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Improvement in Left Ventricular Deformational Indices Following Radiofrequency Ablation in Patients with Tachycardia: A Comparative Study Between AVRT and AVNRT Regarding Left Ventricular Strain and Strain Rates

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Abstract

Background: Ablation will efficiently lead to sinus rhythm preservation, which consequently improves left ventricular function; however, the strain rate and its indices as functional systolic factors of the left ventricle have not been studied.
Objectives: To assess the improvements in different patterns of radial, longitudinal, and circumferential strain rates separately.
Methods: In this case series, 31 patients with symptomatic tachycardia who were candidates for ablation between october 2011 and March 2012 in our tertiary cardiovascular center in Iran were enrolled. Patients underwent trans-thoracic echocardiography 24 hours before and 24 hours and three months after ablation, and left ventricular ejection fraction deformation indices were assessed using the two-dimensional (2D) speckle tracking method during normal sinus rhythm.
Results: Strain and strain rate indices in different aspects (radial and circumferential in the short axis view, and for longitudinal in the long axis view) improved remarkably during the three-month follow-up period ($P < 0.05$). The improvements in ventricular indices were usually between 24 hours to three months after ablation. The systolic strain rate (SR) and strain (SN) were significantly different at echocardiographic views before and 24 hours after ablation ($P < 0.05$), which revealed that myocardial function developed in the first 24 hours of ablation.
Conclusions: Echocardiography and 2D speckle tracking strain imaging shows improvements in left ventricular deformation indices in atrioventricular reentrant tachycardia (AVRT) and atrioventricular nodal reentrant tachycardia (AVNRT) patients for the mean systolic strain and strain rate at 24 hours and the three-month follow-up. In spite of the normal LVEF, even during sinus rhythm, deformation indices may be abnormal before and after ablation.

Keywords: Catheter Ablation, Ejection Fraction, Ventricular, Tachycardia, Atrioventricular Nodal Reentry, Tachycardia, Atrioventricular Nodal Reentry, Left Ventricular Function, Doppler Echocardiography

1. Background

Radiofrequency (RF) ablation is an acceptable treatment for different types of symptomatic drug-resistant tachycardia (1-3). The ablation procedure results in long-term symptom relief as well as improvements in left ventricular (LV) systolic function by effectively restoring sinus rhythm (4, 5). These improvements can be even observed in patients with systolic heart failure (6). However, in patients with preserved systolic function, a change in the left ventricular ejection fraction (LVEF) may not occur after ablation (7). On the other hand, subtle changes in LV systolic function may not be reflected by isolated assessment of the LVEF, and thus the impact of catheter ablation on LV systolic function cannot be detected only by considering the LVEF. Consequently, 2D speckle tracking strain imaging has been recently applied (8, 9), which can be used to study LV strain and strain rates in different views and patterns in patients with sinus rhythm maintenance following ablation, and it may even may be effective to determine the outcome of ablation procedures in affected patients (10).

RF catheter ablation is one possible way to control recurrent VT. It is frequently used in isolation for patients without systemic heart disease (SHD) or in combination with an implantable cardioverter defibrillator (ICD) and antiarrhythmic therapy in scar-related VT associated with SHD.

Preserved LV function may be associated with a change in the LV shape, as less LV spherical geometry has been demonstrated to improve the LV systolic function in idiopathic dilated cardiomyopathy (11). A combination of longitudinal and radial velocities has been shown as a useful tool for derivation of composite velocity in patients with low probability of coronary artery disease (CAD) and also distinguish abnormal form normal myocardium in patients with CAD (12). In this study, we used 2D speckle tracking strain imaging to evaluate the strain substrate associated with atrioventricular reentrant tachycardia (AVRT) and atrioventricular nodal reentrant tachycardia (AVNRT), the procedural evolution, and the long-term effects before and after ablation for all patients with arrhythmia. The estimation of LV function is one of the most frequent indications for echocardiography, but it is subjective and time consuming, particularly when the endocardium is not completely visualized (13, 14).

2. Objectives

We assessed the LV systolic function state for early and mid-term changes in the LV systolic strain and strain rates as well as the LVEF in patients with the different types of tachycardia after RF ablation. With regard to some observational evidence on the relationship between heart disease risk factors and LV dysfunction, risk factors causing heart disease and have confounding effects on improved LV function following ablation were also assessed.

