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Value of the adenosine test for diagnosis of dual AV nodal physiology in patients with AV nodal reentrant tachycardia

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Abstract: Objectives: This study was aimed at assessing the value of the adenosine test for noninvasive diagnosis of dual AV nodal physiology (DAVNP) in patients with AV nodal reentrant tachycardia (AVNRT). Methods: 53 patients with paroxysmal supraventricular tachycardia (PSVT) were given incremental doses of adenosine intravenously during sinus rhythm before electrophysiological study. The adenosine test was repeated on a subset of 18 patients with AVNRT after radiofrequency catheter ablation. Results: Sudden increments of PR interval of more than 60 msec between two consecutive beats were observed in 26(83.9%) of 31 patients with typical AVNRT and 2 (9.1%) of 22 patients with AVRT and AT ($P<0.01$). The maximal PR increment between 2 consecutive beats in the AVNRT group(105 ± 45ms) was significantly greater than that in the AVRT and AT group (20 ± 13ms) ($P<0.01$). In postablation adenosine test, DAVNP was eliminated in all 8 patients who underwent slow pathway abolition that EPS showed the slow pathway disappeared and 4 of 10 patients who underwent slow pathway modification that EPS showed the slow pathway persisted. Six of 10 patients who exhibited persistent duality showed a marked reduction in the number of beats conducted in the slow pathway after adenosine injection ($P<0.01$). Conclusions: Administration of adenosine during sinus rhythm may be a useful bedside test for diagnosis of DAVNP in high percentage of patients with typical AVNRT and additionally for evaluating the effects of radiofrequency ablation.

Key words: Adenosine, Dual AV nodal, Electrophysiology, Tachycardia, AV nodal reentrant
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INTRODUCTION

Atrioventricular nodal reentrant tachycardia (AVNRT) represents the most commonly encountered type of regular paroxysmal supraventricular tachycardia. The electrophysiological basis of AV nodal reentry is dual AV nodal physiology(DAVNP)(Zipes et al., 1990); the diagnosis of which is usually established by transesophageal or intracardiac electrophysiological study. The limitation of these tests is their invasiveness or discomfort. The electrophysiological effects of adenosine on AVNRT had been studied previously(Belhassen et al., 1983). Adenosine terminates the typical slow-fast form of AVNRT mainly due to anterograde block in the slow AV nodal pathway, with no or minimal effect on the fast retrograde nodal pathway (Sethi et al., 1994; Curtis et al., 1997). Less is known, however, about the effects of the administration of adenosine during sinus rhythm in patients with AVNRT. Because the refractory period of the anterograde fast pathway is usually longer than that of the anterograde slow pathway, we speculated that the responses to adenosine during sinus rhythm would differ between these two pathways. Thus, we evaluated the effects of adenosine administration during sinus rhythm in patients with typical AVNRT and investigated whether it was valuable in the noninvasive diagnosis of dual AV nodal physiology.

PATIENTS AND METHODS

Patient

This study population consisted of 53 patients with spontaneous and inducible paroxysmal

supraventricular tachycardia (PSVT). All of these patients had no evidence of organic heart disease, except one had primary hypertension, The study population consisted of 29 males and 24 females, age 39 ± 14 years. All patients had not undergone antiarrhythmic drug therapy. None of the patients had a history of asthma, AV block, sick sinus syndrome and apparent accessory pathway.

Adenosine test

PR intervals were evaluated during sinus rhythm by continuous surface electrocardiogram monitor. Adenosine (Adenocor, Sanofi Winthrop) was injected through the left antecubital vein as a rapid bolus followed by a 20-ml flush of normal saline. The initial dose of adenosine was 3 mg. Repeated doses (with 3mg increments) were given at 1- to 2-minute intervals until one of the following prospectively defined end points was observed: (1) a sudden increment of the PR interval of more than 60 msec between two consecutive beats ; (2) an AV nodal echo beat or (3) AVNRT developed; (4) second- or third-degree AV block. The adenosine test was repeated in a subset of the last 18 patients who underwent radiofrequency ablation of the slow pathway(Wu et al., 1993). Whenever isoproterenol administration was used during the procedure, the adenosine test was performed after discontinuation of isoproterenol infusion and return of the sinus rate to baseline.

