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Original Paper

Left Atrial Function in Patients with Reentrant Paroxysmal Supraventricular Tachycardia with Narrow QRS Complex – The Role of Speckle Tracking Echocardiography

Adriana Alexandrescu[1], S. Onciul[1], Ioana Petre[1], Oana Tautu[1], A. Scafa[2], Maria Dorobanțu[2]

[1]Cardiology Department, Clinical Emergency Hospital Bucharest, Romania
[2]Cardiology Department, "Carol Davila" University of Medicine and Pharmacy, Clinical Emergency Hospital Bucharest, Romania

REZUMAT

Funcția atriului stâng la pacienții cu tahicardie paroxistică supraventriculară reintrantă cu complex QRS îngust – rolul tehnicii ecocardiografice de tip speckle traking

Premise: Acest studiu și-a propus evaluarea prin speckle traking a funcției longitudinale a AS la pacienții cu tahicardii paroxistice supraventriculare reintrante cu complex QRS îngust în vederea identificării precoce a modificărilor funcționale pe care aceste aritmii chiar și paroxistice pot să le producă la nivelul AS.
Material și metodă: 23 pacienți cu tahicardie paroxistică supraventriculară reintrante cu complex QRS îngust au fost evaluați ecocardiografic prin speckle traking în timpul ritmului sinusal. Evaluarea ulterioră electrofiziologică a identificat 13 pacienți cu tahicardie atrioventriculară nodalare intrantă (AVNRT) și 10 pacienți cu tahicardie reintrantă atrioventriculară (AVRT). Examinarea ecocardiografică prin specle traking s-a efectuat conform standardelor actuale în incidenta 4 camere și respective 2 camere folosind sectoare înguste un singur focus și adâncime optimă. Trasearea conturului atriului stâng în zona de interes a permis obținerea valorii străinului longitudinal a 12 segmente. Media măsurătorilor pe fiecare incidență, reprezentata sub forma unei curbe a reprezentat baza analizei ecocardiografice, permitand cuantificarea valorii peak strainului.
Rezultate: Valorile peak-strainului longitudinal evaluate în incidența apical 4 camere la pacienții din lotul AVNRT (cel mai frecvent valoarea de 16% (mod = 16%)) și la pacienții din lotul AVRT (cel mai frecvent valoarea de 8.5% (mod = 8.5%)) sunt statistic semnificativ mai mici față de valorile peak-strain măsurate la pacienții din lotul control (cel mai frecvent valoarea de 39% (mod = 39%)), valorile peak-strain măsurate la cele doua loturi cu tahicardie fiind statistic similare ($F = 30,19$; $p < 0,0001$). Valorile peak-strain evaluate în incidența apical 2 camere au respectat aceeași distribuție fiind statistic semnificativ mai mici la pacienții cu tahicardie față de valorile peak-strain măsurate la pacienții din lotul control (lot control cel mai frecvent valoarea de 38% (mod = 38%), lot AVNRT cel mai frecvent valoarea de 19% (mod = 19%), lot AVRT cel mai frecvent valoarea de 19% (mod = 19%))($F = 36,68$; $p < 0,0001$).
Concluzii: Prezența tahicardiei indiferent de tipul acesteia AVNRT/AVRT se soldează cu afectarea funcție mecanice a atriului stâng la acești pacienți. Valorile maxime ale strainului pozitiv sunt net mai mici la pacienții cu tahicardie, traducând astfel o scădere a complianței atriului stâng la acești pacienți față de lotul control.

Corresponding author: Dr. Adriana Alexandrescu, Cardiology Department, Clinical Emergency Hospital Bucharest
Calea Floreasca no.8, sector 1, postal code 014461, Bucharest, Romania
e-mail: adrianaurgenta@yahoo.com

Cuvinte cheie: AVNRT, AVRT, speckle traking, remodelarea atriului stâng

ABSTRACT

Objectives: We sought to investigate by speckle tracking technique the longitudinal function of the left atrium in patients with reentrant paroxysmal supraventricular tachycardia with narrow QRS complex, in order to identify early functional changes that these arrhythmias may induce even when paroxysmal.

