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## Paroksizmal Supraventriküler Taşikardilerde Tek Merkez Radyofrekans Ablasyon Deneyimi

### Single Center Radiofrequency Ablation Experience In Paroxysmal Supraventricular Tachycardias

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#### ÖZ

**Amaç:** Bu çalışma, Celal Bayar Üniversitesi Tıp Fakültesi Kardiyoloji Kliniği'nde paroksizmal supraventriküler taşikardi (PSVT) nedeniyle radyofrekans ablasyonu (RFA) uygulanan hastaların sonuçlarını değerlendirmeyi amaçlamaktadır.

**Gereç ve Yöntem:** PSVT nedeniyle kliniğe başvuran toplam 156 hasta retrospektif olarak çalışmaya dahil edilmiştir. Tüm hastalara RFA uygulanmıştır.

**Bulgular:** RFA uygulanan hastaların %72'sinde atriyoventriküler nodal reentran taşikardi (AVNRT), %23'ünde atriyoventriküler reentran taşikardi (AVRT), ve %5'inde atriyal taşikardi (AT) tespit edilmiştir. Hastaların %2.7'sinde (n = 3) atipik AVNRT, %5.5'inde (n = 2) antidromik AVRT saptanmıştır. Kadın hastalar %65.3, erkek hastalar %34.7 oranındadır. Çalışmaya dahil edilen hastaların yaş ortalaması 46.2 ± 15.2 yıl olup, AVRT grubunda yaş ortalaması 38.3 ± 13.6 yıl ile diğer iki gruba kıyasla anlamlı derecede daha genç bulunmuştur (p < 0.05). Koroner arter hastalığı, hipertansiyon ve diabetes mellitus AVNRT grubunda, AVRT grubuna göre daha sık görülmüştür. Toplam kolesterol, LDL kolesterol, nötrofil/lenfosit oranı ve CRP düzeyleri de AVNRT grubunda, AVRT grubuna göre anlamlı olarak daha yüksek saptanmıştır (p < 0.05). AVRT grubunda en sık sol lateral aksesuar yol (%44.4) gözlenmiştir. Nüks, AVNRT grubunda iki, AVRT grubunda bir hastada görülmüş ve bu hastalara tekrar işlem uygulanmıştır. AVNRT grubunda dört hastada girişim bölgesinde hematoma gelişmiş ve konservatif olarak takip edilmiştir. Atipik AVNRT üç hastada, AVRT ve AVNRT gruplarından birer hastada kalıcı pacemaker implantasyonu ihtiyacı gelişmiştir. Ayrıca AVRT grubunda bir hastada stent gerektiren koroner arter yaralanması gözlenmiştir.

**Sonuç:** Kliniğimizde PSVT hastaları literatürde bildirilen oranlarla benzer şekilde tedavi edilmiştir. Erken dönem başarı oranlarımız literatüre göre daha yüksek bulunmuştur; ancak çalışmaya dahil edilen hasta sayısının sınırlı olması bir dezavantajdır. 3D haritalama sistemlerindeki teknolojik gelişmelerle birlikte başarı oranlarının daha da artacağı ve komplikasyonların azalacağı açıktır.

**Anahtar Kelimeler:** Paroksizmal supraventriküler taşikardi, radyofrekans ablasyon, kardiyak elektrofizyoloji, atriyoventriküler nodal reentran taşikardi, atriyoventriküler reentran taşikardi, atriyal taşikardi.

## Abstract

**Aim:** This study aims to evaluate the outcomes of patients who underwent radiofrequency ablation (RFA) for paroxysmal supraventricular tachycardia (PSVT) at the Cardiology Clinic of Celal Bayar University Faculty of Medicine.

**Methods:** A total of 156 patients admitted to the clinic for PSVT were retrospectively included in the study. All patients underwent RFA.

