Left Ventricular Systolic Dysfunction by Longitudinal Strain Is an Independent Predictor of Incident Atrial Fibrillation
A Community-Based Cohort Study

Cesare Russo, MD; Zhezhen Jin, PhD; Fusako Sera, MD; Edward S. Lee, MD, MPH; Shunichi Homma, MD; Tatjana Rundek, MD, PhD; Mitchell S.V. Elkind, MS, MD; Ralph L. Sacco, MS, MD; Marco R. Di Tullio, MD

Background—The increasing prevalence of atrial fibrillation (AF) represents a public health issue. Identifying new predictors of AF is therefore necessary to plan preventive strategies. We investigated whether left ventricular (LV) systolic dysfunction by global longitudinal strain (GLS), a predictor of cardiovascular events, may predict new-onset AF in a population setting.

Methods and Results—Participants (n=675; mean age, 71±9 years; 60% women) in sinus rhythm from the population-based Northern Manhattan Study (NOMAS) underwent 2- and 3-dimensional echocardiography as part of the Cardiac Abnormalities and Brain Lesions (CABL) study. LV systolic function was assessed by LV ejection fraction and speckle-tracking GLS. During a mean follow-up of 63.6±18.7 months, 32 (4.7%) new confirmed cases of AF occurred. Lower GLS (adjusted hazard ratio/unit decrease, 1.22; 95% confidence interval, 1.04–1.43; P=0.015) and increased left atrial volume index (LA Vi; adjusted hazard ratio/unit increase, 1.12; 95% confidence interval, 1.07–1.17; P<0.001) were significantly associated with incident AF, whereas LV ejection fraction was not (P=0.176). Abnormal GLS (>–14.7%) was associated with risk of new-onset AF with an adjusted hazard ratio of 3.2 (95% confidence interval, 1.4–7.5; P=0.007). The coexistence of abnormal GLS/abnormal LA Vi was associated with a 28.6% incidence of AF (adjusted hazard ratio, 12.1; 95% confidence interval, 3.3–44.8; P<0.001) compared with participants with normal GLS/normal LA Vi (AF incidence, 2.0%). AF incidence was intermediate in those with either abnormal GLS or abnormal LA Vi (9.3% and 11.1%, respectively). GLS prognostic value for incident AF was incremental over risk factors and LA Vi.

Conclusions—LV systolic dysfunction by GLS was a powerful and independent predictor of incident AF. GLS assessment may improve AF risk stratification in addition to established parameters. (Circ Cardiovasc Imaging. 2015;8:e003520. DOI: 10.1161/CIRCIMAGING.115.003520.)

Key Words: atrial fibrillation • echocardiography • systole • ventricular dysfunction, left

In the United States, atrial fibrillation (AF) affects >2 million people. The prevalence of AF significantly increases in older age, with only 0.1% of the population affected before age 55, 3.8% affected over age 60, and 9.0% among those >80 years old. Because of the aging of the population, AF prevalence is expected to rise significantly, with estimates ranging from 5.6 million to >10 million per year 2050. These figures make AF a public health issue, aggravated by its strong association with stroke, heart failure, and death. It is therefore of critical importance to identify subjects at high risk of developing AF, especially in the elderly subgroup of the general population.

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Population studies identified age, hypertension, diabetes mellitus, heart failure, and myocardial infarction as major risk factors for the development of AF. Among echocardiographic variables, increased left atrial volume is an established predictor of incident AF, independent of and incremental to clinical risk factors. Recently, echocardiographic speckle-tracking imaging provided new insights in cardiac function assessment, shifting the attention from traditional measures of left ventricular (LV) cavity reduction, such as LV ejection fraction (LVEF), to the analysis of myocardial tissue deformation. LV global longitudinal strain (GLS), a measure of the myocardial systolic deformation over the longitudinal axis, is emerging as a robust parameter able to detect early LV systolic dysfunction under a variety of conditions, even in subjects without overt cardiac disease. A reduction of GLS is associated with
unfavorable cardiovascular outcome and mortality, and its prognostic value is independent of LVEF. Although coronary artery disease and congestive heart failure are established risk factors for AF, it is not known whether subclinical LV dysfunction assessed by GLS can predict incident AF in the general population and especially in the elderly, who are at greater risk of AF and stroke. Accordingly, we investigated the association between LV systolic dysfunction measured by speckle-tracking GLS and the development of new-onset AF in a community-based elderly cohort. We also assessed whether GLS provided additional prognostic information toward AF development over cardiovascular risk factors and established AF predictors.

