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THE EFFECTS OF AVNRT ABLATION ON THE CONDUCTION SYSTEM

AVNRT ABLASYONUNUN İLETİ SISTEMİ ÜZERINE ETKİLERİ

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ABSTRACT

Introduction: Atrioventricular nodal reentrant tachycardia (AVNRT) is one of the most common types of narrow QRS complex supraventricular tachycardias. Catheter ablation is considered one of the most effective treatment methods for AVNRT due to its high success rates and low complication risks. However, it is crucial to evaluate the changes in the atrioventricular conduction system following ablation. In this study, electrocardiographic changes in patients who underwent AVNRT ablation were analyzed.

Methods: A total of 148 patients who were presented with palpitations and were diagnosed with AVNRT through an electrophysiological study between January 2023 and December 2024 were included in the study. The minimum required sample size to detect a 1 msn difference between the two groups was calculated as at least 44 individuals with 90% power and a 0.05 Type I error using the open-source program R 3.0.1. Descriptive statistics of the data included mean, standard deviation, ratio, and frequency values. The Kolmogorov-Smirnov test was used to assess the normality of continuous variable distributions. The McNemar test was used for the analysis of dependent variables. The Student's t-test was used for the analysis of parametric data, while the Mann-Whitney U test was used for nonparametric data. Statistical significance was defined as $p < 0.05$.

Results: After ablation, heart rate increased significantly, while the QRS duration also showed a statistically significant prolongation. A slight but significant prolongation was observed in the PR interval as well. However, no significant change was detected in the corrected QT interval.

Conclusions: Following AVNRT ablation, slight but significant changes were observed in heart rate, QRS duration, and PR interval. These changes are thought to be associated with the modification of the slow pathway of the atrioventricular node. The absence of a significant change in the QTc interval suggests that ablation does not have a negative impact on ventricular repolarization. These electrocardiographic changes following successful AVNRT ablation may serve as potential predictors of success, particularly in patients without well-defined endpoints.

Keywords: AVNRT, cardiac conduction system, cathether ablation.

ÖZET

Giriş: Atriyoventriküler nodal reentrant taşikardi (AVNRT), dar QRS kompleksli supraventriküler taşikardiler arasında en sık görülenlerden biridir. Kateter ablasyonu, yüksek başarı oranları ve düşük komplikasyon riskleri nedeniyle AVNRT'nin en etkili tedavi yöntemlerinden biri olarak kabul edilmektedir. Ancak ablasyon sonrası atriyoventriküler iletim sistemindeki değişikliklerin değerlendirilmesi önemlidir. Bu çalışmada, AVNRT ablasyonu yapılan hastaların elektrokardiyografik değişiklikleri incelenmiştir.

Yöntemler: Ocak 2023 ile Aralık 2024 tarihleri arasında çarpıntı şikayetiyle başvuran ve yapılan elektrofizyolojik çalışma sonucunda AVNRT tanısı konulan toplam 148 hasta çalışmaya dahil edilmiştir. İki grup arasındaki 1 msn farkı tespit etmek için gereken minimum örneklem büyüklüğü, açık kaynaklı R 3.0.1 programı kullanılarak %90 güç ve 0.05 tip I hata ile en az 44 birey olarak hesaplanmıştır. Birincil etki değişkeni ± 0,18 olarak hesaplanmıştır. Verilerin tanımlayıcı istatistiklerinde ortalama, standart sapma, oran ve frekans değerleri kullanıldı. Sürekli değişkenlerin dağılımının normal olup olmadığını değerlendirmek için Kolmogorov-Smirnov testi kullanıldı. Bağımlı değişkenlerin analizinde McNemar testi kullanıldı. Parametrik verilerin analizinde Student t-testi kullanıldı. Nonparametrik verilerin analizinde Mann-Whitney U testi kullanıldı. İstatistiksel anlamlılık p<0,05 olarak tanımlandı.

Bulgular: Ablasyon sonrası kalp hızı istatistiksel olarak anlamlı bir şekilde artmış olup QRS süresi de anlamlı düzeyde uzamıştır. PR süresinde ise hafif fakat anlamlı bir uzama gözlenmiştir. Bununla birlikte, düzeltilmiş QT süresi açısından anlamlı bir değişiklik saptanmamıştır.