**Results:** Among the patients who underwent RFA, 72% had atrioventricular nodal reentrant tachycardia (AVNRT), 23% had atrioventricular reentrant tachycardia (AVRT), and 5% had atrial tachycardia (AT). Atypical AVNRT was detected in 2.7% of patients (n = 3), and antidromic AVRT in 5.5% (n = 2). Females accounted for 65.3% of the cohort, while males made up 34.7%. The mean age of the study population was  $46.2 \pm 15.2$  years, with the AVRT group being significantly younger (mean age  $38.3 \pm 13.6$  years,  $p < 0.05$ ). Comorbidities such as coronary artery disease, hypertension, and diabetes mellitus were more prevalent in the AVNRT group than in the AVRT group. Additionally, total cholesterol, LDL cholesterol, neutrophil/lymphocyte ratio, and CRP levels were significantly higher in the AVNRT group ( $p < 0.05$ ). The most common accessory pathway in the AVRT group was the left lateral pathway (44.4%). Recurrence was observed in two AVNRT patients and one AVRT patient, all of whom underwent successful repeat procedures. Hematoma at the intervention site occurred in four AVNRT patients and was managed conservatively. Permanent pacemaker implantation was required in one patient from each of the AVNRT and AVRT groups. Coronary artery injury necessitating stenting occurred in one AVRT patient.

**Conclusion:** The treatment outcomes for PSVT patients in our clinic were comparable to those reported in the literature. Our early success rates were higher; however, the limited number of patients included in the study presents a limitation. Technological advancements in 3D mapping systems are expected to further enhance success rates and reduce complications.

**Keywords:** Paroxysmal supraventricular tachycardia, radiofrequency ablation, cardiac electrophysiology, atrioventricular nodal reentrant tachycardia, atrioventricular reentrant tachycardia, atrial tachycardia.

## 1. Introduction

Supraventricular tachycardia (SVT) refers to rapid rhythms originating from atrial or atrioventricular nodal tissue above the His bundle. SVTs can be paroxysmal or persistent. Although atrial fibrillation and atrial flutter are technically SVTs, in daily practice, paroxysmal supraventricular tachycardia (PSVT) typically includes atrioventricular nodal reentrant tachycardia (AVNRT), atrioventricular reentrant tachycardia (AVRT), and atrial tachycardia (AT) [1]. PSVTs are characterized by a sudden onset, abrupt termination, and heart rates exceeding 150 beats per minute with a regular and narrow QRS complex, distinguishing them from atrial fibrillation, atrial flutter, and multifocal atrial tachycardia.

The exact incidence of PSVT is challenging to estimate due to a high rate of asymptomatic episodes. However, data from the Marshfield Epidemiologic Study Area indicate a PSVT prevalence of 2.25 per 1,000 people and an incidence of 35 per 100,000 person-years [2]. While PSVTs are rarely life-threatening, they can significantly reduce quality of life and frequently necessitate emergency department visits.

Currently, in specialized centers, PSVT is the most common substrate for catheter ablation. Ablation is

recommended in guidelines as a Class I indication for patients with symptomatic PSVT, and patients report significant improvements in quality of life following the procedure [3]. This article aims to share our experience with paroxysmal supraventricular tachycardia and present our findings.

## 2. Material And Methods

We retrospectively reviewed the medical records of patients who underwent radiofrequency ablation for AVNRT, AVRT, or AT between June 1, 2022, and February 29, 2024, in the Celal Bayar University Cardiology Department. Clinical patient data, procedural information, and departmental records were collected from the electronic medical data network. Patients with incomplete records were excluded, leaving 156 cases for analysis.

This study was approved by the Ethics Committee of Celal Bayar University Faculty of Medicine (approval code: 20.478.486/2350; approval date: April 3, 2024). It adhered to the Declaration of Helsinki and the principles of Good Clinical Practice, respecting the rights and dignity of all participants. Institutional permissions were

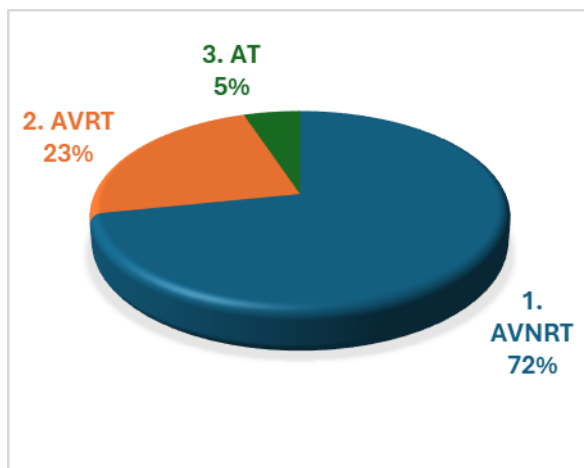
obtained, and since the study was retrospective, informed consent was not required.