**Methods**

**Study Population**
The Cardiovascular Abnormalities and Brain Lesion (CABL) study is a community-based epidemiological study designed to investigate the potential cardiovascular predictors of silent cerebrovascular disease in the community. CABL recruitment was based on the Northern Manhattan Study (NOMAS), a population prospective study investigating the epidemiology and risk factors for stroke and cardiovascular disease that enrolled 3298 participants from the community living in northern Manhattan between 1993 and 2001. The study design and recruitment details of NOMAS have been described previously.

Beginning in 2003, participants were invited to participate in a brain magnetic resonance imaging substudy if they (1) were at least 50 years of age, (2) had no contraindications to magnetic resonance imaging, and (3) did not have a previous diagnosis of stroke. From September 2005 to July 2010, NOMAS magnetic resonance imaging study participants who voluntarily agreed to undergo an extensive cardiovascular examination with native data for speckle-tracking assessment were available in 854 CABL participants. In 125, image quality was suboptimal for speckle-tracking analysis. Of the remaining 729 participants, 44 had either history of AF or AF at study enrollment documented by any observer. Confirmed AF cases were included in the analysis. Only AF cases confirmed by analysis of ECG tracings or medical records. Only cases with ≥ 126 mg/dL, self-reported history of diabetes mellitus, or use of diabetes mellitus medications. Hypercholesterolemia was defined as total serum cholesterol of > 240 mg/dL, self-reported history of diabetes mellitus, or use of diabetes mellitus medications. Hypercholesterolemia was defined as total serum cholesterol of > 240 mg/dL, self-reported history of hypercholesterolemia, or use of lipid-lowering treatment. Obesity was defined as a body mass index of ≥ 30 kg/m². Coronary artery disease was defined as a history of myocardial infarction, coronary artery bypass grafting, or percutaneous coronary intervention. All subjects were followed up annually by telephone interviews. Development of new-onset AF was ascertained through a questionnaire by trained research personnel and then confirmed by analysis of ECG tracings or medical records. Only confirmed AF cases were included in the analysis.

**Baseline Assessment and Follow-Up**
Cardiovascular risk factors were ascertained through direct examination and interview by trained research assistants as previously described. Hypertension was defined as systolic blood pressure of ≥ 140 mmHg or diastolic blood pressure of ≥ 90 mmHg or self-reported history of hypertension, or use of antihypertensive medication. Diabetes mellitus was defined as fasting blood glucose of ≥ 126 mg/dL, self-reported history of diabetes mellitus, or use of diabetes mellitus medications. Hypercholesterolemia was defined as total serum cholesterol of > 240 mg/dL, self-report of hypercholesterolemia, or use of lipid-lowering treatment. Obesity was defined as a body mass index of ≥ 30 kg/m². Coronary artery disease was defined as a history of myocardial infarction, coronary artery bypass grafting, or percutaneous coronary intervention. All subjects were followed up annually by telephone interviews. Development of new-onset AF was ascertained through a questionnaire by trained research personnel and then confirmed by analysis of ECG tracings or medical records. Only confirmed AF cases were included in the analysis.

