Aortic dissection is a medical or surgical emergency, or both, that is catastrophic if not diagnosed and treated promptly. It is the most common aortic pathological lesion in the United States warranting emergent diagnosis and treatment. In untreated or unrecognized patients with aortic dissection, the prognosis is distinctly dismal, with the early mortality (first 48 hours) being as high as 1%/hr; 80% within 2 weeks, and 90% within 3 months.1,2 Patients with operated aortic dissection have a significant in-hospital and follow-up mortality, up to 21% for proximal aortic dissection and 29% for distal aortic dissection.3,4 The rate of reoperations ranges between 7% and 20%.3–5 Factors identified with reoperation include age, site of intimal tear, and presence or absence of pericardial fluid but not the type of surgical procedure or the type of dissection.6 Hence, critical to determination of outcome and management is not only prompt and accurate diagnosis but also detailed information on associated findings such as the extent of dissection, the location of the entry site, estimate of aortic valve regurgitation, evidence of pericardial effusion, whether or not formation of thrombus has taken place in the false lumen, and factors that determine long-term results. Therefore, technologies that make available these vital pieces of information should be used in patients with or suspected of having aortic dissection. Available imaging technologies include aortography, contrast-enhanced computerized tomography (CT), magnetic resonance imaging (MRI), and combined transthoracic/transesophageal echocardiography. It is also important to remember that one or more technologies can be used to provide complementary information and that use of technologies should be preceded by often forgotten (thought to be archaic in some circles) mundane methodology, the history and physical examination. Which of these available technologies to use to provide the best care to the patient continues to remain a subject of debate.7

The principles involved in choosing the technology for the diagnosis of aortic dissection from a surgeon’s perspective can be summed up in three essential steps: 1) confirmation of dissection, 2) determination of whether or not the ascending aorta is involved, and 3) demonstration of abnormal anatomic features.8 However, there are several additional issues to be considered in choosing the imaging modality best suited for making or excluding the diagnosis of aortic dissection. These include the speed with which the test can be obtained in a given facility; the skill of the technologist performing the examination combined with the interpretation skills of the physician; the experience with the technology in that given facility; the proven cost–benefit advantage; whether or not a contraindication for performing the test exists; and last, the sensitivity, specificity, positive predictive accuracy, and negative predictive value of the test in the risk group being considered. It is important to emphasize that each institution needs to identify the specificity, sensitivity, and positive and negative predictive accuracy in its particular setting with each of the available technologies; low-risk, moderate-risk, and high-risk groups should be examined, if at all possible, because of variations in the results depending on the type of population studied.9 However, as one scans through these principles, it becomes clear that there are no studies to date that take into account all of these factors, and one will have to settle for less under one’s circumstances. The key issue is that these factors need to be kept in mind when selecting the imaging modality or a combination of complementary imaging modalities so as to deliver safe, high-quality, low-cost care to patients with aortic dissection. Another point that needs to be considered when selecting a modality is whether or not it will help in the determination of those factors that affect the short-term and long-term outcome, as well as whether or not it can be used in the operating room setting to help plan and modify operative techniques.

Aortography, long considered the study of choice for evaluation of suspected dissection, has at best an accuracy rate of 95–99%.10 Erbel and colleagues11 reported a prospective study of 164 patients with suspected aortic dissection, 126 of whom underwent aortography; the sensitivity of aortography was 88%, with a specificity of 94%. False-negative angiograms are not uncommon and can occur in cases in which the false lumen has thrombosed, opacification of the false lumen is faint, or improper catheter tip placement and simultaneous opacification of both the false and true lumen preclude visualization of the intimal flap. The procedure of aortography is not without risks to the patient and may not be indicated in those who have renal involvement or renal insufficiency. It is conceivable but not practical to do serial aortography in patients who have undergone

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operation for the purpose of follow-up to determine variables influencing prognosis.

The sensitivity, specificity, and positive and negative predictive accuracy of CT scanning are as good as and in most instances better than those of aortography. Pooled data indicate the sensitivity to be 82–100% and specificity 90–100%. Ultrafast CT, which provides superior resolution, may improve diagnostic accuracy. Disadvantages to the use of CT scanning include the lack of mobility of the equipment, inability to provide hemodynamic information such as degree of aortic regurgitation, use of intravenous nephrotoxic contrast agents, and often the inability to visualize branch vessel involvement. Perhaps the biggest disadvantage to the use of CT scanning in the diagnosis of aortic dissection is the low likelihood of being able to detect the entry site and at most 60–70% likelihood of visualization of the intimal flap. Obviously, CT scanning cannot be used in the intraoperative setting, although it could be used for follow-up of patients with successful operation.

