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Original Article

Comparison of Heart Rate Variability Parameters Between Slow Pathway Complete Ablation and Modification/Ablation for AVNRT

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ABSTRACT

Background: Atrioventricular nodal reentry tachycardia (AVNRT) is the most common type of supraventricular tachycardia, and catheter slow pathway ablation is the first-line therapy in this arrhythmia. The endpoint for the successful ablation of AVNRT is the noninducibility of the tachycardia rather than the complete ablation or modification/ablation of slow pathways. We aimed to compare heart rate variability (HRV) parameters between slow pathway complete ablation and slow pathway modification/ablation for AVNRT.

Methods: The current study enrolled 78 eligible patients with AVNRT. Slow pathway complete ablation was performed on 49 patients, and 29 patients underwent slow pathway modification/ablation. HRV parameters on 24-hour Holter monitoring were compared before and 30 days after ablation between these 2 groups.

Results: HRV parameters, consisting of the mean heart rate, the standard deviation of normal-to-normal RR intervals over 24 hours (SDNN), the standard deviation of the average NN intervals for all 5-minute intervals in a 24-hour continuous electrocardiographic recording (SDANN), and a percent NN interval exceeding 50 milliseconds from the prior interval (PNN50), were not significantly different in the group with complete slow pathway ablation. The comparison between pre and post-intervention entities revealed statistically significant differences in SDNN (P=0.041) and PNN50 (P=0.008) in the group with slow pathway modification/ablation. Additionally, PNN50 was significantly lower in the modification/ablation group than in the complete ablation group.

Conclusions: We noted negligible differences regarding HRV-associated indices between the slow pathway complete ablation and modification/ablation for AVNRT groups. ***(Iranian Heart Journal 2023; 24(2): 62-68)***

KEYWORDS: AVNRT, Slow pathway, Heart rate variability, Ablation

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Atrioventricular nodal reentry tachycardia (AVNRT) is the most common type of supraventricular tachycardia (SVT) in adolescents and young adults that chiefly presents with recurrent complaints of palpitations. Further symptoms, such as fatigue, perspiration, dyspnea, and chest pain, might be the other presentations of AVNRT. [1] Paroxysmal tachycardia, caused by AVNRT, occurs due to dual AV nodal physiological supports. [2] Although AVNRT is not generally life-threatening, it undermines the quality of life in terms of daily social activities, medical care requirements, and family life. [3]

Catheter slow pathway ablation is the first-line approach for AVNRT management with considerable long-term success at all ages. [4-6] Nonetheless, negligible rates of up to 1% of heart blocks requiring pacemaker implantation have been reported. [7]

As the location of the AV node and its extensions are predictable in a heart with a normal structure, [8] the orientation of the catheter tip relative to the landmarks of the Koch triangle, combined with certain electrocardiogram (ECG) characteristics, provides reliable guidance for successful slow pathway ablation in nearly all cases. [9]

AVNRT successful ablation is achieved when there is no further arrhythmia recurrence. Sometimes, the elimination of the antegrade conduction through the small pathway is considered the endpoint, particularly while arrhythmia induction at baseline is not reliable. Nevertheless, an echo beat commonly remains after ablation, termed “slow pathway modification”. A successful ablation procedure requires the prevention of any recurrence of the arrhythmia by isoproterenol injection. Accordingly, the endpoint is to prevent the minimal probability of tachycardia rather than completely ablate or modify/ablate slow pathways. [10]

Inappropriate sinus tachycardia is a common complication following fast and slow pathway ablation. Localized parasympathetic denervation has been presented as the underlying etiology of this phenomenon which is chiefly a temporary and self-limited condition but can turn into a persistent or delayed event. [11] Heart rate variability (HRV) Holter monitoring is a method whereby the parasympathetic activity of the cardiac autonomic system can be evaluated.

In the present study, we compared HRV parameters between slow pathway complete ablation and slow pathway modification/ablation for AVNRT.

METHODS

The current cross-sectional study was conducted on 78 patients with AVNRT referred to the Electrophysiology Study (EPS) department of Rajaie Cardiovascular Medical and Research Center, affiliated with Iran University of Medical Sciences, between March 2019 and December 2021.

