

Do Left Atrial Strain Parameters Predict Appendage Thrombus in Atrial Fibrillation? Insights from a Cross-Sectional Analysis

Les paramètres de déformation de l'oreillette gauche prédisent-ils la présence d'un thrombus dans l'auricule en cas de fibrillation atriale ?

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SUMMARY

Introduction: Atrial fibrillation (AF) is associated with an increased risk of thromboembolic events, with the left atrial appendage (LAA) being the main site of thrombus formation. Left atrial (LA) strain is a promising non-invasive tool, but its diagnostic performance remains inconsistent.

Objectives: To evaluate the association between LA strain, LAA function, and LAA thrombus or spontaneous echo contrast (SEC) in patients with non-valvular AF.

Methods: This prospective cross-sectional study included 31 non-valvular AF patients undergoing transesophageal echocardiography (TEE). Patients were divided into a normal TEE group (NT, n=14) and a thrombus/SEC group (T+/-C, n=17). LA strain and echocardiographic parameters were compared.

Results: LA reservoir, conduit, and contractile strains were globally reduced with no significant intergroup differences. However, the E/E' ratio showed a borderline significant trend toward higher values in the T+/-C group (17.7 ± 12.4 vs 13.9 ± 4.8 , $p=0.050$).

Conclusion: LA strain parameters did not significantly discriminate patients with LAA thrombus/SEC in this cohort. The presence of global LA dysfunction and limited sample size may explain these findings. Larger studies are warranted.

KEYWORDS

Atrial Fibrillation,
Left Atrial Strain,
Left Atrial
Appendage,
Thrombus

RÉSUMÉ

Introduction : La fibrillation atriale (FA) est associée à un risque accru d'événements thromboemboliques, l'auricule gauche (AG) étant le principal site de formation de thrombus. Le strain de l'oreillette gauche (OG) est un outil non invasif prometteur, mais ses performances diagnostiques restent inconstantes.

Objectif: Évaluer l'association entre le strain de l'OG, la fonction de l'AG, et la présence d'un thrombus ou d'un contraste échographique spontané (SEC) dans l'AG chez des patients atteints de FA non valvulaire.

Méthodes : Cette étude transversale prospective a inclus 31 patients atteints de FA non valvulaire bénéficiant d'une échocardiographie transesophagienne (ETO). Les patients ont été répartis en un groupe ETO normale (NT, n=14) et un groupe thrombus/SEC (T+/-C, n=17). Le strain de l'OG et les paramètres échocardiographiques ont été comparés.

Résultats : Les strains réservoir, conduit et contractile de l'OG étaient globalement réduits, sans différences intergroupes significatives. Cependant, le ratio E/E' a montré une tendance à la limite de la significativité vers des valeurs plus élevées dans le groupe T+/-C ($17,7 \pm 12,4$ vs $13,9 \pm 4,8$, $p=0,050$).

Conclusion : Les paramètres de strain de l'OG n'ont pas permis de discriminer significativement les patients présentant un thrombus/SEC de l'AG au sein de cette cohorte. La présence d'une dysfonction globale de l'OG et la taille limitée de l'échantillon pourraient expliquer ces résultats. Des études à plus grande échelle sont nécessaires.

MOTS-CLÉS

Fibrillation atriale,
Strain de l'oreillette
gauche, Auricule
gauche, Thrombus

Correspondance

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INTRODUCTION

Atrial fibrillation (AF) is heavily associated with thromboembolic events, specifically ischemic stroke. Thrombus formation within the left atrial appendage (LAA) represents the primary source of emboli in non-valvular AF. Early identification of LAA thrombus is crucial prior to rhythm control procedures. While transesophageal echocardiography (TEE) remains the gold standard for detecting LAA thrombus due to its high spatial resolution [1], its semi-invasive nature drives the search for non-invasive echocardiographic predictors.

Left atrial (LA) strain, assessed via transthoracic echocardiography (TTE) using speckle-tracking, offers a promising non-invasive method for evaluating LA mechanical function [2, 3]. LA strain can detect subtle dysfunction by evaluating the reservoir, conduit, and contractile phases. Recent data suggest reduced LA strain may correlate with thromboembolic events and LAA thrombus [4, 9]. However, available evidence remains heterogeneous. This study aims to evaluate the relationship between LA strain parameters and the presence of LAA thrombus or spontaneous echo contrast (SEC) in patients with non-valvular AF.

METHODS

Study Population

This prospective, descriptive, single-center study was conducted between January and August 2025. Thirty-one consecutive patients with non-valvular AF, referred for echocardiographic assessment prior to rhythm control procedures (cardioversion or catheter ablation), were enrolled. Patients with significant mitral valve disease or inadequate acoustic windows were excluded. All patients underwent both TTE and TEE during the same hospitalization. Oral informed consent was obtained from all participants.

Echocardiographic Assessment

TTE evaluated left ventricular ejection fraction (LVEF), left ventricular mass index (LVMI), and diastolic function (E wave, E' velocity, E/E' ratio). Indexed LA volume (LAVi) and LA strain (reservoir, conduit, and contractile) were quantified using two-dimensional speckle-tracking echocardiography in the apical four-chamber view. TEE was utilized to assess the presence of LAA thrombus, SEC, and to measure LAA emptying velocity (LAA-EV). All echocardiography exams were performed using a VIVID TM E95 Ultra Edition (GE, HealthCare, Chicago, IL, USA).