3. Methods

In this case series, detailed demographic information, family histories, cardiac diseases, clinical and ECG characteristics and echocardiographic findings, right and left ventricle size and function, and previous histories of cardiac intervention were assessed in our tertiary cardiovascular care center in Iran between October 2011 and March 2012 for a period of the six-month. All patients with symptomatic supraventricular tachycardia were included. Patients with coronary artery disease, myocarditis, uncontrolled HTN, valvular heart disease, obesity, and those who were unwilling to participate in our study were excluded. The LVEF was determined using the bi-plane Simpson method. All patients had a normal LVEF during sinus rhythm (LVEF = 55%). Inform consent was obtained from all patients.

Patients underwent echocardiography 24 hours before ablation and 24 hours and three months after ablation. All antiarrhythmic drugs were discontinued. Echocardiographic exams were performed for all subjects placed in the left lateral decubitus position by the same operator who was unaware of the clinical and angiographic results, using a Mylab 60 echo machine (Esaote, Florance) equipped with a multi-frequency 2.5 - 3.4 MHZ transducer. Harmonic image recording of apical four-, three-, and two-chamber (4C, 3C, 2C) views and short axis views at mitral and papillary muscle levels, with good quality ECG signals and a frame rate between 45 and 64 FPS were acquired and stored for offline analysis using Xstrain™ software. For each patient, the clip with the best endocardial border was selected and proceeded as follows: a starting frame was usually chosen at the end systole when the endocardial border was more visible (but this is not mandatory, as the algorithm is designed to follow the points tracked in any frame) and then the LV endocardial surface was manually traced. An epicardial surface tracing was automatically generated by the system, creating a region of interest, which was manually adjusted to cover the full thickness of the myocardium. Before processing, a cine loop preview was used to confirm whether the internal line of interest followed the endocardial border throughout the cardiac cycle. S and SR graphics (for radial and circumferential in the short axis view, and for longitudinal in the long axis view) were automatically obtained using the velocity vector imaging (VVI) method and the average values for different parameters were obtained. The global longitudinal strain and strain rate (GLS and GLSR) values were calculated by averaging 4C, 2C, and 3C values. The LVEF was calculated using the biplane Simpson rule. The ablation procedure was performed as explained in previous studies (15, 16).

3.1. Statistical Analysis

All values are expressed as mean $\pm$ S.D. Student's t-test was used to compare the difference of continuing values between the two groups. chi-squared tests were used to compare non-categorical variables (e.g., medication profile). Categorical variables were compared using the chi-square test or Fisher's exact test when more than 20% of the data were analyzed using standard statistical software (SPSS version 11.0; Chicago, IL, U.S.A.). Multivariate analysis was performed to adjust the confounding factor effects. A P value < 0.05 was considered statistically significant. Multivariate analysis (regression test) was used to remove the effects of confounding factors.

3.2. Key Points

1. In spite of the normal LVEF, even during sinus rhythm, deformation indices may be abnormal before and after ablation.

2. Ablation in those with supraventricular tachycardia can lead to significant improvements in ventricular systolic function assessed by echocardiography changes in 2D speckle tracking strain imaging within mid-term follow-up (24-hour and three-month follow-up period) in LV deformation indices in AVRT and AVNRT cases for the mean systolic strain and strain rates; however, this improvement can be influenced by underlying factors, e.g., advanced age, hypertension, diabetes mellitus, renal function, and underlying arrhythmia type.

4. Results

Thirty-one patients (mean age: 41.35 ± 5.98 years) who were candidates for ablation were enrolled in our study and evaluated according to their echocardiography before ablation and 24 hours and three months after ablation.

4.1. Demographic and Clinical Data

The ECG findings revealed that 58.1% of patients had narrow QRS, while 22.6% had LBBB (Left Bundle Branch Block)and 19.4% had RBBB.(Right Bundle Branch Block) The mean time from the first documented tachycardia episode to the radiofrequency catheter ablation procedure was 1.78 ± 1.66 years. The most frequent origin for arrhythmia was the atrioventricular node (35.5%), followed by the left lateral wall (25.8%), right ventricle (16.1%), and left atrium (9.7%). In addition, 41.9% of the patients suffered from AVNRT, and 35.5% had AVRT (Table 1).

