

## Left atrial function

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### Introduction

The objective of studying left atrial (LA) function is to understand its contribution to the overall stroke volume as well as to find methods for estimating LA pressure as a cause of breathlessness.

LA shares many anatomical features of the left ventricle (LV), and orientationally, it is a mirror image of the latter. Although the overall myocardial thickness of LA is only one-third that of LV, basal myocardial fibers of LA are circumferential and the rest of the myofibers are longitudinal, originating from the back of the atrium, being attached to the mediastinal ligaments, and inserting in the mitral annulus. Such anatomical design makes LA and LV functionally interdependent, with systole of one chamber occurring during diastole of the other and vice versa. LA function encompasses the following components; reservoir, electric, electromechanical and mechanical. Each of these components plays an important role in maintaining the overall normal function of the chamber, despite the age-related changes that have significant functional implications (1).

### LA reservoir function

This function coincides with LV systole and the downward displacement of the LA base toward LV apex, resulting in the enlargement of LA, a fall in its cavity pressure, and maximum cavity filling from the pulmonary veins. There are numerous factors determining the optimum LA reservoir function, including cavity size, pressure, and compliance. An enlarged cavity is usually associated with raised pressure and poor compliance as well as with disturbances that are known to compromise pulmonary venous flow, raise pulmonary venous pressure, and reduce LV fill-

ing volume (2). While mild degree of such disturbances could be tolerable, significant changes cause breathlessness, particularly when patients develop atrial fibrillation. Even in the absence of any pathology, LA reservoir function has been shown to be a potent marker of first atrial fibrillation/flutter in persons aged >65 years, particularly those with LA emptying fraction <49% (3). LA volume reduction surgery has also been shown to improve cavity mechanical function as well as electric instability (4), and reduced LA compliance has been reported to be a predictor of exercise capacity (5) and quality of life (6).

### LA electric function

Similar to LV, electric depolarization of LA is shown as P wave with its amplitude and duration dimensions. While normally the two parameters correlate with each other, they lose the correlation in disease conditions. P wave duration increases in acute inferior myocardial infarction and normalizes over the first 30 days of recovery (7). Progressive broadening of P wave has also been reported to be a predictor of the development of atrial fibrillation and flutter (8). Furthermore, signal-averaged P wave duration has been shown to predict atrial fibrillation occurrence after coronary-artery bypass grafting (9).

### LA electromechanical function

Similar to LV, the LA electromechanical function reflects the time delay between the onset of the P wave and that of LA mechanical systole. Although little work has been done in this field, a direct relationship between P wave duration and prolonged LA electromechanical delay has been reported preceding the development of atrial arrhythmia. Further studies are required to identify the exact determinants of atrial arrhythmia, P wave duration, and delayed electromechanics or both.

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### LA mechanical function

Echocardiography is the best imaging technique, with its multiple modalities, for studying LA mechanical function. Early M-mode studies have already established the extent of normal LA amplitude of motion and its time relation with respect to the onset of atrial depolarization. Also, the physiological explanation of the Bernheim "a" wave being a sign of atrial cross talk rather than right ventricular inflow tract obstruction, as previously thought, has been clearly established (10). Furthermore, reduced LA mechanical amplitude has been shown to explain the suppressed late diastolic filling of LV in patients with stiff cavity and restrictive filling pattern (11). Similar findings can easily be shown using tissue Doppler velocities, although it has not been fully investigated. Recently, speckle tracking echocardiography has become an integral part of routine echocardiographic investigations. Although primarily used for studying LV function, the technique has been explored for assessing LA function and has been proved to be of immense importance. Studies have shown clear evidence of a correlation between reduced LA compliance and heart failure symptoms irrespective of LV functional parameters and of reduced LA myocardial deformation in patients with paroxysmal atrial fibrillation, irrespective of cavity size (12). Such abnormalities have also been shown to be the most accurate predictors of raised cavity pressure (13, 14) and recurrence of atrial fibrillation after catheter ablation, over and above all other structural and function LA parameters (15). These data make LA function assessment an important step in the early identification of cardiac damage that is pathophysiologically linked to the future onset of heart failure and atrial fibrillation.

### Conclusion

Strong evidence exists supporting the importance of normal LA structure and function in maintaining optimum stroke volume and normal post-capillary pulmonary venous pressure. LA electrical and mechanical functions are integrated and closely related to its reservoir function. However, the available echocardiography technology has shed strong light on the pivotal importance of LA mechanical function in various disease conditions, even paroxysmal atrial fibrillation with normal cavity size. Routine adoption of such modalities will assist in early detection of diseases and will guide toward optimum treatment before the damage becomes irreversible, as is the case with LA paralysis (16).

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