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Severe Right Ventricular Contraction Asynchronism Revealing a Large Pericardial Effusion

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A gated blood-pool equilibrium radionuclide angiography was performed in a patient to determine the ejection fraction for doxorubicin cardiotoxicity evaluation. The phase image of the first harmonic of the Fourier analysis revealed a severe delay of the right ventricular contraction compared with that of the left ventricle. This right ventricular contraction asynchronism was due to a large pericardial effusion, confirmed by the presence of the halo sign on the summed gated images and by echocardiography. The phase delay moves towards normalization after pericardiocentesis. Although radionuclide angiocardiography is not the best method for identification of pericardial effusion, this diagnosis should be evoked when a severe homogenous delay of the right ventricular contraction is observed.

Key Words: pericardial effusion; Fourier phase analysis; radionuclide angiography

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In most nuclear medicine departments, routine interpretation of gated blood-pool equilibrium scintigraphy includes the study of the first harmonic of the Fourier analysis (*1*). The parametric phase image has demonstrated a pattern of delayed right ventricular contraction in many heart diseases involving the right ventricle, such as right bundle branch block (*2*), right ventricular myocardial infarction (*3*) and arrhythmogenic right ventricular dysplasia (*4*).

In this article, we report a severely delayed right ventricular contraction demonstrated by the phase image revealing a large pericardial effusion.

CASE REPORT

A 47-yr-old woman, a smoker, without previous history of cardiac disease was admitted to the hospital after the discovery of bilateral nodular opacities and a left pleural effusion on chest radiograph. Bronchoscopy guided biopsies showed a lung adenocarcinoma and the pleural aspiration revealed a metastatic pleural dissemination (mammography, CT scan of the abdomen, gastroscopy and barium enema were negative). The patient underwent a treatment based on cancer chemotherapy and was referred to the nuclear medicine department for left ventricular ejection fraction determination after a cumulated dose of doxorubicin of 200 mg/m^2. At the time of this examination the patient did not complain of dyspnea or chest pain. The cardiac examination showed a tachycardia of about 95 bpm without other clinical abnormalities. The electrocardiogram was normal except for tachycardia (Fig. 1). The blood pool was labeled with 555 MBq of ^{99m}Tc. Imaging was performed using a small field of view Philips gamma-camera equipped with a general-purpose, parallel-hole collimator. Data were acquired in the left anterior oblique view adjusted to obtain the best separation between right and left ventricles. Thirty two 64 × 64 frames were recorded with a total of 6 million counts. The image of the first harmonic of the Fourier analysis showed that the right ventricular contraction was delayed by 79° compared with the left ventricle (Fig. 2A,B). This delay corresponded to 139 msec. On the phase image, the contraction of the right atrium appears also paradoxical. The left ventricular ejection fraction was 47% and the right ventricular ejection fraction was 32% (Table 1).

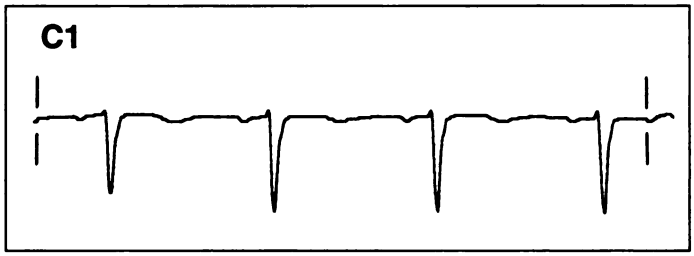

FIGURE 1. Electrocardiogram (before pericardiocentesis) shows the lack of right ventricular electrical conduction delay.

The examination of the left and right ventricular volume curves confirmed the delayed right ventricular minimum of counts with a shortened right ventricular filling (Fig. 3A). The late right ventricular filling was mainly due to the atrial contraction. The examination of the added 32 frames showed the "halo sign" surrounding the heart (Fig. 4). A two-dimensional echocardiography was performed and confirmed the presence of a large circumferential pericardial effusion with a 24 mm anterior echo-free space, a diastolic collapse of the right ventricle and a collapse of the right atrium suggestive of cardiac tamponade (Fig. 5). The pericardiocentesis aspirated 500 cc of cloudy fluid. A cytologic study of the pericardial fluid confirmed the metastatic effusion of an adenocarcinoma.