Table 1. Demographic and Clinical Data in Patients with Tachycardia Before Ablation

Risk Factors	Mean ± SD or No. (%)
Age	41.35 ± 5.98
Sex	
Female	22 (74.2%)
Male	8 (25.8%)
Risk factors	
HTN	9 (29%)
DM	5 (16.1%)
DLP	5 (16.1%)
Lab data	
BUN	19.1 ± 3.9
Hb	13.4 ± 1.4
Drug	
Ca-blocker	11 (35.5%)
Beta blocker	12 (38.7%)
NYHA	
I	3 (9.7%)
II	28 (90.3%)
ECG	
Narrow	18 (58 %)
LBBB	7 (22.6%)
RBBB	6 (19.4%)
TOA	
AVRT	11 (35.5%)
AF/AFL	4 (12.9%)
AVNRT	12 (38.7%)
PVC and VT	4 (12.9%)
OOA	
Atrium	4 (12.9%)
AP	11 (35.5%)
Node	12 (38.7%)
RV	4 (12.9%)

Abbreviations: AF, atrial fibrillation; AP, accessory pathway; AVNRT, atrioventricular nodal reentrant tachycardia; AVRT, atrioventricular reentrant tachycardia; Ca-blocker, calcium channel blocker; DLP, dyslipidemia; DM: diabetes mellitus; HTN, hypertension; OOA, origin of arrhythmia; PVC, premature ventricular contraction; TOA, type of arrhythmia; VT, ventricular tachyarrhythmia.

4.2. The Comparison of Echocardiographic Parameters Between the Two Groups of Arrhythmia Before and After 24 Hours and Three Months of Ablation Follow-Up

Overall, an improvement was observed in the LVEF during the three-month follow-up period. In all three directions (radial, circumferential, and longitudinal), systolic strain and strain rates significantly improved during the follow-up time in the overall study population (Table 2) ($P < 0.05$). Interestingly, the improvement trend in all directions had a more ascending slope at mid-term follow-up than at initial assessment. There was a significant association between the baseline risk factors and improvements in ventricular systolic function parameters ($P < 0.05$). The strain rate was only influenced by the type of arrhythmia as the progressive response to ablation was more common in AVNRT than in AVRT. However, improvements in the directions of strain were not as pronounced in older patients, in patients with a high serum BUN (blood urea nitrogen), in those with hypertension or diabetes mellitus, and in patients who were active smokers. In addition, improvements in LV deformational indices after ablation were not affected by various heart diseases risk factors (Tables 1 and

2).

Systolic strain and strain rate indicators at different aspects including 2C, 3C, 4C, MV, PM, SN, SR, parasternal short axis (mitral valve and papillary muscle surfaces), were remarkably improved during the three-month follow-up period. This development occurred at the two aspects of ventricular longitudinal and circumferential direction. The improvements in ventricular indicators usually occurred between 24 hours and three months after ablation. The present study also showed improvements and significant increases in the mean LVEF in patients who underwent ablation ($P < 0.05$). The systolic strain rate and its indices were significantly different in echocardiographic views before and 24 hours after ablation ($P < 0.05$), which revealed the development of myocardial function in the first 24 hours of ablation. We cannot predict the subtype of arrhythmia according to the systolic strain and strain rates before ablation. These results make true 24 hours and three month after an ablation (Tables 3 and 4). There was a significant difference between AVRT and AVNRT regarding the systolic strain rate in 3C after the three-month follow-up, as no significant differences were found between these types of arrhythmia for 4C strain ($P = 0.1$) ($P = 0.02$). There was also a significant correlation between the two types of arrhythmia regarding the systolic strain rate in 2C ($P = 0.01$), but no significant correlation in 2C strain was observed ($P = 0.6$). No significant differences were found between the systolic SR and SN in the comparison of arrhythmia types the day before and after ablation ($P < 0.01$) (Tables 3 and 4)

The three-chamber systolic strain (SN3C), 3-chamber systolic strain rate (SR3C), 4-chamber systolic strain (SN4C), 4-chamber systolic strain rate (SR4C), 2-chamber systolic strain (SN2C), SR2C, systolic strain rate of the mitral valve (SRMV), and the systolic strain rate of the papillary muscles (SRPM) were compared before and after three months of ablation and showed that the SN and SR significantly increased after ablation ($P < 0.001$) (Table 4).

All the abovementioned indicators were compared 24 hours before and after ablation and 24 hours before and three months after ablation for the AVNRT and AVRT groups (Table 5) and showed a significant correlation, emphasizing improvements in myocardial function after ablation ($P < 0.05$). Similar patterns in SN and SR in patients with AVNRT and AVRT 24 hours before ablation and 24 hours and three months after were seen. The rates of SN and SR have been gradually increased according to the duration of patients' arrhythmias (Figures 1 and 2).

