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ORIGINAL ARTICLE ÖZGÜN / ARAŞTIRMA

Cateheter ablation treatment of atrioventricular nodal re-entrant tachycardia

Atrioventriküler nodal re-entrant taşikardinin kateter ablasyon ile tedavisi

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ABSTRACT

Objectives: In this study, we aimed to evaluate our clinical experience about the catheter ablation of atrioventricular nodal reentrant tachycardia (AVNRT) including complications and long-term outcomes.

Materials and Methods: The study population consisted of 166 patients with AVNRT, 52 of whom from hospital-1 and 114 of who from hospital-2. Radio-frequency (RF) ablation therapy was applied after the basic electrophysiology study. Complications in RF ablation and long-term recurrences were noted.

Results: More than 90% of the patients had symptoms persisting for more than one year and again more than 90% of those were suffering at least 2 episodes per month. The success rate of RF ablation was 98.2% for the entire study population. The recurrence rate was observed to be 3% (n=5) throughout the follow-up period. In the multivariate Cox regression analysis; young age, operator`s experience (Hospital 1 vs. 2), and presence of atypical AVNRT were the independent predictors of long-term recurrence. Major complications related to AVNRT ablation are not encountered frequently. Death, myocardial infarction and stroke were not seen in any of the patients, however, two patients developed deep vein thrombosis. Minor complications in RF ablation included asymptomatic minimal/mild pericardial effusion (n=5), femoral hematoma requiring no transfusion (n=5) and transient AV block (n=5). Atrio-ventricular block requiring permanent pacemaker implantation was found only in one patient (0.6%).

Conclusion: Radio-frequency catheter ablation in patients with AVNRT appears to be a safe and effective method. The presence of atypical AVNRT, young age and operator`s experience were observed to be the independent predictors of long-term recurrence.

Key words: Atrioventricular nodal reentrant tachycardia, radio-frequency ablation, recurrence, complication.

ÖZET

Amaç: Atriyoventriküler nodal re-entrant taşikardilerin (AVNRT) radyo-frekans (RF) ablasyon tedavisi ile ilgili olarak klinik deneyimimizi, gözlenen komplikasyonları ve uzun dönem sonuçları kapsamlı bir şekilde değerlendirmeyi amaçladık.

Gereç ve yöntem: Çalışmaya Hastane-1 (n=52) ve Hastane-2`de (n=114) olmak üzere toplam 166 AVNRT hastası alınmıştır. Bu hastalara temel elektrofizyolojiden sonra RF ablasyon tedavisi uygulanmıştır. işlem esnasında gözlenen komplikasyonlar ve uzun dönem takipte gelişen tekrarlamalar kaydedilmiştir.

Bulgular: Çalışmaya alınan hastaların >%90 da semptomlar bir yıldan fazla devam etmekteydi ve en az 2 atak yaşamaktaydı. Tüm grup için RF ablasyon başarı oranı %98,2 idi. Tüm popülasyon için rekürrens oranı % 3 (5 hasta) idi. AVNRT ablasyonu sonrası uzun dönem takipte rekürrens prediktorleri olarak yaş, operatör deneyimi (hastane 1 ve 2) ve atipik AVNRT varlığı olarak bulundu. AVNRT ablasyonu ile ilişkili majör komplikasyon oranı oldukça düşük olup sadece 2 hastada derin ven trombozu izlenirken, hiç bir hastada ölüm, miyokard enfarktüsü, inme veya kardiyak tamponad izlenmedi. Minor komplikasyonlardan asemptomatik minimal-hafif perikardiyal efüzyon 5 hastada, kasık yerinde transfüzyon gerektirmeyen hematom (5 hasta) ve geçici AV blok (5 hasta) olarak tespit edildi. Sadece 1 hastada (% 0. 6) kalıcı pil implantasyonu gerektiren AV blok izlendi.

Sonuç: AVNRT nin RF ablasyonu hem akut dönemde hemde uzun dönem takipte güvenli ve etkili bir yöntemdir. Atipik AVNRT varlığı, genç yaş ve operatör deneyimi uzun dönem rekürrens için esas belirleyicilerdir.

