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Original Article

Acute Outcomes of Radiofrequency Catheter Ablation in Patients with Typical Atrioventricular Nodal Reentrant Tachycardia: A Single-Center Study

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Abstract

Objectives: This study aimed to evaluate the acute outcomes of radiofrequency catheter ablation (RFA) in patients diagnosed with typical atrioventricular nodal reentrant tachycardia (AVNRT).

Methodology: This retrospective study was conducted at the Punjab Institute of Cardiology, Lahore, from January 1, 2019, to March 31, 2020. A total of 100 patients, each exhibiting at least one episode of sustained narrow QRS complex tachycardia, were included using a consecutive sampling technique. Following electrophysiological (EP) studies, RFA of the slow pathway was performed to successfully terminate the tachycardia.

Results: The study cohort comprised 78% females, with a mean symptom duration of 9.67 ± 4.8 years, and all patients reported palpitations as a primary symptom. The mean fluoroscopy time was 15.7 ± 3.2 minutes, and the mean procedure time was 1.52 ± 0.22 hours. Successful non-inducibility of typical AVNRT was achieved in 99% of patients. Slow pathway (SP) elimination was achieved in 46% of cases, while SP modification was noted in 53%, with 8% of these cases showing one AV node echo beat post-ablation. Only one patient (1%) developed a permanent atrioventricular (AV) block.

Conclusion: Radiofrequency catheter ablation is a highly effective and safe treatment for patients with typical AVNRT who are refractory to drug therapy, demonstrating an acute success rate of 99% with minimal risk of complications in our center.

Keywords: Typical AVNRT, radiofrequency catheter ablation, tachycardia, slow pathway

INTRODUCTION

Tachycardia is characterized by an atrial or ventricular heart rate exceeding 100 beats per minute. It can be classified based on the site of origin into two broad categories: supraventricular and ventricular tachycardia [1]. Supraventricular tachycardia, originating above the ventricles, includes atrioventricular reentry tachycardia (AVRT), atrioventricular nodal reentrant tachycardia (AVNRT), atrial tachycardia, atrial flutter, and atrial fibrillation. Ventricular tachycardia, on the other hand, originates within the ventricles [2].

AVNRT is the most common form of supraventricular tachycardia, accounting for approximately 60% of cases [3]. It arises due to a re-entry phenomenon within or near the atrioventricular node, leading to symptoms such as palpitations, dizziness, and, in severe cases, loss of consciousness [4]. The electrocardiogram (ECG) diagnosis of typical AVNRT is characterized by a normal QRS interval (<120 msec) with P waves that may be obscured by the QRS complex or appear towards the end of it, in contrast to their usual presentation in normal sinus rhythm [5].

According to the American Heart Association guidelines, the management of AVNRT includes both pharmacological and electrophysiological/ablative interventions [6]. While drug therapy serves as a chronic treatment option, radiofrequency catheter ablation has emerged as the standard of care due to its high efficacy and safety profile. This technique involves mapping and ablating the slow pathway, effectively treating the arrhythmia.

However, there is a paucity of literature addressing the acute outcomes of radiofrequency catheter ablation in our population. This study seeks to bridge this gap by evaluating the immediate outcomes of this procedure in the treatment of typical AVNRT. The primary objective of this research is to analyze the acute outcomes following radiofrequency catheter ablation in patients with typical atrioventricular nodal reentrant tachycardia.

METHODOLOGY

Study Design: This study was designed as a single-center, prospective, observational study conducted over a period of 15 months. The investigation focused on the efficacy of radiofrequency catheter ablation in patients diagnosed with typical atrioventricular nodal reentrant tachycardia (AVNRT). Ethical approval was obtained prior to the commencement of the study.

Setting: The study was conducted at the Punjab Institute of Cardiology, Lahore, Pakistan. The institution served as the sole site for patient recruitment and all procedural interventions, ensuring consistent application of protocols and data collection methods.

Participants: The study population consisted of 100 symptomatic patients, aged between 15 and 75 years, who presented with ECG evidence of at least one episode of sustained narrow QRS tachycardia and a left ventricular ejection fraction (LVEF) of ≥50% as confirmed by echocardiography. Consecutive sampling techniques were employed for patient selection to minimize selection bias.

- **Inclusion Criteria:**
  The inclusion criteria for this study required participants to be between the ages of 15 and 75 years, encompassing both male and female patients. Eligible participants had to present with symptomatic narrow QRS tachycardia, and their left ventricular ejection fraction (LVEF) had to be 50% or greater, as assessed through echocardiography.
- **Exclusion Criteria:**
  On the other hand, the study excluded patients who were younger than 15 years or older than 75 years. Pregnant females were also excluded, as were individuals with structural or valvular heart disease detected via echocardiography. Patients with a recent history of ischemia or infarction, a history of cerebrovascular accident, or those who had taken antiarrhythmic drugs within the five days prior to the procedure were also not included in the study.

