Application of Ultrafast Computed Tomography for Diagnosis of Perivalvular Abscesses*

Surgical Implications

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The presence of a perivalvular abscess is associated with an increased risk of morbidity and mortality with valve replacement and can require extensive debridement and reconstructive procedures. An accurate noninvasive method for preoperative diagnosis may hasten operation and aid in preoperative and surgical management. Two cases are presented in which ultrafast computed tomography accurately identified perivalvular abscesses not detected on two-dimensional transthoracic echocardiography and guided operative intervention.

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MRI=magnetic resonance imaging; TEE=transesophageal echocardiography

Perivalvular abscess is a serious complication of infective endocarditis and increases morbidity and mortality.\(^1\),\(^2\) Accurate diagnosis has significant therapeutic implications, since urgent operation is required for clinical cure and thus improved outcome. Transthoracic echocardiography is the principal adjunct used for diagnosis of endocarditis, but this technique is insensitive for identifying valve ring abscesses. Transesophageal echocardiography (TEE) improves diagnostic accuracy with minimal morbidity, but it is an invasive procedure.\(^3\) More importantly, TEE depends on the skills and experience of the technician performing the study and the physician analyzing the images. Ultrafast computed tomography (CT) is a relatively new modality ideally suited for diagnostic imaging of the heart because its rapid scan times eliminate artifact attributable to cardiac motion.\(^4\) Cine, flow, and high resolution modes are available to provide precise three-dimensional anatomic and functional information. In the flow mode, a peripheral intravenous injection of contrast is given, and electrocardiographically triggered scans are obtained at a selected percentage of the RR interval. This particular mode provides anatomic information as well as derivations of iodine time-density curves for evaluation of cardiac output, intracardiac shunts, regional myocardial blood flow, and coronary artery bypass grafts. The cine mode displays consecutive images from one RR interval in a movie loop for evaluation of global and regional wall motion as well as calculation of total and

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segmental ejection fractions. Valve motion also can be assessed. Finally, the high resolution mode demonstrates anatomic detail (eg, coronary artery calcium) similar to conventional CT. Consecutive 3-mm sections are obtained and can be reconstructed in any operator-determined plane. Two cases are presented that illustrate the usefulness of ultrafast CT in diagnosing perivalvular abscesses that were missed by transthoracic echocardiography.

**CASE REPORTS**

**CASE 1**

A 47-year-old man with a history of intravenous drug abuse initially was admitted to Harbor-UCLA Medical Center with a medical history of daily fever, generalized malaise, and weight loss. His physical examination revealed a murmur of aortic insufficiency and mild pulmonary edema. A two-dimensional transthoracic echocardiogram demonstrated severe aortic insufficiency with large aortic valve vegetation. At least one vegetation appeared to prolapse into the left ventricle. Blood cultures done at the time of admission grew Staphylococcus epidermidis, which was sensitive to oxacillin. The patient experienced defervescence and improved while receiving antibiotic therapy and afterload reduction. He was transferred to a long-term care facility for completion of 6 weeks of antibiotic therapy.

Two weeks later, the patient developed shortness of breath and acute pulmonary edema and continued to have spiking fevers despite antibiotic coverage. The patient was subsequently transferred back to Harbor-UCLA Medical Center for reevaluation of his aortic regurgitation. A repeat transthoracic echocardiogram revealed moderate to severe aortic regurgitation with a vegetation on the aortic valve. The left ventricle and left atrium were markedly dilated compared with previous studies, but no perivalvular abscess was visualized. An ultrafast CT scan was obtained to further delineate the aortic pathologic features. An 8-level flow mode study in the cardiac short axis and a 20-level high resolution study in the transaxial plane demonstrated marked thickening of the aortic valve (but no distinct vegetation) and evidence of an abscess and aneurysm of the left sinus aortae (Fig 1). The aneurysm appeared adjacent to but not involving the left main coronary artery. While the flow study identified the aneurysm as a left-sided structure receiving inflow from the left ventricle, the high-resolution study was used to provide the anatomic detail necessary for analysis of the proximity of the aneurysm and abscess to the coronary arteries and other structures. These studies prompted catheterization to assess the coronary arteries. Coronary arteriography was normal, but aneurysmal dilatation of the left coronary cusp and severe aortic regurgitation were confirmed.

