Clinical Investigation

Left Atrial Volume as a Predictor of Left Ventricular Functional Recovery in Patients With Dilated Cardiomyopathy and Absence of Delayed Enhancement in Cardiac Magnetic Resonance

JEONGGEUN MOON, MD,[1] CHI YOUNG SHIM, MD, PhD,[2] YOUNG-JIN KIM, MD, PhD,[3] SUNGHA PARK, MD, PhD,[2] SEOK-MIN KANG, MD, PhD,[2] NAMSIK CHUNG, MD, PhD,[2] AND JONG-WON HA, MD, PhD[2]

Incheon, Republic of Korea; Seoul, Republic of Korea

ABSTRACT

Background: Improvement of left ventricular (LV) systolic dysfunction can occur in patients with dilated cardiomyopathy (DCM), and it is more frequently observed if patients have no delayed enhancement (DE) in cardiac magnetic resonance imaging (CMR). However, even in the absence of DE, not all patients have functional recovery. We retrospectively investigated the predictors of LV functional recovery in patients with DCM who had no DE in CMR.

Methods: A total of 136 patients with DCM underwent CMR. Among them, 44 (29 male, age 55 ± 14 years) showed no DE and these patients composed the study population. The study patients were divided into 2 groups according to the occurrence of functional recovery defined as an increase in LV ejection fraction to a level of ≥50% and net increase in ejection fraction of 20% or more: group 1 (n = 14) with functional recovery and group 2 (n = 30) without functional recovery.

Results: In patients who showed functional recovery, left atrial volume index (LAVI [26 ± 8 mL/m^2 vs 45 ± 18 mL/m^2]) and LV end-diastolic dimension (62 ± 6 mm vs 67 ± 7 mm) were significantly smaller when compared with those without functional recovery ($P < .05$ for all). In Cox multiple regression analysis, LAVI was the only significant parameter associated with LV functional recovery (hazard ratio 0.932, 95% confidence interval 0.877–0.991, $P = .024$). LAVI < 38 mL/m^2 had 100% specificity in predicting the improvement of LV systolic dysfunction.

Conclusion: In DCM patients who had no DE in CMR, LAVI predicts LV functional recovery with high specificity. (*J Cardiac Fail 2016;22:265–271*)

Key Words: Dilated cardiomyopathy, prognosis, magnetic resonance imaging, left atrium.

Despite grave prognosis of dilated cardiomyopathy (DCM), left ventricular (LV) systolic dysfunction recovers in about 25% of patients with DCM.[1,2] Therefore, the prediction of LV functional recovery is of clinical importance because it affects the decision for the need for nonpharmacologic interventions such as cardiac transplantation, LV assist device, implantable cardioverter-defibrillator, and cardiac resynchronization therapy. Recently, delayed enhancement (DE) in cardiac magnetic resonance imaging (CMR) has been suggested to reflect myocardial fibrosis in patients with DCM, and its extent was reported to be inversely related to reversibility of ventricular function in DCM.[3–6] Thus, the presence and the extent of DE have been shown to be useful in predicting future functional recovery in patients with nonischemic LV dysfunction. However, the absence of DE does not

From the [1]Cardiology Division, Department of Internal Medicine, Gachon University of Medicine and Science, Incheon, Republic of Korea; [2]Cardiology Division, Department of Internal Medicine, Yonsei University College of Medicine, Seoul, Republic of Korea and [3]Department of Radiology, Yonsei University College of Medicine, Seoul, Republic of Korea.

Manuscript received June 19, 2015; revised manuscript received November 11, 2015; revised manuscript accepted December 1, 2015.

Reprint requests: Jong-Won Ha, MD, PhD, Cardiology Division, Severance Cardiovascular Hospital, Yonsei University College of Medicine, 134 Shinchon-dong, Seodaemun-gu, 120-752 Seoul, Republic of Korea. Tel: +82 2 2228 8461; Fax: +82 2 2227 7943. E-mail: jwha@yuhs.ac.

Funding: This work was supported by the Korea Science and Engineering Foundation grant funded by the Korean government (M10642120001-06N4212-00110).

See page 270 for disclosure information.

1071-9164/$ - see front matter

http://dx.doi.org/10.1016/j.cardfail.2015.12.011

guarantee LV functional recovery. Therefore, the purpose of the present study was to determine predictors of LV functional recovery in DCM patients who did not have DE in CMR.

