JACC: CARDIOVASCULAR IMAGING VOL. 3, NO. 10, 2010

ISSN 1936-878X/$36.00
PUBLISHED BY ELSEVIER INC. DOI:10.1016/j.jcmg.2010.06.016

CMR Predictors of Mitral Regurgitation in Mitral Valve Prolapse

Francesca N. Delling, MD,* Lih Lisa Kang, MS,‡ Susan B. Yeon, MD,†
Kraig V. Kissinger, RT,* Beth Goddu, RT,* Warren J. Manning, MD,† Yuchi Han, MD*
Boston and Arlington, Massachusetts

OBJECTIVES We sought to assess the correlation between mitral valve characteristics and severity of mitral regurgitation (MR) in subjects with mitral valve prolapse (MVP) undergoing cardiac magnetic resonance (CMR) imaging.

BACKGROUND Compared with extensive echocardiographic studies, CMR predictors of MVP-related MR are unknown. The severity of MR at the time of diagnosis has prognostic implication for patients; therefore, the identification of determinants of MR and its progression may be important for risk stratification, follow-up recommendations, and surgical decision making.

METHODS Seventy-one MVP patients (age 54 ± 11 years, 58% males, left ventricular [LV] ejection fraction 65 ± 5%) underwent cine CMR to assess annular dimensions, maximum systolic anterior and posterior leaflet displacement, papillary muscle (PM) distance to coaptation point and prolapsed leaflets, as well as diastolic anterior and posterior leaflet thickness and length, and LV volumes and mass. Velocity-encoded CMR was used to obtain aortic outflow and to quantify MR volume.

RESULTS Using multiple linear regression analysis including all variables, LV mass ($p < 0.001$), anterior leaflet length ($p = 0.006$), and posterior displacement ($p = 0.01$) were the best determinants of MR volume with a model-adjusted $R^2 = 0.6$. When the analysis was restricted to valvular characteristics, MR volume correlated with anterior mitral leaflet length ($p < 0.001$), posterior mitral leaflet displacement ($p = 0.003$), posterior leaflet thickness ($p = 0.008$), and the presence of flail ($p = 0.005$) with a model-adjusted $R^2 = 0.5$. We also demonstrated acceptable intraobserver and interobserver variability in these measurements.

CONCLUSIONS Anterior leaflet length, posterior leaflet displacement, posterior leaflet thickness, and the presence of flail are the best CMR valvular determinants of MVP-related MR. The acceptable intraobserver and interobserver variability of our measurements confirms the role of CMR as an imaging modality for assessment of MVP patients with significant MR. (J Am Coll Cardiol Img 2010;3:1037–45)

From the *Department of Medicine (Cardiovascular Division) Beth Israel Deaconess Medical Center, Harvard Medical School, Boston, Massachusetts; †Department of Radiology, Beth Israel Deaconess Medical Center, Harvard Medical School, Boston, Massachusetts; and ‡LK Biostat Consulting Inc., Arlington, Massachusetts. Dr. Han has received grant support from the American College of Cardiology Foundation and Beth Israel Deaconess Medical Center and the Clinical Investigator Training Program: Beth Israel Deaconess Medical Center–Harvard/MIT Health Sciences and Technology, in collaboration with Pfizer Inc. and Merck & Co. All authors have reported that they have no relationships to disclose.

Manuscript received January 20, 2010; revised manuscript received June 15, 2010, accepted June 22, 2010.

JACC: CARDIOVASCULAR IMAGING, VOL. 3, NO. 10, 2010
OCTOBER 2010:1037–45

Mitral valve prolapse (MVP) is a common disorder afflicting 2% to 3% of the general population (1). Typical myxomatous changes in the mitral leaflet tissue cause superior displacement of the leaflets into the left atrium (1,2). MVP can be associated with significant mitral regurgitation (MR), arrhythmias, bacterial endocarditis, thrombotic events, congestive heart failure, and even sudden cardiac death (3–5).