5. Discussion

Local material properties, local myocardial fiber contractility, and global forces such as LV pressure are defined as contributing factors to regional myocardial function. Longitudinal movement results from the contraction of sub-endocardial and sub-epicardial fibers and radial movement derives mainly from the contraction of circumferential fibers (17).

In the present study, changes in ventricular systolic function were assessed through the evaluation of the LVEF according to myocardial strain and strain rates in those who had experienced atrial tachycardia following ablation.

According to our investigation, there were considerable improvements in radial, circumferential, and longitudinal strain and strain rates three months after ablation ($P < 0.05$), which were initiated in the first 24 hours after the procedure. The slope showed a steeper increase within the first three months of ablation, and there were no changes in the LVEF, LV volumes, and right ventricular dimensions in patients effectively treated by ablation during follow-up. The results were in accordance with Wijnmaalen et al.; nevertheless, radial, circumferential, and longitudinal strain developed significantly in patients after ablation (18). On the other hand, no significant changes in the LVEF before and after ablation (29.8% before and 29.5% after ablation) were shown in another previous study; however, more than 5% improvement in LVEF was seen in most of the cases (19). Improvements following ablation may be observed in some radial, longitudinal, and circumferential axes.

We presented equivalency between the LVEF and strain imaging to evaluate the improvements in LV function after ablation. Although the restoration of sinus rhythm does have positive effects on LV systolic function, they cannot be identified by conventional parameters such as LVEF. The evaluation of LV strain may detect more subtle abnormalities in LV systolic function (20), which can improve after ablation.

Initial data on patients with a normal LVEF suggest that LV deformation may progress after catheter ablation (21). In the present study, 2D speckle tracking strain imaging was used to evaluate LV function after catheter ablation for supraventricular tachycardia in 31 patients. In comparison, the previous data showed that the mean deformational indices for the LVEF improved after mid-term follow-up, and significant changes in LV radial, circumferential, and longitudinal strain and strain rates were noted. Improvements in deformational indices according to strain and strain rates after effective catheter ablation can be attributed to the normalization of the heart rate or sinus rhythm and following more efficient LV filling (22). There-

Table 2. Comparison of Systolic Strain and Strain Rates in Patients with AVRT and AVNRT 24 Hours Before and 24 Hours and Three Months After Ablation

Echocardiographic Characteristics	24 Hours Before Ablation	24 Hours After Ablation	3 Months After Ablation	P Value
SR. 3C	070 ± 0.15	0.82 ± 014	1.22 ± 0.19	< 0.001
SN.3C	15.4 ± 1.27	16.82 ± 16.82	20 ± 1.9	< 0.001
SR. 4C	0.73 ± 0.13	0.86 ± 0.14	1.20 ± 1.7	< 0.001
SN.4C	15.77 ± 1.10	17.31 ± 17.31	20.6 ± 0.98	< 0.001
SR.2C	0.76 ± 0.14	1.90 ± 1.90	1.30 ± 0.18	< 0.001
SN.2C	16.1 ± 1.20	17.57 ± 17.57	20.5 ± 2.3	< 0.001
SR.MV	0.87 ± 0.12	1.03 ± 1.03	1.4 ± 0.18	< 0.001
SN.MV	16.60 ± 1.25	18.03 ± 18.3	21.4 ± 1.8	< 0.001
SR.PM	0.87 ± 0.12	1.04 ± 1.04	1.4 ± 0.18	0 < 0.001
SN.PM	16.08 ± 1.09	18.2 ± 18.2	21.7 ± 1.8	0 < 0.001

Abbreviations: MV, mitral valve; PM, papillary muscle; SN, strain; SR, strain rate; 2C, two chambers; 3C, three chambers; 4C, four chambers.

Table 3. SN and SR in the AVRT and AVNRT Groups upon Admission

Variables	AVRT	AVNRT	P Value
SR.3CA0	0.73 ± 0.17	0.73 ± 1.15	0.98
SN3CA0	15.5 ± 0.12	15 ± 0.77	0.30
SR.4C0	0.76 ± 0.13	0.77 ± 0.14	0.87
SN.4C0	15.63 ± 0.98	15.71 ± 1.03	0.85
SR. 2C0	0.79 ± 0.13	0.79 ± 0.13	0.99
SN. 2C0	16.01 ± 1.26	15.9 ± 1.02	0.93
SR. MV0	0.88 ± 0.12	0.87 ± 0.13	0.89
SN. MV0	16.6 ± 1.23	16.3 ± 1.23	0.54
SR. PM0	0.89 ± 0.11	0.88 ± 0.13	0.84
SN.PM0	16.8 ± 1.05	16.6 ± 1.20	0.60

Abbreviations: MV, mitral valve; PM, papillary muscle; SN, strain; SR, strain rate; 2C, two chambers; 3C, three chambers; 4C, four chambers.

fore, the current results suggest that the improvements in deformational indices after catheter ablation may be attributed to the return and long-term maintenance of normal sinus rhythm rather than to the normalization of the heart rate.

