Computed Tomography: A New Method for Diagnosing Tumor of the Heart

J. DAVID GODWIN, M.D., LEON AXEL, M.D., JAMES R. ADAMS, M.D.,
NELSON B. SCHILLER, M.D., PAUL C. SIMPSON, JR., M.D., AND EDWARD W. GERTZ, M.D.

SUMMARY An unsuspected metastasis of liposarcoma of the heart was detected on a computed tomographic (CT) examination of the chest. Further CT study with i.v. contrast administration gave excellent delineation of the tumor. Compared with two-dimensional echocardiography and angiocardiography, CT was best at showing the myocardial and intrapericardial extension of the tumor, but did not show movement of the tumor during the cardiac cycle. CT is a useful noninvasive method for evaluating cardiac metastasis. Its advantages and disadvantages with respect to echocardiography and angiocardiography are discussed.

Case Report

A 59-year-old man was admitted to the hospital for evaluation of a mass in the heart. He had a long history of metastatic liposarcoma from a primary tumor of the right thigh. The primary tumor developed 25 years earlier and was initially treated by local excision. Four years later, local recurrence required amputation of the right lower extremity above the knee, and 3 years after amputation, a metastasis to a right rib was resected. He was then well for 18 years before requiring surgical removal of metastatic tumor in the left pleural space, left hemidiaphragm and left upper quadrant of the abdomen. Although the tumor was in contact with the pericardium, invasion of the pericardium was not suspected, so the pericardium was not opened. Two months after the operation, the patient underwent CT scanning to check for residual tumor. Scans showed a large low-density* mass within the right ventricular cavity, extending through the myocardium at the apex into the pericardial sac (fig. 1). Because of the abnormal CT scan, the patient was admitted to the hospital for further studies.

The patient had recently noticed a sound from his chest when he lay on his left side. The sound was synchronous with his heart beat. Physical examination revealed a well-nourished man with a left thoracotomy scar and a right above-the-knee amputation. Cardiac examination was normal except for a grade 2/6 systolic ejection murmur, loudest at the base and left sternal border. The murmur increased in intensity with expiration and with the patient lying on his left side or standing.

An ECG showed a right ventricular conduction delay and nonspecific ST-T-wave changes. A chest radiograph showed normal size of the heart.

Angiocardiography (fig. 2) demonstrated a pedunculated mass attached to the right ventricular apex. During systole, the mass partially obstructed the outflow tract.

Two-dimensional echocardiography (fig. 3) demonstrated a large, echogenic mass within the right ventricular cavity, apparently attached to the ventricular wall. During systole, the mass almost filled the right ventricular outflow tract.

At operation, a large tumor mass was removed from the pericardial sac. Tumor invaded the myocardium of the right ventricular apex and extended into the cavity, forming a pedunculated 4–5-cm mass. The pedunculated part of the tumor was removed along with a 3-cm portion of the right ventricular apex, which was patched.

The pathologic specimen was a well-encapsulated myxoid liposarcoma invading the myocardium that

*The density of the mass was lower than that of water but higher than that of normal fat.
FIGURE 1. Transverse computed tomographic (CT) scan through the right and left ventricles (RV and LV) during i.v. infusion of 76% diatrizoate. The patient's right side is projected at the left side of the illustration, as in a conventional radiograph of the chest. The sternum (ST) and vertebral body (V) are marked for orientation. Contrast fills the ventricles and descending aorta (DA). The large low-density tumor (arrows) occupies the cavity of the right ventricle and lies alongside the interventricular septum (S). (B) Reformatted CT image made from contiguous transverse CT slices taken during contrast infusion. The plane of reformatting passes through the RV, corresponding to the right anterior oblique projection of an angiocardiogram. The low-density tumor (arrows) forms a pedunculated mass in the cavity of the RV with invasion through the myocardium of the apex of the RV into the pericardial sac. The lowermost arrows indicate the intrapericardial component of the tumor. SVC = superior vena cava; AO = ascending aorta. (C) Reformatted CT image made from contiguous transverse CT slices taken during contrast infusion. The plane of reformatting passes through both ventricles, corresponding to the left anterior oblique projection of an angiocardiogram, but the plane is also angled along the axis extending from the right ventricular apex to the outflow tract, roughly corresponding to a half-axial projection. The pedunculated low-density tumor (arrows) is again visualized in the right ventricular cavity and extending through the apex into the pericardial sac (lowermost arrows). ST = sternum; PA = pulmonary artery; S = interventricular septum; LV = left ventricular cavity.

was 5.5 cm in diameter, with a stalk 4 cm in diameter and 2 cm long. Microscopically, the tumor was very cellular, with a myxoid ground substance. Numerous necrotic cells and occasional lipoblasts were present.

**Technique of the CT Examination**

An experimental General Electric scanner with 2.4-second scan time was used. After preliminary scans, a rapid i.v. drip infusion of 125 ml of 76% diatrizoate was administered while contiguous scans at 5-mm intervals were obtained from the aortic arch through the upper abdomen. Special computer programs for image reformatting were used on the series of contiguous transverse scans to construct images corresponding to right anterior oblique and half-axial left anterior oblique angiographic projections (figs. 1B and C).

**Discussion**

Metastasis of liposarcoma to the heart is rare; only two reports document cardiac metastasis from distant primary sites. In a review of primary mediastinal liposarcomas, only five of 50 cases involved the pericardium, and three involved the myocardium; one tumor arose in the interatrial septum.