Statistical analyses were performed using SPSS 21.0 (SPSS Inc., Illinois, USA). Descriptive statistics are presented as frequencies, percentages, means, standard deviations (SD), and medians. The Student's t-test was used to compare means between two independent groups, while the Kruskal-Wallis test was applied for comparisons across more than two groups. Categorical variables were analyzed using the chi-square test. A p-value of <0.05 was considered statistically significant.

### 3. RESULTS

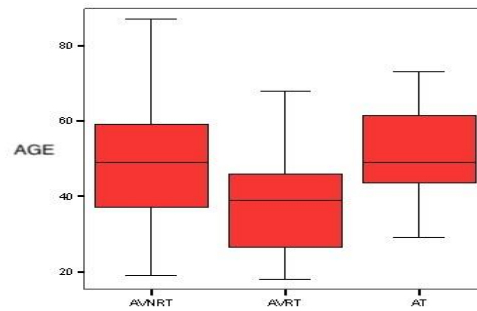
Between June 2022 and February 2024, 161 patients underwent radiofrequency ablation for PSVT. Five patients were excluded due to incomplete data, leaving 156 patients for analysis. PSVT was classified as AVNRT, AVRT, or AT. There were 112 patients in the AVNRT group, 36 in the AVRT group, and 8 in the AT group (Figure 1). Of the total cohort, 102 (65.38%) were female, and 54 (34.61%) were male. Female representation was 67.85% in the AVNRT group, 55.55% in the AVRT group, and 75% in the AT group.

**Figure 1:** Illustration of the classification of PSVT types among the study population.



The mean age of the study population was  $46.2 \pm 15.2$  years, with a range of 18 to 87 years. Patients in the AVNRT group were older than those in the AVRT group ( $p < 0.05$ ) (Figure 2).

**Figure 2:** Age distribution by groups



Chronic conditions were noted as follows: coronary artery disease (10 patients, all in the AVNRT group), hypertension (23 patients; 18 in AVNRT, 2 in AVRT, 3 in AT), and diabetes (20 patients; 17 in AVNRT, 2 in AVRT, and 1 in AT). Baseline blood parameters, including total cholesterol, LDL cholesterol, neutrophil/lymphocyte ratio, and CRP, were higher in the AVNRT group compared to AVRT group ( $p < 0.05$ ) (Table 1).

**Table 1:** Baseline laboratory characteristics

	AVNRT	AVRT	AT
Glucose	95.9	95.9	108.7
Creatinine	0.64	0.62	0.58
Total cholesterol	203	175.5	205.8
HDL	53.3	50.3	52.5
LDL	120.4	99.6	112.8
Triglyceride	153.6	116.5	151.8
Hemoglobin	13.2	13	12.9
Hematocrit	42.7	40.4	39.4
Platelet	256.96	250.8	267.5
MPV	10	9.7	10.3
Neutrophil	4.6	5.5	4.6
Lymphocyte	2.3	2.2	2.2
CRP	0.52	0.4	1.8

Post-procedural complete AV block requiring a permanent pacemaker occurred in one patient each from the AVNRT and AVRT groups. One AVNRT patient was diagnosed with breast cancer three months post-procedure. Hematoma at the intervention site occurred in four AVNRT patients and was managed conservatively.