Anahtar kelimeler: Atriyoventriküler nodal re-entrant taşikardi, Radyofrekans ablasyon, rekürrens, komplikasyon

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INTRODUCTION

Atrioventricular nodal reentrant tachycardia (AVNRT) is the most common type of paroxysmal supraventricular tachycardia. Catheter ablation has become the first choice of curative treatment for symptomatic paroxysmal supraventricular arrhythmia.[1-3] Slow pathway ablation has high short-term and long-term success rates [3,4] with acceptable rates of complication.[5] The radio-frequency (RF) ablation technique has produced a high acute success rate in patients with AVNRT and the risk for complete AV block has been less than 1%. However, recurrences after slow pathway ablation have been reported to vary widely and determinants of AVNRT recurrence after radiofrequency are largely unknown.[3-5] In this two-center study, we aimed to evaluate our clinical experience about the catheter ablation of AVNRT cases including its complications and long-term outcomes.

MATERIALS AND METHODS

Study Population

This prospective and two-center study included 166 patients who were scheduled to receive RF ablation for AVNRT in two hospitals (Hospital-1, 52 patients; Hospital-2, 114 patients) in between January 2007 - January 2011. Electrophysiology study and ablation procedures were performed by two operators (IHT, SS). First operator was junior and had a 6-month basic electrophysiology training (Hospital-1), whereas the second operator was conversant with an experience of >50 cases/year (Hospital-2).

Prior to the ablation procedure, information concerning the clinical data, currently used drugs, atherosclerotic risk factors, presence of coronary artery disease, echocardiography before RF ablation, 12-channel ECGs, and/or ECGs showing tachycardia, were recorded. Following the ablation, 24-hour heart rhythm monitoring was provided, and echocardiography and 12-channel ECG were obtained again at 24 hours. Following RF ablation, the patients were called for follow-up visits at 1 week, 1 month, and 6 months after the procedure during which they received symptomatic evaluation and 12-channel ECG test along with a 24-hour Holter recording in some required cases.

Our study was approved by the local ethics committee.

Electrophysiology study

Electrophysiology study (EPS) was performed by using 3 catheters inserted via femoral vein: two quadripolar catheters into the right ventricle and the His bundle region, a decapolar catheter into the coronary sinus. The drugs used prior to the EPS were discontinued for at least 5 drug half-lives before the procedure. Following the basic electrophysiologic measurements (AH and HV intervals, PR intervals), AVNRT induction was attempted by the predetermined protocols.[6] In case of need, intravenous atropine was administered. A decline of 10 ms in extrastimulus or a jump of >50 ms in A2H2 interval, indicates dual atrioventricular (AV) nodal physiology.

Radio-frequency ablation procedure

Slow pathway ablation was performed with a 4 mm tip electrode ablation catheter in all the patients. RF ablation procedure was applied by using the previously described mapping and ablation techniques.[6] RF energy was delivered to elevate the heat up to 50°C - 65°C. By carefully examining the intracardiac electrogram and fluoroscopy recordings, RF energy was applied over the appropriate sites for 30s - 2 min. RF energy delivery was discontinued when the following conditions were observed: rapid junctional tachycardia (JT) (with cycle length under 350 ms), ventriculoatrial (VA) block or AV block, excessive impedance elevation, and absence of junctional rhythm within the first 10 seconds. RF ablation was carried out via femoral vein in an antegrade fashion through the posteroseptal region of the tricuspid annulus. The success of RF ablation was defined as detection of no more than a single echo beat and no inducible AVNRT during the electrophysiology studies performed 30 minutes after the RF ablation. In cases where there were more than one echo beats, the RF energy delivery was repeated.

Follow-up and complications

The patients were followed-up for a period of 6 to 40 months. During the follow-up, the patients with a symptomatic palpitation episode were evaluated for recurrence. An ECG record showing tachycardia or induction of AVNRT in the repeat EPS, was recognized as recurrence. Major complications were as follows: death, myocardial infarction (MI), stroke, severe valvular pathology, pulmonary embolism, deep vein thrombosis (DVT), cardiac tamponade,

and permanent heart block. Minor complications were pericardial effusion, temporary AV block, hematoma over the inguinal region, and AV fistula or pseudoaneurysm.

