

Simultaneous conduction over the fast and slow pathways during induction of atrioventricular nodal reentrant arrhythmia with a rate of less than 100 bpm and infra-His block after radiofrequency ablation of the slow pathway

Hızı 100 atım/dakikanın altında olan atriyoventriküler nodal reentran aritmi oluşturulması sırasında aynı anda hızlı ve yavaş yol iletimi ve yavaş yolun radyofrekans ablasyonu sonrasında infra-His bloku

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Summary – Atrioventricular nodal reentrant tachycardia (AVNRT) is the most common form of paroxysmal regular supraventricular tachycardia in adults. It is typically induced with an anterograde block over the fast pathway (FP) and conduction over the slow pathway (SP), with subsequent retrograde conduction over the FP. Rarely, a simultaneous conduction of a premature atrial complex occurs over the FP and SP to induce AVNRT and is called “one for two phenomenon”. We present a 46-year-old woman with atrioventricular nodal rhythm with a rate of 95 beats per minute with distinct electrophysiological characteristics showing simultaneous conduction over the FP and SP during induction of tachycardia and an infra-His block after radiofrequency ablation of the SP.

Atrioventricular nodal reentrant tachycardia is the most common form of paroxysmal regular supraventricular tachycardia in adults, accounting for 60% of these tachycardias.^[1] It is typically induced with an anterograde block over the fast pathway and conduction over the slow pathway, with subsequent retrograde conduction over the FP. Rarely, a simultaneous conduction of a premature atrial complex is seen over the FP and SP to induce AVNRT. This phenomenon was first reported by Wu et al. in 1975.^[2] Over the years, a few cases of simultaneous dual AV nodal conduction have been reported during induction of AVNRT, which was eliminated by SP radiofrequency energy abla-

Özet – Atriyoventriküler nodal reentran taşikardi (AVNRT), yetişkinlerde düzenli paroksizmal supraventriküler taşikardiler içinde en sık gözlenendir. Tipik olarak hızlı yolda anterograd blok gelişmesi, uyarının yavaş yol ile iletilmesi ve takiben hızlı yolda retrograd iletimin gerçekleşmesi ile oluşmaktadır. Nadiren, AVNRT oluşumu sırasında atriyal erken vuru eşzamanlı olarak hem hızlı hem de yavaş yoldan iletilmektedir. Bu elektrofizyolojik bulgu “ikisi için bir fenomeni” diye tanımlanmaktadır. Bu yazıda, hızı dakikada 95 vuru olan atriyoventriküler nodal reentran ritim görülen 46 yaşında bir kadın hastada programlı atriyal erken vuru sırasında ortaya çıkan “ikisi için bir fenomeni” ve yavaş yolun radyofrekans ablasyonu sonrasında gelişen infra-His bloku gibi nadir gözlenen elektrofizyolojik özellikler sunuldu.

tion.^[2,3] We present a case of atrioventricular nodal arrhythmia with a rate of 95 beats per minute displaying the unique electrophysiological characteristic of simultaneous conduction over the FP and SP during induction of AVNRT, namely “one for two phenomenon”, and infra-His block after SP ablation.

Abbreviations:

AH	Atrial to His
AV	Atrioventricular
AVNRT	Atrioventricular nodal reentrant tachycardia
bpm	Beats per minute
EPS	Electrophysiological study
ERP	Effective refractory period
FP	Fast pathway
HV	His to ventricle
SDNC	Simultaneous dual AV nodal conduction
SP	Slow pathway

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CASE REPORT

A 46-year-old woman without structural heart disease was admitted to our clinic for drug-resistant recurrent paroxysmal tachycardia including beta-blockers and calcium channel blockers. Physical examination, resting electrocardiography, chest X-ray, and echocardiography were all normal. Laboratory tests including thyroid function tests were also within normal limits. Holter monitoring and exercise testing did not show any arrhythmias.

An electrophysiological study was planned because of the ongoing symptoms of palpitation, after discontinuation of all antiarrhythmic drugs at least before five half-lives. After written informed consent was obtained from the patient, the EPS was performed in a fasting state without sedation. Three quadripolar, closely spaced (interelectrode space 2 mm) electrode catheters were introduced from the right and left femoral veins, and two were placed in the high right atrium and His bundle area, respectively, and the third one, a 4-mm tip 7 F deflectable catheter (Marinr MC, Medtronic, MN, USA) was used for mapping and radiofrequency delivery.

In the ESP, the basic rhythm was sinus rhythm with an atrial to His interval of 90 msec and His to ventricle interval of 42 msec. The HV interval was constant during programmed atrial stimulation. Programmed single atrial stimulation (500-340 msec) revealed SDNC followed by reproducible induction of a narrow complex arrhythmia with a cycle length of 630 msec, accounting for the rate of 95 bpm (Fig. 1a). The HV interval of the arrhythmia was constant at 42 msec and the earliest atrial activation was recorded at the His bundle site. During tachycardia, the VA interval was 84 msec at the high right atrial catheter and was constant in all cycles. The A2-H2 interval was 196 msec, and the A2-H3 interval was 651 msec. A standard study of AV nodal function with premature atrial extrastimuli could not be performed because of disturbing double responses followed by the narrow complex arrhythmia.

After confirming the rhythm as AV nodal reentrant arrhythmia, radiofrequency catheter ablation of the SP in the common posteroseptal location was accomplished. Ablation was performed under 50 watts of energy with a temperature limit of 70°C for 90 seconds. Runs of junctional beats were observed during radiofrequency energy delivery and the tachycardia could no longer be induced with standard pacing maneuvers.

