Relation of Right Atrial Mechanics to Functional Capacity in Patients With Systemic Sclerosis

Ágnes Nógrádi, MD[a], Adél Porpáczy, MD[a], Lili Porcsa[a], Tünde Minier, MD, PhD[b], László Czirják, MD, DSc[b], András Komócsi, MD, DSc[a], and Réka Faludi, MD, PhD[a,*]

Cardiac involvement in systemic sclerosis (SSc) implies a worse prognosis. Little is known about the right atrial (RA) mechanics in this disease, but recent data suggest that it correlates well with the functional capacity of the patients in conditions with known right heart involvement. Thus we aimed to investigate the abnormalities of the RA function as compared with healthy subjects and to assess the potential correlations between RA mechanics and the functional capacity in SSc patients using 2D speckle tracking technique. A total of 70 SSc patients (age: 57 ± 12 years) were investigated. Functional capacity was measured with 6-minute walk test (6MWT). Echocardiographic parameters of the right ventricular (RV) systolic function (TAPSE, RVFAC), parameters of the tricuspid inflow (E, A), and tricuspid annular systolic (S), early- (e') and late- (a') diastolic myocardial velocities were measured. RV wall thickness was obtained. RA reservoir (ε_R), conduit (ε_{CD}), and contractile (ε_{CT}) strain were measured. RA stiffness was calculated as ratio of E/e' to ε_R. Echocardiographic data were compared with an age- and gender-matched group of 25 healthy volunteers. RA ε_R (49.3 ± 10.7 vs 59.6 ± 9.9%, p = 0.000) and ε_{CD} (26.8 ± 8.1 vs 34.3 ± 7.3%, p = 0.000) were significantly lower in SSc patients. No significant difference was found in ε_{CT} (22.9 ± 5.8 vs 25.3 ± 5.7%, p = 0.082). RA stiffness was significantly increased in SSc patients (0.11 ± 0.04 vs 0.08 ± 0.02, p = 0.001). 6MWT distance was 391 ± 95 m. In stepwise multiple linear regression analysis RV wall thickness (r = −0.289, p = 0.030) and RA stiffness (r = −0.418, p = 0.002) became independent predictors of 6MWT distance. In conclusion, RA ε_R and ε_{CD} are impaired, while RA stiffness is increased in SSc compared with healthy subjects. Speckle tracking-derived RA stiffness is turned out to be one of the main determinants of the functional capacity in SSc patients. **(Am J Cardiol 2018;00:1−6)**

Systemic sclerosis (SSc) is a systemic connective tissue disease characterized by inflammation and fibrosis of various organs. Cardiac involvement is common in SSc and implies a worse prognosis.[1] Left ventricular diastolic dysfunction is frequent[2,3] and is often accompanied by impaired left atrial function.[4−6] Right ventricular (RV) dysfunction was traditionally attributed to the development of pulmonary arterial hypertension (PAH) or pulmonary fibrosis.[7] Subclinical RV dysfunction, however, was also proved in SSc patients without the resting elevation of the pulmonary pressure, by using tissue Doppler or speckle tracking measurements.[8−11] Speckle tracking-derived strain imaging also allows us to assess the phasic function of the atria.[12] By the help of this new technique, impaired right atrial (RA) function has been recently reported in SSc.[9] Atrial stiffness—a tissue Doppler and speckle tracking-derived parameter—represents the change in pressure required to increase the volume of the atrium in a given measure.[13,14] Recent data suggest that RA size and mechanics correlate well with the functional capacity of the patients in conditions with known right heart involvement, such as in idiopathic PAH or chronic obstructive pulmonary disease.[15,16] Thus we aimed to investigate the abnormalities of the RA function as compared with healthy subjects and assess the potential correlations between RA mechanics and the functional capacity in SSc patients, by using 2D speckle tracking technique.

Methods

A total of 80 consecutive patients diagnosed with SSc in the tertiary center of the Department of Rheumatology and Immunology, University of Pécs were recruited into our prospective study. All enrolled cases complied with the updated ACR/EULAR classification criteria.[17] Patients with atrial fibrillation, significant left-sided valvular disease as well as with significant peripheral artery disease, cognitive issues, neuromuscular, or musculoskeletal problems were excluded from the study. Right heart catheterization was initiated in the presence of echocardiographic abnormalities suggestive of PAH.[18] Patients with invasively verified PAH (mean pulmonary artery pressure ≥25 mm Hg and pulmonary capillary wedge pressure ≤15 mm Hg) were excluded from the study. An age and gender matched

[a]Heart Institute, Medical School, University of Pécs, Pécs, Hungary; and [b]Department of Rheumatology and Immunology, Medical School, University of Pécs, Pécs, Hungary. Manuscript received February 27, 2018; revised manuscript received and accepted June 14, 2018.

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*Corresponding author: Tel: +3672536000; fax: +3672536388.
E-mail address: faludi.reka@pte.hu (R. Faludi).

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group of 25 healthy volunteers without any signs or symptoms of cardiac disease was used as control.

The study complied with the Declaration of Helsinki. The institutional ethics committee approved the study. All subjects had given written informed consent before inclusion.

