Which parameters describe the electrophysiological properties of successful slow pathway RF ablation in patients with common atrioventricular nodal reentrant tachycardia?

Hangi parametreler ortak antriyoventriküler nodal reenrant taşikardisi olan hastalarda başarılı yavaş yol RF ablasyon seyrinin elektrofizyolojik özelliklerini tanımlar?

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ABSTRACT

Objective: Atrioventricular nodal reentrant tachycardia (AVNRT) accounts for about 60% of the patients presenting with paroxysmal supraventricular tachycardia. The radiofrequency (RF) catheter ablation of the slow atrioventricular (AV) node pathway is the preferred therapeutic approach in patients with AV node reentrant tachycardia. The aim of our study was describe the electrophysiological properties of successful slow pathway RF ablation in patients with common atrioventricular nodal reentrant tachycardia.

Methods: The study design was a retrospective analysis involving fifty consecutive patients (18 males; mean age of 39±22 years) who underwent slow pathway ablation because of AVNRT.

Results: Slow junctional beats with a cycle length longer than 550 ms were observed in 39 patients (79%); the presence of rapid junctional beats with a cycle length less than 550 ms was showed in 5 patients (10%). Moreover, in 32 of 50 patients (65%) duration of atrial electrogram more than 40 ms was noticed. Analyzing data reported, we found the statistically significant presence of slow junctional beats ($p<0.001$) and atrial electrogram >40 ms ($p<0.05$) in successful RF ablation procedures.

Conclusion: In patients with AVNRT undergoing slow pathway ablation, the duration of atrial electrogram >40 ms and slow junctional beats with cycle length >550 ms during the application of RF energy describe the electrophysiological properties of successful slow pathway RF ablation.

(Anadolu Kardiyol Derg 2010; 10: 126-9)

Key words: Radiofrequency catheter ablation, atrioventricular nodal reentrant tachycardia, junctional ectopy, atrial electrogram, arrhythmia

ÖZET

Amaç: Antriyoventriküler nodal reenrant taşikardi (AVNRT) paroksizmal supraventriküler taşikardili hastaların yaklaşık %60'ında görülür. Antriyoventriküler (AV) reenrant taşikardili hastalarda AV düğümün yavaş-yol radyofrekans (RF) kateter ablasyonu tercih edilen terapötik bir yaklaşımdır. Bu çalışmanın amacı, ortak AV nodal reenrant taşikardisi olan hastalarda başarılı yavaş-yol RF ablasyonun elektrofizyolojik özelliklerini tanımlamaktı.

Yöntemler: Bu çalışmanın dizaynı, AVNRT dolayısı ile yavaş-yol ablasyonu yapılan 50 ardışık hastayı içeren (18 erkek; ortalama 39±22 yaş) retrospektif bir analiz olarak tasarlanmıştır.

Bulgular: Hastaların 39'unda (%79) 550 ms'den daha fazla siklus uzunluğu olan yavaş kavşak atımları gözlendi; siklus uzunluğu 550 ms'den daha az olan hızlı kavşak atımların varlığı 5 hastada (%10) görüldü. Bulguların analizinde, başarılı RF ablasyon işlemlerinde yavaş kavşak atımlarının varlığı ($p<0.001$) ve atriyal elektrogramın >40 ms olması istatistik açıdan önemli bulundu.

Sonuç: Yavaş-yol ablasyonu yapılan AVRNT'li hastalarda RF enerji uygulama sırasında atriyal elektrogram süresinin >40 ms ve siklus uzunluğu >50 ms olan yavaş kavşak atımları başarılı yavaş-yol RF ablasyonunun elektrofizyolojik özellikleri olarak tanımlandı.