Variables: The primary outcome variable was the non-inducibility of AVNRT following radiofrequency catheter ablation, defined by the absence of an Atrial-His (AH) jump, echo, or tachycardia initiation during programmed atrial and ventricular stimulation with or without isoproterenol. Secondary outcome measures included fluoroscopy time, procedure time, and the occurrence of any complications during or after the procedure.

Data Sources/Measurement: Baseline data were collected through patient interviews, clinical examination, and review of ECG and echocardiography results. During the

electrophysiological study, standard methods were used to measure conduction velocities and refractory periods of the atrium, ventricle, and AV node. Programmed stimulation protocols were employed, with catheters strategically placed in the high right atrium, His bundle, right ventricular apex, and coronary sinus.

Electrophysiological Procedures:

- Three 6F quadripolar catheters were inserted through the right femoral vein and positioned in the high right atrium, at the His bundle, and in the right ventricular apex.
- A 6F decapolar catheter was placed in the coronary sinus via the right internal jugular vein.
- A constant current stimulator was used to conduct programmed atrial and ventricular stimulation with or without isoproterenol infusion.

Baseline ECG intervals, conduction velocities, and refractory periods were recorded, with dual AV node physiology assessed through antegrade and retrograde conduction curves.

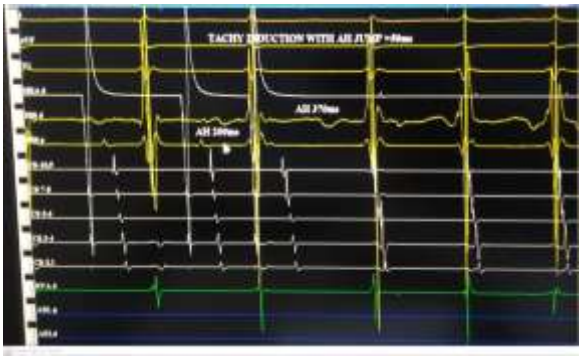

Figure 1: Initiation of typical AVNRT tachycardia with AH jump

Bias: To minimize potential biases, consecutive sampling was employed, and predefined inclusion and exclusion criteria were strictly adhered to. All procedures were performed by experienced electrophysiologists, and data collection followed standardized protocols. The study design as a single-center investigation allowed for consistent methodology but might limit the generalizability of the findings.

Study Size: The sample size was determined based on the availability of patients meeting the inclusion criteria during the study period. A total of 100 patients were included, providing a sufficient population to evaluate the primary and secondary outcomes with statistical significance.

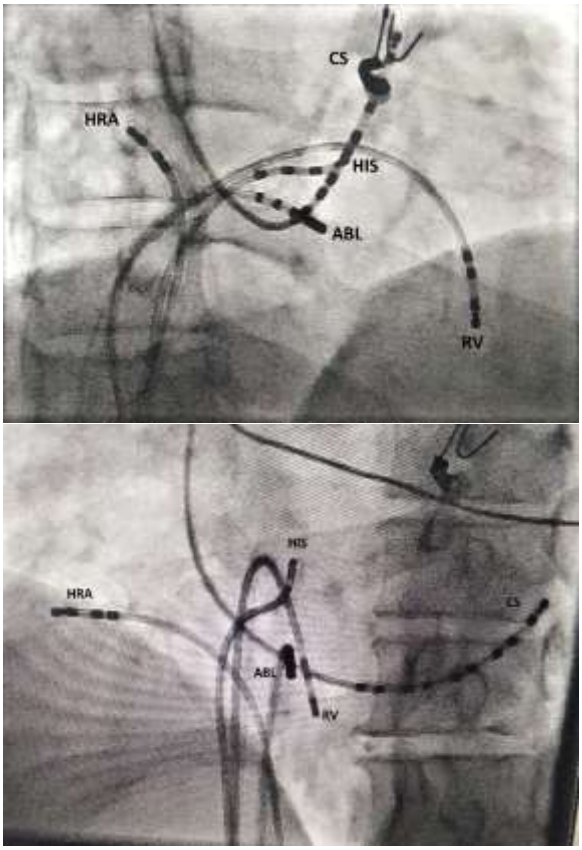

Figure 2: Different catheters in RAO and LAO fluoroscopic views (HRA: High Right Atrium, RV: Right Ventricle, His: His Catheter, CS: Coronary Sinus, ABL: Ablation)

Quantitative Variables: Quantitative variables such as patient age, duration of symptoms, ECG parameters, EP parameters, fluoroscopy time, and procedure time were recorded and presented as mean ± standard deviation (SD). Categorical variables like the presence or absence of junctional rhythm, successful ablation, and complications were expressed as frequencies and percentages.