**Echocardiographic Assessment**
Transthoracic echocardiography was performed using a commercially available system (iE 33; Philips, Andover, MA) by a registered cardiac sonographer according to a standardized protocol. LV wall thickness and diameters were measured from a parasternal long-axis view according to the recommendations of the American Society of Echocardiography. LV volumes and LVEF were calculated using the biplane-modified Simpson rule. LV end-diastolic diameter and LV volumes were indexed by body surface area. LV mass was calculated with a validated method and indexed by body surface area (LV mass index). LV relative wall thickness was calculated as 2×posterior wall thickness/LV end-diastolic diameter. Left atrial end-systolic volume was measured by 3-dimensional (3D) echocardiography as previously described and indexed by body surface area (left atrial volume index [LAVI]). Abnormal LAVI was defined as a value greater than the 95th percentile of the LAVI distribution (31.0 mL/m²) in a healthy subgroup of study participants free of cardiovascular risk factors. LV diastolic function assessment has been previously described. Briefly, in apical 4-chamber view, peak early velocity (E), its deceleration time, and late velocity (A) of mitral inflow were measured by pulsed-wave Doppler with sample volume placed at mitral valve tips. Peak early diastolic velocity (e′) of the lateral and septal mitral annulus were measured by pulsed-wave tissue-Doppler and averaged. LV diastolic dysfunction was defined as E/A of ≤ 0.7 or deceleration time of > 260 ms; or E/A between 0.7 and 1.5 and e′ < 7 cm/s; or E/A > 1.5 and e′ < 7 cm/s or deceleration time < 140 ms. GLS analysis was performed by 2D speckle-tracking technique using commercially available software (Philips QLAB Advanced Quantification Software, version 8.1) from 2D gray-scale loops as described previously. GLS was calculated averaging the negative peak of longitudinal strain from 12 ventricular segments from the apical 4-chamber and 2-chamber views. Abnormal GLS was previously defined as GLS of >−14.7% (GLS is a negative number, therefore less negative values correspond to smaller systolic longitudinal shortening), representing the cut-off identifying the lower 5% of the GLS distribution in a healthy subgroup of participants free of cardiovascular risk factors. Interobserver reproducibility of GLS measurement was assessed in a random sample of 20 study participants. Intraclass correlation coefficient for GLS was 0.85. Mean difference between measurements was 0.08±2.4%, and the coefficient of variation (SD/mean) was 0.09.

**Statistical Analysis**
Data are presented as mean±SD for continuous variables and as percentage for categorical variables. The t test and χ² test were used to compare groups and determine statistical significance.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Incident AF</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, y</td>
<td>70.8±9.2</td>
<td>77.1±7.4</td>
</tr>
<tr>
<td>Women, n (%)</td>
<td>391 (60.8)</td>
<td>17 (53.1)</td>
</tr>
<tr>
<td>Obesity, n (%)</td>
<td>182 (28.3)</td>
<td>15 (46.9)</td>
</tr>
<tr>
<td>Systolic blood pressure, mmHg</td>
<td>135±16.8</td>
<td>138±20.2</td>
</tr>
<tr>
<td>Diastolic blood pressure, mmHg</td>
<td>78.3±9.4</td>
<td>77.4±9.8</td>
</tr>
<tr>
<td>Hypertension, n (%)</td>
<td>492 (76.5)</td>
<td>29 (90.6)</td>
</tr>
<tr>
<td>Antihypertensive treatment, n (%)</td>
<td>442 (69.0)</td>
<td>27 (84.4)</td>
</tr>
<tr>
<td>Diabetes mellitus, n (%)</td>
<td>178 (27.7)</td>
<td>9 (28.1)</td>
</tr>
<tr>
<td>Hypercholesterolemia, n (%)</td>
<td>419 (65.3)</td>
<td>24 (75.0)</td>
</tr>
<tr>
<td>Coronary artery disease, n (%)</td>
<td>36 (5.6)</td>
<td>3 (9.4)</td>
</tr>
<tr>
<td>History of heart failure, n (%)</td>
<td>19 (3.0)</td>
<td>0 (0)</td>
</tr>
</tbody>
</table>

Data are presented as mean±SD for continuous variables or as absolute number and percentage for categorical variables. AF indicates atrial fibrillation.
### Results