Electrophysiological study

After informed consent was obtained , the electrophysiological study(EPS) was performed with the use of standard techniques. Two 6F quadripolar electrode catheters were introduced percutaneously through the right femoral vein and advanced to the right ventricular apex and the His bundle position, respectively. A 6F decapolar electrode catheter was placed into the coronary sinus, usually after the catheterizing left subclavian vein. The study included the following: (1) delivery of 1 extrastimuli during sinus rhythm from the right high atrium until the atrial or AV nodal refractory period was reached; (2) incremental right high atrium pacing up to the AV nodal block cycle length; and (3) incremental rapid ventricular apical pacing up. If sustained tachycardia was not induced by use of this protocol, isoproterenol was administered at incremental dosage until the basic sinus rhythm increased by 20%, and the stimulation protocol was repeated.

Statistical analysis

Statistical comparison was performed by use of t or X^2 test. Data were expressed as mean ± SD. A value of $P<0.05$ was considered statistically significant.

RESULTS

None developed severe side effects. Few experienced transient chest tightness, palpitation, flushing, dizziness, cough and tolerable dyspnea.

By intracardiac electrophysiological study, among these 53 patients, Thirty-one had slow-fast type of AVNRT (AVNRT group), twenty had atrioventricular reentrary tachycardia, and two had atrial tachycardia (AVRT and AT group). Twenty-seven(87.1%) of 31 in the AVNRT group had discontinuous AV node function curves. But the last 4 patients had smooth AV node function curves. Three of 4 patients with smooth AV node function curves had observable sudden increment in PR interval.

A sudden and transient increment in PR interval (60 ms) after adenosine injection during sinus rhythm was observed in 26 (83.9%) of the 31 patients in the AVNRT group (Fig. 1) but in only 2 (9.1%) of the 22 AVRT and AT group ($P<0.01$) (Fig. 2). The maximal PR increment between 2 consecutive beats was significantly greater in the AVNRT group(105 ± 45ms) than in the AVRT and AT group (20 ± 13ms) ($P<0.01$) . AV nodal echoes after adenosine injection were observed in 5 of 26 patients respectively. Twenty of 22 developed ≥ second-degree AV block without ECG signs of DAVNP. No episodes of sustained PSVT and atrial fibrillation was provoked. The sensitivity and specificity of adenosine test to diagnosis of DAVNP in patients with typical AV nodal reentrant tachycardia were 83.9% and 90.9% . The adenosine doses required to reach 1 of the end points were lower in the AVNRT group(7.5 ± 3.7 mg) than in the AVRT and AT group (11.5 ± 5.7 mg) ($P<0.05$). There were 2(7.7%), 10 (38.5%), 12 (46.2%), 2(7.7%) patients who revealed signs suggestive

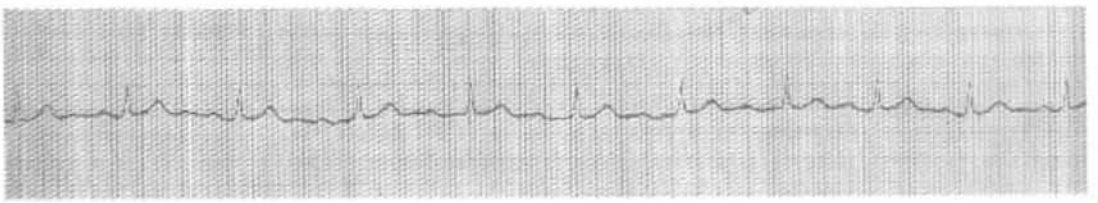

Fig. 1 Effects of adenosine (9 mg) on AV conduction in a patient with AV nodal reentrant tachycardia. The dual AV node physiology was present during the test. PR interval increased by 70 msec on the fourth beat

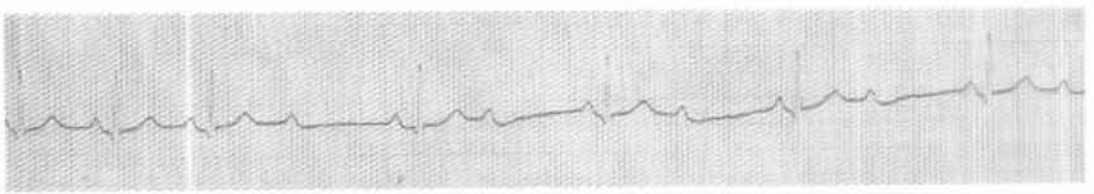

Fig. 2 Lack of dual AV node physiology after administration of 9 mg ATP in a patient with AVRT

of DAVNP at the dosage of 3 mg, 6 mg, 9 mg, 12 mg respectively.

