Original Article

Radiofrequency Catheter Ablation in Patients with Supraventricular Tachycardia: A Cohort Study on Efficacy, Safety, Anxiety, and Quality of Life Outcomes

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Abstract

Background: Over the past two decades, radiofrequency catheter ablation (RFCA) has emerged as a leading treatment for cardiac arrhythmias due to its high efficacy, despite potential complications. This study evaluated success rates, complications, and the procedure's impact on quality of life (QoL) and anxiety in patients with supraventricular arrhythmia (SVT).

Methods: This prospective cohort study involved patients diagnosed with SVT who were treated in Babol, Iran, between 2018 to 2019. The primary outcomes that were assessed included the immediate procedural success rate, success at 3 months post-ablation, associated complications, and their relationship with demographic and clinical factors. Additionally, changes in patients' QoL and anxiety levels before and after the procedure were analyzed. Procedures included recording His bundle electrograms using quadripolar catheters, performing programmed stimulations, autonomic blockade with atropine and propranolol, and delivering radiofrequency energy at target sites for at least 10 min. Complications and recurrence rates were monitored over a follow-up period of 3 months. Data were analyzed using SPSS software (version 23).

Results: Immediate success was achieved in 98% of cases, with two failures due to complications. Recurrence occurred in 13% of patients within 3 months, significantly associated with higher BMI and diabetes (P=0.024; P=0.026), respectively. Post-procedure, anxiety levels decreased significantly (P<0.001), and all QoL dimensions improved substantially (P<0.001), highlighting the holistic benefits of the procedure.

Conclusion: Overall, RFCA is an effective and well-tolerated treatment for SVT, demonstrating high success rates and significant improvements in patient outcomes, including reduced anxiety and enhanced QoL.

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Keywords ● Catheter ablation ● Supraventricular tachycardia ● Quality of life ● Anxiety

What's Known

- Radiofrequency catheter ablation (RFCA) has a higher success rate than other treatments for supraventricular tachyarrhythmias (SVTs).
- RFCA for SVTs leads to a higher quality of life and lower anxiety levels.

What's New

- Smoking could negatively affect the outcomes of RFCA.
- Higher body mass index and diabetes might lead to higher recurrence rates.

Introduction

Supraventricular tachycardias (SVTs) encompass a group of arrhythmias that originate from the sinoatrial node, atria, or atrioventricular (AV) node, characterized by a heart rate

exceeding 100 beats per min (bpm).[1, 2] These arrhythmias may present as regular or irregular rhythms, typically associated with narrow QRS complexes.[3] However, they can also exhibit wide QRS complexes, particularly in cases involving bundle branch blocks or conduction through accessory pathways.[4]

Paroxysmal supraventricular tachycardia (PSVT), a common SVT variant, is a rapid arrhythmia with sudden onset and termination, often exceeding 150 bpm. PSVT includes subtypes, such as atrioventricular nodal reentrant tachycardia (AVNRT) and atrioventricular reentrant tachycardia (AVRT), both of which involve abnormal electrical pathways. Additionally, sinus tachycardia, atrial tachycardia, and other SVTs, such as multifocal atrial tachycardia (MAT), Wolff-Parkinson-White (WPW) syndrome, and atrial flutter, warrant consideration.[5-10]

Understanding the diverse manifestations and mechanisms underlying SVTs is essential for effective treatment, particularly since antiarrhythmic drugs have an efficacy rate below 70%, and traditional treatments may negatively impact the quality of life (QoL) due to recurrent episodes.[11, 12] One promising treatment is radiofrequency catheter ablation (RFCA), which has been employed for SVTs and WPW in the last two decades.[13] A promising alternative is radiofrequency catheter ablation (RFCA), which has been used for SVTs and WPW syndrome over the past two decades. RFCA has demonstrated encouraging outcomes in reducing symptoms, improving QoL, and maintaining a favorable safety profile.[14, 15] Although it has a low complication rate, risks vary by arrhythmia type and may include arrhythmia recurrence, bradycardia, acute ischemic stroke, life-threatening pericardial effusion, and AV block, sometimes necessitating permanent pacemakers.[13]

This cohort study highlighted the essential features, underlying mechanisms, and treatment approaches for various forms of SVTs. By evaluating RFCA outcomes in 102 patients with SVTs, this study aimed to provide valuable insights into the success rates, potential complications, QoL, and anxiety levels in Iranian patients. Ultimately, the findings could contribute to optimizing treatment strategies and improving patient care in this growing field of cardiac intervention.