Sonuç: AVNRT ablasyonu sonrası kalp hızı, QRS süresi ve PR süresinde hafif fakat anlamlı değişiklikler gözlenmiştir. Bu değişikliklerin, atriyoventriküler düğüm yavaş yolunun modifikasyonu ile ilişkili olduğu düşünülmektedir. QTc süresinde belirgin bir değişiklik olmaması, ablasyonun ventriküler repolarizasyon üzerine olumsuz bir etkisi olmadığını göstermektedir. Başarılı AVNRT ablasyonu ile oluşan bu değişikliklerin, özellikle sonlanım noktaları belirli olmayan hastalarda başarıyı öngördürebileceği düşünülmektedir.

Anahtar Kelimeler: AVNRT, kardiyak ileti sistemi, kateter ablasyon.

INTRODUCTION

Atrioventricular nodal reentrant tachycardia (AVNRT) is one of the most common types of narrow QRS complex tachycardias. Although it generally follows a benign course, it can significantly impact on the quality of life in symptomatic patients. While pharmacological agents can be used in the treatment of AVNRT, catheter ablation is the most effective

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treatment method for recurrent cases and symptomatic patients.

Catheter ablation, the standard treatment for AVNRT, has minimal effects on the conduction system, though the risk of complications is present in every case (1). Changes in electrocardiographic (ECG) parameters following ablation provide valuable insights into the physiological responses of the AV conduction system.

Catheter ablation aims to eliminate the tachycardia circuit by targeting the dual pathway phenomenon within the AV node. During this procedure, slow pathway modification is typically performed, interrupting the reentrant tachycardia circuit. Post-ablation side effects such as PR interval prolongation, QRS duration changes due to bundle branch block formation, and, in rare cases, complete AV block may occur (2,3). Therefore, postoperative ECG evaluations are of great importance in assessing the effects of ablation on the conduction system.

After ablation, mild to moderate prolongation of the PR interval may be observed. This results from changes in AV conduction due to slow pathway modification. However, clinically significant PR prolongation is rare and usually does not cause symptoms. Since the ablation procedure does not directly affect the His-Purkinje system, the QRS duration generally remains unchanged. With advancements in technology, selective lesion formation has become more precise, further reducing the risk of AV block (4). Nevertheless, transient widening may occasionally occur during ablation due to changes in the autonomic tonus. Additionally, conduction disturbances such as bundle branch blocks may arise due to conductive thermal damage affecting the AV node, AV nodal artery, or the right and/or left bundle branches (5,6).

In our study, preoperative and postoperative ECGs of patients who underwent AVNRT ablation in our clinic were compared to evaluate potential ECG changes.

METHODS

A total of 148 patients who presented with palpitations and were diagnosed with AVNRT through an electrophysiological study (EPS) between January 2023 and December 2024 were included in the study. Among these patients, 56 were male, and 92 were female. Electrophysiological study and radiofrequency (RF) ablation were performed in patients who had experienced at least two or more episodes of supraventricular tachycardia (SVT). Electrophysiological data obtained during the procedure and any potential complications were recorded.

Approval of this study was obtained from the local clinical research ethics committee (decision no. 297, dated 27.10.2022). The study was conducted in accordance with the International Conference on Harmonization (ICH) guidelines, Good Clinical Practice (GCP) principles, and the Declaration of Helsinki.

Due to the non-experimental and retrospective design, patient consent was not obtained; instead, approval for the retrospective clinical study was obtained.

Body weight, height (cm), and waist circumference (cm) measurements were taken in accordance with proper measurement techniques, and body mass index (BMI) was calculated based on these measurements. BMI was determined by dividing body weight by the square of height (m^2).

Hypertension was defined as a systolic/diastolic blood pressure of 140/90 mmHg or higher and/or the use of antihypertensive medication. Diabetes mellitus was defined as a fasting plasma glucose level of ≥126 mg/dL or active use of oral antidiabetic medication and/or insulin. Hyperlipidemia was defined as a total cholesterol level of ≥200 mg/dL or the use of antihyperlipidemic medication.

Patients with active infections, tachycardia due to secondary causes, congestive heart failure, symptomatic congenital heart disease, symptomatic valvular heart disease, or a diagnosed psychiatric disorder were excluded from the study.

Anti-arrhythmic treatment was discontinued in all patients two weeks before the procedure. None of the patients were on treatment with Amiodarone, which has significantly prolonged half-life elimination time.