Methodology: 23 patients with reentrant paroxysmal supraventricular tachycardia with narrow QRS complex have been evaluated by echocardiographic speckle tracking techniques in the first week after pharmacological conversion to sinus rhythm. The subsequent electrophysiology study identified 13 of these patients with atrioventricular nodal reentrant tachycardia (AVNRT), and 10 patients with atrioventricular reentrant tachycardia (AVRT). The echocardiographic examinationby speckle tracking technique was performed considering current standards, in apical 4 and 2 chamber views, using narrow sector angles, single focus imaging and optimal depth. Left atrium contour was traced defining the region of interest and the longitudinal strain was obtained for 12 segments. The average longitudinal strain obtained in each apical view was represented by a curve allowing the peak-strain quantification.

Results: The peak longitudinal strain values assessed in the apical 4 chamber view in the AVNRT group (most frequent value 16% (mod = 16%)) and in the AVRT group (most frequent value 8.5% (mod = 8.5%)(were significantly lower than the peak longitudinal strain values measured in the control group (most frequent value 39% (mod = 39%)), with no significant difference in peak longitudinal strain between the two different types of tachycardia groups ($F = 30,19$; $p < 0,0001$). In a similar manner, the peak longitudinal strain measured in the apical 2 chamber view were significantly lower in the tachycardia group than in the control group (most frequent value in the control group 38% (mod = 38%), in the AVNRT group 19% (mod = 19%), in the AVRT group 19% (mod = 19%)($F = 36,68$; $p < 0,0001$).

Conclusions: Tachycardia irrespective of the type – AVNRT or AVRT results in the impairment of left atrial mechanical function. The peak positive strain is significantly lower in patients with tachycardia, denoting a decrease in left atrial compliance in these patients compared to the control group.

Key words: AVNRT, AVRT, speckle traking, left atrium remodeling

INTRODUCTION

The reentrant paroxysmal supraventricular tachycardias with narrow QRS complex are in a large majority represented by atrioventricular reentrant tachycardia (AVRT) and atrioventricular nodal reentrant tachycardia (AVNRT). From an electrophysiological (EP) point of view the difference between the two forms is made by the type of the reentry circuit. That means that the former requires an accessory pathway with retrograde conduction while the latter implies the existence of perinodal pathways.

The left atrium (LA) is a part of the circuit in both types of arrhythmias. In sinus rhythm the left atrium has several functions: it acts as a conduit during protodiastole, it has a contractile function raising the filling pressure during atrial systole but it also has a reservoir function during ventricular systole. (1)

To our knowledge, to date there is no data in the literature depicting left atrial structural remodeling in patients with AVNRT/AVRT. Thus we sought to assess the left atrial function in this group of patients. As the assessment of LA function requires image analysis in multiple time points during cardiac cycle, we chose the speckle tracking technique that provides a high frame rate,allowingmore accurate analysis oneach frame of the cardiac cycle.

METHODOLOGY

Study patients

The study group consisted of 23 patients with reentrant paroxysmal supraventricular tachycardia with narrow QRS complex. All patients underwent EP study in our clinic which allowed their division into groups according to the mechanism of tachyarrhythmia. Thus, of the 23 patients, 13 showed AVNRT and 10 patients AVRT.

The echocardiographic evaluation was performed prior EP study, so that at the time of echocardiography we did not know the mechanism of arrhythmia (blind). At the time of echocardiography all patients were in sinus rhythm.

As the assessment of left atrial function requires an accurate visualization of its borderswe selected only those patients who had optimal ultrasound window which allowed a good quality acquisition and accurate subsequent off-line measurements. Patients with known cardiac conditions that may predispose to change in function and size of LA (cardiomyopathy, hypertension with moderate to severe left ventricular hypertrophy, atrial fibrillation, valvular heart disease, etc.) were not included in the study. If these conditions were not known by the patient but were identified with echocardiography, these patients were excluded. The normal reference values of speckle tracking parameters were obtained from 37 healthy subjects – the control group.

The speckle tracking technique

Two-dimensional speckle tracking is now a new method by which myocardial deformation can be assessed independently of the angle of interrogation. It is therefore a non-Doppler method. Strain is defined as the relative change of a dimension from baseline while strain rate is the instantaneous rate of change (2). Recent research had highlighted the importance of this technique for LA function assessment in patients with atrial fibrillation (AF) (3).

