# Using para-Hisian pacing as Electrophysiological maneuver to categorized Supra Ventricular Tachycardia in patient with normal resting ECG

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**Abstract**

**Background:** Paroxysmal SVT is apply to intermittent SVT other than AFL, AF, and multifocal AT which include AVNRT, AVRT & AT. Several EP study maneuvers found to be useful in evaluation & differentiation. parahisian pacing is maneuver used to get whether retro-grade atrial activation occur by the atrioventricular nodes (AVN; "nodal response") or via an AP ("extranodal response") & to detect concealed septal accessory pathway.

**Aims**: To differentiate the types of SVTs using paraHisian pacing in case with normal resting ECG according to PHP response.

**Methods:** A cross-sectional study, enrolling cases with SVT with normal resting ECG who were scheduled for electrophysiological study and radiofrequency ablation from November 2021 to August 2022. Parahisian pacing maneuver, performed in sinus rhythm, with HB-RB capture & non capture to determine whether midline conduction is occurring through the AV node or a septal pathway.

**Results:** The study reveals 73.5% of the cases got AVNRT, 23% AVRT, while only four case got AT. The para-Hisian pacing response were nodal in a 80 cases out of 83 cases of AVNRT, while four out of twenty-six cases with AVRT got nodal response. The sensitivity of PHP to detect AVRT is 84.6%.

**Conclusion:** Para-Hisian pacing is good invasive electro-physiological method to categorize supra-ventricular tachycardia with good sensitivity in predict AVRT as possible type of arrhythmia, nevertheless, needs careful interpretation and implementation to overcome the pitfalls inherent in such method.

**KEYWORDS: para-Hisian pacing, Electrophysiological maneuver, Supra Ventricular Tachycardia, resting ECG, extranodal response**

## Introduction

Supraventricular tachycardia denotes the including of one or more cardiac parts above His bundle bifurcation, like the atrioventricular node (AVN), atrial myocardium, coronary sinus (CS), proximal His bundle (HB), venae cavae, pulmonary veins, or abnormal atrioventricular (AV) linkages other than the HB (bypass tract [BTs]) [1].

Narrow QRS-complex SVT is a tachyarrhythmia with a rate >100 beats/minutes and a QRS duration <120 milliseconds [2, 3].

NC-SVT include inappropriate sinus tachycardia, sinus tachycardia, focal atrial tachycardia (AT), sinoatrial nodal reentrant tachycardia, atrial fibrillation (AF), multifocal AT, atrial flutter (AFL), atrioventricular nodal reentrant tachycardia (AVNRT), junctional tachycardia, and atrio-ventricular reentrant tachycardia (AVRT) [1, 2].

Paroxysmal SVT is apply to intermittent SVT other than AFL, AF, and multifocal AT. It describe a clinical syndromes featured by a presence of a regular and rapid tachycardia (abrupt onset and termination). The major reasons are AVNRT (50-60%), AVRT (30%) and focal AT (10%) [1].

Individual refer for Ablation because of symptomatic paroxysmal SVT. The AVNRT is the commonest mechanism (56%), followed by AVRT (27%) and AT (17%). The mechanism of SVT is depended on age and gender [4]. The majority of cases with AVRT are men, whereas the majority with AVNRT and AT are women. As cases grew up, there was a significant and reasonable decline in the number of cases [4].

AVNRT is the predominant mechanism overall in cases undergoing ablation and post the age of 20 years it account for the largest number in each age group. It is unusual in pediatric age and typically initially manifest in early life [5]. Female gender and elderly favor the AVNRT detection over AVRT. AVRT present earlier in life than AVNRT (common in the first two decades), with an average of >10 years separating the time of clinical presentation of AVRT vs. AVNRT [6]. It is consistent with a substrate congenital nature. However, a minority of cases have relatively late onset of symptoms associated with AVRT and thus continue to account for a small proportion of ablations in older cases. Men account for a higher proportion of AVRT at all ages [7].

During normal electrical activity, reentry of the cardiac cycle begin in the sino-atrial nodes and continue to propagate till entire heart is activate, the impulse die out if all fibers depolarize and completely refractory happen. The link to re-excite areas that previously depolarize have recover from the first depolarization [6]. Reentry, circus movement, reentrant excitation, reciprocal or echo beat, or reciprocating tachycardia (RT) are refer to a repetitive propagation of activation waves, return to its origin sites to reactivate [6].

Several electro-physiology study maneuver found to be helpful in invasive electro-physiological assessment of SVT. The para-Hisian sites are unique via anatomically close whereas electrically distant from the HB. Para-Hisian pacing at high-output capture the proximal RB or HB, as well as the adjacent ventricular myocardium. At lower-output, direct HB-RB captures are losing and retro-grade activation

of the HB are delay due to the RB and HB are insulate from adjacent myocardium and peripheral inputs to Purkinje system, which are situate far from the para-Hisian pacing sites [7-9].

