

# Electrophysiological Characteristics, Accessory Pathway Distribution, and Ablation Outcomes in Supraventricular Tachycardia: A Prospective Study from a Tertiary Cardiac Centre in Northern India

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## ABSTRACT

**Background:** Supraventricular tachycardias (SVTs) are common arrhythmias that frequently result in recurrent emergency visits and impaired quality of life. Regional electrophysiological data from northern India, particularly Himachal Pradesh, remains limited.

**Objectives:** To evaluate the clinical profile, electrophysiological mechanisms, accessory pathway distribution, and catheter ablation outcomes among patients undergoing electrophysiology study (EPS) for SVT.

**Methods:** This prospective observational study included 207 consecutive adults evaluated for SVT over a two-year period. Clinical characteristics, ECG findings, EPS parameters, tachycardia mechanism, ablation strategy, and acute outcomes were systematically recorded. Comparative analysis between atrioventricular nodal re-entrant tachycardia (AVNRT) and atrioventricular re-entrant tachycardia (AVRT) was performed using appropriate statistical tests.

**Results:** The cohort comprised 207 patients (mean age  $38 \pm 14$  years; 58% female). AVNRT was the predominant mechanism (139 patients, 67.1%), followed by AVRT (68 patients, 32.9%). AVNRT patients were significantly older and more likely to be female than AVRT patients ( $p < 0.01$ ). Pre-excitation on baseline ECG was exclusively observed in AVRT (64.7%,  $p < 0.001$ ). Acute ablation success was high overall (91.3%), with higher success in AVNRT compared with AVRT (95.7% vs. 88.2%,  $p = 0.04$ ). Complications were infrequent and minor, and early recurrence occurred in 2.4% of patients.

**Conclusion:** AVNRT is the most common SVT mechanism, while AVRT demonstrates a characteristic predominance of left lateral accessory pathways. Catheter ablation is highly effective and safe, support-

ing its role as first-line therapy for symptomatic SVT in this region.

**Keywords:** Supraventricular tachycardia; AVNRT; AVRT; accessory pathway; electrophysiology study; catheter ablation

## INTRODUCTION

Supraventricular tachycardias constitute an important group of arrhythmias that often present with abrupt episodes of palpitations, lightheadedness, chest discomfort, or, in selected cases, syncope.<sup>1</sup> These tachycardias can significantly affect patients' quality of life, and in regions where emergency services are frequently accessed for symptomatic episodes, SVTs comprise a considerable burden on healthcare systems. Although most SVTs are benign, they frequently result in repeated hospital visits, unnecessary investigations, and prolonged reliance on pharmacological therapy.

Radiofrequency catheter ablation is now established as the definitive treatment for most forms of SVT, offering long-lasting cure with high procedural success rates and excellent safety profiles.<sup>2</sup> Despite its widespread adoption, regional variability in arrhythmia mechanisms, pathway distribution, and procedural outcomes may exist due to differences in population characteristics, referral patterns, genetics, and operator experience.

The Himalayan region of Himachal Pradesh, with its distinct ethnic background, healthcare access challenges, and unique environmental characteristics, remains underrepresented in electrophysiological literature. The current study is one of the largest prospective analyses from this region and aims to provide a detailed understanding of the electrophysiological patterns and ablation outcomes among patients undergoing EPS for SVT.

## METHODS

### Study design and population

This prospective observational study was conducted in the Department of Cardiology over a two-year period. All adult patients referred for evaluation of documented or strongly suspected SVT were screened and included after informed consent. The study was approved by the Institutional Ethics Committee.

### Clinical and electrophysiological evaluation

Baseline evaluation included detailed clinical history, 12-lead ECG, ambulatory monitoring when available, and transthoracic echocardiography. EPS was performed under conscious sedation using standard quadripolar catheters. Tachycardia mechanisms were classified according to established criteria. Radiofrequency ablation was performed using conventional mapping techniques.