Patients and Methods

Study Design and Population

This prospective cohort study was conducted at Ayatollah Rouhani Hospital in Babol, Iran, between 2018-2019. The study focused on patients diagnosed with PSVT who visited the hospital during this period. Patients included in the study were those who underwent radiofrequency ablation in the hospital's catheterization laboratory.

The inclusion criteria were patients with symptomatic, life-threatening tachycardia resistant to drug therapy or those experiencing medication-related adverse effects, and patients either scheduled for surgery or electing to undergo ablation. The exclusion criteria were patients with structural or valvular heart disease, individuals experiencing fewer than one tachycardia episode per week, those with atrial fibrillation or flutter, and pregnant women.

Sample size determination was based on previous studies,[16, 17] using a 95% confidence level, α±5% margin of error, and a success rate of approximately 94.5%. These parameters yielded a calculated sample size of 80 patients. The calculation followed the standard formula for sample size determination in proportion studies:

$$n = \frac{z^2 P(1-p)}{d^2}$$

This calculation was specifically performed for the primary variable of interest, which was the success rate of RFCA in treating patients with SVTs. To increase the study's accuracy, 102 patients were ultimately enrolled through a convenience sampling method. The procedures were conducted in the catheterization laboratory of Ayatollah Rouhani Hospital (Babol, Iran).

All patients underwent echocardiography following electrocardiography to evaluate heart contractility and valve function during hospitalization. A comprehensive medical history, including personal, family, and clinical details, was documented for each patient. Written informed consent was obtained before ablation. Patients fasted for 6 hours before the procedure and received sedation as required.

Postoperatively, patients were monitored in the cardiac department for 24 hours. High-risk cases or those with complications, such as heart block, were transferred to the coronary care unit (CCU) for extended monitoring. If complications such as tamponade were suspected, echocardiography was performed again. This study was approved by the Ethics Committee of Babol University of Medical Sciences (code: IR.MUBABOL.HRI.REC.1397.260).

Data Collection Procedure

The study involved clinical interventions on PSVT patients at Ayatollah Rouhani Hospital. PSVT diagnosis was confirmed through patient-reported

sudden palpitations and corresponding electrocardiographic findings. Using a femoral vein approach, four-pole catheters were positioned above the right atrium after traversing the tricuspid valve. The tricuspid valve featured a 4 mm electrode sensor, and the electrogram was recorded through an oscilloscope.

Following catheter placement, patients received 3000 units of intravenous heparin, after which pacing commenced using a programmed stimulator. The diagnostic phase of the electrophysiological test recorded the presence of AV node-ventricle physiology, AV node conduction interval measurements, and identification of PSVTs with AVNRT mechanisms.

Incremental pacing and programmed stimulation were performed in both the right atrium and ventricle to assess the anterograde and retrograde conduction of the AV node and determine AVNRT re-inducibility. To minimize the confounding effects from clinical symptoms or vagal tone changes, an autonomic blockade was administered before ablation. The blockade was achieved through intravenous administration of atropine (0.4 mg/Kg; Pfizer, USA) and propranolol (0.2 mg/Kg; Novartis, USA) over a 5-min period. Following initial electrophysiological evaluation of PSVT type, ablation procedures commenced. The primary approach for AVNRT ablation involved slow pathway modification. Radiofrequency ablation was delivered continuously for at least 10 min using a generator emitting unmodulated current at a 500 Hz frequency. The target ablation zone was localized to the posterior right atrial region near the coronary sinus ostium.

Mapping procedures encompassed the posterior and inferior right atrial regions, including the coronary sinus exit area. Target sites were identified using either His bundle electrogram or atrial electrogram (Medtronic, Switzerland), with selection criteria requiring an atrial-to-ventricular electrogram ratio <0.5. Upon target site confirmation, radiofrequency energy was applied at 30 W for 10 min. Following successful AVNRT ablation, repeat electrophysiological testing verified complete elimination of slow pathway conduction.

Following successful AVNRT termination, the electrophysiological test was repeated to verify the complete elimination of slow pathway conduction. In cases where AVRT persisted post-ablation, additional evaluation was conducted to assess AV node block and the delta wave resolution. All patients were monitored for procedure-related complications, including AV node block, stroke, pneumothorax, and deep vein thrombosis. Standardized follow-up was maintained for a minimum of 3 months post-procedure to document any adverse outcomes.