Further evaluation using two-dimensional echocardiography showed an important reduction of the effusion and normal right heart chambers. Another radionuclide angiography was performed 2 mo later to estimate anthracycline cardiotoxicity. The right

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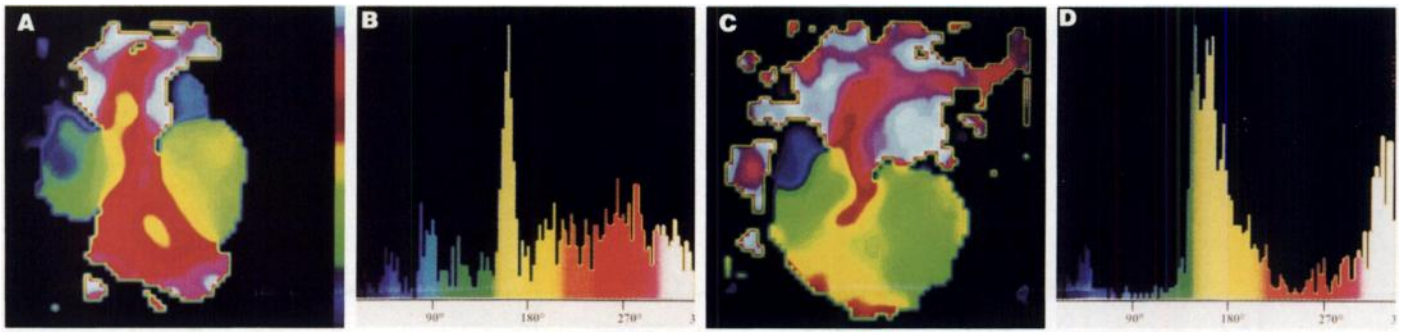

FIGURE 2. Phase image performed in left anterior oblique projection (A) and phase histogram (B) shows the right ventricular phase delay relative to the left ventricle and phase image (C) and phase histogram (D) of the second radionuclide angiography when the right ventricular phase delay moves towards normalization.

ventricular ejection fraction was 49% and the right ventricular phase delay was only 25° (Fig. 2C,D).

DISCUSSION

The presence of a large pericardial effusion can be suspected by the classical clinical picture of cardiac tamponade including tachycardia, dyspnea, hypotension, distension of the jugular veins and pulsus paradoxus. Some patients could suffer a large pericardial effusion without the former clinical features, particularly in case of slowly developing neoplasic pericardial effusion. Echocardiography is then the most valuable diagnostic procedure to confirm the presence of a pericardial effusion (*5*). Our patient presented only a moderate tachycardia at the time of the radionuclide angiography and the presence of the pericardial effusion had not been suspected previously. The importance of screening routine blood-pool images for a possible abundant pericardial effusion has been reviewed in the past (*6*) and the identification of the "halo sign" has been shown to be of great value (*6*). In our case, the finding of an abnormal phase image was the most striking abnormality on the gated blood-pool examination.

Cardiac tamponade is a syndrome of circulatory abnormalities, due to the compression of the heart by a large pericardial effusion. When the intrapericardial pressure exceeds the right ventricular diastolic filling pressure, a paradoxical posterior motion of the right ventricular free wall occurs in early diastole and induces a collapse of the right ventricular cavity (*7*). The reduced compliance of the right ventricle delays the diastolic ventricular filling to the late diastole and makes the right ventricular filling strongly dependent on the active contraction of the right atrium. Engel et al. (*8*) measured a mean time interval of 90 msec ± 20 msec between mitral valve opening and the end of the posterior motion. This time delay is comparable to the 139 msec measured in our patient and much higher than the delay usually observed in right bundle branch blocks, measured at 54 msec by Underwood et al. (*2*). The

TABLE 1
Left and Right Ventricular Parameters Measured by Radionuclide Angiography

	First RNA	Second RNA
RR interval (msec)	633	757
	Left ventricle	
Ejection fraction	47%	48%
PFR (EDV/sec)*	2, 37	2, 19
Mean phase (degree)	180	162
Phase s.d. (degree)†	30	12
	Right ventricle	
Ejection fraction	32%	49%
PFR (EDV/sec)*	2, 43	2, 90
Mean phase (degree)	259	187
Phase s.d. (degree)†	33	17
Phase delay (degree)	79	25

*PFR = peak filling rate in end diastolic volume (EDV) per second.
†Phase s.d.

