SHORT COMMUNICATION

Left atrial longitudinal strain in the contractile phase as a predictor of sinus rhythm maintenance after electrical cardioversion performed due to persistent atrial fibrillation

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Introduction Atrial fibrillation (AF) is the most common persistent arrhythmia and one of the most significant cardiovascular risk factors.[1] Direct current cardioversion (DCCV) is a procedure of choice to restore sinus rhythm (SR) in patients with persistent AF because it is readily available and cost effective.

Numerous studies are investigating risk factors of recurrent AF to better understand how DCCV contributes to SR maintenance. Among many new echocardiographic parameters assessing the prognosis of SR maintenance after DCCV, the prognostic value of left atrial (LA) strain (LAS) and peak LAS rate (pLASR) has been indicated. So far, most studies evaluated the suitability of using the LA wall strain in the prognosis of SR maintenance after DCCV, with a focus on the global strain in the reservoir phase.[2-6] In this study, we used speckle-tracking echocardiography (STE) to measure LAS and pLASR in the reservoir, conduit, and contractile phases the day after effective DCCV. We assessed the prognostic value of LAS and pLARS in all phases regarding SR maintenance for 12 months after a successful DCCV. Previously, we analyzed this group of patients for prognostic value of left atrial wall dyskinesia in terms of maintaining SR after DCCV.[7]

Methods The study protocol was approved by the Institutional Review Board of the Świętokrzyskie Medical Chamber and informed consent was obtained from each patient. We included 89 patients who underwent successful elective DCCV between November 2015 and August 2018 with ejection fraction during SR of 40% or greater and no moderate or severe valve disease. Left atrial wall deformation analysis was performed using STE during SR on the day after successful DCCV. We used the upslope of the R wave as the electrocardiography reference point for strain and pLASR measurements as recommended in the consensus document.[8] Left atrial myocardial deformation assessed during SR after successful cardioversion was presented as the LA strain or as the peak strain rate during the reservoir phase (LASr or pLASRr), conduit phase (LAScd or pLASRcd), and contractile phase (LASct or pLASRct) in the apical 4-chamber (4c) and 2-chamber (2c) views, and the average of both views (mean) as recommended in the consensus document.[8]

Statistical analysis The results are presented as means (SD) and numbers (percentages). The predictors of SR maintenance were analyzed with univariate logistic regression. The stepwise multivariable logistic regression analysis included echocardiographic parameters assessing mechanical remodeling and left ventricular filling pressure with the lowest *P* value evaluated in a univariate logistic analysis. The differences between the area under the curve (AUC) in the same echocardiographic views were compared using the *Z* test. Statistical significance

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TABLE 1 Area under the curve comparisons for 12-month SR maintenance for strain and strain rate measurements in the 4-chamber and 2-chamber apical projections and mean results from both projections

Comparisons	AUC	*P* value
LASr4c vs LASct4c	0.68 vs 0.765	0.1
pLASRr4c vs pLASRct4c	0.563 vs 0.726	0.003
LASr2c vs LASct2c	0.673 vs 0.669	0.92
pLASRr2c vs pLASRct2c	0.605 vs 0.664	0.3
LASr mean vs LASct mean	0.709 vs 0.734	0.58
pLASRr mean vs pLASRct mean	0.59 vs 0.704	0.02

Abbreviations: AUC, area under the curve; ct, contractile phase; 4c, 4-chamber; LAS left atrial strain; pLASR, peak left atrial strain rate; r, reservoir phase; 2c, 2-chamber;

was set at *P* value of less than 0.05. The statistical analyses were performed with the STATISTICA 13.3 software (TIBCO Software Inc., Tulsa, Oklahoma, United States). Detailed methodology, characteristics of the study group, and limitations of the study were described previously.[7]

