



## Long-term outcomes after catheter-ablation of atrioventricular nodal reentrant tachycardia: A ten-year follow-up

Dugoročni ishodi nakon kateter-ablacije atrioventrikularne nodalne *reentrant* tahikardije: desetogodišnje praćenje

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### Abstract

**Background/Aim.** Atrioventricular nodal (AV) reentry tachycardia (AVNRT) is the most common form of supraventricular tachycardia. Treatment of choice is a catheter-ablation of the slow pathway of the AV node. The aim of the study was to present the outcomes of this procedure after ten years of follow-up. **Methods.** The catheter-ablation procedure was performed in 92 patients (30 men and 62 women, mean age  $52.0 \pm 13.3$  years, range 19 to 76 years) with confirmed AVNRT during the electrophysiological examination, from 2007 to 2009. Out of these, 64 patients were followed-up for ten years by inviting them to clinical examinations regularly. The occurrence of AV block, arrhythmia and the use of antiarrhythmic drugs were the main outcomes of the ten-year follow-up. Multivariate logistic regression was applied to identify significant predictors of arrhythmia after a follow-up period. **Results.** The primary success of intervention was achieved in 91 (98.9%) patients. Third-degree AV block was registered in 1 (1.1%) patient after the intervention, which required the implantation of a pacemaker. After ten years of follow-up, AVNRT

relapses were not registered. A total of 7 out of 64 (10.9%) patients died during the follow-up period, mostly due to non-cardiac causes. After ten years of follow-up, first-degree AV block was registered in six (10.5%) patients, whereas other arrhythmias were observed in 17 (29.8%) patients such as atrial fibrillation or flutter, atrial premature beats and sinus tachycardia. The number of antiarrhythmic drugs were reduced from  $2.1 \pm 1.2$  at baseline to  $0.5 \pm 0.6$  during follow-up, mostly beta-blockers, propafenone and amiodarone, and 33 (57.9%) patients were no longer using anti-arrhythmic therapy. Logistic regression identified participant's age above 55 years at baseline and re-intervention performed after the initial catheter-ablation as significant predictors of arrhythmia after a 10-year follow-up, independent from gender and arterial hypertension at baseline. **Conclusion.** The catheter-ablation of AVNRT represents a successful and safe procedure, from the perspective of ten-year follow-up.

### Key words:

tachycardia, atrioventricular nodal reentry; catheter ablation; arrhythmias, cardiac; treatment outcome.

### Apstrakt

**Uvod/Cilj.** Atrioventrikularna (AV) nodalna *reentrant* tahikardija (AVNRT) je najčešća forma supraventrikularne tahikardije. Lečenje izbora predstavlja kateter-ablacija sporog puta AV čvora. Cilj ove studije je bio prikaz ishoda AVNRT nakon desetogodišnjeg perioda praćenja. **Metode.** Procedura je urađena kod 92 bolesnika (30 muškaraca i 62 žene, prosečne starosti  $52,0 \pm 13,3$  godina, raspon 19 do 76 godina) sa dokazanom AVNRT tokom elektrofiziološkog ispitivanja od 2007 do 2009. godine. Od toga, 64 bolesnika su praćena tokom deset godina dolaženjem na redovne

kliničke preglede. Pojava AV bloka, aritmije i upotreba antiaritmika bili su glavni ishodi desetogodišnjeg praćenja bolesnika. Multivarijantna logistička regresija je primenjena kako bi se izdvojili značajni faktori kojima se može predvideti pojava aritmije nakon praćenja od deset godina. **Rezultati.** Primarni uspeh intervencije je bio postignut kod 91 (98,9%) bolesnika. Kod jednog (1,1%) bolesnika registrovan je atrioventrikularni blok III stepena koji je zahtevao ugradnju pejsmejkera. Posle desetogodišnjeg praćenja, nisu registrovani recidivi AVNRT. Ukupno 7 od 64 (10,9%) bolesnika je umrlo u periodu praćenja, većina zbog nekardijalnih uzroka. Posle perioda praćenja utvrđeno je da je kod šest (10,5%)