By maintaining local ventricular captures, while intermittently losing HB-RB captures, the retro-grade VA conduction can be classify as dependent on the local ventricular activation timing, or HB activation, or both (fusion) [9].

The paraHisian pacing techniques are utilize to determine the routes of retro-grade electrical conduction from ventricles to the atriums. A reliable tools in establishing whether a para-septal accessory pathways are present [10,11]. The proper interpretations of paraHisian pacing require a systematic approaches and an under-standing of potential pitfalls [11].

The goals of paraHisian pacing are to get retro-grade atrial activation occur by the atrio-ventricular nodes or by extra-nodal responses. Other are identify various forms of fusion like multiple APs, combinations of retro-grade AVN conduction and APs [12].

Para-Hisian pacing via capture of ventricles (wide paced QRS), atriums (atrial activation in the HB regions post pacing artifacts), the HB (narrow paced QRS), or any combination [11, 12].

The study aimed to differentiate the types of SVTs using paraHisian pacing in case with normal resting ECG according to PHP response.

**Methods**

This study is a cross-sectional study, enrolling cases with SVT with normal resting ECG who were scheduled for electrophysiological study and radiofrequency ablation from November 2021 to August 2022.

The case should stop any anti-arrhythmic drug one week prior to the EP study and six weeks for Amiodarone users.

History, laboratory investigations and ECG were done one day prior to EPS.

Electrophysiological study procedure started using four intravenous lines through right and left femoral veins. The EP device WorkMate Claris system (ST. Jude Medical), One steerable deca-polar catheter deployed in the coronary sinus, then two quadri-polar for right atrium, right ventricular apex, and one hexa-polar catheter in His region.

**Para-Hisian Pacing**

Parahisian pacing This maneuver, performed in sinus rhythm, helps determine whether midline conduction is occurring through the AV node or a septal pathway.

Pacing is started at a high output (10-20 mv) to capture the deeply seated and insulated His directly and the surrounding myocardial tissue. The pacing output is gradually decreased until His capture is lost. When the His is captured directly the resulting QRS will be narrow and when His capture is lost the QRS will widen into a BBB pattern. The time from the stimulation artifact to the subsequent atrial signal (SA interval) is measured during His capture and during the loss of His capture.

The His bundle electrogram was recorded with a 6 F hexa-polar catheter with 2mm interelectrode spacing to localize the His bundle and proximal right bundle branch.

For para-Hisian pacing, the catheter was positioned at the anterobasal right ventricular septum 1 to 2 cm anterior and apical to the His bundle.

Bipolar ventricular pacing was performed through the distal pair of electrodes (2mm spacing) at a long pacing cycle length (>500 ms) and high output (10 mA). Narrow QRS indicate direct HB-RB capture. The pacing output then decreased until the paced QRS complex widened, which indicate loss of HB-RB capture.

The response to para-Hisian pacing was determined by the change in the following variables between HB-RB capture and HB-RB noncapture [7]:

(1) Atrial activation sequences
(2) Stimulus -Atrial Interval
(3) H-A interval measured in His bundle electrogram.

In the setting of no AP, losing of His capture resulted in a widening of the QRS complex and a simultaneous raise in stimulation-atrial time (denote as Noda Para-Hisian response)

In contrast, the presence of a septal AP result in an identical stimulation-atrial time both with and without His capture (Extra-nodal response, via accessory pathway).

**Statistical Analysis**

The data were analyzed in the computer by using SPSS (Statistical Package for Social Science) version 22. The results were presented into simple self- explanatory tabulation. Sensitivity and specificity were measured.

**Results**

This is a cross-sectional study including 113 cases with Supraventricular tachycardia, 78 females (69%) and 35 males (31%), with a mean age of 36 ± 11 years and range of 15- 65 years.

The ventriculo-atrial (VA) conduction of the study cases reveal that 89 cases (78.8 %) had decremental VA conduction while 24 (21.2%) had non-decremental conduction, (Table 1).

**Table 1: VA conduction of study cases**

| VA Conduction | No. | % |
|---|---|---|
| Decremental | 89 | 78.8 |
| Non-Decremental | 24 | 21.2 |

Also, 88 cases (77.9 %) got Nodal Para-hisian pacing response while 25 cases (22.1 %) got extra-nodal response, (Table 2).

**Table 2: Para-hisian response of study case**

| Para-Hisian | No. | % |
|---|---|---|
| Nodal | 88 | 77.9 |
| Extra-Nodal | 25 | 22.1 |

The study reveals that 73.5% of the cases got AVNRT, 23% AVRT, while only four case got AT, (Table 3). The study reveals 74.7% of AVNRT cases were females and 53.8% of AVRT were males, while All AT cases were female.