Methods

Study Sample

Between January 2003 and December 2010, 136 patients with newly diagnosed DCM underwent CMR in our institution. Among them, 46 (34%) showed no DE in CMR and 2 were lost to follow-up. Therefore, a total of 44 patients composed the study population in this retrospective investigation. The diagnosis of DCM was made according to World Health Organization/International Society and Federation of Cardiology criteria.[7] We excluded patients with cardiotoxic chemotherapy-induced/alcoholic/tachycardia-induced cardiomyopathies, because they are known as highly reversible.[1,2,4] Echocardiographic evaluation was performed in all patients at the time of initial diagnosis and during the follow-up period. LV systolic dysfunction was defined as an LV ejection fraction (EF) less than 35% by echocardiography.[8] The clinical course of patients was monitored from the time of enrollment at 3-month intervals during the follow-up period. The study patients were divided into 2 groups according to the occurrence of functional recovery defined as an increase of LVEF to a level of ≥50% and a net increase in EF of 20% or more: group 1 (n = 14) with functional recovery and group 2 (n = 30) without functional recovery. This study was approved by the institutional ethics committee and complies with the Declaration of Helsinki.

CMR

Gyroscan Intera System (Philips Medical System, Best, Netherland) was used for the CMR. Breath-hold multislice contrast enhanced delayed images were obtained by acquiring an inversion-recovery segmented gradient echo T1-weighted sequence 10–15 minutes after intravenous injection of 0.2 mmol/kg of gadolinium DTPA. The "look-locker" sequence (Philips) was used to determine the optimal inversion time to null the enhanced normal myocardial signal, as described previously.[3] Regions of myocardium with abnormally high signals, as evaluated by 2 blinded radiologists, were determined as being positive for DE. We excluded all patients with any form of DE.

Echocardiography

Standard 2-dimensional measurements (LV end-diastolic and end-systolic dimensions [LVEDD and LVESD], ventricular septum and posterior wall thickness, LV mass index, and LV outflow tract diameter) were taken with the patient in the left decubitus position. The measurements were averaged over 5 cardiac cycles in patients with atrial fibrillation. LV mass was calculated using the formula of 0.8 $[1.04\ (SWTd + LVIDd + PWTd)^3 - LVIDd^3] + 0.6$ (g), where LVIDd is the internal diameter of LV at end-diastole, and PWTd and SWTd are posterior wall thickness at end-diastole and septal wall thickness at end-diastole, respectively.[9] LV mass was indexed to the body surface area. LVEF was obtained using the modified Simpson's method. Left atrial (LA) volume was determined from 2 imaging planes by prolate ellipsoid formula and was indexed to the body surface area (left atrial volume index [LAVI]).[9] Stroke volume and cardiac output were determined using pulsed Doppler technique as recommended by the American Society of Echocardiography.[10] From the apical window, a 1–2 mm pulsed Doppler sample volume was placed at the mitral valve tip and mitral flow velocities from 5 to 10 cardiac cycles were recorded. The mitral inflow velocities were traced and the following variables were obtained: peak velocity of early diastolic filling (E), and late filling (A), and deceleration time of the E wave velocity. Early diastolic mitral annulus velocity (e′), late diastolic mitral annulus velocity (A′), and peak systolic mitral annulus velocity (S′) were measured by Doppler tissue imaging at the septal corner of mitral annulus. To estimate LV filling pressures, the ratio of E/e′ was calculated. Measurements were recorded with simultaneous electrocardiography at the sweep speed of 50–100 mm/s. Color flow mapping was used to identify the presence or absence of mitral regurgitation (MR). Quantitative Doppler assessment of regurgitant volume, regurgitant fraction, and effective orifice area was performed using established methods.[11] The echocardiographic data were analyzed by 2 experienced echocardiographers who were unaware of patients' clinical data.

Laboratory Measurements

Blood was sampled at the time of echocardiographic evaluation for the measurements of routine chemistry including N-terminal pro brain natriuretic peptide (NT-proBNP). Blood samples were kept at 4°C and analyzed for NT-proBNP by the electrochemiluminescence immunoassay method (Elecsys proBNP; Roche Diagnostics GmbH, Basel, Switzerland). Glomerular filtration rate was estimated using the Modification of Diet in Renal Disease formula as the following equation: $170 \times (SCr)^{-0.999} \times (age)^{-0.176} \times (BUN)^{-0.170} \times (albumin)^{0.318} \times 0.762$ (if female), where SCr is serum creatinine in mg/dL and BUN is blood urea nitrogen.

Statistical Analysis

Continuous data are expressed as a mean ± standard deviation, and normality tests were performed in each variable to determine whether a data set is well-modeled by a normal distribution or not. Because the NT-proBNP distribution was positively skewed, we used log-transformed NT-proBNP values in statistical analysis. The baseline characteristics of the 2 groups were compared with the 2-sample *t* test for continuous variables, and chi-square test and Fisher's exact test for categorical variables. Cox multiple regression analysis was used to quantify the relationships