Statistical Methods: Data were analyzed using SPSS version 21.0. Quantitative variables were presented as mean ± SD, while categorical variables were expressed as frequencies and percentages. Comparative analyses were performed to evaluate the outcomes of the ablation procedure. Significance levels were set at $p<0.05$ for all statistical tests.

RESULTS

Participants: A total of 100 patients were enrolled in this study, all of whom met the inclusion criteria. The majority of participants were female, comprising 78% of the study population. The mean age of the participants was 40.3 ± 11.2 years. The duration of symptoms prior to the study was substantial, with an average of 9.67 ± 4.8 years. All patients reported experiencing palpitations, which was the most common symptom observed across the cohort.

Table 1: Demographic and baseline procedural characteristics of patients

Characteristic	Summary
Total (N)	**100**
Age(years)	40.3 ± 11.2
Gender	
Female	78%
Male	22%
Symptom duration (years)	9.67 ± 4.8
Symptoms during tachycardia	
Palpitations	100%
Dizziness	22%
Chest pain	19%
Pre-syncope/syncope	5%
Cardiovascular comorbidities	
Hypertension	29%
Diabetes Mellitus	21%
Smoking	9%
Dyslipidemia	28%
ECG findings	
Narrow QRS complex during tachycardia	100%
P-wave invisible	67%
P-wave visible with short RP interval	33%

Descriptive Data: The clinical characteristics and comorbidities of the patients are detailed in Table 1. Alongside palpitations, other symptoms included dizziness (22%), chest pain (19%), and pre-syncope or syncope (5%). Cardiovascular comorbid conditions were prevalent, with hypertension reported in 29% of patients, diabetes mellitus in 21%, dyslipidemia in 28%, and smoking in 9%. The ECG findings during tachycardia indicated that all patients presented with a narrow QRS complex, while 67% had an invisible P-wave, and 33% had a visible P-wave with a short RP interval.

Outcome Data: The results from the electrophysiological study and radiofrequency ablation procedures are presented in Table 2. The basic intervals measured in sinus rhythm included a cycle length (CL) of 661.6 ± 102.3 ms, an Atrio-His (AH) interval of 73.7 ± 12.3 ms, a His-Ventricle (HV) interval of 46.5 ± 6.1 ms, a QRS duration of 87.3 ± 14.8 ms, and a QT interval of 332.2 ± 31.5 ms. Tachycardia was induced spontaneously in 8% of patients, through programmed atrial extra-stimulation (AES) in 54%, and through programmed AES with isoproterenol in 38%. The mean tachycardia cycle length was 326.7 ± 48 ms.

Table 2: EP study and radiofrequency ablation parameters

	Summary
Total (N)	**100**
Basic interval in sinus(milliseconds):	
Cycle Length (CL)	
Atrio His (AH)	661.6 ± 102.3
His-Ventricle (HV)	73.7 ± 12.3
QRS	46.5 ±6.1
QT	87.3 ± 14.8
Tachycardia induction:	332.2 ± 31.5
Spontaneously	
Programmed atrial extra-stimulation	8.0 %
(AES)	54.0 %
Programmed AES with isoproterenol	38.0 %
Tachycardia Cycle Length(milliseconds)	326.7 ± 48
Ablation site(Triangle of Koch):	
Posterior septum	90%
Mid septum	10%
Junctional tachycardia during ablation	100%
Fluoroscopy time (minutes)	15.7 ± 3.2
Procedure time (hours)	1.52 ± 0.22

Radiofrequency ablation was primarily conducted at the posterior septum of the Triangle of Koch in 90% of patients, while the remaining 10% had the ablation at the mid-septum. All patients exhibited junctional tachycardia during the ablation process. The mean fluoroscopy time recorded was 15.7 ± 3.2 minutes, and the mean procedure time was 1.52 ± 0.22 hours.