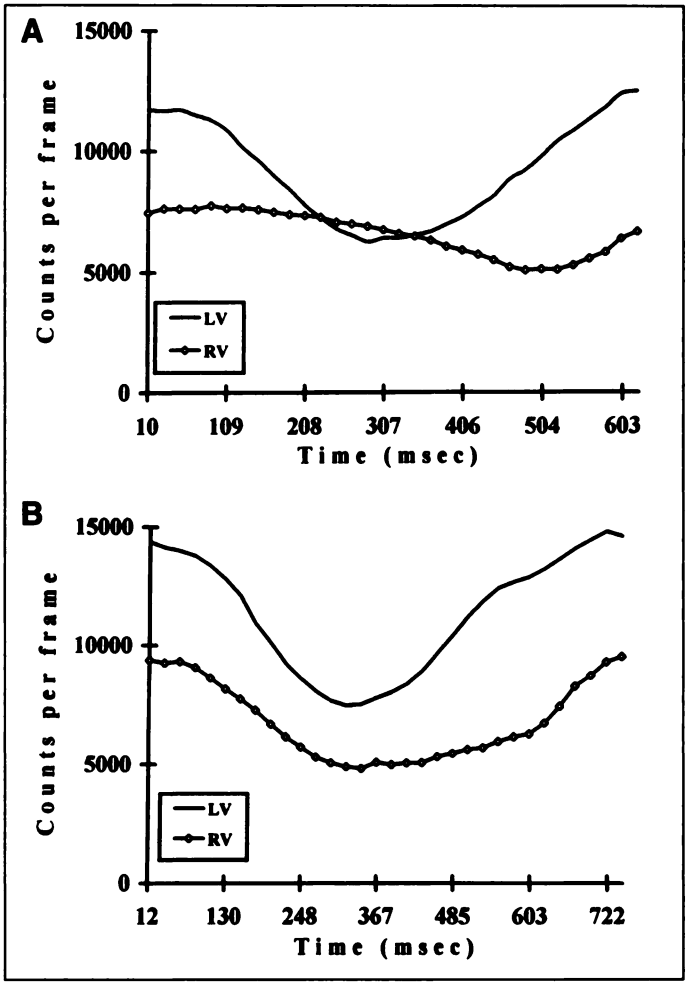

FIGURE 3. Left and right ventricular time-activity curves: First radionuclide angiography shows the delayed right ventricular minimum of counts (A), the second 2 mo later when right and left ventricles contract simultaneously (B).

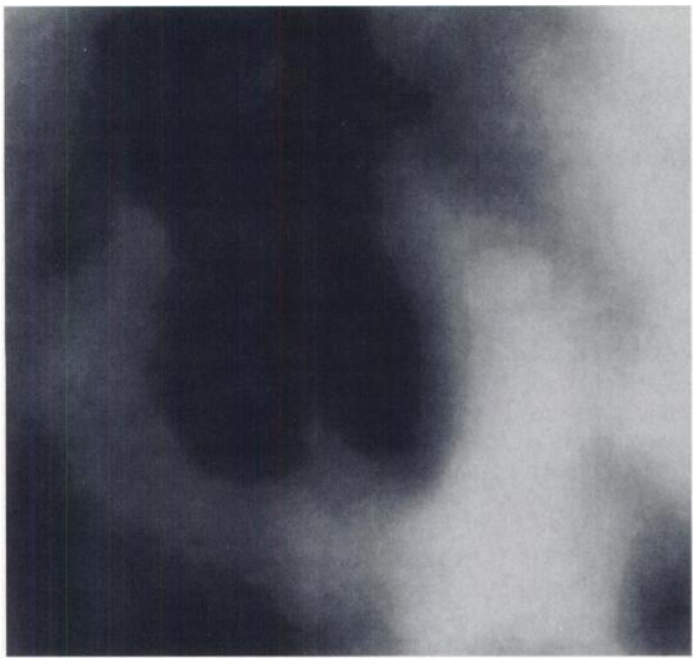

FIGURE 4. Added 32 frames in left anterior oblique view showing the photon-deficient halo around the heart due to the pericardial effusion.