The research followed the principles of the Declaration of Helsinki. The institutional ethics committee approved the study protocols (ethics code: IR.IUMS.FMD.REC.1400.235). The study protocol was explained to the recruited patients, who were reassured concerning the confidentiality of their personal information. Written informed consent was obtained from all the participants.

Patients over 18 years old with a confirmed diagnosis of AVNRT who had a left ventricular ejection fraction (LVEF) above 50%, normal right ventricular size and function, an interventricular diameter of less than 13 mm, and a history of rhythm Holter monitoring for more than 24 hours within 6 months before AVNRT ablation were included in the study.

Moderate-to-severe valvular dysfunction, cardiac structural disorders, abnormal HRV and mean heart rates in the previous Holter monitoring, and reluctance to participate in the study constituted the exclusion criteria.

The study population was divided into 2 groups: the complete ablation group and the modification/ablation group.

Primarily, heart rate before and immediately within a minute after ablation was measured. Thirty days after ablation, 24-hour Holter monitoring was performed for all the participants, and parameters, including the mean heart rate and HRV, were analyzed. Antiarrhythmic agents were stopped for at least 5 half-lives before 24-hour monitoring. Accordingly, a mean heart rate exceeding 90 bpm, the standard deviation of normal-to-normal RR intervals over 24 hours (SDNN), a standard deviation of the average NN intervals for all 5-minute intervals in a 24-hour continuous ECG recording (SDANN) below 100, and a percent NN interval exceeding 50 milliseconds from the prior interval (PNN50) below 3% were considered abnormal.

The obtained data were entered into the Statistical Package for Social Sciences (SPSS Inc, Chicago, IL, USA), version 23. The Kolmogorov–Smirnov test was applied to determine data distribution normality. Descriptive data were presented as means, standard deviations, percentages, and absolute numbers. Categorical variables were compared using the χ^2 test. For continuous variables with normal distributions, the independent *t* test was administered; otherwise, the Mann–Whitney *U* test was utilized. The paired *t* test was used to compare the variables between the 2 groups. A *P* value of less than 0.05 was considered a significant level.

RESULTS

The current study was conducted on 78 patients. For the management of AVNRT, 49 patients underwent slow pathway complete ablation, and 29 patients underwent slow pathway modification/ablation. The studied patients had a mean age of 47.27±11.35 years and were predominantly female (n=47, 60.25%). Table 1 presents the demographic characteristics of the study population.

Table 1: Demographic and medical characteristics of the study population

Variables	
Demographic Characteristics	
Age, y, mean ± standard deviation	47.27±11.35
Sex, male, n (%)	31 (39.75)
Smoking, n (%)	9 (11.5)
Positive family history of dysrhythmia, n (%)	12 (15.4)
Chronic Medical Disorders, n (%)	
Diabetes	5 (6.4)
Hypertension	18 (23.1)
Dyslipidemia	13 (16.7)
Ischemic heart disease	2 (2.6)
Other dysrhythmias	0 (0)

Table 2 demonstrates a comparison of the variables related to the outcomes of ablation. The 2 techniques were not statistically significantly different, except in terms of PNN50, since the modified technique led to significantly lower values (*P*=0.005). Additionally, the comparison between pre and post-intervention entities revealed statistically significant differences in SDNN (*P*=0.041) and PNN50 (*P*=0.008).

Figure 1 demonstrates the comparison of the assessed parameters between the groups.

Table 2: Comparisons of ablation-related parameters between the 2 approaches

		Before the Intervention	30 Days After the Intervention	*P* value*
MHR	Complete ablation	78.8±10.1	77.1±8.7	0.23
	Modified ablation	76.8±10.6	77.6±7.8	0.65
*P***		0.46		
SDNN	Complete ablation	113.8±30	112.9±31.6	0.84
	Modified ablation	112.9±33	101.9±22.1	0.041
*P***		0.17		

SDANN	Complete ablation	97±25.4	97.9±26.3	0.81
	Modified ablation	95.9±21.9	90.7±25.7	0.23
*P***		0.64		
PNN50	Complete ablation	8.2±6.8	6.2±4.4	0.058
	Modified ablation	6.4±5.6	4.4±3.3	0.008
*P***		0.005		