Statistical analysis

Continuous variables are expressed as mean (SD) or median (interquartile range) as which appropriate. The level of significance was 0.05. To compare parametric continuous variables, the Independent Student t test or the Mann-Whitney U test were used. For categorical variables, the chi-square test was used. Recurrence rate during the follow-ups after AVNRT ablation was carried out with Kaplan-Meier analysis, and the difference between groups with and without recurrence was analyzed by log-rank test. In order to determine the predictors of recurrence in univariate and multivariate analyses, Cox regression analysis was used after the verification of proportional hazards assumption (the variables with $p<0.20$ were included in the multivariate analysis). Statistical analyses were carried out by SPSS 15.0 (Statistical Package for Social Science - SPSS, Inc., Chicago, Illinois, USA) package program.

RESULTS

The study population consisted of 166 AVNRT patients (RF ablation was applied on 52 patients in Hospital-1 and 114 patients in Hospital-2). The basic clinical characteristics of the study population are shown in table 1. More than 90% of the patients had symptoms persisting for more than a year and more than 90% of those were suffering at least 2 episodes per month. Overall, 80% of the patients were on at least 1 antiarrhythmic agent. Among the antiarrhythmic agents, digoxin (n=11) and sotalol (n=3) were remarkable. One of our patients with history of paroxysmal atrial fibrillation attacks was on amiodarone.

The basic electrophysiologic characteristics of our study group are shown in Table 1. In basic EPS, 54.2% of the patients demonstrated a jump. Seven of those patients were diagnosed with atypical AVNRT. During the ablation, 98.8% of the patients exhibited JT, whereas 5.6% displayed VA block. There was no difference between the PR intervals before and after the ablation. Overall RF ablation success rate was 98.2% (Table 2).

Table 1. Basic clinical characteristics of the study group

Age (year, mean ± SD)	47±18
Gender (male %)	31.9
Diabetes mellitus (%)	10.8
Hypertension (%)	24.7
Smoking (%)	30.7
Duration of symptoms (year, median)	6
An ECG showing tachycardia (%)	89.1
Symptom frequency (number of episodes/month, median)	2
Used antiarrhythmic drugs (%)	80
Metoprolol	40
Atenolol	3
Carvedilol	2.5
Bisoprolol	1.8
Propranolol	7.2
Sotalol	1.8
Digoxin	7.2
Verapamil	10.8
Diltiazem	24.7
Amiodarone	0.6
Ejection fraction (%, mean ± SD)	63.2±6,3
Coronary artery disease (%)	4.2

SD, Standard deviation

Table 2. Basic electrophysiologic characteristics of the study group (n=166)

Basal PR interval (ms, mean ± SD)	155±33
Basal AH interval (ms, mean ± SD)	90.5±33
Basal HV interval (ms, mean ± SD)	43.4±6,3
Tachycardia cycle length (ms, mean±SD)	305±28
Jump presence before ablation (%)	54.2
Atypical AVNRT (%)	4.2
JT presence during ablation (%)	98.8
VA block during ablation (%)	5.4
RF duration (ms, mean ± SD)	123±53
Number of RF (median)	3
Fluoroscopy duration (min, mean ± SD)	52±17
PR duration after ablation (ms, mean±SD)	165±32
Jump after ablation (%)	11.4
Single echo beat after ablation (%)	10.2
Ablation success (%)	98.2

SD, Standard deviation; ms, millisecond; AVNRT, Atrioventricular nodal reentrant tachycardia; JT, Junctional tachycardia; VA, Ventriculoatrial; RF, radiofrequency