In our study image analysis was performed offline using Echo PAC (General Electric) workstation to calculate LA strain and strain rate.

Echocardiographic recordings were performed in the apical 4C and 2C views using narrow sector angles, with single focus positioned at the level of LA, optimal depth so that we could get a higher frame rate than that of a conventional two-dimensional image (50-80 fps) (**Fig. 1 a,b**). All patients were analyzed in the first week after pharmacological conversion to sinus rhythm.

A line was manually dragged along the LA endocardium at the end of systole, and then the region of interest width was adjusted. The software automatically generates the movement of the atrial wall (**Fig. 2 a,b**). Using this technique we were able to separately analyze 6 segments of the atrial wall in each apical view (total 12 segments situated along the atrial septum, LA roof and LA free wall).

For each segment, the obtained curves display:

- a lengthening of the atrial myocardium - positive strain during LA filling when the mitral valve is closed (ventricular systole) and
- shortening of myocardial fibers during diastole - negative strain as LA empties into the ventricle. The latter has two phases namely: early negative strain during protodiastole and late negative strain during atrial systole.

Therefore the contractile function of the LA is characterized by negative strain, while the reservoir function identifies with positive strain. The average longitudinal strain of the 6 segments in each apical view is displayed as a white dotted line. We chose this value for performing statistical analysis since it express the overall atrial myocardial function (**Fig. 3 a,b**). We focused on the positive values of strain since this one was reported to have strong diagnostic and prognostic significance in patients with AF, in earlier studies. (4)

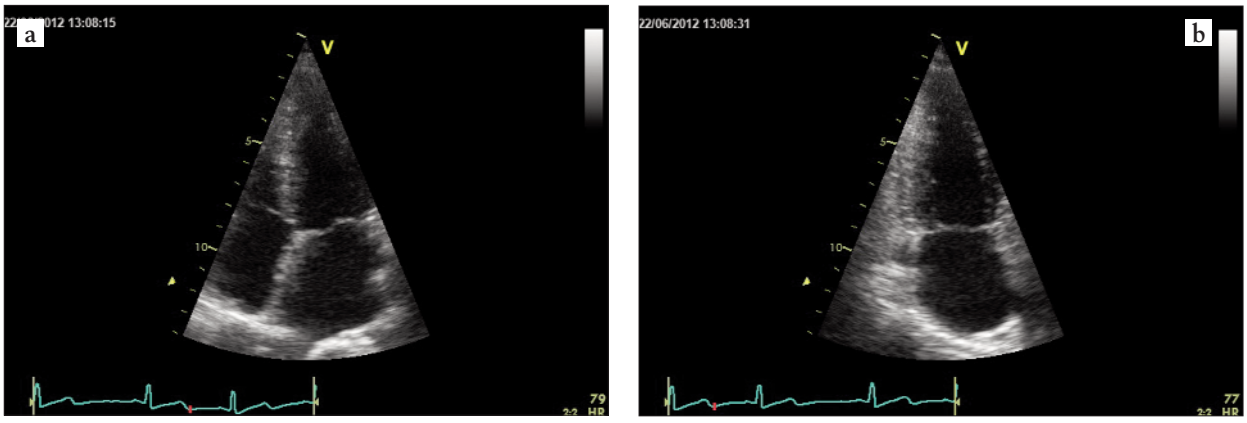

Figure 1. Improvement of image quality using narrow sector angle, one focus positionedat the level of LA, and optimal depth to obtain a high frame rate in apical 4 chamber (a) and 2 chamber (b) views