#### Population Characteristics and Incident AF

The study sample included 680 participants in sinus rhythm and with no history of AF. During a mean follow-up of 63.6±18.7 months, 37 new cases of AF were recorded, of whom could not be confirmed by ECG or medical records and were therefore excluded from the analysis. The group of participants with suboptimal speckle-tracking analysis was older (73.2±8.2 versus 71.1±9.3 years; \( P=0.02 \)) and more frequently obese (29% versus 53%; \( P<0.001 \)) than the group in which speckle-tracking was feasible, but the 2 groups did not significantly differ in AF incidence (4.7% versus 6.0%; \( P=0.524 \)). Demographics and clinical characteristics of the study participants are shown in Table 1. Development of AF was significantly associated with older age (\( P<0.001 \)) and obesity (\( P=0.024 \)) and showed borderline association with hypertension (\( P=0.063 \)). Among echocardiographic variables (Table 2), greater LV wall thickness, LV mass index, relative wall thickness, and LAVi were significantly associated with incident AF (all \( P<0.001 \)). LA diastolic dysfunction was also more frequent in the incident AF group (\( P=0.007 \)).

#### LV Function, LA Vi, and Incident AF

Among variables of LV systolic function, GLS was significantly lower in participants who developed AF compared with those who did not (−15.2±4.1% versus −17.2±3.0%; \( P<0.01 \); Table 2), whereas no difference in LVEF was seen between the 2 groups. In participants with normal GLS incidence of AF was 3.1%, whereas it was 12.2% in those with abnormal GLS (\( P<0.001 \)). During follow-up, 63 participants died without developing AF, and therefore, death was used as a competing risk in all subsequent survival analyses. In univariate analysis (Table 3), GLS (HR/unit decrease, 1.20; 95% CI, 1.08–1.34; \( P=0.001 \)), LAVi (HR/unit increase, 1.11; 95% CI, 1.07–1.16; and >10%) in addition to risk factors.\(^{19,20}\) For all statistical analyses, a 2-tailed \( P<0.05 \) was considered significant. Statistical analyses were performed usingStata software version 12.0 (StataCorp, College Station, TX).
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As and greater LA Vi (P<0.001) had an aHR of 4.0 (95% CI, 1.5–10.5; P<0.001). The incremental prognostic value of GLS for incident AF with an HR of 3.8 (95% CI, 1.9–7.6; P<0.001; Table 4). Abnormal GLS was associated with incident AF with an HR of 3.8 (95% CI, 1.9–7.6; P<0.001; Table 4). In a multivariable model also including LAVi, abnormal GLS remained strongly associated with incident AF (adjusted HR [aHR], 3.2; 95% CI, 1.4–7.5; P=0.007). Increased LAVi was also independently associated with incident AF with an aHR of 3.8 (95% CI, 1.8–8.2; P<0.001; Table 4).

Figure 1A shows cumulative AF incidence in participants stratified by GLS and LAVi categories. Cumulative AF incidence was intermediate in the groups with either normal GLS or LAVi and was significantly worse in the abnormal GLS/abnormal LAVi group (P<0.001). Participants with normal GLS and normal LAVi experienced the lowest rate of AF during follow-up (2.0%) and those with either impaired GLS or increased LAVi showed intermediate rates of AF development (9.3% and 11.1%, respectively), whereas subjects with both impaired GLS and increased LAVi had the highest AF rate (28.6%; P<0.001 for the overall comparison; Figure 2B). Compared with subjects with both normal GLS and normal LAVi, those with abnormal GLS and normal LAVi had an aHR for incident AF of 3.3 (95% CI, 1.2–9.1; P=0.020), those with normal GLS and abnormal LAVi had an aHR of 4.0 (95% CI, 1.5–10.5; P=0.005), and those with abnormal GLS and abnormal LAVi showed the highest risk of AF (aHR, 12.1; 95% CI, 3.3–44.8; P<0.001; Table 5).

