MR Imaging of Primary Cardiac and Pericardiac Tumors

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Purpose: To evaluate characteristic MR findings of primary cardiac and pericardiac tumors.

Materials and Methods: There were myxomas (n=7), malignant lymphoma (n=1), lipoma (n=1), and pericardiac mesotheliomas (n=2). We analyzed location, size, shape, signal intensity, contrast enhancement, and associated findings of adjacent structures such as pericardiac and pleural effusion, and mediastinal lymph node enlargement.

Results: Locations of the myxomas were left atrium in four cases, left ventricle in one, right atrium in one, and right ventricle in one. Mean diameter was 3.5 cm (range, 2–7 cm). They were polypoid or lobulated in shape, and attached to interatrial or interventricular septum in all cases except in right atrial myxoma which was attached to lateral wall. Their peduncles were demonstrated in three left atrial myxomas. The signal intensities were iso or slightly high on T1-weighted images and high on T2-weighted images. Pleural and pericardiac effusions were shown in the three cases. Malignant lymphoma was manifested as large mass in right ventricle infiltrating to right atrium, interventricular septum, right paratracheal and retrocardiac area. It had slightly high intensity in both T1- and T2-weighted images with a strong contrast enhancement and associated with both pericardiac and pleural effusion. Lipoma was polypoid in shape and attached to lateral wall of left ventricle with bright T1 and high T2 signal intensity. Pericardiac mesothelioma was manifested as a pericardiac and atrial mass with diffuse irregular uneven thickening of pericardium which had iso signal on T1- and high T2-weighted images with moderate contrast enhancement.

Conclusion: MR imaging is a very useful method in demonstration of the location, extent, tissue characteristics of the mass, and relationship with its adjacent structures in evaluation of cardiac and pericardiac tumors.

Index Words: Heart, MR
Heart, neoplasms

Primary cardiac tumor of the heart is rare, and one-third of it is malignant(1, 2). At present time, echocardiography is the most important non-invasive technique for imaging of heart, and generally it is an initial imaging procedure(1, 3-6). ECG-gated MR imaging has been known to provide high-quality images of the heart and to be useful in the detection of cardiac tumors, thrombi, and pericardiac masses(7, 8). This report is to describe the characteristic findings of MRI in 11 patients with surgically and pathologically proven primary cardiac and pericardiac tumors.

MATERIALS and METHODS

MR image of 11 patients with surgically and pathologically proven primary cardiac and pericardiac tumors were reviewed retrospectively. Six male and 5 female patients, ranging in age from 27 to 64 years were examined. All studies were done with 0.5T superconductive ECG-gated MR imager (Supertech. 5000, GoldStar, Seoul, Korea). Imaging was done in the transverse plane in all 11
patients, with additional imaging in coronal in 8 patients and sagittal plane in 7 patients. Multisection imaging was performed to have seven or fifteen sections per imaging sequences. The spin-echo technique was used with a repetition time (TR) equal to RR interval of the ECG and echo delay time (TE) of 30 msec. The section thickness was 6–10 mm and sequential images were contiguous.

We analyzed the tumors in terms of location of the mass, size or extent, shape, signal intensity with heterogeneity, and degree of contrast enhancement. We also reviewed relationship of the tumor to surrounding structure such as pleural effusion, mediastinal lymph node enlargement, pericardial effusion. Signal intensity was compared with cardiac muscles and shape of the mass was classified as exophytic, infiltrative, and polypoid.

RESULTS

There were 11 patients with primary cardiac and pericardiac tumors including 7 myxomas, a malignant lymphoma, a lipoma, and two pericardiac mesothelomas. All were operated and pathologically proven.

Myxomas were at left atrium in four (Fig. 1), and left ventricle, right atrium, and right ventricle in one case, respectively. Mean diameter was 3.5 cm with range of 2–7 cm. They were polypoid or lobulated in shape, and attached to interatrial or interventricular septum in all cases except in right atrial myxoma which was attached to lateral wall. The peduncle was demonstrated in three left atrial myxomas. The signal intensity was iso or slightly high on T1-weighted images and high on T2-weighted images. Pleural effusion was shown in 3 cases and pericardial effusion was in 2 cases. There was no mediastinal lymph node enlargement.