Table 3: Acute outcome of the AVNRT patients and the complications

Characteristic	Summary
Total (N)	**100**
Non-inducibility of ANVRT	99%
Slow pathway modification	45%
Slow pathway elimination	46%
Slow pathway modification with one AVN echo beat	8%
Complications	
Transient AV block during ablation	3%
Permanent AV block	1%
Femoral Hematoma	0%
Mild pericardial effusion	2%

Main Results: The acute outcomes of the study are summarized in Table 3. The primary endpoint, non-inducibility of AVNRT, was successfully achieved in 99% of patients following the ablation procedure. Among these, 53% experienced total slow pathway modification, while 46% had complete elimination of the slow pathway. Additionally, 8% of patients had one AV nodal echo beat present, but the AVNRT was

rendered non-inducible in these cases as well. Regarding complications, transient AV block was observed in 3% of patients, and a permanent AV block was recorded in 1%. No femoral hematomas were reported, and mild pericardial effusion occurred in 2% of patients.

DISCUSSION

Radiofrequency catheter ablation (RFA) has rapidly evolved as the treatment of choice for patients presenting with typical atrioventricular nodal reentrant tachycardia (AVNRT) [7]. In this study, ablation was performed primarily in the posterior septal area of the Triangle of Koch (ToK) in 90% of patients, while the remaining 10% underwent ablation at the mid-septum. This targeted approach aimed to create discrete and precise lesions at the slow pathway site. Remarkably, 99% of patients experienced successful ablation or modification of the slow pathway, demonstrating the high efficacy of RFA in treating typical AVNRT.

At baseline, patients reported a range of clinical symptoms, with palpitations being the most prevalent, occurring in 100% of the cohort. Other common symptoms included dizziness (22%), chest pain (19%), and pre-syncope or syncope (5%). These findings are consistent with previous studies, indicating the typical symptomatology associated with tachyarrhythmias [8].

Our study underscores the effectiveness and safety of slow pathway ablation in managing typical AVNRT. Acute success, defined as the non-inducibility of tachycardia, was achieved in 99% of patients. Among these, 53% underwent slow pathway modification, while 46% experienced complete elimination of the slow pathway. In 8% of the cases, a single AV nodal echo beat was observed following ablation, yet the AVNRT was rendered non-inducible through maneuvers such as programmed atrial and ventricular extra-stimulation, with or without isoproterenol infusion. Notably, one patient developed a permanent AV block and required the implantation of a dual-chamber permanent pacemaker, a complication in line with previously reported outcomes in AVNRT ablation studies by Clague J et al. and Holmqvist F et al [9].

The presence of junctional rhythm during slow pathway ablation is often considered a highly sensitive indicator of successful ablation, although it lacks specificity [10]. Our data suggest a very low rate of AVNRT recurrence, likely due to our protocol, which included monitoring junctional rhythm during RFA and verifying the absence of tachycardia re-induction with isoproterenol post-ablation.

In 8% of patients, a single echo beat was observed, indicating slow pathway modification rather than complete elimination [11,12]. The significance of residual slow pathway conduction concerning recurrence rates remains debated. While some studies suggest that not all slow pathway conductions need to be eliminated for successful treatment, others advocate for the complete elimination of slow pathway conduction and any AV nodal echo beat [13]. Our findings support the view that total elimination is not necessary, as non-inducibility of tachycardia may suffice for successful treatment.

The mean fluoroscopy time in our study was 15.7 ± 3.2 minutes, which is lower than reported in some studies but higher than in others [9,14,15]. The total procedural time for the electrophysiological study and RFA was 1.52 ± 0.22 hours, consistent with findings from other research [16,17]. The incidence of permanent atrioventricular block was low, with only one patient (1%) affected, which compares favorably with other studies reporting rates between 1% and 2.3% [18,19]. This complication likely resulted from prolonged energy delivery during ablation, underscoring the importance of careful signal monitoring during the procedure.

Limitations: Despite the promising results, our study has some limitations. It was conducted at a single center, which may limit the generalizability of the findings to other populations or settings. Additionally, the follow-up period was relatively short, preventing us from assessing the long-term recurrence rates and potential late complications of the procedure. Future studies with larger sample sizes and extended follow-up periods are needed to further validate these outcomes.

CONCLUSION

Radiofrequency catheter ablation has established itself as the standard treatment for patients with typical AVNRT who are refractory to drug therapy. In our study, the procedure achieved a remarkable acute success rate of 99%, with a minimal incidence of permanent atrioventricular block (1%). These results confirm that RFA is a highly effective and safe

therapeutic option for managing typical AVNRT in our hospital setting.

AUTHORS' CONTRIBUTION

WH, HAMS, IS, AZQ, and UMB: Concept and design, data acquisition, interpretation, drafting, final approval, and agree to be accountable for all aspects of the work. WH, HAMS, IS, AZQ, and UMB: Data acquisition, interpretation, drafting, final approval and agree to be accountable for all aspects of the work.

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