Incremental Prognostic Value of GLS for AF Prediction

The incremental prognostic value of GLS for incident AF is shown in Figure 3. When added to a model including clinical risk factors (−2log likelihood, 211.289), LAVi significantly increased the model predictive value (−2log likelihood, 199.374; χ² change, 11.914 versus previous step with 1 degree of freedom; P<0.001), whereas the addition of LVEF did not (−2log likelihood, 199.333; χ² change from previous step, 0.041 with 1 degree of freedom; P=0.802). The further addition of GLS resulted in a significant incremental improvement in the predictive value of the model (−2log likelihood, 190.025; χ² change from previous step, 9.308 with 1 degree of freedom; P=0.004). C-statistic was 0.75 in the model with risk factors, 0.78 after adding LAVi, and 0.81 after adding GLS. The net reclassification index for GLS in addition to the model including LA volume and risk factors was 0.29 (SE, 0.13; P=0.028).

Discussion

In this study, we assessed the value of GLS in predicting future development of AF in predominantly elderly individuals from the community. We found that impaired GLS was a strong independent predictor of AF development. Over a mean follow-up period of 5.3 years, AF incidence in participants with an abnormal GLS was 4x higher than in those with normal GLS (12.2% versus 3.1%). Traditional assessment of LV systolic function by LVEF did not provide any prognostic information for prediction of incident AF. We also confirmed the independent association of increased LAVi with the development of AF. Furthermore, our study showed that GLS and LAVi predicted incident AF independently of each other and of other risk factors. Most importantly, we demonstrated that the coexistence of both abnormal GLS and abnormal LAVi was associated with significantly higher incidence of AF (28.6%), whereas the presence of either impaired GLS or dilated LAVi was associated with an intermediate risk of AF during follow-up.

Although it is known that the presence of overt congestive heart failure is associated with AF and that impaired LVEF predicts AF occurrence in subjects with coronary artery disease, our study is the first to describe the association between a parameter of subclinical LV dysfunction and incident AF in a general elderly population. The mechanisms behind the association of GLS with incident AF, however, are not known. GLS is a measure of the contraction of the longitudinally oriented myocardial fibers, which are mostly located in the subendocardial region of the LV. Because the LV subendocardium

Table 4. Cox Proportional Hazards Regression With Death as a Competing Risk Showing the Association of Abnormal GLS and LAVi With Incident Atrial Fibrillation

<table>
<thead>
<tr>
<th>GLS</th>
<th>HR (95% CI)</th>
<th>P Value</th>
<th>LAVi</th>
<th>HR (95% CI)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>GLS &gt;−14.7%</td>
<td>3.8 (1.9–7.6)</td>
<td>&lt;0.001</td>
<td>LAVi &gt;31 mL/m²</td>
<td>3.2 (1.4–7.5)</td>
<td>0.007</td>
</tr>
<tr>
<td>GLS ≤−14.7%</td>
<td>3.8 (1.8–8.2)</td>
<td>&lt;0.001</td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

*Each variable is entered in a separate model.
†Both variables are included in the same model. Covariates: left ventricular ejection fraction, diastolic dysfunction, age, obesity, hypertension, antihypertensive treatment, coronary artery disease, left ventricular mass index, and relative wall thickness.
CI indicates confidence interval; HR, hazard ratio; GLS, global longitudinal strain; and LAVi, left atrial volume index.
is especially vulnerable to ischemic injury and hemodynamic overload. GLS can document myocardial dysfunction at a stage when LVEF is still normal as the decrease in longitudinal strain can be compensated by either an increase in circumferential fiber contraction or by the development of myocardial hypertrophy. The advantage of using GLS over LVEF lies therefore in its ability to detect the early isolated systolic impairment of the longitudinal myocardial contraction component, often the first event in the natural history of LV dysfunction. At this stage, LVEF is generally preserved, thus explaining its lack of prognostic value in population studies, in which LVEF is mostly in the normal range. In this context, longitudinal strain can be a useful tool to re-stratify the risk of subjects without overt LV dysfunction. The detection of subclinical LV dysfunction by GLS is a sign of a more advanced stage of LV disease, rather than just a risk factor, and therefore its strong association with AF, and with cardiovascular events in general, is likely related to the fact that it is the evidence of an already existing myocardial damage and of a more advanced disease process that is more reasonable to assimilate to stage B heart failure than to stage A. GLS has been shown to be associated with several cardiovascular risk factors also linked to AF, such as hypertension, LV hypertrophy, and diabetes mellitus, and to predict cardiovascular events in addition to and independent of LVEF. In previous studies, we demonstrated that GLS, but not LVEF, was reduced in subjects with increased arterial stiffness, a marker of atherosclerosis. Consistently, in the Multi-Ethnic Study of Atherosclerosis (MESA) study, an association of myocardial strain with coronary artery calcium score was reported. In a previous study, we demonstrated that a reduction in GLS was independently associated with silent brain infarctions and with white matter disease, further strengthening the hypothesis that a reduced LV longitudinal strain might be the expression of a generalized underlying macrovascular and microvascular involvement. In this light, the association of GLS with subclinical atherosclerosis and microvascular disease may be one hypothesis for the association with incident AF through chronic hypoperfusion and subsequent fibrosis of the LA tissue and sinus node, conditions both favoring reentry