bolesnika registrovan AV blok I stepena, dok su druge aritmije zabeležene kod 17 (29,8%) bolesnika, kao što su atrijalna fibrilacija i flater, pretkomorske ekstrasistole i sinusna tahikardija. Prosečan broj antiaritmika redukovan je sa  $2,1 \pm 1,2$  leka, na početku, na  $0,5 \pm 0,6$  leka u periodu praćenja, najčešće beta-blokatori, propafenon i amiodaron, pri čemu 33 (57,9%) bolesnika više nije koristilo antiaritmij-sku terapiju. Logističkom regresijom izdvojili su se starost bolesnika preko 55 godina, na početku studije, i izvršena ponovna reintervencija posle kateter ablacije kao značajni

prediktori pojave aritmije posle desetogodišnjeg praćenja, nezavisno od pola i postojanja arterijske hipertenzije na početku. **Zaključak.** Kateter-ablacija AVNRT predstavlja uspešnu i bezbednu proceduru iz perspektive desetogodišnjeg praćenja.

**Ključne reči:**  
tahikardija, atrioventrikularna nodalna kružna; ablacija preko katetera; aritmija; lečenje, ishod.

## Introduction

Atrioventricular (AV) nodal reentry tachycardia (AVNRT) is the most common form of supraventricular tachycardia (SVT). The prevalence of SVT is 2.25 per 1,000 persons and more than half of them have AVNRT<sup>1</sup>. The substrate for AVNRT is the existence of dual physiology of the AV node; the electrophysiological difference in the slow and fast pathway properties is a predisposition to trigger the circular motion mechanism of the impulse<sup>2,3</sup>. The therapy of choice is a catheter-ablation of the slow pathway (SP) by radio frequency (RF) or cryo-energy, and this method is primarily successful in more than 95% of patients<sup>4</sup>. The most common procedural complication is I-III degree AV block that occurs in 1% of all procedures<sup>5</sup>.

The aim of this study was to present the outcomes of the RF catheter-ablation after ten years of follow-up, in terms of the occurrence of AV block, occurrence of other arrhythmias and the use of antiarrhythmic therapy.

## Methods

### *Study population*

The study was done at the Clinic for Cardiology of the Clinical Center of Serbia, Belgrade in the period from 2007 to 2009. The study comprised a total of 92 consecutive patients diagnosed with AVNRT during the electrophysiological study; RF catheter-ablation of the slow pathway was performed in all patients. During the reception, patients were introduced to the method of the procedure, the rate of its success in our institution and possible complications. Given the fact that the RF catheter-ablation is an invasive cardiac procedure, patients were required to give their written consent before the procedure.

### *Study protocol*

Antiarrhythmic therapy was discontinued 3–7 days before the procedure, in order to facilitate clinical tachycardia induction during the intervention. In all patients, electrophysiological study and catheter-ablation were performed during the same procedure. The intervention was performed in local anesthesia, except in rare cases when the patient was upset during the procedure due to the use of an intravenous analgesic, in the presence of anesthesiologist.

Vascular access via the right femoral vein was used. Under the control of fluoroscopy, two catheters were placed through the 7Fr sheaths, via the inferior cava vein. Quadripolar Diagnostic Catheter (Medtronic MC XL or Biosense Webster) for the stimulation and ablation catheter (Medtronic MC) were used.

The diagnostic catheter was positioned at the right ventricular apex for continuous pacing in order to evaluate retrograde conduction. After the ventricular stimulation, the quadripolar catheter was positioned on the lateral wall of the right atrium for atrial stimulation. For the purpose of the induction of AVNRT, programmed stimulation was performed with one (S2) and two (S2, S3) extrastimuli. The ablation catheter was positioned in the coronary sinus for the anatomical marking of this structure and the detection of intracardial signals in the left heart, and then the position of His is marked. If the clinical tachycardia was induced, an anatomical mapping of the right atrium and coronary sinus was performed in order to establish the exact diagnosis of tachycardia. Ablation was mainly performed in the sinus rhythm with the prior detection of slow pathway potential (an integrated anatomical and electrophysiological approach), and in some patients it was performed during AVNRT with the goal of termination of tachycardia. In both cases, an accelerated nodal rhythm was recorded, a non-specific parameter of the site of the successful ablation. The use of RF pulses was limited to 50 Watts. At the end of the procedure, programmed stimulation was repeated under the same conditions and with the same stimulation protocol as well as pre-ablation. In addition to the inducibility of tachycardia, other electrophysiological parameters were compared with those obtained before the ablation itself.