In contrast to aortography and CT scanning, MRI, the newest technology to be used in patients with aortic dissection, has many appealing features. It is noninvasive and, unlike aortography or CT scanning, does not require nephrotoxic contrast injections. Anatomic delineation of the aorta is better with MRI than with other techniques. The sensitivity and specificity of this procedure have been reported to be as high as 100%. MRI can identify the site of entry in almost 100% of the cases with a very high specificity. It can visualize pericardial effusion with a sensitivity and specificity of 100%. Cine MRI can be used to semiquantify aortic regurgitation. In fact, data would suggest that this be the technology of choice and the new “gold standard” for aortic dissection. However, there are several disadvantages to MRI worthy of note that may dissuade even the most ardent supporters of this method from making it the technology of choice. MRI cannot be safely performed in patients with pacemakers or patients who have certain types of metallic prosthesis in any body organ. MRI scanners are not available at all primary care facilities, do not have the portability at the present time for bedside examinations, have high maintenance costs, are expensive, and require special expertise for interpretation. None of these problems are as important as the fact that the majority of the patients with aortic dissection are hemodynamically unstable and often are receiving intravenous medications and are intubated. Moving these patients to a MRI scanner and then having them accessible to limited life-saving modalities for the duration of scanning, which may take up to an hour, present a logistical problem for the physicians involved. Although there are no reports of deaths in the MRI gantry, one can conceive of scenarios in which patient safety may be compromised during the scanning process, since it is prolonged and the patient is virtually inaccessible while being scanned. MRI cannot be used in the operating room to guide operation, although it could be used for follow-up of patients after successful operation.

Ultrasound, in particular echocardiography, is well suited for the evaluation of patients with suspected aortic dissection. Echocardiography is a noninvasive imaging technology that is widely available, does not require use of intravenous contrast agents or ionizing radiation, offers portability, and has been shown to have a diagnostic value in aortic dissection. Echocardiography, when used in conjunction with Doppler and color-flow imaging, will provide hemodynamic information such as semiquantification of aortic valve regurgitation. Transthoracic echocardiography has lower sensitivity and specificity (59–85% and 63–96%, respectively) but a high positive predictive accuracy (90–96%). The major limitations of transthoracic echocardiography include inability to visualize the thoracic aorta in its entirety, poor quality of images in approximately 10% of patients, especially those with chronic lung disease, obesity, and the lack of coronary artery visualization. However, transesophageal echocardiography (TEE) overcomes most of these limitations. The procedure is safe and provides very high sensitivity as well as specificity in the diagnosis of aortic dissection. In the European multicenter trial reported by Erbel et al., the sensitivity and specificity of TEE were 99% and 97%, respectively. This study was done using single-plane transducers. Limitations to the use of single-plane TEE such as that used in this and other studies include the inability to visualize the entire thoracic aorta, the semi-invasive nature of the technology, contraindications to use in patients with esophageal pathological lesions, and the lack of widespread availability at the present time. Biplane and multiplane transducers would improve the diagnostic accuracy and have been demonstrated to visualize the entire thoracic aorta, but data on sensitivity and specificity are lacking.

Several advantages of the combined echocardiographic technique are worthy of mention in recommending its use as the first-line modality of choice in the majority of patients with suspected aortic dissection. It fulfills all three principles from the perspective of a surgeon (i.e., making the diagnosis, determining the ascending aortic involvement, and defining abnormal anatomy). Echocardiography can be performed with rapidity in locations such as the emergency room and trauma unit and at the bedside of the patient in a critical care unit. It does not involve movement of large equipment, nor does it require mobilization of many personnel (in most instances, it can be performed by a single trained echocardiologist). Combined echocardiography permits evaluation of other intracardiac features, including pericardial effusion, global and regional systolic function, and semiquantification of valvular insufficiency, and often it elucidates other causes for the patient’s symptoms. Lastly, echocardiographic examination is considerably less expensive than the aforementioned technologies, all of which provide only partial information in patients with suspected or proven aortic dissection. Among all of the imaging technologies available at the present time, it is clear that combined echocardiographic examination can provide the physician with almost all of the information that is needed to make the diagnosis, plan the management strategy, and carry it into the operating room, with a satisfied surgeon who more than likely will not find surprises upon opening the chest.

