Reduced left atrial strain can predict stroke in atrial fibrillation – A meta-analysis

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To the Editor,

Atrial Fibrillation (AF) is the most common cardiac arrhythmia with a worldwide prevalence of over 46 million cases [1]. There has been over a 30% increase in its prevalence in the last 20 years [2]. AF can cause sequelae such as cardiac failure, emboli, etc., which consequently cause a significant clinical burden. The risk of ischemic stroke in AF is increased five-fold as compared to the general population. About 25–30% of strokes can be attributed to cerebral emboli which are caused by AF [3]. About 1/3rd of cases of AF are asymptomatic and are commonly undetected clinically [3,4]. Hence, it could be significantly underestimated as a causing factor of ischemic stroke. In the USA, about 795,000 people experience a stroke each year. Stroke has a significant impact on quality of life, morbidity, and morbidty in the US with 1 in 19 deaths attributed to it [4].

Traditionally, clinical assessments like the CHA2DS2-VASc score and echocardiographic parameters like left atrial (LA) size, LA appendage flow velocity and/or thrombi/spontaneous echo contrast, left ventricular systolic function have been used to predict stroke in patients with AF [5,6,7]. Structural, functional, and electrical changes of the left atrium are noted in patients with AF [8]. LA strain and strain rate are subtle measures of left atrial compliance and remodeling [7] and are being increasingly used to evaluate LA structure and function in clinical practice. However, its role as a determinant of cerebrovascular events and risk stratification in AF is unclear.

We performed a systematic search of PUBMED and Google Scholar Databases to find studies evaluating the role of left atrial strain in risk stratification of cerebrovascular events such as stroke/Transient ischemic attack (TIA) in patients with atrial fibrillation (AF). Keywords used for the search included- ‘stroke’, ‘cerebrovascular disease’, ‘transient ischemic attack’, ‘atrial fibrillation’, ‘left atrial’, ‘strain’, ‘echocardiography’, and ‘speckle tracking’. A random-effects model was employed to calculate the pooled odds ratio. I² statistics were employed to test heterogeneity. Publication bias was detected using Funnel Plot and sensitivity analysis with leave one out approach. Open MetaAnalyst and metaXL were used for analysis.

The initial search yielded 315 articles, out of which six [7,8,9,10,11,12] were included in the final analysis after excluding reviews and duplicate items. The sample size consisted of 3587 patients with AF, of which 361 (10.1%) suffered from a cerebrovascular accident. The mean age of the population was 68.81 ± 11.74 years and it comprised of 2325 (64.8%) males. All studies reported peak atrial longitudinal strain measured using the Echo Pac software (GE). The baseline characteristics of the included studies have been summarized in Table 1. The meta-analysis of odds ratio revealed that reduced left atrial strain is predictive of cerebrovascular accident in AF patients (Odds ratio 0.88, 95% CI: 0.81–0.96, P = 0.005). Moderate-high heterogeneity was observed between the studies (I² = 86%, P < 0.001) [Fig. 1]. Although publication bias was detected; the funnel plot and trim and fill analysis is not considered very reliable for meta-analysis of less than 10 studies.

Speckle-tracking echocardiography is a technique used to characterize and quantify myocardial deformation and is based on images obtained by traditional transthoracic 2-dimensional (2D) echocardiography, which can be stored and later analyzed offline using software to measure cardiac deformation parameters like strain and strain rate.

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the CHA2DS2-VASc score is recommended by most of the guidelines pertaining to AF and stroke, it largely fails to incorporate information needed for comprehensive characterization of LA structure/function. Left atrial strain offered incremental value beyond traditional clinical and echocardiography methods in the prediction and risk stratification of cerebrovascular accident in atrial fibrillation patients \[7,8,10,11,12\]. Measuring LA strain by speckle-tracking echocardiography in AF is a feasible and convenient tool; it may aid in predicting CVA in this patient population and providing a timely opportunity for prophylactic intervention.

**Declaration of Competing Interest**

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

**References**

[1] J. Kornej, C.S. Börschel, E.J. Benjamin, R.B. Schnabel, Epidemiology of atrial fibrillation in the 21st century: novel methods and new insights, Circ. Res. 127 (1) (2020) 6–20, https://doi.org/10.1161/CIRCRESAHA.120.316340, Epub 2020 Jun 18. PMID: 32716709; PMCID: PMC7577553, Jun 19.

[2] G. Lippi, F. Sanchis-Gomar, G. Cervellin, Global epidemiology of atrial fibrillation: An increasing epidemic and public health challenge, Int. J. Stroke 16 (2) (2021) 217–221, https://doi.org/10.1117/1747493019897870, Epub 2020 Jan 19. Erratum in: Int J Stroke. 2020 Jan 28;1747493020905964. PMID: 31955707, Feb.

[3] F.E. D’Ilari, H.L. Kennedy, Silent atrial fibrillation: epidemiology, diagnosis, and clinical impact, Clin. Cardiol. 40 (6) (2017) 413–418, https://doi.org/10.1002/clc.22667.