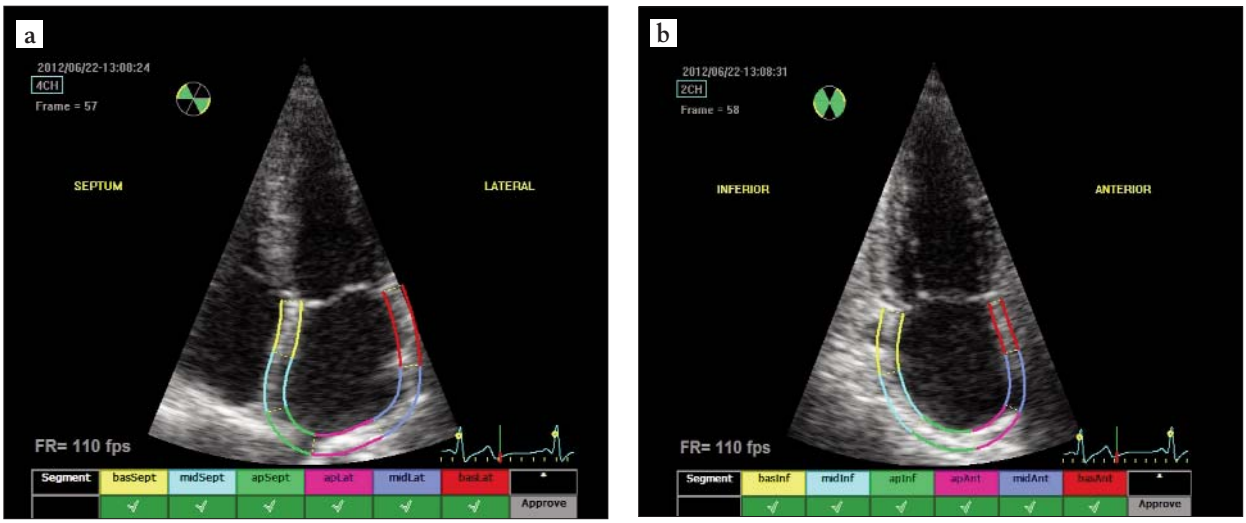

Figure 2. Tracing the region of interest for subsequent analysis by speckle traking of the longitudinal function of LA in apical 4 chamber (a) and 2 chamber (b) views. Each of the 6 segments in one view is identified by a different colour

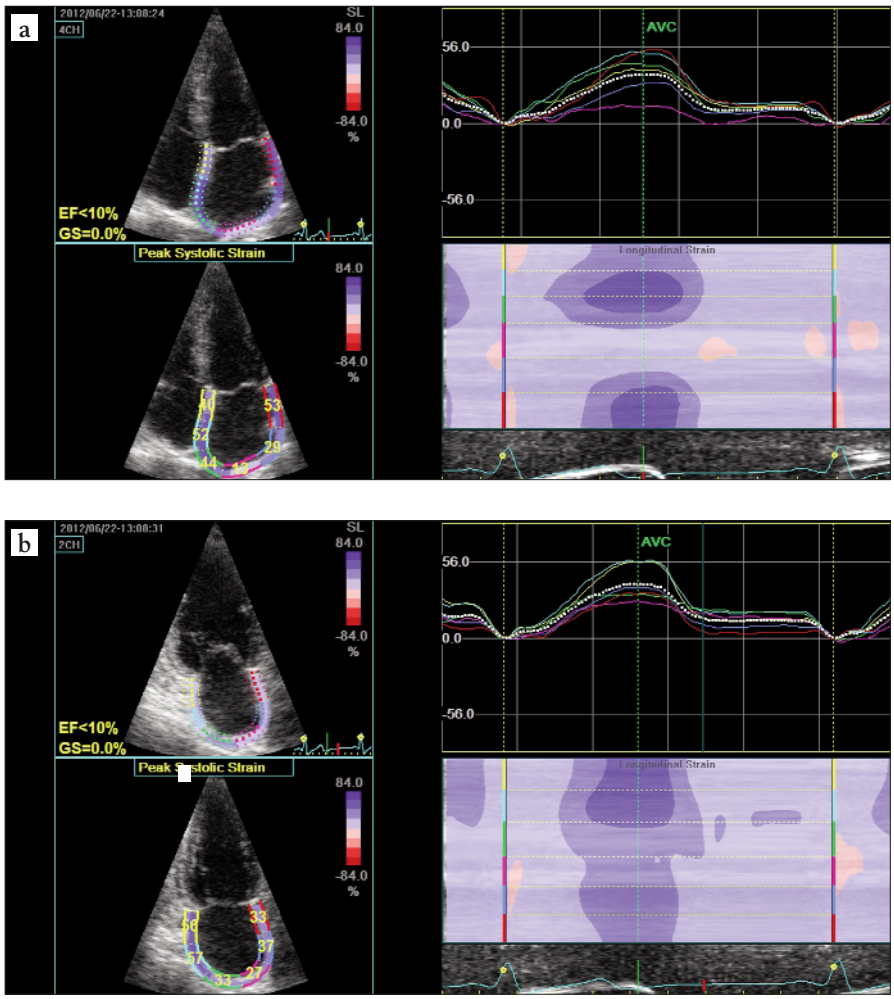

Figure 3. Automatic tracing of the LA longitudinal strain for each segment - in total 6 curves for each view:apical 4 chamber (a) and 2 chamber (b) views. Remark its positive value during ventricular systole-positive strain