At operation, the left cusp of the aortic valve was noted to be completely destroyed. Beneath this area, a perivalvular abscess was found which extended from the left coronary sinus to a blind sac posterior and inferior to the aortic root. The abscess approached the left main coronary ostium but did not involve it. The sinus abscess and aneurysm were debrided, and the aortic root was reconstructed with a pericardial patch. Aortic valve replacement with a 23-mm St. Jude’s prosthesis proceeded without difficulty. The patient had an uneventful postoperative hospital course and remained well after completion of antibiotic therapy.

**CASE 2**

A 37-year-old man with a long history of intravenous drug abuse was treated at another hospital for mitral valve endocarditis diagnosed by transthoracic echocardiography, and concomitant acute bacterial meningitis. Broad-spectrum antibiotics were started prior to drawing blood cultures, and all subsequent cultures were negative. However, eczma skin lesions were present and culture-positive for Staphylococcus aureus. Antibiotic treatment
was continued, but he remained febrile and was transferred to Harbor-UCLA Medical Center for further evaluation. On presentation, the patient was short of breath at rest and febrile. An apical thrill and murmur consistent with mitral regurgitation were noted. There were multiple erythemic lesions on the arms and legs, and splinter hemorhages were seen. Neurologic examination disclosed no abnormalities. A two-dimensional transthoracic echocardiogram was obtained and verified the presence of severe mitral regurgitation and a vegetation on the posterior leaflet of the prolapsing mitral valve. No perivalvular abscesses were seen. An abdominal CT revealed low-density lesions in the spleen and kidney that we suspected might lead to embolic events, but a gallium scan was negative. During the hospitalization, the patient developed a central visual field defect and was found to have a new small left occipital ring-enhancing lesion on a head CT scan consistent with a small brain abscess.

With evidence of ongoing sepsis and embolic phenomena, an ultrafast CT was obtained to rule out a perivalvular abscess. A contrast-enhanced cine study was performed in the short axis. The posterior leaflet of the mitral valve was thickened, and a 1.5x1-cm vegetation was present at the tip of the posterior leaflet. There also was a loculated pericardial effusion extending from the lateral to the posterior wall and communicating with the mitral valve annulus (Fig 2). This was interpreted as consistent with a ring abscess of the mitral valve. The regurgitant fraction of the left ventricular stroke volume was calculated to be 40 percent by ultrafast CT.

At the time of operation, the entire posterior leaflet of the mitral valve was grossly purulent, with extension of the infectious process into the mitral annulus. After thorough debridement, the mitral annulus was reconstructed using a glutaraldehyde-treated pericardial patch. Mitral valve replacement was then completed using a 31-mm St. Jude’s valve. The patient recovered from an ongoing septic picture in the early postoperative period, and his course was subsequently uneventful. He remained well following completion of a 6-week course of intravenous antibiotic therapy.

**DISCUSSION**

The early identification of perivalvular abscesses complicating endocarditis is extremely important, since antibiotic therapy alone is often not sufficient. Operative intervention before widespread destruction of the valve apparatus may improve patient prognosis.5 Transthoracic echocardiography is a noninvasive means for diagnosing valvular lesions, including infective endocarditis and its complications, but it is insensitive for perivalvular abscesses. Echocardiographic assessment of valvular lesions can be performed rapidly and at the bedside if necessary. Transesophageal echocardiography significantly improves diagnostic capability compared with transthoracic echocardiography, but it is invasive and dependent upon operator skill and patient cooperation.3 Other techniques, such as gallium scans and magnetic resonance imaging (MRI), have been used6 but have significant limitations obviating routine use. For example, MRI is extremely expensive and not widely available. Although it can produce high-quality cardiac images, MRI requires long scanning times, which are not tolerated by critically ill patients. On the other hand, nuclear studies are more widespread but lack the anatomic resolution needed for diagnosing myocardial abscesses.