*Independent *t* test
** Paired *t* test
MHR, Mean heart rate; SDNN, Standard deviation of normal-to-normal RR intervals over 24 hours; SDANN, Standard deviation of the average NN intervals for all 5-minute intervals in a 24-hour continuous electrocardiographic recording; PNN50, Percent NN intervals

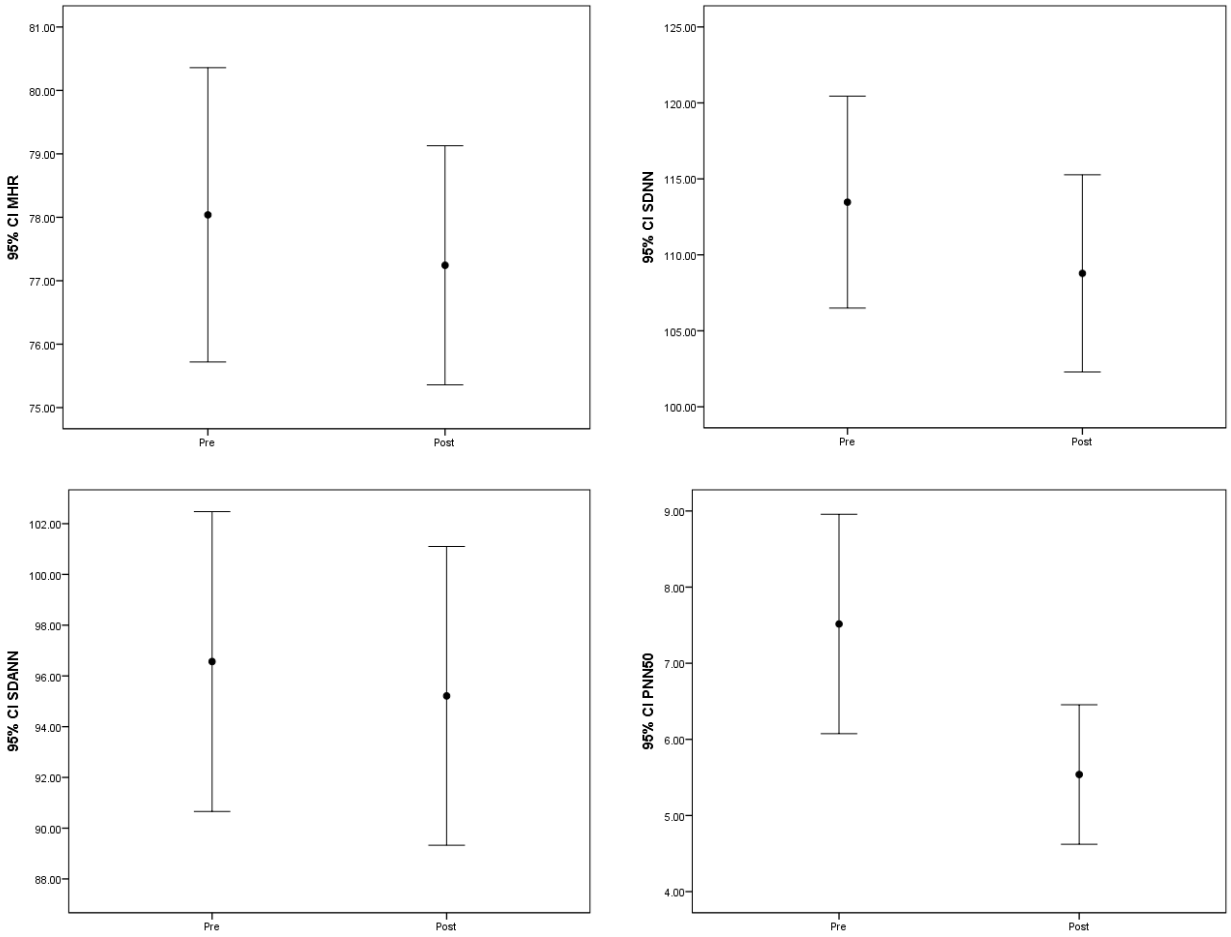

Figure 1: The images present the comparisons of pre- and post-intervention parameters between the 2 groups.
a) MHR (*P*=0.46), b) SDNN (*P*=0.17), c) SDANN (*P*=0.64), and d) PNN50 (*P*=0.005)