After 10 years of follow-up, patients were invited to examination in order to obtain anamnestic symptom and occurrence of other arrhythmia data and to perform a 12-channel electrocardiogram to measure the PQ interval. Data on AVNRT relapse were reported and occurrence of other arrhythmias were observed in the meantime. Patients gave information on taking antiarrhythmic drugs.

### *Statistical analysis*

Descriptive statistic was presented as mean values  $\pm$  standard deviation (SD) for numeric variables, or as percents (relative numbers) for categorical variables. Multiple logistic regression analysis was used to compute adjusted odds ratios

(OR) for the prediction of permanent arrhythmia after a ten-year follow-up in relation to age, gender, arterial hypertension diagnosed at baseline, and the need for re-intervention. A probability level of less than 0.05 was accepted as significant. The SPSS 15.0 for Windows software (SPSS Inc. 1989–2006) was used.

## Results

Basic demographic and clinical characteristics of the investigated patients at baseline are presented in Table 1. Most patients were female, aged 52 years, who had more than 82 paroxysms for more than 15 years. Common comorbidities were present in 38 (41.3%) patients. Structural heart disease was diagnosed in 14 (15.2%) patients, 33% of the patients had arterial hypertension and only 4% had diabetes at baseline. The average number of anti-arrhythmic drugs was 2.1 (range 0 to 6), and only 5% of the patients had no anti-arrhythmic therapy at baseline. Our data records showed that the patients were treated with anti-arrhythmic drugs such as amiodarone, propafenone, verapamil and different beta-blockers at baseline.

**Table 1**  
**Basic demographic and clinical characteristics of the investigated patients at baseline**

Characteristics	Number (%) or mean $\pm$ SD
Number of patients	92 (100.0)
Men	30 (32.6)
Women	62 (67.4)
Age (years)	52.0 $\pm$ 13.3
Number of paroxysms	82.5 $\pm$ 125.5
Duration of paroxysms (years)	15.1 $\pm$ 10.2
Structural heart disease	14 (15.2)
Other diseases (co-morbidities)	38 (41.3)
Arterial hypertension	31 (33.7)
Diabetes mellitus	4 (4.4)
Number of anti-arrhythmic drugs	2.1 $\pm$ 1.2
Without anti-arrhythmic therapy	5 (5.4)

SD – standard deviation.

Cardiological characteristics of the investigated patients before, during and after the catheter-ablation are presented in Table 2. Less than 20% of the patients experienced atrial fibrillation or atrial flutter during the intervention, transitory AV or ventriculoatrial (VA) block during the intervention, or needed to be treated with atropine during the intervention. The success rate was 98.9%, and only 10.9% of the patients underwent a re-intervention. Permanent AV block of any degree after the intervention was present in only 3 patients. The average number of anti-arrhythmic drugs was 0.2 (range 0 to 2), and 80% of the patients had no anti-arrhythmic therapy after the ablation. Our patients were given the following anti-arrhythmic drugs after the ten-year follow-up: beta-blockers, amiodarone and propafenone.

Characteristics of the investigated patients after the 10-year follow-up period are presented in Table 3. The total number of

patients followed for 10 years was 64; seven of them died during the follow-up period and 57 were still alive.