See page 1046

Controversy exists regarding the prognosis of MVP (1,6–8). These discrepancies may be due to selection bias in the referral of either tertiary care, symptomatic patients or, conversely, healthier asymptomatic volunteers (8). Changes in diagnostic criteria may have further exacerbated these controversies (9). More recently, a community-based study carried out in a primary care hospital has underscored the heterogeneity of MVP, and its wide prognostic spectrum (3). The common denominator of these and other prognostic studies is the role of MR at diagnosis in determining the risk for cardiovascular morbidity and mortality (6–8,10–13).

ABBREVIATIONS AND ACRONYMS

CMR = cardiac magnetic resonance

LV = left ventricle/ventricular

MR = mitral regurgitation

MVP = mitral valve prolapse

PM = papillary muscle

Given the prognostic implications of MR, identification of determinants of progression is important for risk stratification, follow-up recommendations and surgical decision making. Echocardiographic studies have analyzed determinants of MVP-related MR and its progression (12–14). Among these determinants, leaflet thickness, progression of the valvular lesion, particularly a new flail leaflet, and an increase in the mitral annular diameter were the most important predictors of MR (12).

Cardiac magnetic resonance (CMR) is an important noninvasive imaging modality that readily identifies MVP (15). In addition, CMR can quantify MR using phase-contrast velocity mapping (16,17). Because CMR can reliably provide quantitative determination of ventricular volumes and function (18,19), it is becoming an important clinical tool for follow-up of patients with MVP and moderate-to-severe MR in anticipation of future mitral valve repair (20).

Compared with echocardiography, CMR predictors of MVP-related MR are yet to be defined. We sought to investigate the correlation between mitral valve characteristics and MR in the MVP population, so as to further define the potential role of CMR in this common disease.

METHODS

Patient selection. Seventy-five subjects with echocardiographically identified MVP without greater than mild aortic regurgitation were prospectively enrolled based on an institutional review board–approved protocol. Similar to echocardiography (9,21), CMR evidence of MVP was defined as >2-mm displacement of the mitral leaflets into the left atrium as viewed in the left ventricular (LV) outflow tract orientation (15). Of the 75 subjects, 4 (5%) were excluded due to suboptimal CMR image quality, resulting in a final cohort of 71 participants (age 55 ± 11 years, 58% males). All subjects were in normal sinus rhythm without any history of coronary artery disease or intrinsic cardiomyopathies.

CMR. CMR imaging was performed using a Philips Achieva 1.5-T whole-body CMR scanner (Philips Medical Systems, Best, the Netherlands) equipped with a 5-element cardiac coil. Breath-hold, retrospectively electrocardiogram-gated cine, steady-state free-precession images were acquired in the 2- and 4-chamber long-axis views, and a short-axis stack covering the entire LV (8-mm slices with 2-mm gaps). The LV outflow track long-axis stack images (Fig. 1) were obtained by prescribing an image plane perpendicular to the mitral annular major axis centered at the aortic outflow track (15). Six to eight 7-mm slices with no gap were obtained to cover the entire mitral valve. Sequence parameters were repetition time 3 ms, echo time 1.5 ms, flip angle 60°, field-of-view 320 × 320 mm^2, matrix 160 × 160. Temporal resolution was 30 to 35 ms. A free-breathing, electrocardiogram-triggered, phase-contrast velocity-encoded CMR sequence of the aortic outflow was acquired in the axial plane at the level of the bifurcation of the pulmonary artery, as previously described (17).

Image analysis. The CMR images were analyzed using ViewForum (Release 4) software (Philips Medical Systems) as previously described (15). Briefly, in the LV outflow track view (Fig. 1A), anterior and posterior leaflet displacement were measured as the maximum excursion of the leaflets during systole (each phase repeatedly examined to find the maximum excursion) beyond the mitral annular diameter as defined by a line connecting the inferolateral mitral annulus to the aortomitral junction (Fig. 1A). Additional measurements on the same image included the distance between the