### Table 5. Cox Proportional Hazards Regression With Death as a Competing Risk Showing the Risk of Incident AF in Different GLS and LAVi Categories

<table>
<thead>
<tr>
<th></th>
<th>Univariate</th>
<th>Multivariate*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>HR (95% CI)</td>
<td>P Value</td>
</tr>
<tr>
<td>Normal GLS/normal LAVi</td>
<td>Reference</td>
<td>...</td>
</tr>
<tr>
<td>Abnormal GLS/normal LAVi</td>
<td>4.4 (1.7–11.0)</td>
<td>0.002</td>
</tr>
<tr>
<td>Normal GLS/abnormal LAVi</td>
<td>6.6 (2.6–17.3)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Abnormal GLS/abnormal LAVi</td>
<td>17.6 (5.4–57.5)</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

*Covariates: left ventricular ejection fraction, diastolic dysfunction, age, obesity, hypertension, antihypertensive treatment, coronary artery disease, left ventricular mass index, and relative wall thickness.

CI indicates confidence interval; HR, hazard ratio; GLS, global longitudinal strain; and LAVi, left atrial volume index.
compared with healthy controls37; therefore, it is possible that lower GLS but similar LVEF in patients with paroxysmal AF mechanisms and development of AF.31–33 Another possible explanation for the association between GLS and AF may be found in the relationship between GLS and LA function. It is known that the LV longitudinal systolic function is a major determinant of the LA reservoir function through its effect on the systolic descent of the mitral plane.34 We previously demonstrated that a reduction in GLS can be in fact associated with a lower LA reservoir function,35 which has in turn been demonstrated to be a strong predictor of development of first-onset AF.36 In line with our findings, a previous study reported lower GLS but similar LVEF in patients with paroxysmal AF compared with healthy controls37; therefore, it is possible that an impaired GLS may in some cases be associated with undiagnosed paroxysmal AF, progressing toward permanent AF over time, an hypothesis that deserves further investigation.

We performed an annual follow-up by actively contacting the study participants and using a standardized questionnaire to detect new-onset AF. This approach could lead to an underestimation of the AF detection rate, a problem common to other population studies using similar methodology, because of the impossibility of detecting asymptomatic AF or paroxysmal episodes. ECG monitoring devices would provide a better AF detection in our study, including paroxysmal and asymptomatic episodes, but this methodology was not feasible in our study. AF detection, however, was specific, as new-onset AF cases were confirmed by ECG or medical records, and unconfirmed cases were excluded. Further studies are needed to investigate the GLS ability to predict asymptomatic AF and undiagnosed paroxysmal AF.