Assessing QoL and anxiety

The WHOQOL-BREF questionnaire and State-Trait Anxiety Inventory (STAI) questionnaire were administered to patients in Persian, both before the ablation procedure and at the 3-month follow-up.[18-20] The WHOQOL-BREF questionnaire assessed four key domains: physical health (3 questions), mental health (six questions), social relationships (seven questions), and environmental health (eight questions), totaling 24 domain-specific questions. Two additional questions assessed overall health status and QoL independently, making a total of 26 questions. Each item was scored from 1 to 5, with higher scores indicating greater satisfaction. Domain scores were calculated on a 4-20 scale (4=the poorest condition, 20=best condition). These scores could be converted to a 0-100 scale. For this study, all domain scores were normalized to a 100-point scale to enable more precise QoL comparisons.[21]

The STAI included separate self-assessment scales measuring both state (immediate) and trait (long-term) anxiety. The state anxiety scale (STAI form Y-1) consisted of 20 items evaluating the individual's current feelings at the time of assessment. Similarly, the trait anxiety scale (STAI form Y-2) had 20 items, measuring general and habitual anxiety levels. Both scales used a four-point scoring system: for state anxiety, responses ranged from 1="not at all" to 4 "very much," and for trait anxiety, from 1 "almost never" to 4 "almost always", with higher scores indicating greater anxiety in each case. The total score for each scale ranged from 20 to 80, with established classification thresholds: 20-31 indicated mild anxiety; 32-42 represented moderate-to-low anxiety; 43-53 corresponded to moderate-to-high anxiety; 54-64 showed relatively severe anxiety; 65-75 reflected severe anxiety; and scores above 75 were considered very severe anxiety.[22]

Data Analysis

Data were analyzed using SPSS software (version 23, IBM Corp., Armonk, NY, USA). Continuous paired data were analyzed using a paired *t* test, and unpaired parametric data were evaluated using the Student's *t* test. Categorical variables were assessed using either the Chi square test or Fisher's exact test, as appropriate. Changes in QoL measures were analyzed using the paired *t* tests, and alterations in anxiety scores before and after RFCA were evaluated using McNemar's test. In all analyses, $P \leq 0.05$ was considered statistically significant.

Results

This study enrolled 102 patients with PSVT who underwent RFCA. Among these, 100 patients (98.0%) achieved successful ablation, with a mean age of 40.19±04.94 years. The demographic and clinical characteristics of these successfully treated patients are presented in table 1. The procedure was unsuccessful in two cases of AVRT, leading to their exclusion from subsequent analyses. Both unsuccessful cases involved female patients: an 18-year-old female with a large His bundle area and a 26-year-old female with a pulmonary embolism. Neither patient had diabetes or heart failure, both had a BMI under 30, and both had accessory pathways.

As demonstrated in table 2, none of the examined variables showed statistically significant associations with acute RFCA success. Age (P=0.368) and sex (P=0.195) did not significantly influence procedural outcomes. Similarly, body mass index (BMI, P=0.454), diabetes (P=0.602), and heart failure (P=0.677) demonstrated no significant impact on RFCA success rates. The analysis conclusively showed that none of these factors were statistically significant predictors of acute RFCA success in our patient cohort.

During the three-month follow-up period, arrhythmia recurrence was observed in 13 of the 100 patients (13%). As shown in table 3, statistical analysis revealed significant associations between recurrence and higher BMI (P=0.024), diabetes (P=0.026), and arrhythmia type (P=0.047), with no recurrences occurring in WPW patients compared to those with AVRT or AVNRT. The smoking status indicated that its relationship with the outcome was not statistically significant (P=0.092). In contrast, factors such as age (P=0.420), sex (P=0.559), heart failure (P=0.293), and the presence of accessory pathways (P=0.0674) demonstrated no statistically significant association with recurrence. These findings suggested that BMI, diabetes status, and specific arrhythmia type served as important predictors of post-procedural recurrence following RFCA.

Table 1: Demographic and clinical characteristics of patients with successful radiofrequency catheter ablation (n=100)

Variable	Number of Patients (n)
Age (under 50 years)	71
Sex (male)	46
Smoking	10
BMI	22
Diabetes	12
Heart failure	8
Heart block (post-RFCA)	4
Thrombosis (post-RFCA)	8
Types of arrhythmias'	
WPW	9
AVRT	27
AVNRT	64
Accessory pathway	
Right ventricular	4
Left Lateral	15
Left posterolateral	7
Left posterior	2
Right posteroseptal	8

RFCA: Radiofrequency catheter ablation; BMI: Body mass index; WPW: Wolff-Parkinson-White syndrome; AVRT: Atrioventricular reentrant tachycardia; AVNRT: Atrioventricular nodal reentrant tachycardia

Table 2: The acute success rates of radiofrequency catheter ablation across various demographic and clinical factors

