

ORIGINAL RESEARCH

# Atrial Function as a Guide to Timing of Intervention in Mitral Valve Prolapse With Mitral Regurgitation

Liam Ring, MD,\* Bushra S. Rana, MD,† Francis C. Wells, MD,†  
Anna C. Kydd, MD,\* David P. Dutka, MD\*  
*Cambridge and Papworth Everard, United Kingdom*

**OBJECTIVES** The purpose of this study was to determine the clinical utility of left atrial (LA) functional indexes in patients with mitral valve prolapse (MVP) and mitral regurgitation (MR).

**BACKGROUND** Timing of surgery for MVP remains challenging. We hypothesized that assessment of LA function may provide diagnostic utility in these patients.

**METHODS** We studied 192 consecutive patients in sinus rhythm with MVP, classified into 3 groups: moderate or less MR (MOD group, n = 54); severe MR without surgical indication (SEV group, n = 52); and severe MR with  $\geq 1$  surgical indication (SURG group, n = 86). Comparison was made with 50 control patients. Using 2D speckle imaging, average peak contractile, conduit, and reservoir atrial strain was recorded. Using Simpson's method we recorded maximal left atrial volume (LAV<sub>max</sub>) and minimal left atrial volume (LAV<sub>min</sub>), from which the total left atrial emptying fraction (TLAEF) was derived:  $(LAV_{max} - LAV_{min}) / LAV_{max} \times 100\%$ .

**RESULTS** TLAEF was similar in the MOD and control groups (61% vs. 57%; p = NS), was reduced in the SEV group (55%; p < 0.001 vs. control group), and markedly lower in the SURG group (40%; p < 0.001 vs. other groups). Reservoir strain demonstrated a similar pattern. Contractile strain was similarly reduced in the MOD and SEV groups (MOD 15%; SEV 14%; p = NS; both p < 0.05 vs. control group 20%) and further reduced in the SURG group (8%; p < 0.001 vs. other groups). By multivariate analysis, TLAEF (odds ratio [OR]: 0.78; p < 0.001), reservoir strain (OR: 0.91; p = 0.028), and contractile strain (OR: 0.86; p = 0.021) were independent predictors of severe MR requiring surgery. Using receiver-operating characteristic analysis, TLAEF < 50% demonstrated 91% sensitivity and 92% specificity for predicting MVP with surgical indication (area under the curve: 0.96; p < 0.001).

**CONCLUSIONS** We report the changes in left atrial function in humans with MVP and the relationship of LA dysfunction to clinical indications for mitral valve surgery. We propose that the findings support the utility of quantitative assessment of atrial function by echocardiography as an additional tool to guide the optimum timing of surgery for MVP. (J Am Coll Cardiol Img 2014;7:225–32) © 2014 by the American College of Cardiology Foundation

From the \*Department of Medicine, University of Cambridge, Addenbrooke's Hospital, Cambridge, United Kingdom; and the †Papworth Hospital NHS Foundation Trust, Papworth Everard, United Kingdom. Dr. Wells has served as a consultant to St. Jude Medical. Dr. Dutka has received unrestricted research support from Sorin and Merck Sharp & Dohme; and has received grants from the National Institute for Health Research, Medical Research Council and British Heart Foundation. All other authors have reported that they have no relationships relevant to this paper to disclose.

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Mitral valve prolapse (MVP) is the second most common valvular lesion requiring cardiac surgery (1). If severe mitral regurgitation (MR) is not treated, there is increased morbidity and a constrained prognosis (2,3). Optimum timing of surgical intervention is of paramount importance, but remains clinically challenging. Symptomatic deterioration is a clear indication that surgery should be undertaken (4), but this may occur late in the natural history of the

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condition and be secondary to irreversible left ventricular (LV) dysfunction (5). Current guidelines highlight the importance of LV size and function to identify those with latent LV dysfunction who should be considered for surgery (6).