(Anadolu Kardiyol Derg 2010; 10: 126-9)

Anahtar kelimeler: Radyofrekans ablasyonu, antriyoventriküler nodal reenrant taşikardi, kavşak atımı, atriyal elektrogram, aritmi

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Accepted/Kabul Tarihi: 25.01.2010

doi:10.5152/akd.2010.036

Introduction

Atrioventricular nodal reentrant tachycardia (AVNRT) accounts for about 60% of the patients presenting with paroxysmal supraventricular tachycardia (PSVT). It is the result of functional dissociation of atrioventricular (AV) nodal conduction into a so-called 'fast pathway' (FP) and 'slow pathway' (SP) (1). The fast pathway, connecting to the atrium in the anterior (superior) septum, forms the normal physiological conduction axis. Conduction over the slow pathway, connecting to the atrium in the posterior (inferior) septum, can be revealed when an atrial impulse is blocked in the fast pathway (which generally has a longer antegrade effective refractory period than the slow pathway) leading to a sudden prolongation of the AH interval. Therefore, the impulse reaches the ventricle through the slow way and runs through again, in retrograde direction, the rapid way, which in meanwhile, has recovered the excitability, creating the re-entry of the common junctional tachycardia (slow-fast).

The radiofrequency (RF) catheter ablation of the slow atrioventricular (AV) node pathway is the preferred therapeutic approach in patients with AV node reentrant tachycardia. The occurrence of junctional ectopy during perinodal RF energy delivery has been associated with the successful elimination of AVNRT (2). However, the electrophysiological features of different patterns of junctional rhythm (JR) and the importance of the multicomponent atrial electrogram are still unclear. The aim of our study is to describe the electrophysiological properties of successful slow pathway RF ablation in patients with common atrioventricular nodal reentrant tachycardia.

Methods

Study population

Fifty consecutive patients (18 males; mean age of 39±22 years) who underwent successful slow pathway ablation for AVNRT were enrolled in the present retrospective study, after having given written informed consent. All patients enrolled had no structural heart disease. All antiarrhythmic drugs were discontinued at least five elimination half-lives before RF ablation procedure.

Electrophysiological study

All patients underwent electrophysiological study in non-sedated, fasting state. The atrial programmed stimulation was performed to define the nodal antegrade function, while the ventricular incremental stimulation was performed to value the nodal retrograde conduction. The programmed atrial stimulation was performed with a decrement of the coupling interval of atrial extrastimulus of 10 ms with sensed cycle or with stimulated cycles, the length of which were 600, 500, and 430 ms, until the achievement of the atrial refractoriness. An increment of the interval A1-H1 more than 50 ms, as a response to the decrement of 10 ms of the coupling interval A-A1, defined a discontinuation of nodal function curve and underlined a double way of anterograde atrioventricular conduction. This coupling interval, coinciding with the rapid way's refractory period, often coincided with the induction of the tachycardia. Analogous protocol was subsequently repeated after every ablative procedure.

Mapping and ablation

The method used for mapping and ablation has been described previously (3). Briefly, the triangle of Koch, extending from the coronary sinus ostium up to the His bundle region, is divided into three regions designated posterior, mid and anterior. The ablation catheter was placed along the tricuspid septal annulus down to the posterior aspect of the interatrial septum adjacent to the coronary sinus ostium (posterior zone), obtaining a recorded atrial/ventricular electrogram amplitude ratio of 0.1 to 0.5 with a multicomponent or a putative slow-pathway potential (4, 5). Radiofrequency energy was applied for 15 seconds after a target site was identified. If AV nodal reentrant tachycardia could not be eliminated after delivery of radiofrequency energy to the optimal sites, areas with different electrogram characteristics were chosen for ablation. The electrode catheter used for ablation had a thermistor embedded in the deflectable 4-mm-tip electrode. Radiofrequency energy was delivered from a generator (EPT-1000, EP Technologies, Inc, Sunnyvale, CA, USA), which supplied continuous, unmodulated sine-wave output at 500 kHz. Power, impedance, and temperature were measured, displayed and stored during each application of radiofrequency energy via an interface with a microcomputer. The maximum preset temperature was 55°C with a fixed power of 30 W, in every patient. Radiofrequency energy was terminated immediately in the event of impedance rise, displacement of the catheter, an increase in PR interval, occurrence of AV conduction block, accelerated JR with cycle length shorter than 450 ms or JR without ventriculo-atrial conduction.

Electrophysiological parameters

During the delivery, we analyzed some important electrophysiological parameters:

1) Rapid junctional beats with a cycle length shorter than 550 ms;
2) Slow junctional beats with a cycle length longer than 550 ms;
3) Duration of atrial electrogram (ms).

