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Relation between left atrial measurements and thromboembolic risk markers assessed by echocardiography in patients with nonvalvular atrial fibrillation: A cross-sectional study

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KEYWORDS

Nonvalvular atrial fibrillation;
Left atrial size;
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Transthoracic echocardiography;
Transesophageal echocardiography

Abstract *Background:* Left atrium (LA) dilatation has been associated with adverse cardiovascular outcomes in patients with sinus rhythm and atrial fibrillation (AF).

Aim of the study: We aimed to evaluate the accuracy of left atrial (LA) size to predict transesophageal echocardiographic (TEE) markers of increased thromboembolic risk left atrial appendage (LAA) thrombus, low LAA velocities and dense spontaneous echocardiographic contrast (SEC), and also to assess the best method to evaluate LA size.

Patients and methods: Cross-sectional study included 64 patients with nonvalvular AF undergoing transthoracic and transesophageal echocardiographic (TTE and TEE) evaluation. LA size was measured on TTE by several methods including the following: anteroposterior diameter (AP), LA area in four and two apical chamber views and volumes by ellipsoid, single plane (1P) and biplane area-length (2P) formulas. All these measures were indexed to the body surface area (BSA). Thromboembolic markers including LAA thrombus, low LAA velocities, dense SEC and LA abnormality (LA ABN) which means the presence of one or more of the previous three parameters were evaluated by TEE.

Results: There was statistically significant increase in indexed and non-indexed LA parameters in patients with LA ABN compared to patients without LA ABN. According to ROC curve, the study found that all indexed LA parameters were predictive for LAA thrombus with the highest AUC was indexed LA 1P area length volume (AUC 0.91, CI 95% 0.81–1.01, $p < 0.000$), for LAA low flow velocity were indexed and non-indexed LA AP diameters with the highest AUC was indexed LA

Abbreviations: ABN, abnormality; AP, anteroposterior; AF, atrial fibrillation; 2P, biplane; BMI, body mass index; BSA, body surface area; DM, diabetes mellitus; EF, ejection fraction; GFR, glomerular filtration rate; HTN, hypertension; ICD, implantable cardioverter defibrillator; INR, international normalized ratio; LA, left atrium; LAA, left atrial appendage; LV, left ventricle; 1P, single plane; SEC, spontaneous echocardiographic contrast; TEE, transesophageal echocardiography; TIA, transient ischemic attack; TTE, transthoracic echocardiography

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AP diameter (AUC 0.89, CI 95% 0.80–0.98, $p < 0.000$), for LA dense SEC were indexed LA ellipsoid volume (AUC 0.78, CI 95% 0.66–0.96, $p = 0.002$) and indexed LA IP area length volume (AUC 0.78, CI 95% 0.66–0.90, $p = 0.002$) and for LA ABN were all LA parameters with the highest AUC was indexed LA IP area length volume (AUC 0.87, CI 95% 0.79–0.96, $p < 0.000$). On multivariate logistic regression analysis of TEE parameters, the study found that the most predictive LA measurement for LAA thrombus was indexed LA AP diameter with cutoff 3 cm/m² (OR 7.5, 95% CI 1.24–45.2, $p = 0.02$), for LAA low flow velocity was LA AP diameter with cutoff 6 cm (OR 17.6, 95% CI 3.23–95.84, $p = 0.001$), for LA dense SEC was indexed LA ellipsoid volume with cutoff 42 cm³/m² (OR 6.5, 95% CI 1.32–32.07, $p = 0.02$), and for LA ABN was indexed LA ellipsoid volume with cutoff 42 cm³/m² (OR 10.45, 95% CI 2.18–51.9, $p = 0.008$).

Conclusion: LA enlargement is suitable to predict thromboembolic markers in patients with non-valvular AF. The indexed and non-indexed LA AP diameter and indexed LA ellipsoid volume were the most accurate parameters for predicting thromboembolic markers.

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1. Introduction

Enlargement of left atrium (LA) has been established as a prognostic marker for adverse CV outcomes such as atrial fibrillation,^{1,2} stroke,³ congestive heart failure,⁴ and cardiovascular death.⁵ Different methods exist for the assessment of LA size. The American Society of Echocardiography recommended LA volume and its indexed value assessed by 2-dimensional echocardiography to measure LA size.⁶

The pathogenesis of LAA thrombus has not been fully elucidated, but the prediction for its formation in the LAA is likely to result from stagnation within the long, blind ended trabeculated pouch.⁷ Diminished contractility of the appendage understandably leads to reduction in blood flow as well.⁸

LAA thrombus is associated with a large LAA area.⁹ The prevalence of LA/LAA thrombi gradually increases with the number of clinical risk factors.¹⁰ The LAA is the site most commonly associated with thrombus formation, particularly in patients with nonvalvular AF.⁵ Larger LA and LAA sizes are associated with lower LAA flow velocity and risk of ischemic stroke.^{11,8}

Transesophageal echocardiography (TEE) is sensitive in the assessment of parameters associated with thromboembolism including thrombus in the LA appendage (LAA thrombus),¹² dense spontaneous echocardiographic contrast (SEC), low LA appendage flow velocities (low LAA velocities).^{13,14} The presence of at least one of the three previous TEE changes has been designated by left atrial abnormality (LA ABN) and is associated with a risk of stroke of 7.8% a year.¹⁵

TEE is the most sensitive and specific technique to detect LAA thrombus in patients with AF prior to cardioversion and radiofrequency ablation procedures.¹⁶ However, several studies demonstrated that LAA is free of thrombi in ~86% of AF patients who underwent a TEE prior to cardioversion.¹⁷ The cost implications of this practice are particularly important because TEE is an increasingly utilized procedure,¹⁸ in addition to the associated risk of complications such as oral and esophageal trauma and the risks of conscious sedation.¹⁹ Therefore, there may be a role for risk stratification in patients with AF to determine the need for a TEE to exclude the presence of LAA thrombus prior to cardioversion and radiofrequency ablation procedures.

2. Aim of the study

This study aims to evaluate the accuracy of LA size to predict transesophageal echocardiographic (TEE) markers of increased thromboembolic risk left atrial appendage (LAA) thrombus, low LAA velocities and dense spontaneous echocardiographic contrast (SEC), and also to assess the best method to evaluate LA size.

3. Patients and methods

3.1. Patients

This is a cross-sectional study included 65 patients with nonvalvular atrial fibrillation (AF) admitted to cardiology department or referred to transthoracic and transesophageal echocardiography (TTE and TEE) from outpatient cardiology clinic in Zagazig University Hospitals from November 2014 to April 2015. Exclusion criteria were patients with mitral stenosis, mitral regurgitation (moderate or severe), aortic stenosis (moderate or severe), prosthetic mitral or aortic valves, patients with unsuitable images for accurate assessment of transthoracic echocardiography (TTE) measurements or transesophageal echocardiography (TEE) markers of thromboembolic risk and any contraindication to TEE.

3.2. Methods

3.2.1.

All patients in the study were subjected to the following: complete medical history and physical examination including calculated body surface area (BSA), body mass index (BMI),²⁰ CHADS2 and CHA2DS2-VASc scores.^{21,22} Electrocardiogram (ECG) and laboratory examination includes prothrombin time, international normalized ratio (INR) and glomerular filtration rate (GFR).

3.2.1. Transthoracic echocardiography

All patients underwent Doppler echocardiographic examination using a commercially available system (GE). Examinations were performed by three trained echo cardiographers according to American society of echocardiography. M-mode and two-

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