracoabdominal aorta. However, if left untreated, this pathology is invariably fatal. In situ graft replacement is

preferable, in addition to the management of the esophagus or pulmonary parenchyma.⁸ Endovascular repair appears to be a relatively safe alternative or bridge to future surgical intervention under better clinical circumstances.⁹

Mycotic Aneurysms

Bacterial infections of the thoracoabdominal aorta are rare but can often lead to penetration through the aortic wall, resulting in false aneurysm formation and rupture. Also in this instance, in situ replacement is preferred, accompanied by debridement of all infected tissues, omentoplasty, and local irrigation.

ELECTIVE INDICATIONS

In the elective setting, which is the ideal scenario, indications for repair of the thoracoabdominal aorta are completely related to its maximal size. This is underscored by the fact that the risk of rupture increases with aneurysmal size and that aneurysm growth increases with initial size: the larger the diameter, the faster its growth. Abdominal aortic aneurysms have a mean growth rate of 0.28 cm/y; for descending thoracic aneurysms, this is 0.29 to 0.32 cm/y.^{10,11} Once dissected, the descending and thoracoabdominal aortas might grow as rapidly as 0.28 cm/y,¹⁰ and this certainly might warrant more aggressive imaging follow-up. Rapid growth, defined as a yearly increase of more than 1 cm in size, is an indication for early repair. In addition to size, the configuration and symptomatology of the aneurysm can also play an important role in the decision to operate: eccentricity of an aneurysmal segment (or a more saccular configuration), tenderness and increasing back pain, or both can prompt earlier intervention.

FIGURE 2. This drawing shows how different horizontal computed tomographic slices can be interpreted. The true maximal aortic diameter is not 107 mm but 55 mm.

With regard to this, correct sizing is mandatory, but practice shows that this might pose problems not only in the thorax but also in the abdomen. In general, TAAAs are not regular or circular in shape, but they possess different adjacent smaller and wider areas. First, we have to determine the region of maximal aortic dilatation. The horizontal CT scan slices create most often an elliptical cross-section, always with a maximal and minimal diameter because the aneurysm is not a perfect circle (if it is, the maximal and minimal diameters are equal). The true maximal diameter of the aneurysm is the smallest diameter of the elliptical cross-section in the region of greatest aortic dilatation (Figure 2). Computer technology can help us in obtaining not only diameters but also volumes and 3-dimensional reconstructions.⁴ It is absolutely necessary for accurate assessment of aortic growth that comparisons of size be made at exactly the same level of the aorta to make them reliable.

Once the aortic dimensions are estimated correctly, we should be able to rely on strict size criteria to determine the operative threshold because, based on Laplace's law, the diameter of the aneurysm is an important determinant of the probability of rupture.

The Yale group¹⁰ has shown that for descending thoracic aneurysms, a hinge point occurs in the risk of complications: the rate of acute dissection or rupture increases 43% in descending aneurysms larger than 7.0 cm. The Mount Sinai group has shown that postdissection descending aneurysms tend to rupture at a median maximal diameter of 54 mm versus 58 mm for nondissecting aneurysms. An abdominal aortic diameter of more than 55 mm is also related to an increased risk of rupture.

Based on these findings, suggested criteria for surgical intervention with these hinge points have been developed.

Repair at a maximal diameter of 60 mm for the descending aorta and 55 mm for the abdominal aorta will avoid most ruptures or dissections. If we combine or extrapolate these numbers, it means that a TAAA that reaches a maximal diameter of 60 mm in the thorax, 55 mm in the abdomen, or both, wherever this limit is reached first, is a surgical indication. In patients with connective tissue disorders, of which Marfan syndrome is the prototype, a smaller size criterion should be applied: 1 cm less, or a maximal aortic diameter of 50 mm in the chest or 45 mm in the abdomen, is justified in patients with Marfan syndrome.

Apart from the absolute size, it can be helpful to adjust indications on the basis of body surface area by using nomograms.¹² The simple 2× rule, in which we consider surgical intervention when the maximal aneurysmal diameter approaches or exceeds twice the caliber of the aorta measured at a relatively normal segment (if there is one), remains very useful as well.

A growing number of elective open repairs of the thoracoabdominal aorta are being performed for failing endovascular thoracic procedures or for growing endoleaks or distal aneurysms after previous endovascular stent graft placements. These procedures are associated with high risks and might raise questions regarding the justification for the original endovascular procedures.

Apart from criteria like size, growth rate, or symptomatology, the surgeon should always balance the risk of surgical intervention against the effect on and potential benefit for the patient. The decision to replace the thoracoabdominal aorta has huge implications, and these must be considered together with age, comorbidity, and assessment of life expectancy.

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