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Comparison between Transesophageal Echocardiography and Transthoracic Echocardiography with Harmonic Tissue Imaging for Left Atrial Appendage Assessment

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Summary

Background: Transesophageal echocardiography (TEE) is the method of choice for evaluating both anatomy and function of left atrial appendage (LAA). In contrast, conventional transthoracic echocardiography (TTE) does not result in images of sufficient quality to explore LAA.

Hypothesis: The aim of this study was to evaluate the potential role of TTE with harmonic frequency imaging (HFI) for assessing LAA normal anatomy and function.

Methods: The study group comprised 25 patients, (9 men, 16 women, mean age 51 years, range 20–82). The TTE assessment of LAA both in fundamental frequency imaging (FFI) and HFI was performed using the apical two-chamber view; the longitudinal two-chamber view was used for TEE assessment of LAA. According to image quality, images were categorized into three classes: A: good quality, B: sufficient quality, C: poor quality.

Results: Transthoracic echocardiography conventional imaging allowed sufficient LAA visualization (class B) in only 5 of 25 patients (20%); the HFI resulted in adequate LAA visualization in 23 of 25 patients (92%). Images were of good quality (class A) in 18 of 23 patients and of sufficient quality (class B) in 5 of 23 patients. Transesophageal echocardiography achieved good quality images in 24 of 25 patients (96%). Average LAA maximum area determined by HFI and TEE was 3.46 ± 1.17 and 3.59 ± 1.16 cm^2, respectively; LAA minimum area was 1.81 ± 0.98 and 1.77 ± 0.97 cm^2, respectively. Percent LAA area change was 51 ± 16.5 and $50.9 \pm 16\%$ with HFI and TEE, respectively. Statistical analysis showed no difference between the data obtained with the two methods.

Conclusions: The results suggest that HFI TTE may be a useful tool for the exploration of LAA.

Key words: transesophageal echocardiography, transthoracic harmonic imaging, left atrial appendage

Introduction

Transesophageal echocardiography (TEE) is the method of choice for evaluating both anatomy and function of left atrial appendage (LAA),[1–11] and in particular for detecting the presence of thrombi. In contrast, in the vast majority of patients conventional transthoracic echocardiography (TTE) in fundamental frequency imaging (FFI) does not result in images of sufficient quality to explore LAA.[12]

Due to the improved signal-to-noise ratio, harmonic frequency imaging (HFI) has the potential for a better definition of cardiac structures compared with FFI two-dimensional (2-D) echocardiography.[13–17] However, HFI has not yet been widely validated for investigation of LAA.

The aim of this study was to evaluate the potential role of TTE with HFI for assessing LAA normal anatomy and function. The results were compared with those obtained with TEE.

Methods

The study group comprised 25 patients (9 men, 16 women, mean age of 51 years, range 20–82). Seventeen patients (68%) were in sinus rhythm and 8 (32%) in atrial fibrillation (AF). Indications for TEE were search for possible intracardiac thrombi in patients with cerebral ischemia (n = 11); evaluation

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of atrial septal defect (n = 4); congenital or acquired valvular disease (n = 7); aortic dissection (n = 1). In two patients TEE was performed as evaluation before cardioversion.

Echocardiographic images were obtained using a commercial equipment (General Electrics Vingmed System Five, Horten, Norway). Fundamental frequency imaging was obtained at 2.5–3.25 MHz, whereas HFI was obtained with ultrasound waves transmitted at 1.7 MHz and received at 3.4 MHz. Transesophageal echocardiography studies were performed using a 5 MHz mechanical multiplane transducer.

Transthoracic echocardiography assessment of LAA, both in FFI and in HFI, was performed using the apical two-chamber view (Fig. 1A) with the patient in the left lateral position. The longitudinal two-chamber view at mid-esophageal level was used for TEE LAA study (Fig. 1B). According to the image quality, echocardiographic examinations were categorized by consensus of two readers into three classes: good quality (class A), sufficient quality (class B), poor quality (class C). The following parameters were determined for LAA: maximum area, minimum area, and % area change. Each parameter was calculated by two expert independent observers. For patients in sinus rhythm, the mean value of each parameter was obtained from three consecutive cycles, while for patients in AF the mean value was obtained from six consecutive cycles. The LAA end-systolic area, measured at the end of the T wave on the electrocardiogram (ECG), was considered as the maximum area. The end-diastolic area, measured simultaneously with the R wave of the ECG, was considered as the minimum area. The % area change was calculated as follows: (maximum area − minimum area)/maximum area.

Data are expressed as mean ± standard deviation (SD) and compared by one-way analysis of variance (ANOVA) for repeated measures. If the normality test failed, the nonparametric Kruskal-Wallis test was performed. A two-tailed test value of $p < 0.05$ was considered statistically significant.