In our study, different patterns of strain and strain rates in different directions were influenced by a variety of underlying factors; however, improvements in strain were primarily associated with various risk factors, including age, hypertension, diabetes, and serum BUN level, whereas the strain rate was commonly affected by the type of arrhythmia. Diabetes mellitus has been shown to be an independent predictor for longitudinal strain, and the systolic strain rate and the left ventricular longitudinal systolic function are subsequently compromised, but the circumferential and radial functions have been well-maintained in patients with uncomplicated diabetes mellitus (23). Previous researchers have suggested that The patients with diabetic mellitus had significant longitudinal strain reductions versus controls. A significant longitudinal strain reduction in hypertensive patients versus control groups has been demonstrated as well (24).

In addition, older age has been shown to be associated with reduced systolic strain and strain rates (25).

Moreover, because of the the faster heart rate(tachycardia)in the AVRT in comparison with the AVNRT group, improvements in systolic function can be more predictable in the AVRT group. Consequently, because of the associations between these factors and the level of improvements in ventricular function following ablation, all the determining factors should be considered in initial patients' management.

Table 4. SN and SR 24 Hours and 3 Months after Ablation in the AVNRT and AVRT Groups

SN and SR in the Two Groups	SN and SR After 24 Hours, Mean ± SD	P Value	SN and SR After Three Months (Mean ± SD)	P Value
SR 3C1		0.93		0.02
AVRT	0.85 ± 0.15		1.34 ± 0.18	
AVNRT	0.86 ± 0.13		1.15 ± 0.17	
SN. 3C 1		0.27		0.19
AVRT	17.03 ± 0.93		20.8 ± 1.32	
AVNRT	16.52 ± 1.20		19.7 ± 2.48	
SR. 4C1		0.75		0.04
AVRT	0.90 ± 0.16		1.38 ± 0.16	
AVNRT	0.88 ± 0.12		1.22 ± 0.12	
SN.4C1		0.43		0.14
AVRT	17.40 ± 1.06		21.34 ± 0.70	
AVNRT	17.01 ± 1.30		20.10 ± 2.3	
SR.2C1		0.71		0.01
AVRT	0.94 ± 0.16		1.42 ± 0.17	
AVNRT	0.92 ± 0.14		1.23 ± 0.15	
SN.2C1		0.73		0.6
AVRT	17.7 ± 1.17		20.62 ± 2.72	
AVNRT	17.3 ± 1.07		20.44 ± 2.04	
SR.MV1		0.67		0.09
AVRT	1.05 ± 1.09		1.50 ± 0.17	
AVNRT	1.17 ± 1.12		1.36 ± 0.18	
SN.MV1		0.19		0.18
AVRT	18.33 ± 1.01		22.13 ± 0.82	
AVNRT	17.75 ± 1.62		20.85 ± 2.25	
SR.PM1		0.43		0.15
AVRT	1.10 ± 0.17		1.53 ± 0.17	
AVNRT	1.05 ± 0.13		1.42 ± 0.16	
SN.PM1		0.17		0.4
AVRT	18.7 ± 0.78		22.34 ± 0.74	
AVNRT	17.9 ± 1.59		24.01 ± 0.25	

Abbreviations: MV, mitral valve; PM, papillary muscle; SN, strain; SR, strain rate; 2C, two chambers; 3C, three chambers; 4C, four chambers.

The systolic strain and strain rate in patients with AVRT and AVNRT in comparison to the normal population decreased. In addition, the systolic dimension of theses indices improved in these two types of arrhythmia after ablation. The present study indicated that in addition to arrthymia, confounding risk factors may also have affected our results obtained by strain imaging.