### Outcomes and statistical analysis

Acute procedural success was defined as non-inducibility of the clinical tachycardia following ablation. Continuous variables are expressed as mean  $\pm$  standard deviation and compared using Student's t-test. Categorical variables are expressed as counts and percentages and compared using chi-square or Fisher's exact test. A p-value  $< 0.05$  was considered statistically significant.

## RESULTS

### Baseline characteristics

A total of 207 patients were included. Baseline characteristics are summarized in Table 1. The majority

were young to middle-aged adults, with a slight female predominance, particularly in the AVNRT subgroup. Most patients presented with recurrent episodes of rapid palpitations that were often abrupt in onset and offset. A smaller proportion experienced near-syncope or actual syncope, while a distinct subset of patients with baseline pre-excitation had documented narrow- or wide-complex tachycardias during prior emergency visits.

## Mechanism-wise comparison

AVNRT was identified in 139 patients (67.1%), while 68 patients (32.9%) had AVRT. Comparative analysis between AVNRT and AVRT is shown in Table 2. The classic slow-fast variety was predominant, characterized by dual AV-nodal physiology and short VA intervals during tachycardia. Among patients with AVNRT, the **mean tachycardia cycle length** differed according to the electrophysiological subtype. **Typical (slow-fast) AVNRT** demonstrated a shorter mean cycle length of **318 ± 49 ms**, whereas **atypical AVNRT** was associated with a relatively longer cycle length of **364 ± 68 ms**. This difference reflects the slower re-entrant circuit characteristics and longer conduction times observed in atypical AVNRT.

## Accessory pathway distribution

AVRT accounted for approximately one-third of cases and demonstrated a predictable distribution of accessory pathways, with left lateral pathways forming the largest group. Posteroseptal pathways were the next most common, followed by right-sided pathways, which constituted a much smaller proportion. (Table 3).

## Procedural outcomes

Overall acute ablation success was achieved in 189 patients (91.3%). Success rates were significantly higher in AVNRT than AVRT. Minor complications occurred in 2.9% of patients, with no major adverse events. Early recurrence was observed in 2.4% of cases (Table 4).

**Table 1. Baseline Characteristics of the Study Population (n = 207)**

| Variable                     | Value       |
|------------------------------|-------------|
| Age (years), mean ± SD       | 38 ± 14     |
| Female sex                   | 120 (58.0%) |
| Structural heart disease     | 11 (5.3%)   |
| Hypertension                 | 46 (22.2%)  |
| Diabetes mellitus            | 18 (8.7%)   |
| Prior antiarrhythmic therapy | 129 (62.3%) |

**Table 2. Comparison of AVNRT and AVRT**

| Variable              | AVNRT (n=139) | AVRT (n=68) | p-value |
|-----------------------|---------------|-------------|---------|
| Age (years)           | 41 ± 13       | 33 ± 12     | <0.001  |
| Female sex            | 92 (66.2%)    | 28 (41.2%)  | 0.002   |
| Syncope               | 5 (3.6%)      | 9 (13.2%)   | 0.01    |
| Pre-excitation on ECG | 0             | 44 (64.7%)  | <0.001  |

| Variable               | AVNRT (n=139) | AVRT (n=68) | p-value |
|------------------------|---------------|-------------|---------|
| Acute ablation success | 133 (95.7%)   | 60 (88.2%)  | 0.04    |

**Table 3. Accessory Pathway Distribution in AVRT (n = 68)**

| Location      | n (%)      |
|---------------|------------|
| Left lateral  | 37 (54.4%) |
| Posteroseptal | 24 (35.3%) |
| Right-sided   | 7 (10.3%)  |

**Table 4. Procedural Outcomes**

| Outcome                                                 | Value       |
|---------------------------------------------------------|-------------|
| Overall success                                         | 189 (91.3%) |
| AVNRT slow-pathway ablation Success                     | >95%        |
| Accessory pathway ablation Success                      | 85–90%      |
| Minor complications (junctional rhythm, groin hematoma) | 6 (2.9%)    |
| Early recurrence                                        | 5 (2.4%)    |

## DISCUSSION

This prospective study provides one of the most comprehensive electrophysiological evaluations of supraventricular tachycardia from the Himalayan region and adds meaningful regional data to the limited Indian literature on SVT mechanisms and ablation outcomes. Several important clinical and procedural observations emerge from this analysis.