Statistical analysis

Continuous quantitative variables are presented as averages ± standard deviations, whilecategorical variablesare presented as variables. For comparing continuous variables we used ANOVA analysis.A p value <0,05 was considered statistically significant.

RESULTS

Characteristics of study groups

Age of the subjects included in this study was analyzed in comparison between the three groups, the following values being obtained (**Table 1**):

- In the control group age ranged from 24 years (minimum) and 71 years (maximum) with a mean of 41.46 ± 13.43 years of age, most frequently recorded age in patients of this group being 33 years (mod = 33);
- In AVNRT group age ranged from 29 years (minimum) and 76 years (maximum) with a mean of 51.54 ± 15.02 years of age, most frequently recorded age in patients of this group being 33 years (mod = 33);
- In AVRT group age ranged from 22 years (minimum) and 71 years (maximum) with a mean of 51.30 ± 17.08 years of age, most frequently recorded age in patients of this group being 63 years (mod = 63).

The ANOVA test showed that the three groups were statistically different only in terms of age without any interference in subsequent analysis of ultrasound parameters, all patients being in adults (F = 3.40; p = 0.040), post-hoc analysis of variance showed that age in the control group was significantly lower (on average about 10 years) in the control group than in both the AVNRT and AVRT, which were statistically similar. There were no statistically significant differences noted between the 3 groups in terms of gender distribution all three groups all three groups including more women than men.

The echo-strain assesment of the left atrium

The values of the peak longitudinal strain of LA in apical 4 chamber view variedbetween 23% (minimal value) and 44% (the maximal value), with the most frequent value of 39% (mod = 39%) in the control group, between 15% (minimal value) and 36.7% (maximal value) with the most frequent value of 16% (mod = 16%) in the AVNRT group and between 8.5% (minimal value) and 31.5% (maximal value) with the most frequent value of 8.5% (mod = 8.5%) in the AVRT group respectively, these values being statistically different between the three groups (F = 30,19; p < 0,0001); the post-hoc analysis of variance showed that the peak strain values in the apical 4 chamber view were significantly lower in the AVNRT and AVRT groups than in the control group, while in both of the tachycardia groups the peak-strain values were statistically simillar (**Table 2**).

The values of the peak longitudinal strain in apical 2 chamber view variedbetween 17,7% (minimal value) and 50% (maximal value), with the most frequent value of 38% (mod = 38%) in the control group, between 13,8% (minimal value) and 30,2% (maximal value) with the most frequent value of 19% (mod = 19%) in the AVNRT group and between 15% (minimal value) and 39,4% (maximal value) with the most frequent value of 19% (mod = 19%) in the AVRT group respectively, these values being statistically different between the three groups (F = 36,68; p< 0,0001); the post-hoc analysis of variance showed that the peak strain values in the apical 2 chamber view were significantly lower in the AVNRT and AVRT groups than in the control group, while in both of the tachycardia groups the peak-strain values were statistically simillar (**Table 2**).

Table 1. General characteristics of the study groups

	CONTROL N = 37	AVNRT N = 13	AVRT N = 10	p
Age (years)	41.46±13.43	51.54±15.02	51.30±17.08	0,040*
Sex				
• Feminin	25 (67.6)	8 (61.5)	7 (70)	NS**
• Masculin	12 (32.4)	5 (38.5)	3 (30)	

Values are presented as mean ± standard deviation for numeric data and as absolute value (percentage) for categorical data. N: total number of patients in the group; F: female; M: male; NS: not statistically significant (p> 0.05); * ANOVA test; Chi square test **

Table 2. The left atrium peak strain

	CONTROL N = 37	AVNRT N = 13	AVRT N = 10	p*
Peak_strain_4C (%)	33,65±6.35	21.74±6.11	19.35±6.27	<0.0001
Peak_strain_2C (%)	36.83±7.04	20.26±4.69	22.05±8.73	<0.0001