Ablation Procedure

Patients underwent the procedure under local femoral anesthesia without sedation after completing a 12-hour fasting period. Coronary sinus catheter, diagnostic catheter, and a 4 mm tip ablation catheter (Marinr RF, Medtronic, Minneapolis, USA) were used. The procedure was performed under fluoroscopic guidance with right and left anterior oblique views. When tachycardia could not be induced under baseline conditions, patients received a bolus of either atropine (0.01–0.02 mg/kg) or isoproterenol (0.02–0.06 mg) to facilitate stimulation-induced tachycardia. The diagnosis of AVNRT was based on electrophysiological study (EPS) criteria, including a sudden prolongation of the AH interval by 50 ms or more ("jump"), followed by the observation of an echo beat and subsequent tachycardia induction. Additionally, a VA interval of less than 70 msn on the HIS catheter during tachycardia was considered a key diagnostic finding. Patients were monitored for 12 to 24 hours following the ablation procedure. Before discharge, patients were started on a daily oral dose of 81 mg acetylsalicylic acid. No other antiarrhythmic medication was administered.

Statistical Methods

All statistical analyses were performed using SPSS for Windows version 19.0 (SPSS, Chicago, IL). The minimum required sample size to detect a 1 ms difference between the two groups was calculated as at least 44 individuals with

90% power and a 0.05 Type I error using the open-source program R 3.0.1.

Descriptive statistics included mean, standard deviation, ratio, and frequency values. The Kolmogorov-Smirnov test was used to assess the normality of continuous variable distributions. The McNemar test was used for the analysis of dependent variables. The Student's t-test was applied for the analysis of parametric data, while the Mann-Whitney U test was used for nonparametric data. Statistical significance was defined as $p < 0.05$.

Due to the reason that anti-arrhythmic drugs were stopped at least 2 weeks prior to the ablation procedure, logistic regression analysis on anti-arrhythmic drug usage wasn't performed.

RESULTS

The demographic characteristics, comorbid conditions, and medication use of the patients included in the study are presented in Table 1. Beta-blockers were used for tachyarrhythmia control in 54.1% of the patients, and there was no statistically significant difference in other medication use or comorbid conditions compared to the general population.

Compared to pre-ablation values, the heart rate increased significantly (76.15 ± 7.65 vs. 77.58 ± 7.72 bpm, $p < 0.001$). A statistically significant prolongation was observed in QRS duration (90.97 ± 6.90 ms vs. 93.48 ± 9.39 ms, $p < 0.001$). Similarly, PR interval increased significantly after ablation (156.65 ± 13.85 ms vs. 159.86 ± 21.15 ms, $p = 0.022$). However, no significant difference was detected in the corrected QT interval. (Table 2).

DISCUSSION

AVNRT is one of the most common forms of supraventricular tachycardia and is typically observed in individuals without structural heart disease. Due to its high success rates and low complication risks, catheter ablation is the first-line treatment option for AVNRT.

In our study, the demographic, clinical, and electrocardiographic characteristics of patients who underwent AVNRT ablation were analyzed. Approximately 42% of the patients were female, supporting the existing literature indicating that AVNRT is more frequently observed in women (7). As AVNRT is a supraventricular tachyarrhythmia that typically occurs in individuals without structural heart disease, the normal ejection fraction levels and the low prevalence of coronary artery disease in our study cohort align with this finding.

When evaluating cardiovascular risk factors, the smoking rate was notably high at 45.9%, highlighting a significant cardiovascular risk factor in this patient population. Given its effects on the autonomic nervous system, smoking is thought to enhance arrhythmogenic potential and may contribute to the development of AVNRT (8).

Table 1. Demographic, Clinical, Echocardiographic, and Laboratory Characteristics of the Patients

Variables	(n=148)
Age (years)	52.98 ± 5.07
Female Sex, n(%)	21 (42.0%)
Body Mass Index, kg/m^2	27.92 ± 2.78
Diabetes Mellitus, n(%)	24 (16.2%)
Hypertension, n(%)	18 (12.2%)
Dyslipidemiae, n(%)	27 (18.2%)
Smoking, n(%)	68 (45.9%)
Coronary Artery Disease, n(%)	10 (6.8%)
Left Ventricular Ejection Fraction (%)	61.96 ± 3.94
Systolic Blood Pressure, mmHg	118.96 ± 11.02
Diastolic Blood Pressure, mmHg	76.55 ± 7.85
Serum Glucose Levels, mg/dl	111.47 ± 36.76
Serum Kreatinin Levels, mg/dl	0.79 ± 0.17
LDL, mg/dL	106.30 ± 33.35
HDL, mg/dL	50.77 ± 9.33
Triglyceride, mg/dL	138.77 ± 73.36
White Blood Cell Count, 10^3/mm^3	7.11 ± 2.11
Neutrophil Count, 10^3/mm^3	5.00 ± 2.30
Lymphocyte Count, 10^3/mm^3	1.75 ± 0.55
Hemoglobin, g/dL	13.21 ± 1.65
Thrombocyte Count , 10^3/mm^3	275.2 ± 35.67
Medication Use	
-Propafenone	4 (2.7%)
-Amiodarone	0 (0%)
-Beta-blockers	80 (54.1%)
-Non-dihydropyridine Calcium Channel Blockers	4 (2.7%)
-Acetylsalicylic Acid	36 (24.3%)
- Clopidogrel	8 (5.4%)
- ACE inhibitor/ARB	18 (12.2%)
- Statins	27 (18.2%)
- Other Medications	36 (24.3%)
Post-procedural Complications	
-Complete AV Block	1 (0.7%)
-Access Site Hematoma	7 (4.7%)
-Inappropriate Sinus Tachycardia	3 (2%)
-Symptomatic Premature Atrial Contractions	4 (2.7%)