5.1. Conclusion

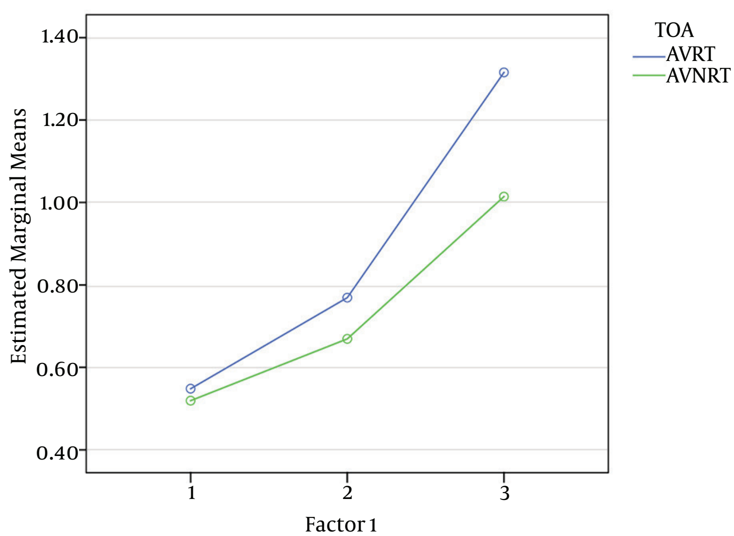
In conclusion, ablation in those with supraventricular tachycardia can lead to significant improvements in ventricular systolic function assessed by echocardiography changes in left deformational indices and 2D speckle tracking strain imaging at mid-term follow-up; however this improvement can be influenced by several underlying factors, such as advanced age, hypertension, diabetes mellitus, renal function, and underlying arrhythmia type.

Table 5. Comparison of SN and SR one Day Before and Three Months After Ablation in Patients with AVRT and AVNRT

SN and SR	One Day Before Ablation	Three Months After Ablation	P Value
SR 3C	0.70 ± 0.15	1.22 ± 0.19	< 0.001
SN3C	15.4 ± 1.27	20 ± 1.9	< 0.001
SR4C	0.73 ± 0.13	1.2 ± 0.17	< 0.001
SN4C	15.7 ± 1.1	20.6 ± 0.98	< 0.001
SR2C	0.76 ± 0.14	1.30 ± 0.18	< 0.001
SN2C	15.9 ± 1.1	20.5 ± 2.3	< 0.001
SRMV	0.87 ± 0.12	1.4 ± 0.18	< 0.001
SNMV	16.5 ± 1.2	21.4 ± 0.18	< 0.001
SRPM	0.87 ± 0.12	1.4 ± 0.18	< 0.001
SNPM	16.7 ± 1.1	21.7 ± 1.8	< 0.001
Mean-SR-S	0.78 ± 0.13	1.3 ± 0.17	< 0.001
Mean-strain-S	16.04 ± 0.9	20.9 ± 1.7	< 0.001

Abbreviations: MV, mitral valve; PM, papillary muscle; SN, strain; SR, strain rate; 2C, two chambers; 3C, three chambers; 4C, four chambers.

Figure 1. Estimated Marginal Means of MEASURE-1



The rates of strain gradually and significantly increased 24 hours before and 24 hours and three months after ablation (P < 0.001); however, this trend regarding SN PLA in the three mentioned times in the AVRT and AVNRT groups was similar, and there was no significant interaction (P = 0.4).

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Footnotes

Authors' Contribution: Mohammad-Ali Sadr-Ameli, leader of the project; Monireh Soltani, Sadaf Sadr-Ameli, collecting the data; Mona Heidarali, scientific writing of the manuscript and preparing the paper; Behshid Ghadrdoost, data analysis; Naser Movassaghi, patient management; Maryam Shojaeifard, leader of the project; Hooman Bakhshandeh, consulting in statistical analysis and methodology of the project.