Variable		Acute Success in RFCA (n)
Age	Under 50 years	71
	50 years and above	29
Sex	Male	46
	Female	54
Smoking	Yes	10
	No	90
BMI	<30 Kg/m²	78
	≥30 Kg/m²	22
Diabetes	Yes	12
	No	88
Heart failure	Yes	8
	No	92
Type of arrhythmia	WPW	9
	AVRT	27
	AVNRT	64
Accessory pathway	Yes	36
	No	64

RFCA: Radiofrequency catheter ablation; BMI: Body mass index; WPW: Wolff-Parkinson-White syndrome; AVRT: Atrioventricular reentrant tachycardia; AVNRT: Atrioventricular nodal reentrant tachycardia

Table 3: Recurrence of arrhythmia during follow-up by demographic and clinical factors

Variable		Recurrence of arrhythmia during follow-up (n)	P value
Age	<50 years	8	0.420
	≥50 years	5	
Sex	Male	5	0.559
	Female	8	
Smoking	Yes	3	0.092
	No	10	
BMI	<30 Kg/m²	7	0.024
	≥30 Kg/m²	6	
Diabetes	Yes	4	0.026
	No	9	
Heart failure	Yes	2	0.293
	No	11	
Type of arrhythmia	WPW	-	0.0475
	AVRT	4	
	AVNRT	9	
Accessory Pathway	Yes	4	0.0674
	No	9	

BMI: Body mass index; WPW: Wolff-Parkinson-White syndrome; AVRT: Atrioventricular reentrant tachycardia; AVNRT: Atrioventricular nodal reentrant tachycardia; Statistical analysis was performed using the Chi square test (or Fisher's exact test where applicable). P≤0.05 was considered statistically significant.

The QoL and anxiety changes were evaluated using paired *t* tests and McNemar's test, respectively, comparing pre-procedure baseline to 3-month follow-up after RFCA. The WHOQOL-BREF questionnaire demonstrated statistically significant improvements across all dimensions of QoL (physical, mental, social, and environmental, all P<0.001). The anxiety levels were assessed with STAI before and 3 months after RFCA. As shown in table 4, anxiety scores demonstrated significant improvement (P<0.001), with the proportion of patients experiencing moderate-to-high explicit anxiety decreasing substantially from 9 to 1, and those reporting moderate-to-low anxiety increasing from 0 to 73. Similarly, table 5 reveals a significant reduction in implicit anxiety (P<0.001), with cases of moderate-to-high anxiety declining from 64 to just 1. These findings indicated that RFCA had a substantial

Table 4: Assessment of explicit and implicit anxiety in patients before and after radiofrequency catheter ablation

Variable		Time	
		Before RFCA	After RFCA
Explicit Anxiety	Mild	91	-
	Moderate to Low	9	12
	Moderate to High	-	73
	Relatively Severe	-	14
	Severe	-	1
Implicit Anxiety	Mild	3	89
	Moderate to Low	10	10
	Moderate to High	64	1
	Relatively Severe	19	-
	Severe	4	-

RFCA: Radiofrequency catheter ablation; Statistical analysis was performed using paired *t* tests. P<0.05 was considered statistically significant.

Table 5: Assessment of mean quality of life scores in patients before and after radiofrequency catheter ablation

Variable	Quality of Life		P value
	Before RFCA	After RFCA	
Physical QoL	27.23±9.89	54.95±14.41	<0.001
Mental QoL	26.08±10.28	53.65±15.71	<0.001
Social QoL	29.53±10.05	57.92±14.31	<0.001
Environmental QoL	35.10±7.83	62.82±15.33	<0.001

RFCA: Radiofrequency catheter ablation; QoL: Quality of life; Statistical analysis was performed using paired *t* tests. P<0.05 was considered statistically significant.

positive effect on reducing both explicit and implicit anxiety levels, suggesting significant improvement in patients' psychological well-being following the procedure.

As shown in table 5, all dimensions of QoL (physical, mental, social, and environmental) demonstrated statistically significant improvement following RFCA (P<0.001 for all). This suggested that the changes observed in patients' QoL after the procedure were not due to chance, underscoring the effectiveness of RFCA in improving patients' overall well-being.