Malignant lymphoma was represented with a large right ventricular mass infiltrated to right atrium and interventricular septum, and extended to mediastinum, that is, right paratracheal and retrocardiac area (Fig. 2). Its signal intensity was homogeneous and slightly high on both T1- and T2-weighted images with a strong contrast enhancement. There was bilateral pleural effusion and minimal pericardial effusion. No
mediastinallymph node enlargement was shown.

Lipoma was polypoid in shape and attached to lateral wall and apex of left ventricle (Fig. 3) with high signal intensity on T1- and T2- weighted image. No contrast enhancement was done. No reaction with surrounding structure was shown.

In one pericardiac mesothelioma, it was manifested as a diffuse irregular uneven pericardial thickening and partially infiltrated to right ventricle, left atrium and right lung (Fig. 4). It had iso signal intensity on T1-weighted image and high T2 signal intensity with moderate contrast enhancement. In another pericardiac mesothelioma, diffuse even pericardial wall thickening was seen with encasement of the aorta and pulmonary artery. The signal intensity was identical with the other one.

**DISCUSSION**

Primary tumors of heart and pericardium are found in less than 0.1% of autopsy series and are two to three times more often benign than malignant (3, 4, 7). Metastatic neoplasms involving the heart are 20–40 times more frequent than primary tumors (9, 10). Left atrial myxoma comprises 50% of the benign cardiac tumors in adults, while rhabdomyoma, fibroma, and myxoma

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**Fig. 2. Lymphoma.**
a. There is a soft tissue mass in right ventricular free wall with extension into left ventricle (white arrow) and interventricular septum (small white arrows). On T1WI, it shows high signal intensity. There are pericardial effusion (black arrows) and pleural effusion (arrow heads).
b. Contrast enhanced coronal scan shows heterogeneous mild enhancement of the mass with tumoral infiltration to the diaphragmatic surface (arrows).

**Fig. 3. Lipoma.**
a. There is a well-demarcated polypoid mass in left ventricular apex and lateral wall with very high signal intensity on T1WI.
b. On T2WI, this mass shows slight high signal intensity.
are most common in infants and children (4-6).

In spite of modern diagnostic methods, cardiac tumors still present a diagnostic challenge. These tumors may remain asymptomatic for periods of time, and present with nonspecific symptoms such as chest pain, unexplained heart failure, embolization, or heart murmurs, nonspecific ECG changes, variation in heart size, and pericardial effusion. If a cardiac tumor is suspected from history and physical examination, the first diagnostic tool should be echocardiography, which is an efficient and noninvasive method. In cases positive for cardiac tumor the following are of special clinical interest: localization, size, infiltration of cardiac structures, hemodynamic effects, vascularization, consistency, and histologic classification.

If, in spite of negative echocardiographic findings, a cardiac tumor is still suspected clinically, additional diagnostic work-up is mandatory. The following methods can be used: conventional or ultrafast CT with and without contrast enhancement, MR imaging with and without paramagnetic agents such as gadolinium diethylenetriamine pentaacetate (Gd-DTPA), angiography, endomyocardial biopsy, and direct surgical procedures (5, 11-14). MR and echocardiography share the advantage of direct imaging of the cardiac masses, whereas angiography relies on indirect evidence such as filling defects, focal wall thickening, or distortion. The ability of MR to perform sagittal and coronal imaging as well as the expanding capability to obtain images in the plane of the short axis of the heart enables MR to define the anatomic location and extent of mass lesions precisely. Additionally, MR imaging, with its wide field of view, can also define any extracardiac portions of the mass. A relative disadvantage of CT compared with MR imaging is that diagnostic yield of the former depends to a large extent on the proper timing of the injection of an adequate amount of ionized contrast material with scan acquisition at the various anatomical levels. The relative disadvantages of echocardiography are its limitation in obese patients and those with obstructive lung disease, and a much smaller field of view than MR imaging. However, 2D echocardiography has the advantages of thinner tomographic sections and limitless imaging planes (3, 15).

MR imaging, which provides two-dimensional cross-sectional images of the cardiac chambers, is an accurate method for detecting cardiac tumors. Rapidly flowing blood, which emits little or no signal, appears black within the chambers of the heart. This enables the excellent separation of blood-filled chambers from the soft tissue that makes up the wall of the chamber. Intracardiac tumors are identifiable within the chambers of the heart without contrast enhancement, as used with CT. MR imaging also allows direct imaging in multiple planes—sagittal, coronal, and transaxial. Multiple plane imaging assists in determining the relationship of the tumor to various cardiac structures. The images are also obtained without ionizing radiation.