There were three cases of atypical AVNRT, two of which required ablation from the left side. Two AVNRT patients with prior failed slow pathway ablation underwent successful repeat procedures in our clinic. Additionally, one AVNRT patient with a history of accessory pathway ablation underwent ventricular extrasystole ablation from the right

ventricular outflow tract during the same session. Two cases of AVNRT recurrence occurred within six months, necessitating repeat ablation. Accessory pathway (AP) locations in the AVRT group included left lateral (16), right posteroseptal (9), left posteroseptal (3), coronary sinus (3), parahisian (2), and mahaim (1) pathways (Figure 2). One patient with a coronary sinus AP and a large diverticulum required epicardial access for successful ablation. During coronary sinus AP ablation, one patient experienced circumflex coronary artery injury, requiring coronary stent implantation. In the AT group, locations included the crista terminalis (2 patients), right atrial appendage (1), septum (1), lateral tricuspid annulus (2), left coronary cusp (1), and left superior pulmonary vein–atrial roof connection (1). Recurrence occurred in one crista terminalis AT patient one month post-ablation, necessitating a repeat procedure, after which the patient remained symptom-free for six months.

#### 4. Discussion

This single-center study focuses on patients undergoing ablation for the treatment of supraventricular tachycardias (SVTs), a prevalent group of arrhythmias originating above the ventricles. Three key mechanisms play a role in the development of arrhythmia. These mechanisms include reentry, triggered activity and enhanced automaticity. Among these mechanism, most common type is reentry. Catheter ablation has emerged as a cornerstone in the management of SVTs, offering high success rates and favorable outcomes in appropriately selected patients. Excluding atrial fibrillation, paroxysmal supraventricular tachycardias (PSVTs) are the most commonly encountered and treated arrhythmias in electrophysiology laboratories. The most common type of PSVT is AVNRT, which accounts for 60-70% of cases and female-to-male ratio of approximately 2:1 [4].

In our study AVNRT accounted for 72% of cases, which aligns with existing literature. Catheter ablation is the current treatment of choice in symptomatic patients and approximately 56% of cases referred for catheter ablation [5]. In AVNRT treatment, the ablation of the slow pathway is typically targeted. This approach aims to disrupt the reentrant circuit responsible for the arrhythmia while preserving normal conduction pathways.

In the past, anatomical approach was used for ablation, but now, 3D mapping techniques have rapidly become part of routine practice. At the time we conducted this study, we were performing procedures using the anatomical approach, whereas nowadays, we actively utilize 3D mapping. Although findings may vary, the recurrence rate after AVNRT ablation is observed to be between 2-

5% [6-7]. In our study, recurrence was observed in two patients (1.8%) within 6 months. Roughly, AVNRT can be categorized into typical and atypical types. In typical AVNRT, the slow pathway is used for antegrade conduction, while the fast pathway is used for retrograde conduction. On the other hand, in atypical AVNRT, the fast pathway can be used for antegrade conduction and the slow pathway for retrograde conduction (fast-slow type), or the slow pathway can be used for both antegrade and retrograde conduction (slow-slow type). Studies show that more than 90% of cases are typical AVNRT, while atypical AVNRT accounts for 5-7% [7-8]. In our study, we detected atypical AVNRT in 2.7% of cases. Major complications related to AVNRT ablation are not encountered frequently.

The most concerning complication related with AVNRT ablation is iatrogenic atrioventricular block with the need for pacemaker implantation. According to a large study, in a four-year follow-up, 3% of patients required a permanent pacemaker after AVNRT ablation [9]. In our study, only one patient (0.9%) required a permanent pacemaker implantation following AVNRT ablation. However, studies have shown that the need for a permanent pacemaker can also arise after the index procedure [10]. When we followed up on our patients through the national health system, we found that no other patients had required a permanent pacemaker to date. Cryoablation is used as an alternative to RF ablation to avoid permanent AV block; however, late recurrence is more common. [11] AVNRT is observed at an older average age compared to AVRT. Similarly, in our study, the average age of AVNRT patients was higher ( $p < 0.01$ ). According to a study by Zeljkovic I et al., higher cholesterol levels were detected in AVNRT and AVRT patients compared to the control group; however, no difference was observed between the AVNRT and AVRT groups [12]. In our study, cholesterol levels in the AVNRT group were found to be higher than those in the AVRT group ( $p < 0.5$ ). We believe this is due to the lower average age of the AVRT group; however, studies with larger patient populations are needed.