Discussion

The findings of this study provided important insights into the effectiveness of RFCA for treating patients with SVTs, including AVNRT, AVRT, and WPW syndrome. Among 102 treated patients, RFCA showed a 98% acute success rate with 13% recurrence at 3-month follow-up, yielding an 87% long-term success rate. The most frequently treated arrhythmia was AVNRT. However, two procedures failed—one due to a large His bundle area and another due to pulmonary embolism.[23] These findings were consistent in terms of acute success rate with previous research, which reported an acute success rate of 89.1% and a long-term success rate of 77.2%.[24] The higher success rates observed in the present study might be attributed to differences in patient demographics, procedural techniques, and follow-up durations.[25] For example, a previous study indicated a 100% success rate in patients under 14 years and a 90% success rate in those over 60, while the present study focused exclusively on adults (over 18 years).[16] These variations in age and study design underscored the influence of patient characteristics on procedural outcomes, reinforcing RFCA as a reliable intervention for SVTs management.[26-28]

Analysis of acute RFCA success rates revealed no statistically significant associations with any demographic or clinical factors, including age, sex, smoking status, BMI, diabetes, heart failure, or arrhythmia type (table 2). While trends suggested a potential relationship between smoking (P=0.071), arrhythmia type (P=0.077), and accessory pathways (P=0.064) with procedural success rates, these associations were not significant. Notably, existing evidence indicated that smoking might reduce RFCA efficacy in atrial fibrillation patients.[29] Importantly, no RFCA failure was observed in patients over 50 years, male patients, those with WPW or AVNRT, or those without accessory pathways. These findings suggested that RFCA could achieve a high success rate across diverse patient populations, regardless of factors such as age, sex, BMI, diabetes, and heart failure status. This broad applicability underscored RFCA's value as an effective treatment option for different patient demographics.[30]

This study revealed a clinically significant arrhythmia recurrence rate of 13% within 3 months post-RFCA. Multivariate analysis identified two independent predictors of recurrence, including higher BMI (P=0.024) and diabetes (P=0.026). These findings suggested that patients with these conditions might be at higher risk for arrhythmia recurrence and highlighted the need for tailored follow-up strategies and potentially adjunctive therapies for these high-risk subgroups.[31-33] The association between arrhythmia subtype and recurrence (P=0.0475) further reinforced the technical challenges of RFCA in treating certain SVTs, particularly AVRT and AVNRT, which demonstrated higher recurrence rates than WPW syndrome.[34]

Beyond its efficacy in controlling arrhythmias, RFCA significantly enhanced patients' QoL and reduced anxiety levels, underscoring its comprehensive physiological and psychological benefits. The procedure resulted in a marked reduction of both explicit and implicit anxiety levels (P<0.001), highlighting the significant psychological relief patients achieve following successful ablation. This anxiety reduction is particularly important given the stress and fear that recurrent arrhythmias can impose on patients' daily lives.[15, 17] Furthermore, all domains of QoL, including physical, mental, social, and environmental, demonstrated significant improvement (P<0.001), reflecting a holistic enhancement in patient well-being. This holistic improvement further supported the efficacy of RFCA as a key therapeutic intervention for patients with supraventricular arrhythmias.[15, 17, 30]

This study had several limitations that should be acknowledged. First, the research was conducted at a single center (Ayatollah Rouhani Hospital) over a limited time frame (2018-2019), which might affect the generalizability of the findings to other populations or settings. While the sample size (n=102) was adequate for preliminary analysis, it might not fully represent the diversity of patient demographics and comorbidities encountered in broader practice. The use of convenience sampling rather than randomized recruitment could introduce selection bias, potentially influencing the observed outcomes.

Furthermore, the follow-up period of 3 months might also be insufficient to evaluate long-term outcomes, as arrhythmia recurrences

or quality of life changes might manifest beyond this timeframe. Additionally, our reliance on self-reported questionnaires (WHOQOL-BREF and STAI) for assessing anxiety and quality of life introduced the possibility of reporting bias and might not capture all relevant psychological dimensions. Future studies with larger, multicenter cohorts, longer follow-up periods, and objective measures of anxiety and quality of life could provide more comprehensive insights into RFCA's efficacy across diverse patient populations.

Conclusion

In conclusion, RFCA was a highly effective treatment for SVTs, demonstrating both high acute success rates and favorable long-term outcomes with minimal complications. Its benefits extend beyond arrhythmia control, contributing to improved QoL and mental health parameters. However, patients with higher BMI and diabetes might require more tailored follow-up strategies to mitigate the risk of recurrence. Overall, these insights could help guide clinical decision-making and enhance patient-centered care in the management of cardiac arrhythmias.

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Authors' Contribution

MT.HG: Conceptualization, data acquisition, study design, and drafting; M.A: Conceptualization, data acquisition, study design, and drafting; I.B: Conceptualization, drafting and reviewing the manuscript; M.S: Methodology, data acquisition H.S: Data interpretation, reviewing, and editing of the manuscript; All authors have reviewed and approved the manuscript's final draft and consented to be accountable for all aspects of the work, ensuring that any questions regarding the accuracy or integrity of any part of the work are appropriately addressed and resolved.

Conflict of Interest: None declared.

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