In ECG-gated MR imaging, the TR interval cannot be
chosen freely but is determined by the RR interval of the patient’s ECG. The typical TR and TE values on spin-echo EEG-gated MR imaging fall into the category of partial-saturation spin-echo sequences. Such sequences tend not to differentiate between various nonfatty soft tissues. Nevertheless, the combination of intensity characteristics, morphologic information, and clinical data allowed a correct diagnosis to be made in several cases. Qualitative tissue characterization was possible with fatty lesions and those containing large vascular structures. Relative tissue-intensity characteristics have been shown to allow a degree of specificity in the MR diagnosis of some cardiac lesions, such as lipomatous hypertrophy of the atrial septum, fibroma, thrombus, myxoma, and pericardial cyst or fat pad (1,4). In our study, specific diagnosis were possible in myxoma, lipoma and lymphoma with tissue-intensity characteristics and in pericardic mesotheliomas with morphologic information. That is, heterogeneous intermediate or slightly high signal on T1-weighted image and high signal on T2-weighted image is seen in cardiac myxoma (15-17), infiltrative high signal intensity lesions on T1- and T2-weighted images in lymphoma, very high signal mass on T1-weighted image and slight high signal intensity on T2WI in lipoma (11,18-20). Also, irregular diffuse uneven thickening of pericardium is relatively specific morphological characteristics in pericardic mesothelioma. But, as others have noted, the primary contribution of MR imaging in these cases was not its ability to obtain a tissue diagnosis, but rather its ability to delineate the anatomic extent and to aid in treatment planning (4,21,22). In conclusion, MR images are useful method in demonstration of the location, extent, tissue characteristics, and relationship with its adjacent structures in evaluation of cardiac and pericardic tumors.

REFERENCES

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원발성 심장 및 심막 종양의 자기공명영상

목 적 : 원발성 심장 및 심막 종양의 특징적인 자기영상소견을 알아보고자 하였다.

대상 및 방법 : 7예의 점액종, 악성 림프종, 지방종 각 1예, 심막 중피종 2예 중 총 11예의 종양이 대상이었으며, 자기공명영상소견에서 종괴의 위치와 크기, 모양, 신호강도와 조영증강정도를 분석하였고 심막 혹은 심방삼출이나 증격동 림프절의 비후등 동반된 소견들을 분석하였다.

결 과 : 점액종의 위치는 좌심방이 4예로 가장 많았고 그 외 좌심실과 우심방, 우심실이 각각 1예씩이었다. 평균 크기는 3.5cm(2~7cm 범위)였다. 모양은 폴립형이거나 분엽 모양이었고 외측벽에 붙어 있었던 1예의 우심방의 종괴를 제외하면 모두에서 심방중격 혹은 심실중격에 붙어 있었다. 종괴형(peduncle)은 3예의 좌심방 점액종에서 보였다. 신호강도는 T1강조영상에서는 심장근육에 비해 같거나 약간 높고 T2 강조영상에서는 높은 신호강도를 나타내었다. 심박삼출과 심박삼출이 각각 3예에서 보였다. 악성 림프종은 커다란 중심실의 종괴로 나타났으며 우심방과 심실중격, 우측 기관주위와 심장후방공간을 광범위하게 침범하고 있었다. T1 및 T2강조영상에서 모두 약간 높은 신호강도를 보였으며 강하게 조영증강이 되었고 심막 및 심방삼출이 동반되었다. 지방종은 폴립으로 좌심실의 외측벽에 붙어 있었다. 특징적으로 T1강조영상에서 매우 높은 신호강도를 T2강조영상에서도 높은 신호강도를 나타내었다. 심박 중피종은 우측 심막과 양측 심방의 종괴로 나타났으며 심막의 전반적인 불규칙적인 비후 소견을 보였다. T1강조영상에서는 주위 근육과 비슷한 신호강도를 T2강조영상에서는 높은 신호강도를 나타냈으며 중등도로 조영증강 되었다.

결 론 : 자기공명영상은 여러 신호강도와 여러 단면영상으로 심장 및 심막 종괴를 평가함에 있어, 그 위치나 크기, 조직학적 특성 및 주위 조직간의 관계를 보는데 매우 유용할 것으로 생각된다.