MHR, Mean heart rate; SDNN, Standard deviation of normal-to-normal RR intervals over 24 hours; SDANN, Standard deviation of the average NN intervals for all 5-minute intervals in a 24-hour continuous electrocardiographic recording; PNN50, Percent NN intervals

DISCUSSION

The current study aimed to explain the efficacy of slow pathway ablation concerning the electrophysiological criteria of HRV in patients with AVNRT. We found negligible differences between the slow

pathway complete ablation and slow pathway modification/ablation for AVNRT. Still, the modified approach led to a significant decrease in PNN50. Given the insignificant superiority of the former ablation method over the latter one, we assume that the modified technique is a better choice than the complete ablative method to reduce the risk of atrioventricular blocks (AV blocks). [7]

To our knowledge, despite the long-term investigations on the efficacy and complications associated with different ablative therapies for dysrhythmia, data are scarce regarding the comparison of effects on diverse cardiac parameters, HRV in particular, between slow pathway modification/ablation and complete ablation. Nevertheless, researchers have unanimously stated that catheter ablative therapy is the most obvious approach to control AVNRT, particularly in drug-resistant patients. [12] Still, the complete ablation of slow pathways has a 0.5% to 1% risk of AV blocks and about a 4% risk of recurrence, [13] hence the application of other alternative strategies leading to the advent of the modified technique.

Significant changes in HRV before the onset of AVNRT are responsible for this tachyarrhythmia. Thus, while the increase in low-frequency components during the hour preceding the onset of AVNRT denotes an adrenergic predominance, the decrease in high-frequency components suggests diminished parasympathetic drive. [14] The fluctuations of autonomic tone before AVNRT onset are emphasized by the results of time-domain HRV analysis. Consequently, a decrease in SDNN and SDANN implies an increase in the sympathetic tone with a reduction in PNN50, reflecting vagal modulation and accounting for AVNRT incidence. [15] The regularity of atrial and ventricular ectopic beats plays a vital role in tachycardia, antegrade and retrograde conduction, and the refractory periods of the AV node and accessory pathways. [16]

Sileikiene et al [17] reported a significant rise in the mean and maximal heart rates and a decrease in HRV parameters among children undergoing AV slow accessory pathway ablation. In agreement with our investigation, Stern et al [18] reported insignificant differences in the HRV indices of patients undergoing the complete elimination of slow pathways compared with those treated with the modified approach. Similarly, the evaluation of the slow accessory pathway and the generation of AV nodal echo beats revealed insignificant differences.

Although most studies in the literature have reported remarkably lower probabilities of AV block recurrence in slow pathway modification/ablation, post-ablation palpitations are not an unexpected event. [12,19] Nonetheless, Karbasi-Afshar et al [20] concluded that the anatomical site but not the completeness of ablation played a crucial role in AVNRT recurrence.

The underlying reason for palpitation persistence without AVNRT recurrence after slow pathway modification/ablation has yet to be elucidated. However, it is estimated that patients with a history of AVNRT are more aware of the heart rhythm, and benign irregularities, such as premature atrial contractions, premature ventricular contractions, and paroxysmal sinus tachycardia, might be perceived as palpitations. [21] The other probability for palpitations refers to the incidence of ectopic beats occurring due to HRV alterations, [22] which chimes with our study since PNN50 as the determinant of vagal modulation status was significantly altered in our patients undergoing the modified approach. This difference in the slow pathway modification/ablation group might be due to the longer duration and larger extent of the

ablation area and subsequent further damage to the parasympathetic ganglia in the posteroseptal region.

Limitations

As our study was conducted based on the existing data and medical records of patients at Rajaie Cardiovascular Medical and Research Center, data generalizability is questioned, and further studies with a randomized clinical trial design are required. Furthermore, larger sample populations and longer follow-ups can provide more comprehensive data on the effects of interventions. The other point in regard to our study is the limitation in the gathered data insofar as some unseen variables that could affect the intervention outcomes may have been ignored.

CONCLUSIONS

The findings of the present study indicated negligible differences concerning HRV-associated indices between slow pathway complete ablation and slow pathway modification/ablation for AVNRT. Nevertheless, further studies with a more comprehensive vision and design are strongly recommended.

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