Values are presented as mean ± standard deviation for numeric data; N: total number of patients in the group; NS: not statistically significant (p> 0.05); * ANOVA test

DISCUSSIONS

Left atrium size correlates directly with pressure overload (mitral stenosis or elevated ventricular filling pressure) or volume overload (5). Is today known that atrial arrhythmias as it is atrial fibrillation regardless of type has as a consequence anatomical structural remodeling of LA objectively assesed by its increased diameters and volume at the echocardiography study. Regarding the adverse impacts of atrial arrhythmias on the function and size of LA, the data reported in the medical literature are obtained only from patients in atrial fibrillation. Clinical trials aimed primarily on depicting the role of LA as a predictive factor of thromboembolic complications or relapse after AF ablation.

Several echocardiographic parameters have been proposed over the years for depicting LA function. Thus, there have been studies that have analysed the parameters derived from mitral diastolic flow anvelope, but lately the study of LA myocardial mechanics identified its three functions, namely: the function of reservoir, the conduit function and the contractile function (5).

Myocardial strain techniques have been used subsequently for better understanding of the mechanical function of the LA. In this regard, an article published in 2010 showed that left atrial compliance, quantified based on peak-strain value of the lateral wall during ventricular systole, is improving from baseline in patients with atrial fibrillation one year after successful ablation (3).

Speckle tracking technique originally used only for the evaluation of left ventricular longitudinal, radial and circumferential functions became in 2010 a technique used for theassesment of left atrial mechanical function (4). The first studies in this regard in atrial fibrillation patients showed improvement in this function after their conversion to sinus rhythm. As the parameter that correlated best with postconversion positive remodeling in patients with atrial fibrillation was the average value of global strain and its peak (the positive value at the end of ventricular systole) this was the analysed speckle tracking parameter in the present work (4).

LA strain curve displays a negative deflection namely during atrial systole, when LA shrinks emptying in the left ventricle so the strain values recorded during atrial systole are negative. Paradoxically, although it directly correlates with the function of contraction of LA this value has not shown the same prognostic implications as the aforementioned in patients with atrial fibrillation. The advantage of speckle tracking analysis is that it provides information on each component of the LA function, with a much better frame rate, which means a better temporal assessment reported at some point in the cardiac cycle.

In this paper we have shown that episodes of reentrant supraventricular tachycardia with narrow QRS complex althoughparoxysmal conduct nevertheless toremodelling of LA. This translates into lower left atrium compliance in these patients compared to the control group, the most frequent valueof the strain beingof 16% (mode = 16%) - 4C, 19% (mode = 19%) - 2C in the AVNRT group and 8.5% (mode = 8.5%) - 4C, 19% (mode = 19%) - 2C in the AVRT group,these values being statistically different in the three groups (F = 30.19; p <0.0001 F = 36.68; p <0.0001) significantly lower in patients with tachycardia and without any statistical difference between the values recorded in the two groups of tachycardia (**Fig. 4 a,b**).

We also obtained the normal value of the LA strain by analysing individuals in the control group; we obtained a value of 33.65 ± 6.35% in the apical 4C viewand a value of 36.83 ± 7.04% in the apical 2C view, the values being similar to those described recently in literature. Thus in 2011 an article published in EJE whichanalysed atrioventricular coupling function in patients with cardiovascular risk factors showed that the maximum positive value of LA strain in the control group was 40.6 ± 7.1%.