Data are presented as mean ± standard deviation or as percentages [n (%)]. LDL: low-density lipoprotein, HDL: high-density lipoprotein, ACE: angiotensin-converting enzyme, ARB: angiotensin receptor blocker.

When comparing pre- and post-ablation ECG parameters, a slight but significant increase in heart rate was observed. This change can be explained by the reorganization of AV conduction and a decrease in vagal tone following ablation (9,10). Additionally, a small but statistically significant prolongation in QRS duration was detected. Since AVNRT ablation involves modifying the slow pathway of the AV node, it may lead to minimal intraventricular conduction

Table 2. Pre- and post-ablation ECG parameters.

Variables	Pre-Ablation	Post-Ablation	P value
Heart Rate, BPM	76.15 ± 7.65	77.58 ± 7.72	**<0.001**
QRS duration, msn	90.97 ± 6.90	93.48 ± 9.39	**<0.001**
PR duration, msn	156.65 ± 13.85	159.86 ± 21.15	**0.022**
Corrected QT Interval, msn	410.65 ± 21.76	412.81 ± 25.31	0.751

Data are presented as mean ± standard deviation or as percentages [n (%)].

changes, which could be associated with the observed QRS prolongation (11). Moreover, potential thermal damage to the AV nodal artery may alter AV node conduction properties (12).

The slight prolongation of the PR interval also supports the slow pathway modification within the AV node (13-16). However, the absence of a significant change in QTc duration post-ablation suggests that the procedure does not have a negative impact on ventricular repolarization.

The ablation of AVNRT has become safer and more effective in recent years due to technological advancements and procedural optimizations. In addition to conventional RF ablation, alternative energy sources such as cryoablation are increasingly used, particularly in young patients, as they offer a significant option for reducing the risk of AV block. Electroanatomic mapping systems and high-resolution catheter technologies enhance the accuracy of ablation by improving the localization of target tissue and increasing success rates. Furthermore, studies on emerging energy modalities, such as non-contact ablation and pulsed field ablation (PFA), promise a safer approach by minimizing the risk of complications in AVNRT treatment. These advancements contribute to improving both the short- and long-term efficacy of AVNRT ablation, representing a significant step forward in patient management.

Some data in the literature report that AV block is more common in older ages during conventional AVNRT ablations. Transitioning from conventional methods to modern techniques may enhance protection against potential conduction system damage, as observed in our study (17).

CONCLUSION

Overall, the ECG changes observed after AVNRT ablation are expected and clinically acceptable outcomes of slow pathway modification and can be considered indicators of a successful ablation. In cases where a clear endpoint for successful ablation is not definitively achieved, these changes may serve as markers of effective slow pathway modification. However, further long-term studies in a larger population are needed to confirm this relationship.

LIMITATIONS

First, the number of patients included in the study is relatively low. Second, edema occurring in atrial tissue during the acute phase may cause ECG changes, but we do not yet have long-term ECG follow-up results. Finally, the study has a retrospective nature; therefore, there may be standardization issues.

Ethics Committee Approval: Approval of this study was obtained from the local clinical research ethics committee (decision no. 297, dated 27.10.2022).

Informed Consent: Due to the non-experimental and retrospective nature of the study, informed consent from patients was not obtained. Instead, approval for retrospective clinical study was obtained from local ethics committee and the hospital administration.

Authorship Contributions: Idea/Concept: MHU, MSK, Design: MSK, Supervision: MSK, Data Collection and Processing: MHU, Analysis or Interpretation: MSK, Literature Search: MSK, Writing: MHU, Critical Review: MSK.

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