RESULTS

Demographic and Clinical Characteristics

The study population (n=31) was divided into a normal TEE group (NT, n=14) and a thrombus/SEC group (T+/-C, n=17). Baseline demographic and clinical characteristics were comparable between both groups (Table 1). The CHA2DS2-VA score was numerically higher in the T+/-C group but did not reach statistical significance (p=0.377).

Table 1. Demographic and Clinical Characteristics

Variable	NT (n=14)	T+/-C (n=17)	P-value
Age (years)	64.2 ± 9.7	65.7 ± 9.6	0.673
Male (%)	71.4	82.4	-
Hypertension (%)	64.3	35.3	0.115
Diabetes Mellitus (%)	21.4	41.2	0.256
Heart Failure (%)	64.3	52.9	0.540
BMI	28.7 ± 5.1	27.0 ± 6.4	0.457
CHA2DS2-VA	2 ± 1	3 ± 1	0.377

Echocardiographic Parameters

Echocardiographic measurements revealed comparable LVEF and LA strain values between the two groups. Reservoir, conduit, and contractile strains were uniformly reduced across the cohort (Table 2). Notably, the E/E' ratio was higher in the T+/-C group (17.7 ± 12.4 vs. 13.9 ± 4.8), reaching borderline statistical significance (p=0.05). LAA-EV showed a non-significant reduction in the T+/-C group compared to the NT group (0.28 ± 0.07 m/s vs. 0.35 ± 0.17 m/s, p=0.207).

Table 2. Echocardiographic Measurements

Parameter	NT (n=14)	T+/-C (n=17)	P-value
LVEF (%)	42.6 ± 13.4	43.5 ± 19.2	0.885
E/E' ratio	13.9 ± 4.8	17.7 ± 12.4	0.050
Contractile Strain (%)	-1.84 ± 2.64	-1.76 ± 3.03	0.939
Reservoir Strain (%)	7.30 ± 3.49	7.00 ± 4.71	0.845
Conduit Strain (%)	-5.53 ± 4.09	-5.17 ± 5.13	0.837
LAVi (mL/m ²)	51.0 ± 14.8	52.5 ± 20.9	0.818
LAA-EV (m/s)	0.35 ± 0.17	0.28 ± 0.07	0.207

LVEF = Left Ventricular Ejection Fraction, E-wave* = Transmitral E-wave velocity, Septal E' = Septal early diastolic velocity, TDI = Tissue Doppler Imaging, TR Vmax = Maximal velocity of tricuspid regurgitation, LVH=Left Ventricular Hypertrophy

DISCUSSION

The present study evaluated the association between LA strain parameters and LAA thrombus/SEC in patients with non-valvular AF. Our findings highlight a global impairment in LA mechanical function across the entire cohort, with uniformly reduced reservoir, conduit, and contractile strain

values regardless of the presence of LAA thrombus. These findings differ from previous reports where reduced LA strain—particularly reservoir and contractile phases—was independently associated with incident ischemic stroke and the presence of LAA thrombus [2, 3, 4, 8].

While LA strain parameters did not show statistical divergence between our study arms, we observed a borderline significant increase in the E/E' ratio within the thrombus/SEC group. This elevation may reflect higher left ventricular filling pressures and early diastolic dysfunction, established risk factors contributing to LAA stasis and thrombus formation [5]. Concurrently, lower LAA emptying velocities trended within the T+/-C group, aligning with broader evidence linking decreased LAA velocity to pro-thrombotic states [6].

Additionally, clinical risk assessments, such as the CHA₂DS₂-VA score, have historically been solid predictors for thromboembolic risk and stroke [7, 9]. In our cohort, the numerical trend of higher scores in the thrombus group corroborates these established paradigms, despite missing statistical significance due to sample size constraints.

The lack of discriminative power for LA strain in our specific population may be attributed to a uniformly advanced degree of structural remodeling, as evidenced by universally high indexed LA volumes (LAVi). Furthermore, this study is inherently limited by its small sample size, which reduces statistical power, and its cross-sectional nature, precluding long-term outcome tracking. Future large-scale, prospective, multicenter studies incorporating direct LAA strain analysis are warranted to fully validate the diagnostic and prognostic utility of deformation imaging in AF patients.

CONCLUSIONS

Although left atrial (LA) strain was globally reduced in the cohort, there was no statistically significant difference in strain values between patients with and without left atrial appendage (LAA) thrombus or spontaneous echo contrast (SEC). This lack of significant association contrasts with prior studies and may be attributed to the small sample size, the overall reduced LA strain across all patients, and the lack of direct assessment of LAA mechanics. While LA strain remains a promising non-invasive tool for evaluating atrial function, larger multicenter studies incorporating direct LAA strain analysis are needed to confirm its predictive value and potentially reduce the need for routine transesophageal echocardiography (TEE).

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