abnormal phase of the right atrium was also the result of the collapse of the right chambers. Singh et al. (*9*) described a collapse of the right atrium during late diastole, which continues through early systole in patients with cardiac tamponade. Unlike certain right ventricular diseases, such as right ventricular myocardial infarction (*3*) or right ventricular arrhythmogenic dysplasia (*4*), the asynchronism appears homogenous on the entire area of the right ventricle. A pendulum-like swing of the heart may also have accounted for the paradoxical appearance of the right ventricular phase but this hypothesis seems unlikely since no parallel paradoxical contraction was observed in the left ventricle.

The hemodynamic abnormalities in cardiac tamponade are reversible as demonstrated by the progressive disappearance of the echocardiographic abnormalities during pericardiocentesis (*9*). The gated blood-pool scintigraphy and the delay of the right ventricular filling returned to normal in the follow-up of our patient confirming that the phase delay was entirely due to the pericardial effusion and not to an alteration of the contraction or the conduction in the right myocardium.

CONCLUSION

The role of gated blood-pool scintigraphy is limited in identifying large pericardial effusion. Nevertheless, when performing such an examination one should be aware of a few signs that could lead to the suspicion of such a pathology. The presence of the "halo sign" or the identification of a prolonged delay of the right ventricular diastole should be emphasized as possible signs of a cardiac tamponade.

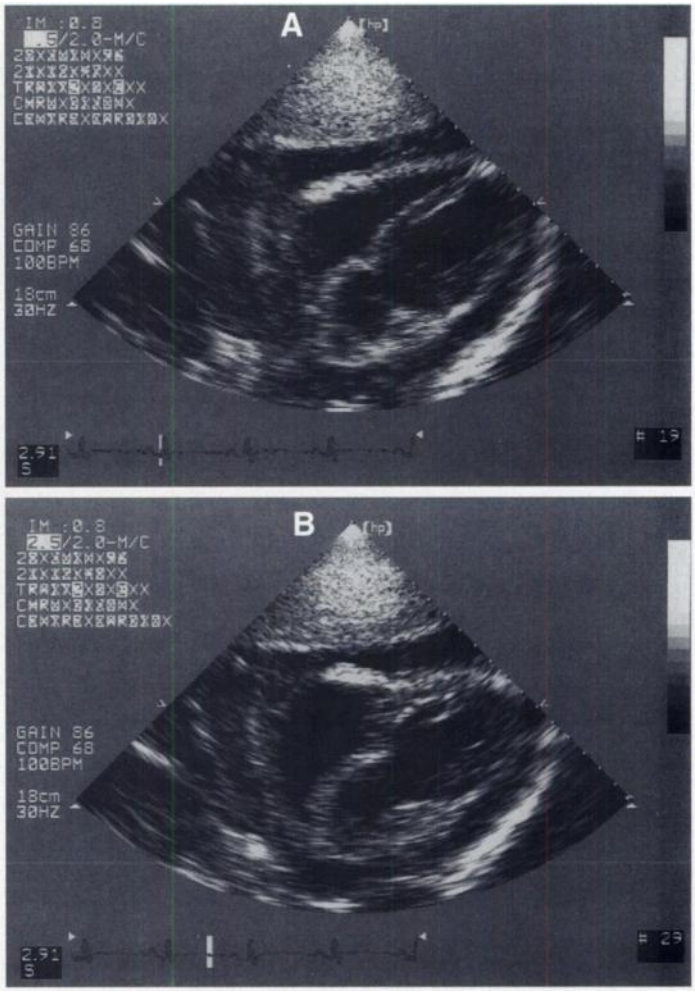

FIGURE 5. Subcostal two-dimensional echocardiogram through the four-chamber plane: diastolic image (A) and systolic images (B) show right ventricular collapse.

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