Results and discussion After 12 months, 42 patients (47.2%) maintained SR (Supplementary material, *Tables S1* and *S2*). The univariate logistic regression analysis revealed several significant predictors of SR maintenance after 12 months of observation, including male sex (odds ratio [OR], 2.96; 95% CI, 1.16–7.54; *P* = 0.02), LA end-diastolic volume index (OR, 0.95; 95% CI, 0.91–0.99; *P* = 0.01), LA ejection fraction (OR, 1.06; 95% CI, 1.02–1.1; *P* = 0.005), e' mean (OR, 1.29; 95% CI, 1.03–1.62; *P* = 0.03), a' mean (OR, 1.35; 95% CI, 1.09–1.66; *P* = 0.005), E wave (OR, 0.07; 95% CI, 0.01–0.71; *P* = 0.02), E DT (OR, 1.02; 95% CI, 1.01–1.03; *P* = 0.002), E/e' mean ratio (OR, 0.83; 95% CI, 0.72–0.95; *P* = 0.007), and E/A ratio (OR 0.54; 95% CI, 0.35–0.84; *P* = 0.006). The following echocardiographic parameters assessing strain and strain rate were significant predictors of SR: the LASr4c (OR, 1.14; 95% CI, 1.04–1.25; *P* = 0.005), LASct4c (OR, 1.45; 95% CI, 1.179–1.79; *P* < 0.001), pLASRct4c (OR, 16.53; 95% CI, 2.95–92.67; *P* = 0.001), LASr2c (OR, 1.14; 95% CI, 1.04–1.25; *P* = 0.003), LAScd2c (OR, 1.14; 95% CI, 1.01–1.29; *P* = 0.03), LASct2c (OR, 1.19; 95% CI, 1.04–1.36; *P* = 0.01), and pLASRct2c (OR, 5.65; 95% CI, 1.77–18.05; *P* = 0.004). The mean values from the 4c and 2c views were also among the significant predictors of SR: LASr mean (OR, 1.18; 95% CI, 1.06–1.31; *P* = 0.002), LASct mean (OR, 1.34; 95% CI, 1.12–1.6; *P* = 0.002), and pLASRct mean (OR, 10.7; 95% CI, 2.44–46.89; *P* = 0.002).

Multivariable logistic regression analysis that included LA ejection fraction, E/e' mean ratio, LASr4c, and LASct4c showed that LASct4c was an independent predictor of SR maintenance during 12-month following DCCV (OR, 1.44, 95% CI, 1.17–1.77; *P* = 0.001).

The comparative analysis of the AUCs of the LA strain and strain rate measured in the 4c view and the average measurements from the 4c and 2c views showed that these parameters had better prognostic properties regarding SR maintenance when measured in the contractile phase than in the reservoir phase (TABLE 1).

In the receiver operating characteristic analysis, the following AUCs were obtained for predicting SR maintenance 12 months after DCCV: 0.765 for LASct4c (95% CI, 0.667–0.863; *P* <0.001), 0.68 for LASr4c (95% CI, 0.561–0.784; *P* = 0.003), and 0.726 for pLASRct4c (95% CI, 0.621–0.831; *P* <0.001) (optimal cutoff values, 3.44%, 14.55%, 0.39 s^{-1}; sensitivity: 69%, 52.4%, 73.8%; specificity, 74.5%, 78.7%, 63.8%; positive predictive value, 70.73%, 68.75%, 64.58%; and negative predicting value, 72.92%, 64.91%, 73.17% for LASct4c, LASr4c, and pLASRct4c, respectively).

Our results show that the LA wall strain and strain rate measured the day after DCCV were significant predictors of SR maintenance after DCCV. Additionally, these parameters had a greater prognostic value when they were measured in the contractile phase than in the reservoir phase. Regarding the strain and strain rate, a 4c view resulted in the best AUC values for assessing patient prognosis.

Most of the studies published so far on the prognostic value of the LA strain and strain rate have focused on the reservoir phase, which reflects the susceptibility to stretching of the LA muscle but not its contractility. Di Salvo et al[2] showed that the strain and strain rate measured before DCCV have a prognostic value in predicting SR maintenance after DCCV in patients with recent-onset, lone AF.[2] Wang et al[3] demonstrated that the LA strain rate measurement has a prognostic value for SR maintenance after DCCV, but they focused mainly on the basal segments of the left atrium. However, both of these studies were based on the tissue Doppler imaging method. Shaikh et al,[4] who used the STE technique, found that the predictor of SR maintenance was not the measurement of the LA strain before and after DCCV, but the difference between these values. Morenzo-Ruiz et al[5] showed that the LA reservoir strain measured before

DCCV using the STE technique can be useful in assessing the prognosis of SR maintenance after DCCV. Furthermore, Doruchowa et al[6] evaluated the LA strain and the dispersion of time to the LA wall maximum strain, and only the latter had prognostic value in terms of SR maintenance after DCCV. In the studies by Shaikh et al[4] and Doruchowska et al,[6] although strain measurements were taken during SR, no measurements were performed in the LA contractility phase.

Conclusions The LASct4c measurement is a predictor of SR maintenance for 12 months after DCCV. The LASct4c and pLASRct4c have a better prognostic value than these same parameters assessed in the reservoir or conduit phases. Echocardiographic parameters assessing mechanical remodeling better estimate the prognosis of SR maintenance after DCCV than those evaluating structural remodeling.

SUPPLEMENTARY MATERIAL

Supplementary material is available at www.mp.pl/kardiologiapolska.

ARTICLE INFORMATION

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CONFLICT OF INTEREST None declared.

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