Statistical analysis

Analyses were performed using the statistical package SPSS 11.0 software for Windows (Chicago, Illinois, USA). Statistical analysis was performed using unpaired Student's t-test for continuous variables. Data are presented as mean±SD. Differences were considered to be significant at a p-value <0.05.

Results

Slow junctional beats with a cycle length longer than 550 ms (782±127 ms) were observed in 39 patients (79%); the presence of rapid junctional beats with a cycle length less than 550 ms (340±95 ms) was showed in 5 patients (10%). Six patients received successful ablation without having a JR. Moreover, in 32 of 50 patients (65%) a duration of atrial electrogram more than

Anadolu Kardiyol Derg
2010; 10: 126-9

40 ms (67±5 ms) was noticed. This group also showed slow junctional beats with a cycle length longer than 550 ms. Analyzing data reported, we found the statistically significant presence of slow junctional beats ($p<0.001$) and the atrial electrogram >40 ms ($p<0.05$) in successful RF ablation procedures. There was no statistically significant presence of rapid junctional beats in successful RF ablation procedures. All results are shown in Table 1.

The population study was divided into two groups according to JR cycle length (Fig. 1) and atrial electrogram duration (Fig. 2). Junctional rhythm cycle length was significantly greater ($p<0.005$) in patients with rapid junctional beats as compared with patients with slow junctional beats. Atrial electrogram duration was significantly greater ($p<0.01$) in patients with atrial electrogram duration >40 ms as compared with patients with atrial electrogram duration <40 ms.

Discussion

Main findings

In this series of patients undergoing slow pathway ablation to eliminate AVNRT, a combined anatomic and electrogram mapping approach was used and a successful outcome was achieved in all patients. Slow junctional beats with a cycle length longer than 550 ms and atrial electrogram duration more than 40 ms were found to be parameters that describe the electrophysiological properties of successful slow pathway RF ablation.

Junctional beats

As reported in previous studies, junctional ectopy was found to be a sensitive, but non-specific marker of successful ablation (6). It appears in 75-92% of all AVNRT ablation attempts (5, 7). McGavigan et al. (8). demonstrated that successful ablation of slow pathway seldom occurs in the absence of JR. Although JR almost invariably occurs with successful ablation, its lack of specificity and low positive predictive value questions the use of it as an endpoint in AVNRT ablation.

In the study of Lipscomb et al (9), fast junctional tachycardia with cycle lengths less than 350 ms seen during slow pathway modification was a predictor of conduction block, suggesting proximity to the compact node. Lee et al. (10) showed that there were different characteristics of the JR during slow pathway ablation of different types of AVNRT. Jentzer et al. (11) demonstrated that the quantification of junctional ectopy that occurs during delivery of RF energy is unlikely to be clinically useful in predicting whether a particular application was effective in eliminating the inducibility of AVNRT. Wagshal et al. (12) in their study compared different patterns of accelerated JR. Higher ablation temperature resulted in the most successful slow pathway ablation and was characterized by the least duration and few accelerated junctional rhythm beats. Higher temperature lesions simultaneously abolished all slow pathway activity as well as the focus of accelerated slow pathway potential. They concluded that this accelerated JR was specific for the slow pathway and was not à non-specific regional effect. According to Iakobishvili et al. (13), the induction of a higher amount and longer duration of accelerated JR (with cycle length longer than 380 ms) results in more complete abolition of slow pathway conduction. In our study, the occurrence of slow junctional beats with a cycle length longer than 550 ms, during slow pathway RF ablation procedures was reported to be 79% and according to our experience, it could be considered a sensitive marker of successful slow pathway ablation in patients with common nodal reentrant tachycardia.

Table 1. Electrophysiological parameters in the population study

Parameters	Patients, n	Incidence, %	Mean±SD, ms	p*
Slow junctional beats with cycle length >550 ms	39	79	782±127	0.001
Rapid junctional beats with cycle length <550 ms	5	10	340±95	
Atrial electrogram duration >40 ms	32	65	67±5	0.05
Atrial electrogram duration <40 ms	18	35	31±8	
Data are presented as proportions/percentages and mean±SD *unpaired t test				