Table 3. The comparison of groups with and without recurrence

Variables	Recurrence (-) (n=161)	Recurrence (+) (n=5)	P value
Age (year, mean ± SD)	48±18	33±14	0.07
Gender (male, %)	31.1	60	0.17
Symptom duration (year, median)	6	6	-
Symptom frequency (number of episodes/month, median)	2	2	-
Hospital type (region, %)	30.4	60	0.15
Basal PR interval (ms, mean ± SD)	155±33	168±20	0.36
Basal AH interval (ms, mean ± SD)	90±33	101±39	0.47
Tachycardia cycle length (ms, mean ± SD)	305±28	292±28	0.32
jump during basal EPS (%)	54.7	60	0.51
Atypical AVNRT (%)	3.1	40	<0.001
RF duration (s, mean ± SD)	122±53	162±44	0.10
Number of RF (median)	4	3	0.78
Fluoroscopy duration (min, mean ± SD)	52±17	55±15	0.73
JT presence during ablation (%)	98.8	100	0.93
VA block during ablation (%)	5.6	0	0.66
Temporary AV block during ablation (%)	3.7	0	0.58
Jump after ablation (%)	11.8	0	0.41
Single echo beat after ablation (%)	10.6	0	0.44
PR duration after ablation (ms, mean ± SD)	166±32	142±27	0.09

SD, Standard deviation, ms, millisecond; EPS: Electrophysiology study; AVNRT, Atrioventricular nodal reentrant tachycardia; JT, Junctional tachycardia; RF, radiofrequency; AV, Atrioventricular; VA, Ventriculoatrial.

Table 4. Complication rates of the study group

Complication	Rate (n, %)
Death, myocardial infarction, stroke	0
Pulmonary embolism and/or DVT	2 (1.2%)
Cardiac tamponade	0
Pericardial effusion	5 (3%)
Hematoma	5 (3%)
Pseudoaneurysm/ Arteriovenous fistula	1 (0.6%)
Permanent AV block	1 (0.6%)
Temporary AV block	5 (3%)

DVT, Deep vein thrombosis; AV, Atrioventricular.

Overall recurrence rate was 3% (n=5) during the follow-up period varying between 6 to 40 months (mean 11 months). Two of the patients diagnosed with recurrence were subjected to repeat RF ablation, however, the remaining three rejected the procedure. The patients with recurrence were younger and had a higher atypical AVNRT rate, compared with the patients without recurrence (Table 3). As shown in Kaplan-Meier analysis, most of the recurrences were observed within the initial months. Three of the recurrences occurred during the first month, whereas the other 2 occurred within the first 3 months (recurrence at 11, 18, 23, 67 and 88 days, respectively). While there was no difference between the overall recurrence rates with regard to operator experience and young age, overall recurrence rates were found to be statistically significantly higher in cases with atypical AVNRT (Figure 1). In Cox regression model, univariate uncorrected hazard ratio (HR) was calculated and by using variables with a p value <0.20, multivariate HR and p value were calculated. Thus, predictors of recurrence during the long-term follow-up after AVNRT ablation were found to be young age (<30 years), operator experience and atypical AVNRT (Table 4).

Table 5. Univariate and multivariate Cox regression analysis in the estimation of long-term recurrence

Variable	Uncorrected HR (95% CI)	P value	Corrected HR (95% CI)	P value
Age	0.95 (0.90 - 1.00)	0.10	0.92 (0.86 - 0.99)	0.03
Gender	0.30 (0.05 - 1.84)	0.19	0.21 (0.02 - 2.00)	0.17
Hospital 1-2	3.3 (0.56 - 20.0)	0.18	20.9 (1.6 - 278)	0.02
Atypical AVNRT	15.4 (2.5 - 92.4)	0.003	17.2 (0.99 - 305)	0.05
RF duration	1.01 (0.99 - 1.04)	0.12	1.01 (0.98 - 1.03)	0.43
PR interval after ablation	0.97 (0.93 - 1.00)	0.11	0.98 (0.93 - 1.02)	0.36

HR, Hazards ratio; CI: Confidence interval; AVNRT, Atrioventricular nodal reentrant tachycardia; RF, radiofrequency