AVRT is the second most common PSVT, occurring in 30-40% of cases, and unlike AVNRT, it is observed more frequently in males (54.6%) compared women [5,13]. However, in our study, males constituted 30.7% of the AVRT population. AVRT involves reentry via an accessory pathway. The majority of AVRTs exhibit orthodromic characteristics (antegrade conduction via the AV node), while less commonly, they present as antidromic (antegrade conduction via the accessory pathway). These pathways insert along the mitral or tricuspid valve; approximately 60% of them insert

mitral valve, 25% of them insert septal aspect of the tricuspid or mitral valve and the remaining are right free wall pathways[14]. In our study, we detected a left lateral accessory pathway in sixteen (44.4%) patients, which is consistent with the literature. In our study, we observed only two cases (5.5%) of antidromic AVRT. Mahaim accessory pathways exhibit antidromic, unique characteristics and are rarely observed. In our study, we identified one Mahaim accessory pathway located at the tricuspid lateral annulus, which was treated by ablation from the atrial and ventricular sites where Mahaim potentials were recorded. We encountered a patient with a large diverticulum who experienced recurrence despite a transvenous epicardial approach performed via the coronary sinus and repeated procedure via epicardial approach. Permanent AV block is a very rare complication following AVRT ablation. In a study by G.E. O'Hara et al., its incidence was reported as 0.017% [15]. In our study, one complete AV block was observed following the ablation of a posteroseptal accessory pathway, and a permanent pacemaker was implanted for the patient. Coronary artery injury is an uncommon complication of RFA. Vasospasm, intimal damage and thrombus formation can be observed [16]. In one of our patients, chest pain and ST-segment elevation on the electrocardiogram developed during ablation from within the coronary sinus. Subsequent coronary angiography revealed intimal injury and thrombus formation in the circumflex artery, leading to stent implantation. Although routine coronary angiography is not generally recommended during epicardial ablations, we incorporated it into our clinical practice following this case. For left-sided accessory pathways, either an aortic retrograde approach or a transseptal approach to the left atrium can be used. In our clinic, we always use the transseptal approach for left-sided accessory pathways. To date, no major complications such as perforation or tamponade have been observed. RFA can be performed using conventional methods or 3D mapping systems. All AVRT cases in this study were performed using the CARTO™3 System (Biosense Webster). Focal AT is the third most common type of PSVT and accounts 5-10% of cases. Among patients with PSVT, the prevalence of focal AT increases with age [17]. Focal ATs tend to cluster in specific regions of the atria. In the right atrium, these regions include the crista terminalis, coronary sinus, parahisian region, tricuspid annulus, and right atrial appendage. In the left atrium, they are typically located around the pulmonary veins, mitral annulus, left atrial appendage, and left septum. Additionally, although less common, they may also originate from the coronary cusps [18-19].

Catheter ablation is associated with long term success with low complication rates [20]. Although the number of patients in our data was small, the group with the highest average age was the AT group. In our study we identified a very rare case of AT originating from the left coronary cusp. In AT cases originating from the cusp and aorto-mitral junction, ablation can be performed via a transseptal route or a retroaortic approach. In our case, we preferred the retroaortic approach. On the other hand, Gonzales et al. preferred the transseptal route in ATs originating from the aorto-mitral junction, a closely related anatomical region [21].

Additionally, despite the limited number of cases, we observed focal AT in two patients who had previously undergone cryoablation for AF. As the number of ablation procedures for AF increases, it seems likely that cases of AT and atrial flutter will become more common. Recurrence is uncommon; however, in one patient with AT originating from the crista terminalis, we observed a recurrence within 4 months and performed a repeat procedure. Due to the small number of cases, we did not encounter any major complications in our AT ablation procedures.

## 5. Limitations

The limitations of our study include its single-center retrospective design, the small number of cases, particularly in the AT group, the absence of cryoablation procedures, and the lack of 3D mapping system usage in the AVNRT group.

## 6. Conclusion

In conclusion, PSVTs, particularly AVNRT, are frequently encountered in daily practice. RFA has long been widely used as an effective and safe treatment for symptomatic patients. With advancing technological developments, the increased availability of 3D mapping systems and the use of more multifunctional catheters have led to higher success rates, lower complication rates and lower procedure times.

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