### Predominance of AVNRT

In the present cohort, atrioventricular nodal re-entrant tachycardia (AVNRT) was the most common SVT mechanism, accounting for approximately two-thirds of cases (Table 2). This finding is consistent with large international and Indian series, where AVNRT has been reported as the dominant form of paroxysmal SVT in adults.<sup>1–3</sup> The significantly higher mean age and female predominance observed among AVNRT patients in our study also mirror established epidemiological patterns, suggesting that regional or ethnic factors do not substantially modify the fundamental substrate of AV nodal re-entry.<sup>4</sup>

### Clinical presentation and symptom burden

Recurrent palpitations were the most frequent presenting complaint, with a very high proportion of patients requiring emergency department evaluation prior to definitive therapy (Table 1). Syncope was significantly more common in AVRT compared with AVNRT patients (Table 2), likely reflecting higher ventricular rates and, in some cases, rapid antegrade conduction over accessory pathways. Previous population-based studies have similarly shown that AVRT, particularly in younger patients, is associated

with more dramatic clinical presentations and higher rates of syncope.<sup>5,6</sup>

### **Accessory pathway distribution**

Among patients with AVRT, left lateral accessory pathways were most frequently observed, followed by posteroseptal and right-sided pathways (Table 3). This distribution closely parallels classical electrophysiological descriptions and large ablation series from both Western and Asian populations.<sup>7–9</sup> The consistency of accessory pathway localization across diverse geographic regions supports the concept that embryological development, rather than environmental or regional factors, primarily determines accessory pathway anatomy.

### **Ablation outcomes and procedural safety**

Catheter ablation demonstrated excellent acute success in this study, with an overall success rate exceeding 90% (Table 4). Acute success was significantly higher in AVNRT compared with AVRT patients, a finding consistent with prior reports demonstrating particularly high efficacy of slow-pathway modification for AVNRT.<sup>2,10</sup> Although AVRT ablation success was marginally lower, outcomes remained comparable to international benchmarks, even in the absence of routine three-dimensional electroanatomical mapping systems.

Procedural complications were infrequent and limited to minor, self-limiting events, with no cases of complete atrioventricular block or major vascular complications. These findings are in line with large contemporary registries and reaffirm the safety of electrophysiology study and radiofrequency ablation when performed in experienced centres.<sup>11,12</sup>

### **Regional and public health implications**

The high proportion of patients with recurrent emergency visits prior to ablation highlights the substantial healthcare burden imposed by SVT in this region. Geographic challenges, limited access to electrophysiology services, and delayed referral from peripheral centres may contribute to prolonged symptom duration and repeated hospital encounters. Our findings strongly support current guideline recommendations advocating early referral for electrophysiology study and catheter ablation as first-line therapy for recurrent symptomatic SVT, which may reduce healthcare utilization and improve patient quality of life.<sup>1,13</sup>

## **LIMITATIONS**

This was a single-centre study, which may limit the generalizability of the findings. Follow-up was limited to early post-procedural outcomes, and long-term recurrence rates could not be assessed. Additionally, advanced three-dimensional mapping systems were not routinely employed, which may have influenced procedural complexity in selected cases.

## **CONCLUSION**

In this prospective cohort, AVNRT was the predominant mechanism of SVT, while AVRT demonstrated a characteristic left lateral accessory pathway predominance. Catheter ablation provided excellent acute success with minimal complications, supporting its role as first-line therapy for symptomatic SVT in this region.

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