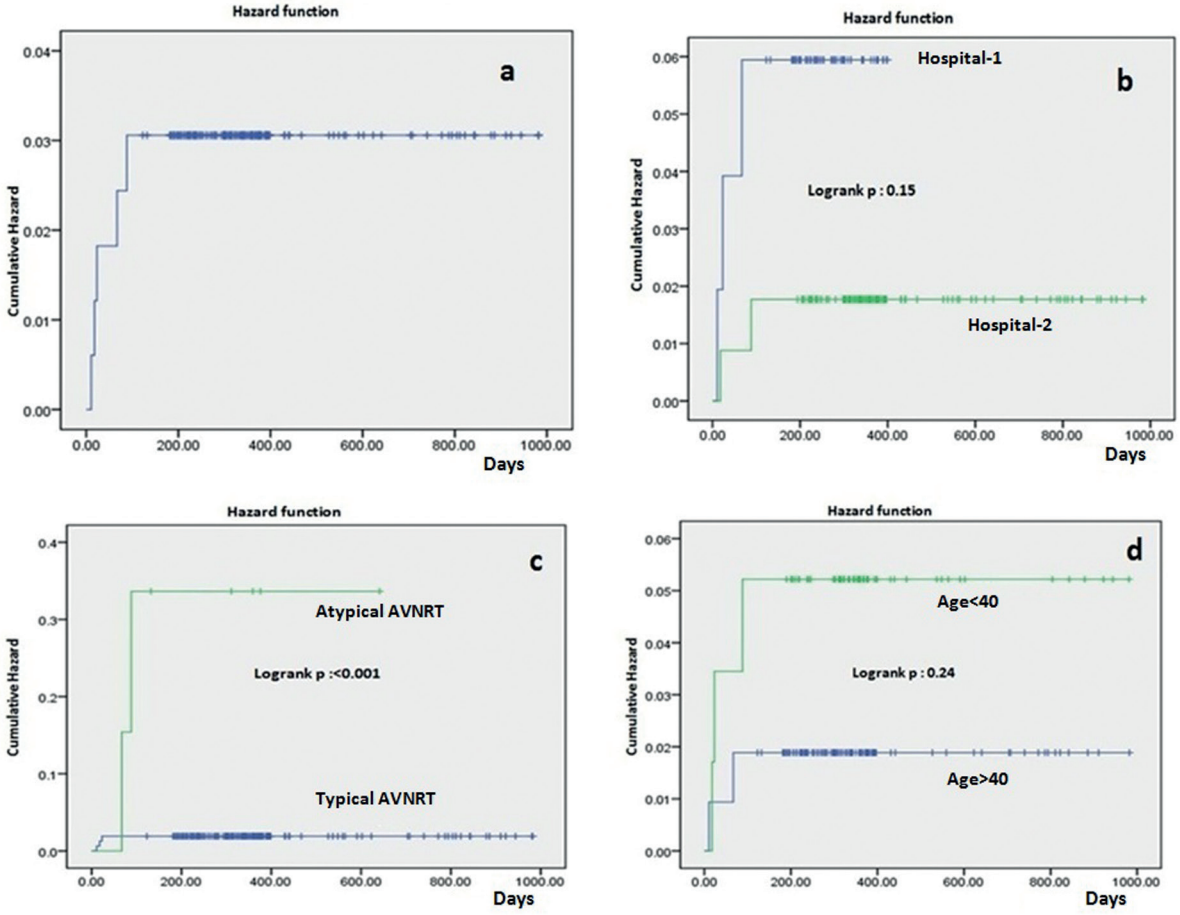

Figure 1. Results of Kaplan-Meier analysis

Major complication rate associated with AVNRT ablation was markedly low. Only 2 patients exhibited DVT (both were distal DVT cases). However, none of the patients demonstrated death, MI, stroke or cardiac tamponade. The most common minor complications detected by echocardiography were asymptomatic minimal/mild pericardial effusion (minimal in 3 patients and mild in 2 patients), hematoma over the inguinal region requiring no transfusion (n=5), and temporary AV block (n=5, lasting for 10 to 15 seconds). AV bock requiring pacemaker implantation was occurred only in one patient (0.6%).