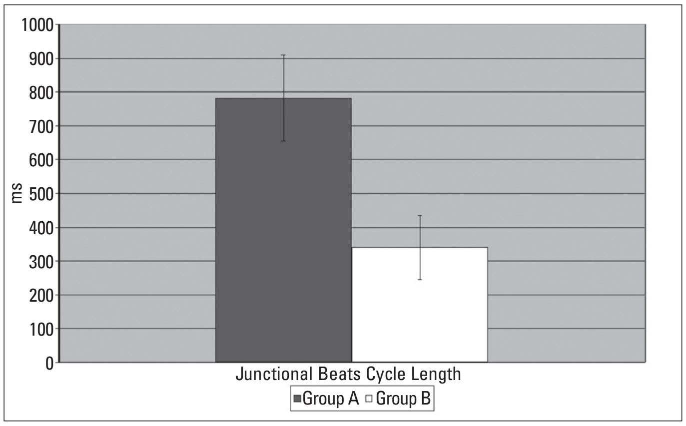

Figure 1. Junctional rhythm cycle length (Mean± SD) in the population study divided into two groups. Group A: rapid junctional beats (cycle length <550 ms); Group B: slow junctional beats (cycle length >550 ms), p<0.005

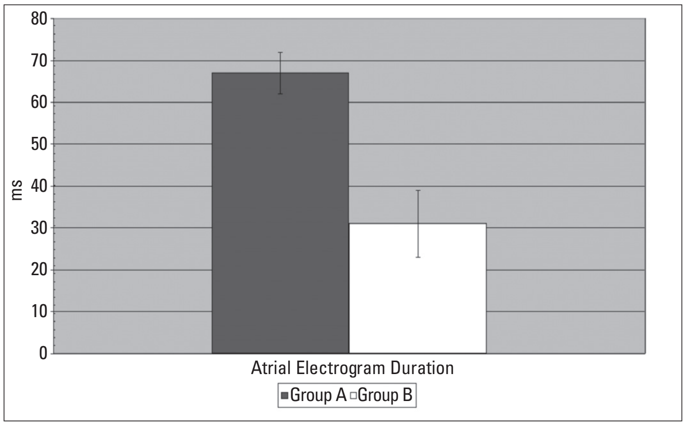

Figure 2. Atrial electrogram duration (Mean±SD) in the population study divided into two groups. Group A: atrial electrogram duration >40 ms; Group B: atrial electrogram duration <40 ms, p<0.01

Local atrial electrogram

Although Jackman et al. (4) found a discrete slow-pathway potential at nearly all successful ablation sites, there have been several conflicting reports discussing the different prevalence's and definitions of these potentials (14-16). Haissaguerre et al (5) reported that during ablation of the slow pathway with discrete slow potentials used as a guide, 78% of 64 patients developed junctional rhythms. Kelly et al (17) demonstrated several independent predictors of successful ablation, including the occurrence of JR (93%) during ablation and the presence of a discrete slow-pathway potential (81%) in the successful ablation site. In our study, the occurrence of atrial electrogram duration more than 40 ms was reported to be 65%. Our data suggest that multi-component atrial electrogram or slow-pathway potentials occur in the presence of slow JR.

Study limitations

This was a retrospective study and therefore we could not study several variables that would have further extended our understanding of the electrophysiological mechanisms in patients with or without JRs during slow-pathway ablation. The small number of patients could decrease the statistical power of our findings. No evaluation of the number of cumulative junctional beats was performed.

Conclusion

According to our findings, the duration of atrial electrogram more than 40 ms, recorded by the ablator catheter previously the ablation and the presence, during the delivery of slow junctional beats with a cycle length longer than 550 ms are parameters that describe the electrophysiological properties of successful slow pathway RF ablation. When a combined anatomic and electrogram approach to slow pathway ablation is used, an application of RF energy that is not accompanied by junctional ectopy is highly unlikely to have been successful in eliminating the inducibility of AVNRT. These data underline the necessity to dedicate more time for the "mapping" of the slow pathway, searching the multicomponent atrial electrogram or slow-pathway potentials. The efficiency of the procedure can be improved by performing short RF delivery-tests for the evaluation of the slow junctional beats presence, to confirm the right position of the ablation catheter on slow pathway. These delivery tests may render the slow pathway radiofrequency ablation more rapid, safe and with a smaller risk of relapse.

Conflict of interest: None declared

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