Echocardiography was performed using Philips Epiq 7G ultrasound system (Philips Healthtech, Best, The Netherlands) by a single investigator. 2D and M-mode echocardiographic data collected for analysis included: left ventricular ejection fraction measured by Simpson's method; basal, midcavity, and longitudinal dimensions of the RV corrected for body surface area; tricuspid annular plane systolic excursion (TAPSE); RV fractional area change (RVFAC); maximal and minimal diameters of the inferior vena cava (IVC); collapsibility index of IVC (the percent decrease in the diameter during inspiration). RV wall thickness was measured at end-diastole, in a zoomed subcostal view, by 0.5 mm increments. The following Doppler data were collected: tricuspid E/A, pulmonary artery systolic pressure (assessed as a sum of the pressure difference across the tricuspid valve and an estimate of mean RA pressure (5 to 15 mmHg) using the diameter and collapsibility index of the IVC); myocardial systolic (S), early- (e'), and late- (a') diastolic velocities measured at the lateral tricuspid annulus; tricuspid E/e' ratio. Doppler measurements were obtained from $\geq$3 consecutive beats during end-expiratory apnea. Elevated RV filling pressure was diagnosed if tricuspid E/e' > 6.[19]

For atrial speckle tracking analysis, RA−focused apical 4-chamber view movies were obtained. Care was taken to obtain true apical images using standard anatomic landmarks to avoid foreshortening (a situation where the ultrasound plane is not appropriate and RA is not opened up to its fullest size). A total 3 consecutive heart cycles were recorded digitally and processed by a single investigator blinded to standard echocardiographic and clinical data of the patients. The beginning of the QRS was predefined by the software (QLab 10.5, Philips Healthtech, Andover, Massachusetts) as reference point. The first positive peak of the curve was measured at the end of the reservoir phase, just before tricuspid valve opening (reservoir strain, ε_R). This was followed by a plateau and a second late peak at the onset of the P wave on the electrocardiogram (contractile strain, ε_{CT}). The conduit strain (ε_{CD}) was defined as the difference between the reservoir and the contractile strain (Figure 1).[12,20] Maximal RA volume was assessed by the same software and corrected for body surface area (RA Vmax index). RA stiffness was calculated as ratio of tricuspid E/e' to ε_R.[13,14,21]

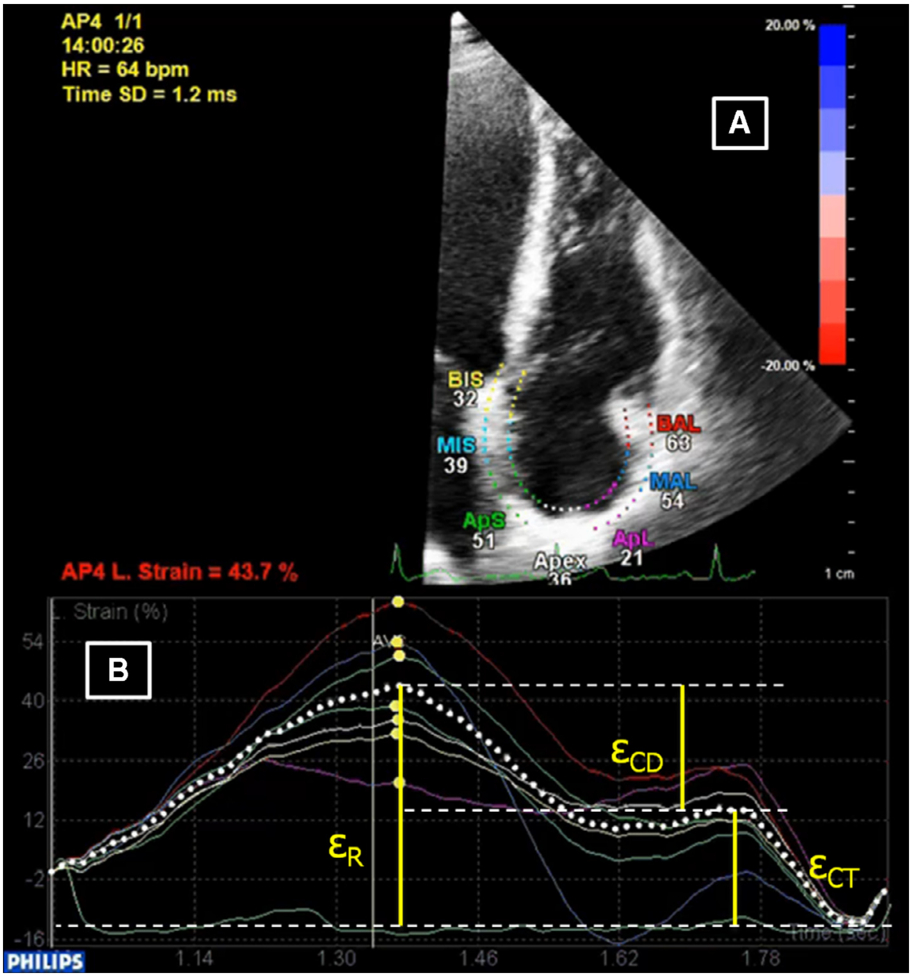

Figure 1. Speckle tracking analysis of RA strain: 4-chamber view depicting the region of interest created by the speckle tracking software (A). The global strain curve (dashed line) is obtained after averaging the seven regional strain curves (B). (ε_R: reservoir strain; ε_{CT}: contractile strain; ε_{CD}: conduit strain.)