DISCUSSION

The results of this study showed that AVNRT ablation is a safe and effective procedure with regard to both acute complications and long-term recurrence. RF ablation was successful in 98% of the patients without any major complication (death, MI, CEs or tamponed). However, AV block requiring permanent pacemaker implantation was determined in 0.6% of the patients. The recurrence rate throughout the long-term follow-up was 3%. Besides, young age, operator experience as well as presence of atypical AVNRT were found to be associated with long-term recurrence. Moreover, we observed application of drugs that have little or no efficacy in the medical treatment of supraventricular tachycardia.

RF ablation of the slow pathway has become the first choice of treatment in symptomatic AVNRT cases resistant to medical therapy.[7] It has a high procedural success rate (>97%) and low recurrence risk in long-term follow-up (0.7-5.2%).[8-11] In our study, the success and recurrence rates were consistent with those of the previous studies in the literature. The most dreaded complication of AVNRT is AV block. Many studies have reported permanent AV block rates less than 1%.[8,12,13] In our study, we found similar rates, as well (0.6%). During the RF ablation procedure, temporary AV blocks are frequently encountered (2-24%),[14,15] and although majority of them are of benign character, around 4-5% may result in late permanent AV block.[16] In the present study, 5 patients exhibited transient AV block (3%), however, none of the patients demonstrated a late permanent AV block throughout the follow-up period.

Recurrence rates during the follow-up period after AVNRT ablation are observed to be low (0.7-5.2%).[8-11] Moreover, most of the recurrence cases occur within the first days or months.[8,17] Similarly, in our study, recurrence was observed in 3% of the study group and all the recurrences were found to occur within the first 3 months. In some studies, residual slow pathway conduction or single echo beat following ablation procedure, have been shown to present a risk for long-term recurrence.[18-20] However, contrary to those studies, there are many other studies which show that single echo beat or residual slow pathway conduction do not present a risk for recurrence.[3,21,23,24] In our study, we determined that residual slow pathway conduction or single echo beat following ablation did not increase the risk of recurrence. In the current study, we determined young age, operator experience, and atypical AVNRT as the predictors of long-term recurrence. There are two principal reasons why young age can be a predictor of AVNRT recurrence:[1] Young patients have a smaller Koch triangle which limits the aggression of the operator.[25,2] As in the entire conduction system, dual nodal conduction is also degenerated with increasing age, therefore, damaging of the dual pathways by RF energy, limits the maturation of degenerative conduction pathways.[8,26] To our knowledge, ours is the first study which showed that atypical AVNRT might be a predictor of long-term recurrence. Estner et al. did not find a relationship between atypical AVNRT and recurrence,[8] however, Feldman et al. showed that atypical AVNRT reduced the success rate of acute procedure.[25] In another study which evaluated the long-term outcomes of 10 atypical AVNRT patients, one patient (10%) was found to show recurrence.[27] However, in this study, comparison with typical AVNRT was not performed.

In our study, 5 (3%) patients developed pericardial effusion. While 3 of them had minimal effusion, 2 had mild pericardial effusion. However, none of the patients demonstrated tamponade. Similar to our study, many studies in the literature have found the rate of pericardial effusion detectable only by echocardiography, showing no clinical significance as 1.5-4%. Current low rates of pericardial effusion do not support the routine application of echocardiography following ablation procedure.[28-30]

When the drugs used by the patients before presenting to our hospitals were reviewed, most of them were observed to be in agreement with the recommendations of American Heart Association 2003 Supraventricular Arrhythmia guideline. However, some patients were found use inappropriate agents such as digoxin (7.2%) and sotalol (1.8%). Those two agents have very limited efficacy in prophylactic therapy against AVNRT episodes. We believe that treatment provided by specialists other than cardiologists may be the reason behind inappropriate use of those agents.

In conclusion, catheter ablation of AVNRT is a safe and effective procedure, however, several factors such as young age, operator experience, and atypical AVNRT, may have an influence over long-

term arrhythmia recurrence. Increasing operator experience and advancing arrhythmia technologies may help overcome those limitations.

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