**Table 3: SVT category**

| SVT | No. | % |
|---|---|---|
| AVNRT | 83 | 73.5 |
| AVRT | 26 | 23 |
| AT | 4 | 3.5 |

The para-Hisian pacing response were nodal in a 84 of VA, while 4 cases with VA got non-decremental conduction, (Table 4). The para-Hisian pacing response were nodal in a 80 cases of AVNRT, while four with AVRT got nodal response, (Table 4).

**Table 4: Correlation between para-Hisian pacing response with VA conduction and types of SVT**

| VA conduction | Para-Hisian pacing | |
|---|---|---|
| | Nodal | Extra-Nodal |
| Decremental | 84 (95.5) | 5 (20) |
| Non-decremental | 4 (4.5) | 20 (80) |
| Total | 88 | 25 |
| SVT | Para-Hisian Pacing | |
| | Nodal | Extra-Nodal |
| AVNRT | 80 (91) | 3 (12) |
| AVRT | 4 (4.5) | 22 (88) |
| AT | 4 (4.5) | - |
| Total | 88 | 25 |

The para-Hisian pacing response were nodal in a 81 cases of AVNRT, while 4 cases with AVRT got decremental conduction, (Table 5). Types of AVRT in the study cases was listed: Orthodromic in 16 cases, Antidromic in 7 cases and PJRT in 3 cases. Sites of accessory pathway of AVRT were: 6 of Left lateral, 2 of Left inferolateral, 3 of Anteroseptal, 8 of Posteroseptal, 4 of Mid septal and 3 of Right sided.

**Table 5: Correlation of VA conduction with types of SVT**

| SVT | VA conduction | |
|---|---|---|
| | Decremental | Non-Decremental |
| AVNRT | 81 (91) | 2 (8.4) |

| | | |
|---|---|---|
| AVRT | 4 (4.5) | 22 (91.6) |
| AT | 4 (4.5) | - |
| Total | 89 | 24 |

**Discussion**

The study results reveal that 73.5% of the study case got AVNRT and 23% AVRT while only 4% suffer from AT, and the gender distribution of various form of SVT which is consistent the epidemiological data regarding the frequency of SVT from ACC/AHA/HRS [1].

The use of para-hisian pacing is valuable method to categorize SVT according to the response whether it is nodal (via AVN whether fast or slow pathway) or extranodal (via concealed Accessory pathway).

The sensitivity in our study about 84.6 % for para-hisian pacing to detect AVRT as the possible mechanism of arrhythmia. Nevertheless, there are multiple pitfalls [13, 14]: using hexa-polar catheter can abolish ability to recording retro-grade His bundle electrogram potential and HA intervals when pacing. So, need either two quadri-polar catheters, one for pacing and the other for recording (octa-polar catheter).

Assurance of lack of atrial captures via the pacing stimulus are important for correct interpretation of parahisian pacing. When very short stimulation to proximal coronary sinus A <60 ms present and stimulation to high right A <70 ms are suggestive of direct captures of atriums from pacing catheters. A stimulation atrial EGM time of >90 ms (proximal coronary sinus) and >100 ms (high right atrium) argue strongly against direct atrial capture.

Para-Hisian pacing during sinus rhythm useful prove the presence of an AV septal BT, it does't show whether that BT is participating during the arrhythmia or not.

The classic PHP only allows determination of whether the present mapped retrograde atrial activation, at a certain time and PCL, is dependent on HB activation.

Moreover, although a nodal pattern does not exclude the presence of an AP, the latter does not confirm the underlying mechanism of tachycardia [14].

The technique needs extra care and case education to overcome the pitfall of catheter movement during respiration which may result in inadvertent atrial capture or failure to pace the para-hisian region.

The location of the AP and the retrograde conduction time over this bypass tract must be taken into account when interpreting the results of para-Hisian pacing [15].

Because the stimulus to ventricular bypass tract interval (SVBT) is increased as APs located progressively farther from the para-Hisian pacing site

So, for left free-wall BTs, which are located far from the pacing site, the SVBT interval can be sufficiently long to have the atria retrogradely activated via the AVN during HB-RB non capture state and incorrectly exclude left sided accessory pathway [7].

**Conclusion**

Para-Hisian pacing is good invasive electro-physiological method to categorize supra-ventricular tachycardia with good sensitivity in predict AVRT as possible type of arrhythmia, nevertheless, needs careful interpretation and implementation to overcome the pitfalls inherent in such method.

We recommend to use Para-hisian routinely in case with SVT subjected to EP study & radiofrequency ablation to detect possible concealed accessory pathway not detected in another test.

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