**Table 2**  
**Cardiological characteristics of the investigated patients before, during and after the intervention**

Characteristics before, during and after the intervention	Number (%) or mean $\pm$ SD
Dual physiology of AV node before the intervention	90 (97.8)
Application of atropine during the intervention	15 (16.3)
Atrial fibrillation or atrial flutter during the intervention	16 (17.4)
Cycle of tachycardia (ms)	353.8 $\pm$ 60.0
Number of RF applications	9.4 $\pm$ 6.8
Time of RF application (seconds)	444.4 $\pm$ 239.3
Total RF energy applied (Ws)	14123.0 $\pm$ 8514.5
Rtg time of exposure (seconds)	530.3 $\pm$ 315.8
Absorbed dose (mGy)	224.9 $\pm$ 194.4
Transitory AV block during the intervention	19 (20.7)
Transitory VA block during the intervention	20 (21.7)
Acute success of the intervention	91 (98.9)
Re-intervention rate	10 (10.9)
Dual physiology of AV node after the intervention	54 (58.7)
Atrial Echo impulse after the intervention	47 (51.1)
Effective refraction period after the intervention (ms)	282.9 $\pm$ 56.6
Weckenbach cycle after the intervention (ms)	376.8 $\pm$ 73.4
PQ interval after the intervention (ms)	160.3 $\pm$ 29.2
Permanent AV block after the intervention	3 (3.3)
Number of anti-arrhythmic drugs after the intervention	0.2 $\pm$ 0.5
Without anti-arrhythmic therapy after the intervention	74 (80.4)

RF – radio frequency; Rtg – Roetgen; AV – atrioventricular; VA – ventriculoatrial; SD – standard deviation.

**Table 3**  
**Characteristics of the investigated patients after the ten-year follow-up**

Characteristics	Number (%) or mean $\pm$ SD
Number of patients	64 (100.0)
Men	19 (29.7)
Women	45 (70.3)
Alive	57 (89.1)
Deceased	7 (10.9)
Recidivism of tachycardia	0
Permanent AV block	6 (10.5)
Paroxysmal arrhythmia	17 (29.8)
PQ interval (ms)	180.0 $\pm$ 30.9
Number of anti-arrhythmic drugs	0.5 $\pm$ 0.6
Without anti-arrhythmic therapy	33 (57.9)

SD – standard deviation.

**Table 4****Multivariate logistic regression model for the prediction of arrhythmia after a ten-year follow-up**

Variables	Probability coefficient	95% Confidence interval	Standard error	<i>p</i>
Male gender	0.638	0.137–2.975	0.785	0.567
Age above 55 years at baseline	3.945	1.022–15.223	0.689	0.046
Arterial hypertension at baseline	3.502	0.874–14.031	0.708	0.077
Re-intervention	5.437	1.028–28.740	0.850	0.046
Constant	0.137		0.556	0.000

None of the patients experienced recidivism of tachycardia, whereas permanent AV block of any degree was reported in 6 (10.5%) patients, and paroxysm of other arrhythmia was found in 17 (29.8%) patients. The average number of anti-arrhythmic drugs was 0.5 (range 0 to 2), and 58% of the patients had no anti-arrhythmic therapy after the 10-year follow-up period.

Univariate logistic regression models identified age (categorized as 0 – less than 54 years, and 1 – aged 55 years and older), arterial hypertension at baseline (categorized as 0 – not diagnosed, and 1 – diagnosed), and the need for re-intervention (categorized as 0 – not performed, and 1 – performed) as significant predictors for the paroxysmal arrhythmia after a 10-year follow-up.

A multiple logistic regression model was fitted, including gender and the above mentioned variables (Table 4). This model was statistically significant ( $\chi^2$  value = 12.069;  $p = 0.017$ ) and explains between 18.8% and 26.4% of the variance in the occurrence of arrhythmia 10 years after the intervention. The model adequately classified 72.4% of all cases with arrhythmia after 10 years of follow-up. In this model, participant's age above 55 years at baseline and re-intervention performed after the intervention were identified as significant predictors of arrhythmia occurrence after a 10-year follow-up, independent from gender and arterial hypertension at baseline.

## Discussion

According to the guidelines for the treatment of supraventricular tachycardia, catheter-ablation of the slow pathway AV node is indicated in patients with diagnosed AVNRT – Class I, Level B-RN<sup>6</sup>. In our study, in a group of 64 patients who were available after 10 years of follow-up, no supraventricular tachycardia relapse was registered in a single patient. High long-term effectiveness of 90-100% of the procedure was recorded in studies by D'Este et al.<sup>7</sup>, Clague et al.<sup>8</sup> and Kimman et al.<sup>9</sup>. The D'Este et al.<sup>7</sup> study also monitored a group of patients on antiarrhythmic therapy. In the last mentioned study, after three years of follow-up, AVNRT relapse was no longer registered.