Results

Conventional transthoracic imaging allowed a sufficient LAA visualization (class B) in only 5 of 25 patients (20%). In the remaining 20 patients, the fundamental frequency images were too poor to allow LAA measurements (class C). The harmonic imaging resulted in adequate LAA visualization in 23 of 25 patients (92%); good quality images (class A) were obtained in 18 of 25 patients, sufficient quality images (class B) in 5 of 25 patients, and poor quality images (class C) in 2 patients only. Transesophageal echocardiography permitted a good quality (class A) LAA visualization in 24 of 25 patients (96%), whereas only 1 patient had class C images. Concordance between the two readers was 100% for TEE, 84% for conventional TTE, and 92% for HFI-TTE.

Mean LAA maximum area determined by HFI and TEE was 3.46 ± 1.17 and 3.59 ± 1.16 cm^2, respectively. The LAA minimum area was 1.81 ± 0.98 and 1.77 ± 0.97 cm^2, respectively.

The LAA area change was 51 ± 16.5% with HFI-TTE and 50.9 ± 16% with TEE. Statistical analysis showed no difference between data obtained with the two methods (Table I).

Discussion

Our results demonstrate that LAA anatomic and functional parameters obtained with HFI do not differ from those measured with TEE. This suggests that transthoracic echocardiogram with HFI is a good tool for LAA exploration.

The main purpose of our research on HFI was the functional study of LAA rather than the detection of thrombi, since none of our patients showed a thrombotic mass at TEE. On the other hand, TEE continues to play an outstanding role in the search for thrombi, also because LAA is often plurilobated,

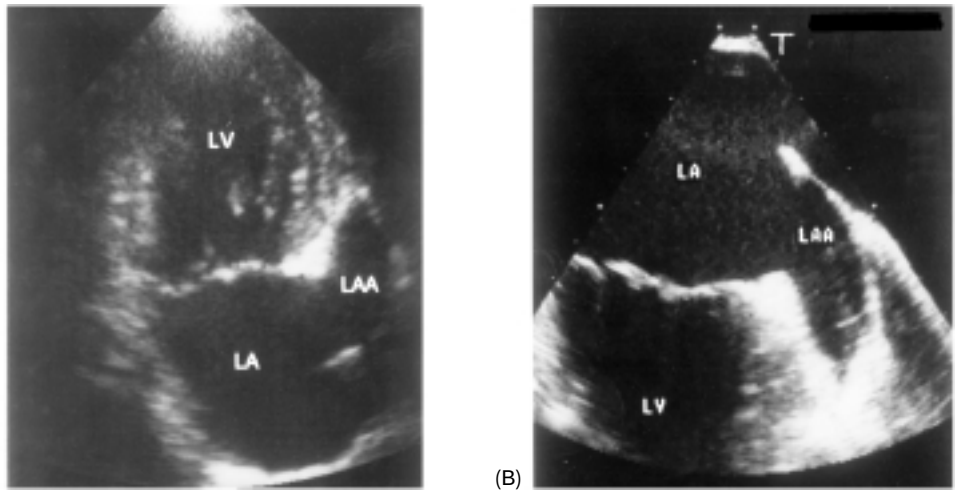

FIG. 1 (A) Transthoracic echocardiogram in harmonic frequency imaging recorded from the apical two-chamber view. (B) Transesophageal echocardiogram of the same patient recorded from the longitudinal two-chamber view. LA = left atrium, LAA = left atrial appendage, LV = left ventricle.

TABLE I Mean value ± standard deviation of left atrial appendage maximum area, minimum area, and % change determined by transthoracic and transesophageal echocardiography

	TTE	TEE	p Value
Maximum area (cm^2)	3.46 ± 1.17	3.59 ± 1.16	0.9
Minimum area (cm^2)	1.81 ± 0.98	1.77 ± 0.97	0.5
Area change (%)	51 ± 16.5	50.9 ± 16	0.6

Abbreviations: TTE = transthoracic echocardiography with harmonic imaging, TEE = Transesophageal echocardiography

so that it must be explored on several planes, a goal that can be achieved only with multiplane TEE.[18] Accordingly, TEE has been proposed as a screening method for patients with AF as candidates for cardioversion. Transthoracic echocardiographic imaging has been markedly improved by HFI, which ameliorates visualization not only of the left ventricular endocardial borders but of any cardiac structure. In the evaluation of LAA, HFI TTE has shown a good sensitivity and specificity for assessment of LAA function and detection of thrombi.[19–21]

Although some authors have reported a good relationship between LAA pulsed wave (PW) Doppler flow data obtained with TTE and those measured with TEE,[21, 22] we did not use PW Doppler to evaluate LAA flow. This is because we observed that transthoracic echo does not permit an optimal alignment of the Doppler beam with the LAA flow, and also because wall artifacts hamper PW Doppler flow curves.

Conclusion

Our results suggest that TTE with second harmonic imaging is suitable for the functional exploration of the LAA. The main present application of this technique could be monitoring of postcardioversion atrial stunning, aimed at the management of anticoagulant treatment. Further studies with larger groups of patients will better assess the role of transthoracic evaluation of LAA.

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