Our study has potential clinical implications. The finding that impaired GLS was independently associated with a significant risk of incident AF, whereas neither LVEF nor LV diastolic dysfunction was, suggests that the use of speckle-tracking echocardiography to detect subclinical LV systolic dysfunction may help identify subjects at high risk of developing AF. Furthermore, we demonstrated that the combined use of GLS and LA Vi was able to identify subjects at different risk of future AF, with the group having both abnormalities being at an extremely high risk. The abnormal LA Vi cut-off identified in our reference group (31 mL/m²) was slightly smaller than the one recommended by recent guidelines (34 mL/m²). Our population is composed of subjects from 3 race-ethnic groups, mostly Hispanic, and with high mean body size, a factor that might have contributed to the slightly lower LA volume once indexed by body size. In addition, it is not clear to what extent 3D echo software from different vendors is interchangeable, as there is a lack of data on intervendor differences in 3D LA volumes. Our approach, however, allowed the reclassification of new-onset AF risk with significant net reclassification improvement. The subjects at higher AF risk, as identified by GLS and LA Vi assessment, might benefit from preventive strategies to stop or delay the progression to AF, and from closer follow-up for early detection of AF, an hypothesis that needs to be investigated in future studies.

**Strengths and Limitations**

The main strengths of our study are the prospective design, the long follow-up duration, the confirmation of AF by ECG and medical records, the large number of subjects studied with modern imaging techniques, the wide range of cardiovascular risk profiles present in our study population, and the confirmation of our findings in multivariable models and in competing risks analyses. However, our study has also limitations. The study sample included subjects >50 years of age with a large representation of Hispanic ethnicity, which might preclude the generalization of our findings to populations with different demographic compositions. However, because the frequency of AF is extremely low <50 years of age, our study cohort age was an optimal setting to explore this topic. Another limitation is that the AF detection during follow-up was based on participants’ self-report; therefore, although only ECG-confirmed AF episodes were included in the analysis, the possibility of AF underdetection cannot be excluded. Finally, analyses stratified by sex and race–ethnicity were not performed because the number of events limited the feasibility of subgroup analysis.

**Conclusions**

Subclinical LV systolic dysfunction by GLS was a powerful and independent predictor of future development of AF in this predominantly elderly community cohort. The prognostic value of GLS was independent of cardiovascular risk factors and incremental to established markers of AF risk, such as LA Vi. The combined assessment of GLS and LA Vi identified subjects at different risks for developing AF. The reclassification of subjects at low, intermediate, and high risk of AF might be guidance for different treatment and monitoring strategies.

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Disclosures

None.

References


12. Lang RM, Bierig M, Devereux RB, Flachskampf FA, Foster E, Pellikka PA, Picard MH, Roman MJ, Seward J, Shawe H, Solomon SD, Spencer KT, Sutton MS, Stewart WJ. Chamber Quantification Writing Group; American Society of Echocardiography’s Guidelines and Standards Committee; European Association of Echocardiography; Recommendations for chamber quantification: a report from the American Society of Echocardiography’s Guidelines and Standards Committee and the Chamber Quantification Writing Group, developed in conjunction with the European Association of Echocardiography, a branch of the European Society of Cardiology. J Am Soc Echocardiogr. 2005;18:1440–1463. doi: 10.1016/j.echo.2005.10.005.

Atrial fibrillation (AF) represents a public health issue because of its increasing prevalence and association with cardiovascular and cerebrovascular events. It is necessary to identify new predictors of AF to plan preventive strategies. In this study, we assessed the ability of left ventricular global longitudinal strain (GLS) in predicting the future development of AF in a community cohort of predominantly elderly individuals. Our study demonstrated that an impaired GLS was an independent predictor of incident AF over a mean follow-up period of 5.3 years. AF incidence in participants with an abnormal GLS was 4x higher than in those with normal GLS (12.2% versus 3.1%). Furthermore, the combined assessment of GLS with the other established AF predictor, left atrial volume enlargement, identified categories of individuals at different risks of developing AF. In particular, the coexistence of both abnormal GLS and abnormal left atrial volume was associated with high incidence of AF (28.6%), whereas the presence of either impaired GLS or dilated left atrial volume was associated with an intermediate AF incidence (9.3%–11.1%). The incidence of AF in subjects with both normal GLS and left atrial volume was the lowest (2.0%). This restratification of subjects at low, intermediate, and high risks of AF might translate to different treatments and monitoring strategies. Our study, therefore, suggests that the use of speckle-tracking echocardiography to assess GLS may have an important clinical application in refining the risk of new-onset AF in the elderly, a population at high risk of this arrhythmia.
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