In our group during the follow-up period, seven patients died (five due to malignancies, one due to pulmonary embolism and one due to acute abdomen).

During and immediately after the catheter-ablation, AV block was registered in 3 (3.3%) patients and after 10 years in six (10.5%) patients. In 1 patient from this group third-degree AV block was registered, which required the implan-

tation of the pacemaker, immediately after the ablation. The other five patients had first-degree AV block, and were recommended for further monitoring. In a multicenter study with 880 patients<sup>5</sup> complete AV block was registered in 4.7% of patients in total (slow and fast pathway ablation), or in 2.0% of patients who underwent slow pathway ablation. In a recent study by Jensen<sup>10</sup> the rate of late AV block appearance was 0.57%. Our results largely coincide with the results of the published studies so far.

The use of anti-arrhythmic therapy was significantly reduced during the follow-up period. The average number of anti-arrhythmic drugs used to prevent supraventricular tachycardia before ablation was 2.1 while this number was reduced to 0.5 in the period after the ablation and after the ten-year follow-up. More than a half of all patients did not have the need for medication in the meantime. Most patients used beta-blockers. A similar result was also found in the Brachmann et al.<sup>11</sup> study where about 58% of patients were exempted from antiarrhythmic drugs.

In some previously published papers, it has been shown that radio frequency catheter-ablation of slow pathway may be responsible for the emergence of substrate for new arrhythmias. In 30% of patients who underwent slow pathway ablation, new arrhythmias were reported: half of them had atrial fibrillation or atrial flutter, while at the second half were registered atrial premature beats or sinus tachycardia<sup>8</sup>. The assumption for the onset of atrial flutter is that the slow pathway is anatomically close to zone of slow conduction in the right atrium<sup>12, 13</sup>. In the study of Schernthaner et al.<sup>14</sup>, 35% of patients in the follow-up period had arrhythmias that required the use of anti-arrhythmic drugs. It is possible that AVNRT is a substrate for the occurrence of atrial fibrillation in a group of younger patients<sup>15</sup>, and in these patients, slow pathway ablation would be sufficient to prevent atrial fibrillation.

In our patient group, 17 (29.8%) of them had documented arrhythmia in the monitoring period. From this group, 10 patients had sinus tachycardia, two patients had extrasystoles, and five patients had atrial fibrillation or atrial flutter. A small number of patients had short palpitations not documented by an electrocardiogram. Most of these patients used beta-blockers during the monitoring period.

Using the univariate logistic regression model, our study showed that independent predictors of the onset of these arrhythmias over the course of 10 years follow-up were patients' age above 55 years at baseline and the need for re-intervention, independent from gender and arterial hypertension at baseline. The possible reason for the occurrence of

sinus tachycardia as the dominant arrhythmia in this group of patients is the ablation of parasympathetic fibres in the septal zone, that leads to an acceleration of the heart rate<sup>16</sup> while the other possible reason is the rebound phenomenon after stopping the taking of the beta-blocker in order to prepare for intervention. Nevertheless, other studies contradict this finding by showing that younger patients may be more prone to AVNRT recidivism than the older ones<sup>17</sup>.

The limitation of this study is a relatively small sample, particularly after the follow-up, where almost a third of the original sample was lost. Although the patients were called for medical examination on the regular basis, the contact was lost due to unresponsiveness, address change, death or other circumstances. The presented results cannot therefore be easily generalized to the whole population of patients with

AVNRT, but they might serve as an indicator of a long-term prediction of adverse outcomes of the intervention.

## Conclusion

Our long-term follow-up study of patients following radio frequency catheter-ablation AVNRT showed that ablation is an effective and safe method of treating these patients. Total mortality was not associated with cardiovascular causes. The rate of recurrence of tachycardia and the complication rate are very low and most patients do not use antiarrhythmic therapy during the monitoring period. Independent predictors for the occurrence of other arrhythmias were age above 55 years and the need for re-intervention, and the most commonly reported arrhythmia during the follow-up period was sinus tachycardia.

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