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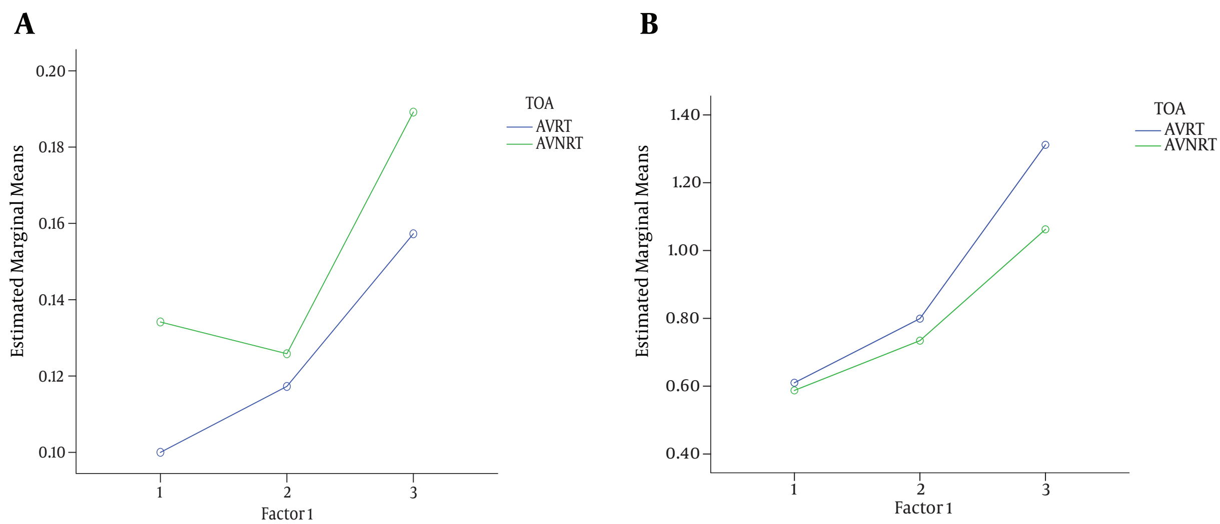

Figure 2. A, The strain rate in 4C (SR4C) changed significantly in both groups 24 hours before and 24 hours and three months after ablation (P = 0.01). However, this figure shows that no significant interaction between the two groups was found over time for this gradually increasing trend (P = 0.08); B, The rate of strain in 4C changed significantly in both groups 24 hours before and 24 hours and three months after ablation (P = < 0.001). However, this figure shows that no significant interaction between the two groups was found over time for this gradually increasing trend (P = 0.1).

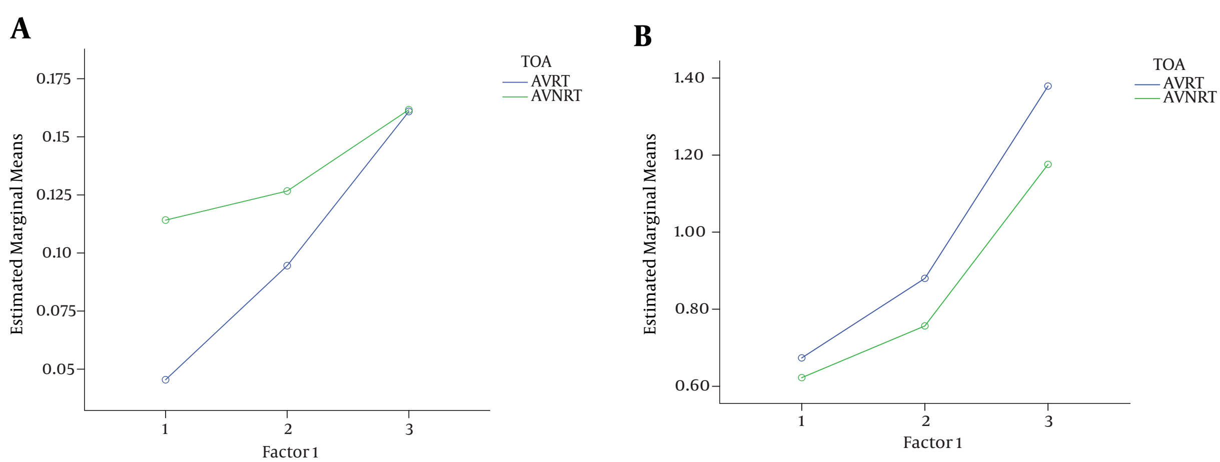

Figure 3. A, shows that the strain rate of 2C changed significantly in both groups of 24 hours before and 24 hours and three months after ablation (P = 0.01) and a significant interaction between the two groups was found over time for this gradually increasing trend (P = 0.04); B, shows that the rate of strain of 2C changed significantly in both groups 24 hours before and 24 hours and three months after ablation (P < 0.001); however, no significant interaction between the two groups was found over time for this gradually increasing trend (P = 0.9).