The last 18 of 31 patients in the AVNRT group, who had signs of DAVNP according to the baseline adenosine test, underwent a postablation adenosine test after ablation. EPS showed the slow pathway disappeared in 8 patients but persisted in 10 patients. Signs of DAVNP by adenosine test disappeared in all 8 patients and were replaced by transient episodes of $\geqslant$second-degree AV block. Of the 10 patients who had persistent slow pathway by EPS, 4(40%) developed $\geqslant$second-degree AV block while 6 (60%) had ECG signs of DAVNP. During the postablation adenosine test, the number of beats conducted in the slow pathway was significantly reduced after slow pathway ablation (from 4~8 to 1~3 beats)(6.17 ± 1.48, 1.83 ± 0.75, $P < 0.01$) which reflects a severe impairment of slow pathway conduction.

DISCUSSION

Dual AV node pathways are considered as the substrate for AV nodal reentry which assumes that the AV node is longitudinally dissociated into two functionally different pathways: (1) a beta pathway which exhibits rapid conduction and a long refractory period(fast pathway), and (2) an alpha pathway which has a short refractory period but conducts slowly(slow pathway). During sinus rhythm the atrial impulse propagates in the beta pathways to produce a single QRS complex with a normal PR interval. The impulse which simultaneously conducts down the slow pathway reaches the His bundle after it has depolarized and is therefore refractory. Atrial extrastimulus is blocked in the beta pathway because of its longer refractory period and is conducted slowly through the alpha pathway when the sudden prolongation of the PR interval occurres. In this study, when the impulse was blocked by adenosine and conducted down the slow pathway, there would be sudden prolongation of PR interval. These similar to ECG changes suggest that during sinus rhythm the fast pathway is more sensitive to adenosine than the slow pathway. If conduction down the slow pathway is slow enough to allow the previously refractory fast pathway to recover excitability, a single atrial echo or sustained tachycardia ensues.

In this study, we chose a noninvasive diagnostic test that uses administration of adenosine to identify patients with dual AV nodal pathways. Administration of adenosine during sinus rhythm revealed signs suggestive of dual AV node physiology in a high percentage (83.9%) of patients with inducible sustained AVNRT but in only 9.1% of the AVRT and AT group. Moreover, intravenous administration of adenosine is safe and free of severe side effects. These results suggest that the adenosine test may be a

useful bedside test for identifying patients prone to AVNRT. Commonly the required dosage of adenosine is 6 or 9 mg.

About 85% of patients with typical slow-fast form of AVNRT exhibited sudden prolongation of PR interval during incremental pacing or extrastimulation from the right atrium (Josephson, 1993). But some patients with typical AVNRT showed continuity of the AV nodal curves during atrial extrastimulation (Sheahan et al., 1996; Tai et al., 1997). In our study, adenosine test disclosed DAVNP in 3 of 4 patients who had no evidence of DAVNP during single atrial extrastimulation which strongly suggested that two distinct components, representing both fast and slow pathways, are present in patients with AVNRT, irrespective of the existence of discontinuity of the AV nodal curves during atrial extrastimulation. This observation is consistent with the report of Sheahan et al on the electrophysiological effects of radiofrequency ablation of the slow pathway in patients without discontinuous curves of AV nodal conduction who nevertheless have AVNRT (Sheahan et al., 1996). They concluded that the apparently "smooth" AV node refractory curve consists of two distinct components representing both fast and slow AV node pathways, even when the typical discontinuity is absent.

The aim of successful radiofrequency ablation of the slow pathway is either total elimination of anterograde conduction in the slow pathway or "modification". The later term is used to denote the fact that despite the persistence of anterograde slow pathway conduction, no more than a single AV nodal echo beat can be induced, even after isoproterenol administration. In the present study, the results of the ablation procedure correlated with the results of the postablation adenosine test, so it may be used as a follow-up parameter after slow pathway ablation in AVNRT. Recently, Dierkes S et al reported 4 patients after slow pathway radiofrequency abalation who had persistent signs of DAVNP according to adenosine test. Three of these 4 patients had a relapse of AVNRT during a follow-up of 3 months (Dierkes et al., 2001). But the value of the adenosine test to predict unsuccessful ablation needs further investigation.

Patients who complain of palpitation after radiofrequency ablation of the slow pathway (Mann et al., 2001) also may benefit from the adenosine test. In such patients, the adenosine test during follow-up would be useful to assess the possibility of recurrent AVNRT and to select patients who will need repeat EP evaluation.

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