Three techniques — echocardiography, angiography, and computed tomography — provide
sufficiently detailed images to diagnose intracardiac tumor. Each method has advantages and disadvantages. In particular, echocardiography gives excellent temporal resolution; it requires no preparation or catheterization of the patient and is risk-free and inexpensive. However, it is limited by relatively low spatial resolution and by its inability to penetrate bone or lung. Angiocardiography offers excellent spatial and temporal resolution, but entails the risks of ionizing radiation, catheter injury and contrast reaction. CT provides a high degree of tissue discrimination, detailed evaluation of extracardiac structures, and image construction in any plane. Scan times, however, are too long to detect motion of the heart or of a tumor within the heart, and patients are exposed to the risks of ionizing radiation (less than for angiocardiography) and contrast reaction.

CT's tissue discrimination (based on density or specific gravity of the tissue) is 10 times greater than that for cineangiocardiography. CT clearly distinguished the fatty tumor from surrounding structures and showed the invasion of the right ventricular wall by low-density tumor and extension into the pericardial sac. The myocardial involvement was not detected by echocardiography or angiocardiography.

In addition, CT gives the best evaluation of the extracardiac mediastinal structures, which are usually not imaged in detail by angiocardiography or echocardiography. In this patient, demonstration of the pericardium by CT was particularly important. Although not illustrated, the parietal pericardium was visible, and its relation to the tumor at the apex of the heart established that the extracardiac portion of tumor was within the pericardial sac.

Another advantage of CT is that images can be presented in any format. For many applications, the basic cross-sectional CT image is the preferred format. For instance, a small mass lying against the endocardium is easy to detect on cross section, but could be missed by a projection technique such as angiocardiography if the mass is not projected in tangent to the x-ray beam. In other applications, images parallel to the body axis or oblique to this axis are valuable. Such image reformatting permits a single image to demonstrate tumor extending from outside the apex of the right ventricle all the way into the outflow tract (fig. 1).

The cost of CT for this patient, including image reformatting, was $540, substantially less than for cardiac angiography ($1500). Also, CT did not require hospitalization, as does angiography.

The disadvantages of CT are: (1) It exposes the patient to ionizing radiation. The radiation doses are substantially less than from angiography (1 rad/slice for CT vs 2.5–5.0 mrad/frame or 150–300 mrad/sec for cineangiography). (2) As with angiography, CT exposes the patient to the risk of contrast reaction. Although the possibility of allergic reaction is probably not dose-related, high doses of contrast may cause acute tubular necrosis in patients with renal insufficiency. (3) The principal limitation of CT for study of the heart is that a single CT image requires at least 1 second with current CT scanners; cardiac motion blurs the image and temporal (motion) resolution is poor. Thus, the movement of the tumor with the heart cycle could not be detected by CT in our patient. Electrocardiographic gating may help to solve this problem.

CT has already established a role in one aspect of cardiac evaluation, the study of patency of coronary artery bypass grafts. Only two other papers have reported the effectiveness in the detection of cardiac tumors (atrial myxomas). We have also found CT useful in a problem that is similar to detection of intracavitary tumors — the detection of mural thrombi in patients who have had myocardial infarction. Further experience with CT is required before its role can be definitely established for diagnosing masses within the heart, but we believe that CT will prove to be a sensitive noninvasive technique for evaluating patients with suspected tumors of the heart.
Figure 3. (A) Two-dimensional echocardiogram in short-axis view. (B) Drawing of (A). The large tumor (T) occupies the right ventricular outflow tract (RV). RVW = inferior wall of the right ventricle; IW = inferior wall of the left ventricle; LV = left ventricular cavity; MV = mitral valve; AW = anterior wall of the left ventricle. (C) Two-dimensional echocardiogram in four-chamber apical view. (D) Drawing from (C): The large tumor occupies the cavity of the right ventricle (RV). TV = tricuspid valve; RA = right atrium; LV = left ventricle; LA = left atrium; PV = pulmonary veins. Dashed lines indicate the interventricular and interatrial septa.

Acknowledgment

Some of this material was presented at a teaching conference at the University of California, San Francisco, February 1980. Lauranne Cox, R.T., performed the CT scans. William Bunker made photographs, and Ann Tso typed the manuscript. W. Berninger, R.W. Redington and W. Leue developed the CT scanner and computer program. Dr. Robert Gould supplied technical information.

References

7. Scott RW, Garvin CF: Tumors of the heart and pericardium. Am Heart J 17: 431, 1939
Computed tomography: a new method for diagnosing tumor of the heart.
J D Godwin, L Axel, J R Adams, N B Schiller, P C Simpson, Jr and E W Gertz

doi: 10.1161/01.CIR.63.2.448

Circulation is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231
Copyright © 1981 American Heart Association, Inc. All rights reserved.
Print ISSN: 0009-7322. Online ISSN: 1524-4539

The online version of this article, along with updated information and services, is located on the World Wide Web at:
http://circ.ahajournals.org/content/63/2/448

Permissions: Requests for permissions to reproduce figures, tables, or portions of articles originally published in Circulation can be obtained via RightsLink, a service of the Copyright Clearance Center, not the Editorial Office. Once the online version of the published article for which permission is being requested is located, click Request Permissions in the middle column of the Web page under Services. Further information about this process is available in the Permissions and Rights Question and Answer document.

Reprints: Information about reprints can be found online at:
http://www.lww.com/reprints

Subscriptions: Information about subscribing to Circulation is online at:
http://circ.ahajournals.org//subscriptions/