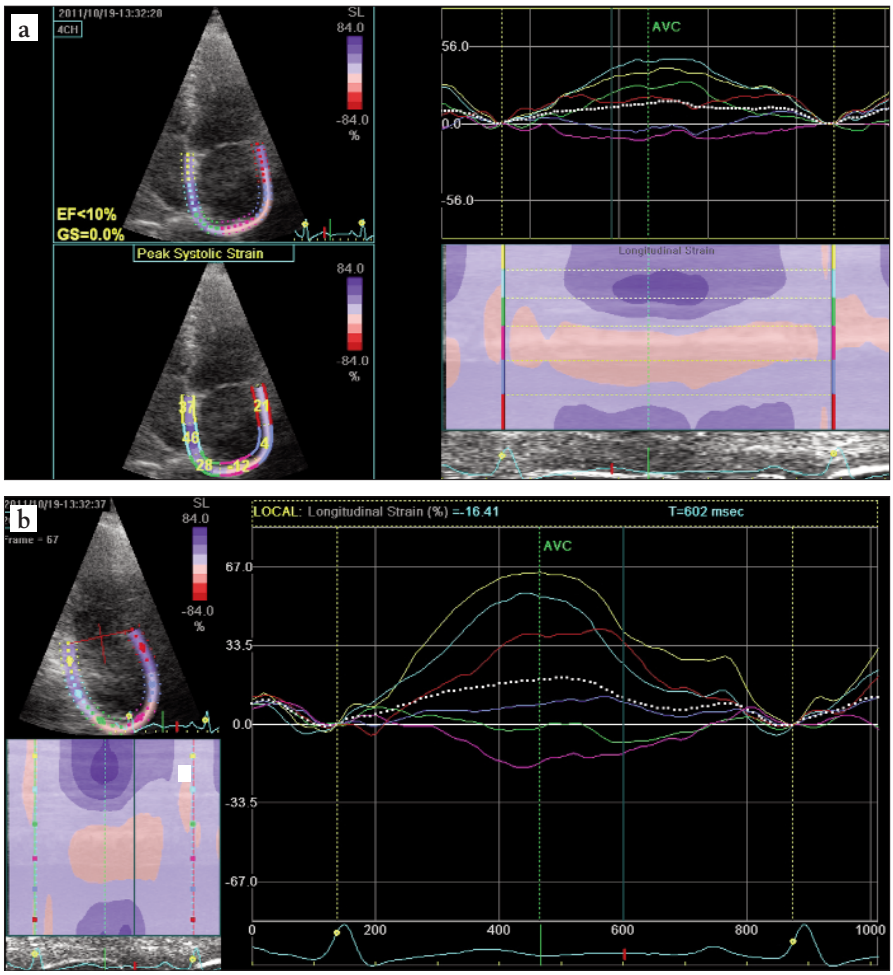

Figure 4. Speckle tracking evaluation in a patient with AVNRT. Remark the decrease of the positive strain value in both 4 chamber (a) and 2 chamber (b) views

CONCLUSIONS

The presence of tachycardia whatever of its type (AVNRT / AVRT) results in the impairment of left atrial mechanical function in these patients.The maximum values of positive strain are significantly lower in patients with tachycardia, suggesting the decrease in left atrium compliance compared to the control group. If this parameter returns to normal after radiofrequency ablation and what is the time required, these are other directions that we hope to be followed later in other prospective studies. The role of the strain measured during atrial systole that we know it correlates with contractile function of left atrium is another parameter that we have set for subsequent analyzes.

REFERENCES

1. Liza Thomas, Michelle Hoy, Karen Byth, Nelson B, Schiller.The left atrial function index:a rhythm independent marker of atrial function.European Journal of Echocardiography.2008:9,356-362.
2. Hirokazu Miyoshi, Yukio Mizuguchi,Yoshifumi Oishi, Arata Iuchi, Norio Nagase, Nusrat Ara, et al. Early detection of abnormal left atrial – left ventricular –arterial coupling in preclinical patients with cardiovascular risck factors:evaluation by two-dimensional speckle-tracking echocardiography. European Journal of Echocardiography. 2011:12,431-439.
3. Erwan Donal, Romain Olliver, David Veillard, Stephanie Harmonic, Dominique Pavin, J Claude Daubert, et al. Left atrial function assessed by trans-thoracic echocardiography in patients treated by ablation for a lone paroxymal atrial fibtillation. European Journal of Echocardiography 2010:11,845-852.
4. Gabriele Dell Era, Elisa Rondano, Elena Franchi, Paulo N. Marino on behalf of Novara Atrial Fibrillation Study Group. Atrial asynchrony and function before and after electrical cardioversion for persistent atrial fibrillation. European Journal of Echocardiography. 2010:11,577-583.
5. Andrew C.Y.To, MBChB, Scott D, Flamm, Thomas H, Marwick, Allan L, Klein. Clinical Utility of Multimodality La imaging. JACC. cardiovascular imaging. 2011: vol4 no7, 788-798.