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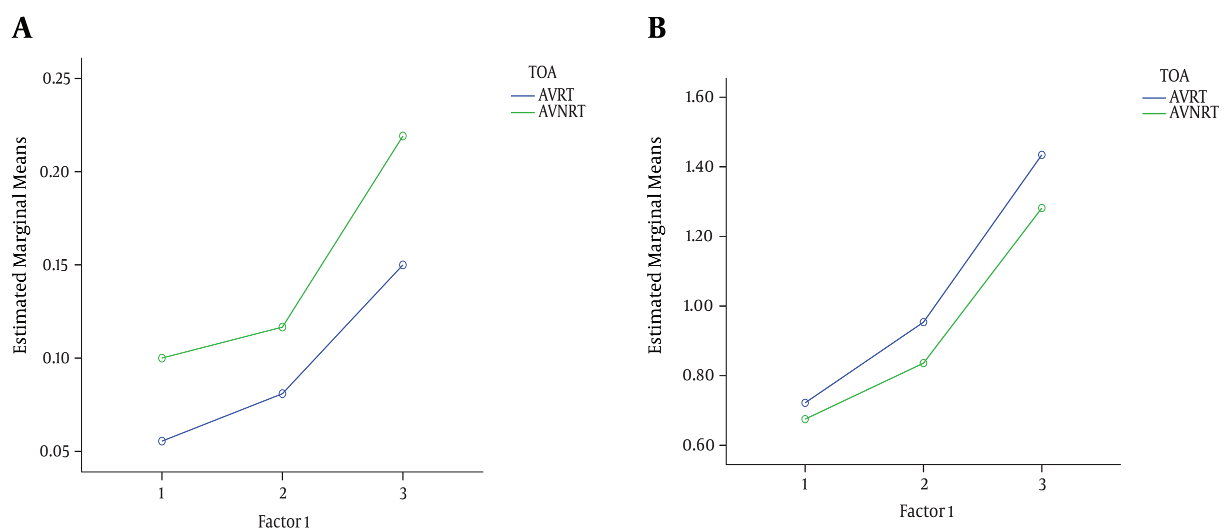

Figure 4. A, shows that the strain rate (S.MV) of MV changed significantly in both groups 24 hours before and 24 hours and three months after ablation (P = 0.01); however, no significant interaction between the two groups was found over time for this gradually increasing trend (P = 0.2); B, shows that the rate of strain (SN.MV) of MV changed significantly in both groups 24 hours before and 24 hours and three months after ablation (P = <0.001); however, no significant interaction between the two groups was found over time for this gradually increasing trend (P = 0.2).

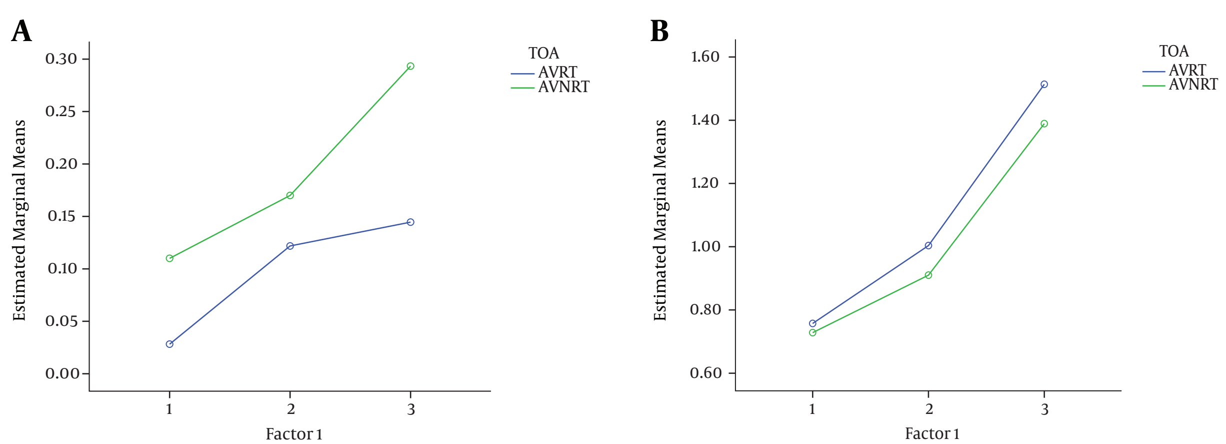

Figure 5. A shows that the rate of strain (S.PM) of PM altered significantly totally in both AVRT and AVNRT groups 24 hours before and 24 hours and three months after ablation (P < 0.001); however, no significant interaction between the two groups was found over time for this gradually increasing trend (P = 0.4); B shows that the strain rate (SR.PM) of PM changed significantly in both groups 24 hours before and 24 hours and three months after ablation (P < 0.001); however, no significant interaction between the two groups was found over time for this gradually increasing trend (P = 0.3).

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