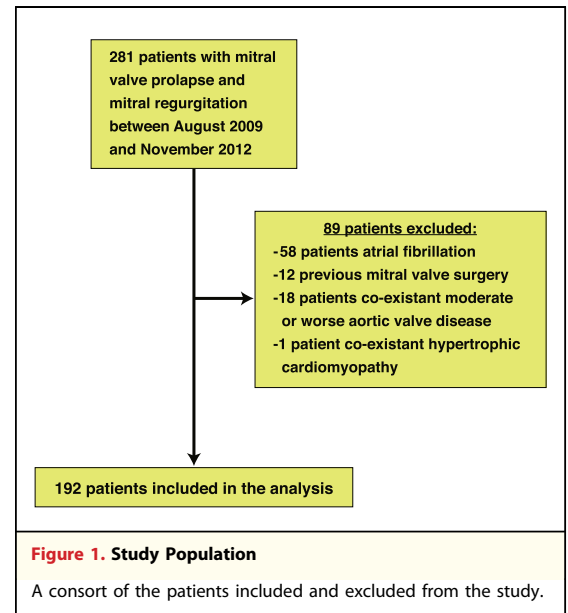
Additionally, the development of atrial fibrillation (AF) or the presence of elevated pulmonary artery (PA) pressures are associated with an adverse prognosis, and indicate the need for detailed assessment of the asymptomatic patient regarding surgical referral (6–9).

The effect of MR on left atrial (LA) behavior and function has received less attention. The LA dilates as a consequence of the regurgitant load, and an LA volume index  $>60$  ml/m<sup>2</sup> predicts an adverse cardiovascular outcome (10,11). Characterization of atrial function using speckle tracking technology has been proposed to offer insights into the atrial adaptation to chronic MR. In a heterogeneous group of patients with severe MR,

atrial strain was impaired, which may relate to the presence of atrial fibrosis (12,13). We hypothesized that atrial function may be closely linked to adverse pathophysiological findings in MVP, and offer potential as a useful additional tool to help define the optimum timing of surgery in these patients.

## METHODS

**Patient population.** We studied consecutive patients with MVP and associated MR assessed within our service between August 2009 and November 2012. Only patients with MVP or a flail leaflet were included (MVP was defined as displacement of the tip of 1 or more segments of the mitral valve by  $\geq 2$  mm relative to the hinge points of the leaflets, and flail as the systolic eversion of the leaflet tip into the LA). We excluded subjects who were in AF,



patients with more than moderate coexistent aortic valve disease, and those with prior mitral valve surgery (Fig. 1). All patients underwent complete clinical assessment including comprehensive echocardiography and were included prospectively in a clinical database. Patients were classified according to MR severity and the presence of established indications for surgical intervention according to American guidelines (6), including symptoms, left ventricular internal diameter in systole (LVIDs)  $\geq 40$  mm, ejection fraction (EF)  $<60\%$ , or PA pressure  $>50$  mm Hg at rest or 60 mm Hg with exercise. Comparison was made with a group of 50 patients in sinus rhythm, with normal LV size and function, normal LA size, and normal mitral valves with less than mild MR. There was institutional approval for the study.

**Image acquisition.** Studies were performed using an S5-1 transducer and an iE33 imaging platform (Philips, Andover, Massachusetts) and were analyzed offline using Xcelera (Philips). The LV and LA dimensions were determined from the parasternal long-axis window, and MR severity was defined using a multiparametric approach, including an assessment of the effective regurgitant orifice area (EROA), the regurgitant volume, and the presence of pulmonary venous flow reversal (14). The PA pressure was estimated through assessment of the tricuspid regurgitant jet and right atrial pressure. Diastolic function was described with the E/E' ratio, where E was measured using pulsed Doppler of mitral inflow from the 4-chamber view, and E' as the average of the septal and lateral mitral annular

### ABBREVIATIONS AND ACRONYMS

AF = atrial fibrillation

EF = ejection fraction

EROA = effective regurgitant orifice area

LA = left atrial/left atrium

LAV = left atrial volume

LV = left ventricular

LVIDs = left ventricular internal diameter in systole

MR = mitral regurgitation

MVP = mitral valve prolapse

NYHA = New York Heart Association

PA = pulmonary artery

TLAEF = total left atrial emptying fraction

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