Even the hard-core group of nonbelievers in echocardiography must come to grips with the fact that combined echocardiography does afford one of the best imaging technologies in patients with aortic dissection, given the overwhelming literature being published on
this subject documenting its utility and reliability in making the diagnosis, as well as all the facts stated above.

The article by Erbel and colleagues in this issue of Circulation21 embarks upon the exploration of the final frontier in the saga of aortic dissection. The observed high mortality rates in the hospital and during follow up and detection of factors determining high postoperative and long-term mortality continue to pose challenges in patient management. In the present study, Erbel and colleagues elegantly identify potential causes of late mortality using TEE to follow up 188 patients with proven aortic dissection for a mean duration of 10 months, the highest follow-up duration being 65 months.21 Of importance, this study looked at those patients who received some form of treatment, either medical or surgical. The study identified two determinants having a significant negative impact on the long-term outcome of these patients. These included the presence of an open false lumen with persistent communication between it and the true lumen, as well as extravasation of fluid in the pleural cavity or the mediastinum. The study also shatters the myth that type III dissections do not need to have interventions performed, because those type III patients who had evidence of fluid extravasation and were medically treated had a dismal survival rate, with mortality as high as 50% in 36 months. The importance of reclassification based on flow in the false lumen, the presence of an active communication between the true and false lumen, is also brought to light by this study. In Erbel et al’s study, the reoperation rate and the mortality were higher in those patients who had open false lumen with communication.21 Conversely, patients who had a thrombosed false lumen or showed progressive thrombus formation during the follow-up period had lower long-term mortality and reoperation rates. It follows that the incidence of rupture or extension of dissection would be higher in those with flow in the false lumen and an open communication. In the overall population, the presence of pleural effusion or finding of mediastinal hematoma was bad prognostic indicator, with a mortality rate of as high as 51%. The availability of TEE, which can detect flow in the lumen and can diagnose extravasation of fluid, has made possible the exploration of this aspect in the management of patients with aortic dissection. As data from this and other studies emerge documenting that complete thrombosis of the false lumen portends a better outcome, surgical techniques may need to be refined.

The imaging modality of choice for making the diagnosis, operating room use to guide the surgical approach, and for long-term follow-up would appear to be combined echocardiographic examination. This technology appears to provide almost all the information that would be required to plan appropriate management options in patients who have aortic dissection or who are suspected of having aortic dissection. If the coronary anatomy needs to be delineated before operation, one can undertake limited coronary arteriography, rather than a full cardiac catheterization including aortography. However, acceptance of this technology requires more than publication of articles. Surgeons who are involved in the management of these patients must be intimately involved in reviewing studies with the echocardiographer. Acceptance of TEE by surgical colleagues can come only if they are involved in each step of the procedure.

It is also imperative that attempts be made to reclassify aortic dissection on the basis of the presence or absence of flow in the false lumen or communications between the two lumina, as well as the accepted DeBakey classification for site of dissection. Similar classification attempts could be made for the Stanford classification scheme. It also may behoove the surgeons to consider modification of operative procedure by using measures that result in closing of all entry sites, which can be identified at the time of the operation using intraoperative TEE. This will induce thrombus formation and diminish or abolish flow in the false lumen, reducing wall stress and thereby decreasing the long-term mortality.

Notwithstanding the usefulness of combined echocardiography, one must keep in mind its limitations, including the fact that not all patients are echogenic, that introduction of a TEE probe may not be possible in 1% of patients, and that false-positive and false-negative results can occur given the nature of the disease and technological limitations. However, each of the available technologies has its inherent limitations. Thus, the use and choice of technologies must be made on a case-by-case basis. Protocols need to be established on how often TEE examinations should be done in the follow-up of patients with treated aortic dissection.

Lastly, strong emphasis needs to be placed on the fact that in a disease such as aortic dissection, with its protein manifestations, if there continues to be clinical suspicion and if one of the imaging techniques has not provided a satisfactory answer, one must pursue all modalities until the diagnosis is completely ruled in or out.

References


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