[4] S.S. Virani, A. Alonso, H.J. Aparicio, E.J. Benjamin, M.S. Bittencourt, C.W. Callaway, A.P. Carson, A.M. Chamberlain, S. Cheng, F.N. Delling, M.S.V. Elkind, K.R. Evenson, J.F. Ferguson, D.K. Gupta, S.S. Khan, B.M. Kissela, K.L. Knutsen, C.D. Lee, T.T. Lewis, J. Liu, M.S. Loop, P.L. Lutsey, J. Ma, J.A. Mackey, S.S. Martin, D.B. Matchar, M.E. Mussolino, S.D. Navaneethan, A.M. Perak, G.A. Roth, Z. Samad, G.M. Satou, E.B. Schroeder, S.H. Shah, C.M. Shay, A. Stokes, L.B. VanWagner, N.Y. Wang, C.W. Tsao, American Heart Association Council on Epidemiology and Prevention Statistics Committee and Stroke Statistics Subcommittee, Heart Disease and Stroke Statistics-2021 Update: A Report From the American Heart Association, Circulation 143 (8) (2021) e254–e743, https://doi.org/10.11711/ CIR.0000000000000950, Epub 2021 Jan 27. PMID: 33501848, Feb 23.

[5] Echocardiographic predictors of stroke in patients with atrial fibrillation: a prospective study of 1006 patients from 3 clinical trials. Arch. Intern. Med. 1998 Jun 22;158(12):1316–20. doi: 10.1001/archinte.158.12.1316. PMID: 9645825.

[6] W.G. Daniel, U. Nellesen, E. Schröder, B. Nonnast-Daniel, P. Bednarski, P.R. Lichtlen, Left atrial spontaneous echo contrast in mitral valve disease: an indicator for an increased thromboembolic risk, J. Am. Coll. Cardiol. 11 (6) (1988 Jun) 1204–1211, https://doi.org/10.1016/0735-1097(88)90283-5, PMID: 2966840.

[7] P.C. Hsu, W.H. Lee, C.Y. Chu, et al., Prognostic role of left atrial strain and its combination index with transmitral E-wave velocity in patients with atrial fibrillation, Sci. Rep. 6 (2016) 17318, https://doi.org/10.1038/srep17318.

[8] M. Leung, P.J. van Rosendaal, R. Abou, N. Ajmone Marsan, D.Y. Leung, J. Delgado, J.J. Bax, Left atrial function to identify patients with atrial fibrillation at high risk of stroke: new insights from a large registry, Eur. Heart J. 39 (16) (2018 Apr 21) 1416–1425, https://doi.org/10.1093/eurheartj/ehx736, PMID: 29300883.

[9] J.Y. Shih, W.C. Tsai, Y.Y. Huang, Y.W. Liu, C.C. Lin, Y.S. Huang, L.M. Tsai, J.L. Lin, Association of decreased left atrial strain and strain rate with stroke in chronic atrial fibrillation, J. Am. Soc. Echocardiogr. 24 (5) (2011 May) 513–519, https://doi.org/10.1016/j.echo.2011.01.016, Epub 2011 Feb 24 PMID: 21354689.

[10] J.N. Liao, T.F. Chao, J.Y. Kuo, K.T. Sung, J.P. Tsai, C.I. Lo, Y.H. Lai, C.H. Su, C.L. Hung, H.I. Yeh, Global left atrial longitudinal strain using 3-beat method improves risk prediction of stroke over conventional echocardiography in atrial fibrillation, Circ. Cardiovasc. Imaging 13 (8) (2020), https://doi.org/10.1161/CIRCIMAGING.119.010287, Epub 2020 Aug 13. PMID: 32787500, Aug.

[11] Y. Mao, C. Yu, Y. Yang, M. Ma, Y. Wang, R. Jiang, R. Chen, B. Zhao, C. Jiang, Comparison of left atrial and left appendage mechanics in the risk stratification of stroke in patients with atrial fibrillation, Cardiovasc. 

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**Table 1**

| Author          | Year | Type of study            | Country/ Region | Sample size | Mean age | Males, n (%) | Stroke/AF, n (%) | Mean LA strain in control group | Mean LA strain in stroke group |
|-----------------|------|--------------------------|-----------------|-------------|----------|--------------|-----------------|---------------------------------|-------------------------------|
| Liao et al      | 2020 | Prospective observational study | Taiwan         | 1457        | 71.6 ± 12.4 | 809 (55.5%)   | 111 (7.6%)      | –                               | –                             |
| Mao et al       | 2021 | Retrospective observational study | China          | 208         | 63.58 ± 10.37 | 133 (63.9%)   | 31 (14.9%)      | 19.99 ± 9.79                   | 13.09 ± 7.01                  |
| Leung et al     | 2018 | Prospective observational study | Netherlands     | 1361        | 65 ± 12     | 1008 (74%)   | 100 (7.3%)      | 18.9 (11.0, 28.5)               | 14.5 (9.2, 22.7)              |
| Hsu et al       | 2016 | Prospective observational study | Taiwan         | 190         | 70 ± 10     | 128 (67%)    | 15 (7.8%)       | –                               | –                             |
| Obokata et al   | 2014 | Cross sectional study      | Japan           | 305         | 74 ± 10     | 209 (68.5%)  | 66 (21.6%)      | 18.9 ± 6.0                     | 12.6 ± 3.7                   |
| Shih et al      | 2011 | Prospective cross sectional study | Taiwan    | 66          | 75.9 ± 9.4  | 38 (57.6%)   | 20 (30%)        | 15.69 ± 5.08                   | 10.44 ± 4.23                 |

**Fig. 1.** Forest plot for LA strain as a predictor of stroke.
[12] M. Obokata, K. Negishi, K. Kurosawa, R. Tateno, S. Tange, M. Arai, M. Amano, M. Kurabayashi, Left atrial strain provides incremental value for embolism risk stratification over CHA\textsubscript{2}DS-VASc score and indicates prognostic impact in patients with atrial fibrillation, J. Am. Soc. Echocardiogr. 27 (7) (2014 Jul) 709–716.e4, https://doi.org/10.1016/j.echo.2014.03.010, Epub 2014 Apr 24 PMID: 24767972.