Ultrafast CT shows great promise as an adjunct in the evaluation of valvular disease. In the cine and flow modes, short- and long-axis projections can be used to provide anatomic and functional information. Transaxial 3-mm sections are available in the high-resolution mode for fine anatomic detail. Ultrafast CT also allows clear visualization of prosthetic valves7 and has been used to identify a valve ring abscess in a patient with prosthetic valve endocarditis.8 As these two cases illustrate, ultrafast CT may clearly identify vegetations on the valve (as in case 2) indicative of infectious endocarditis or abnormal thickening (as in case 2) suggestive of valve pathologic findings. The disadvantages of ultrafast CT include the requirement of modest doses of radiation and intravenously administered contrast medium and its current limited availability. Even though ultrafast CT is more expensive than conventional CT, it has both cardiac and noncardiac applications and the speed to perform as many as two times the number of examinations in a given time period that makes its cost comparable or less than that of conventional CT. In the two patients discussed, ultrafast CT identified perivalvular abscesses not seen on transthoracic echocardiography and subsequently hastened appropriate additional studies and surgical intervention. Ultrafast CT can provide the surgeon with clear anatomic delineation of the problem prior to operation so that blind exploration can be avoided. In both cases presented, the extensive information provided by ultrafast CT prepared the surgical team for major debridement and reconstructive procedures. Preoperative TEE, although more invasive, also may have demonstrated these lesions but was not necessary in these cases once the diagnoses were made and the extent of disease determined. In the future, studies comparing ultrafast CT, TEE, and other techniques (eg, MRI) are needed to determine their relative sensitivities.

**FIGURE 2.** A single image from a cine-mode ultrafast CT scanning sequence in a patient with mitral valve endocarditis. A large vegetation on the posterior leaflet of the mitral valve (black arrowheads) as well as a loculated pericardial effusion (hypodense, crescent-shaped area marked by open arrows) emanating from the mitral annulus suggested an extensive mitral valve ring abscess with pericardial extension. LA, left atrium; LV, left ventricle; RV, right ventricle.
Atherosclerosis in the pulmonary arteries is an uncommon occurrence which has been reported in autopsy series and case reports of patients with severe or long-standing pulmonary hypertension. Until now, in vivo identification of pulmonary atherosclerosis has been impossible noninvasively and unreliable by invasive means short of thoracotomy with open-lung biopsy. Here, we describe a case of pulmonary atherosclerosis in a patient with long-standing pulmonary hypertension diagnosed by intravascular ultrasound (IVUS).

**Case Report**

A 50-year-old white man was transferred to Hahnemann University Hospital for the management of acute myocardial infarction. Past medical history was significant for primary pulmonary hypertension diagnosed in 1960 at the age of 18 years. Cardiac catheterization at that time revealed the following pressures: mean right atrial, 6 mm Hg; right ventricular, 74/6 mm Hg; mean pulmonary capillary wedge, 6 mm Hg; pulmonary arterial, 72/42 mm Hg. A left-to-right shunt was noted through a patent foramen ovale. At the time of transfer to our institution, he was taking no medications. The pulse rate was 86 beats per minute; blood pressure, 120/78 mm Hg; and respiratory rate, 28 breaths per minute. At the time of cardiac examination, the rhythm was regular, pulmonic valve closure was accentuated, an S3/S4 gallop was

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**In Vivo Diagnosis of Pulmonary Atherosclerosis**

**Role of Intravascular Ultrasound**

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**FIGURE 1.** Posteroanterior and lateral chest x-ray films. Posteroanterior film demonstrates calcification at location of pulmonary artery (arrow). Lateral view demonstrates marked pulmonary artery calcification (arrow).