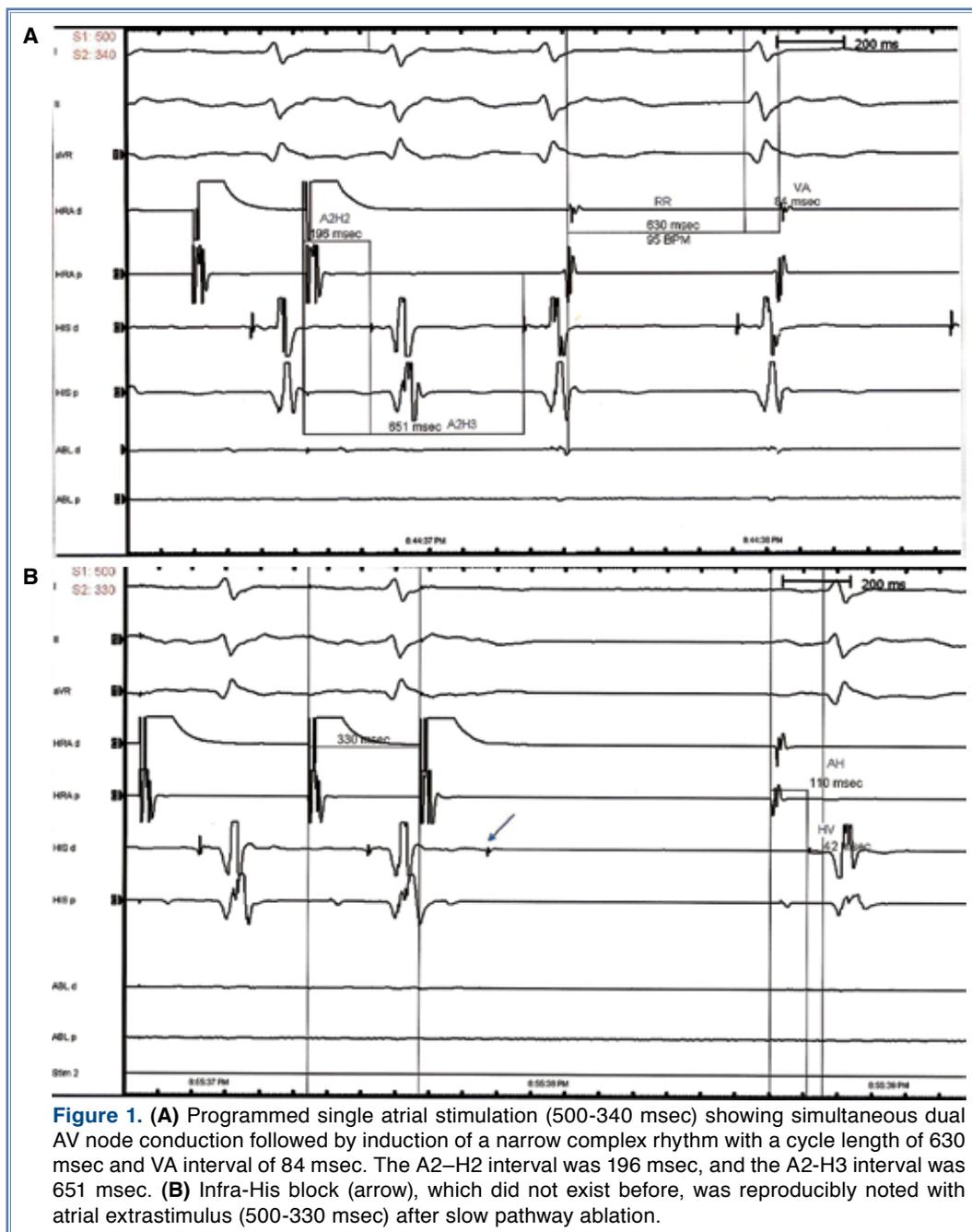
However, an infra-His block, which was not present before SP ablation, was reproducibly noted with atrial extrastimulus (500-330 msec) after SP ablation (Fig. 1b). The Wenckebach cycle length was 370 msec and AH and HV intervals were within normal limits after the ablation procedure. The patient remained asymptomatic without any antiarrhythmic therapy during six months of follow-up.

DISCUSSION

In this report, we present a patient with AVNRT with a rate of 95 bpm, in whom the rhythm turned out to be AV nodal arrhythmia during the ESP, accompanied by the “one for two phenomenon” during tachycardia induction and an infra-His block during programmed atrial stimulation after SP ablation. To our best knowledge, although occasionally seen separately in AVNRT, such a combination has not been reported before.

In cases with narrow complex tachycardias with short RP interval, the differential diagnosis would include AVNRT, orthodromic AVRT, and atrial and junctional tachycardias. In the case of atrial tachycardia, a relatively fixed AA interval with alternating longer and shorter AV and VA intervals would be expected. However, in the present case, the VA and AV intervals were fixed in all cycles. Premature ventricular extrastimuli delivered during His bundle refractoriness failed to preexcite the atrium and terminate the tachycardia, thus not favoring reentrant tachycardias through a concealed accessory pathway. The reproducible initiation of tachycardia with atrial pacing showing the one for two phenomenon, as well as the pacing maneuvers performed made it less likely that these arrhythmias represented junctional automatic rhythms, which can rarely be seen in adults.

Tachycardia, by definition, refers to rates above 100 bpm. Rarely, a reentrant arrhythmia with a rate below 100 bpm (cycle length >600 msec) may be encountered. Vijayaraman et al.^[4] reported six patients with sustained slow supraventricular arrhythmias at rates <100 bpm. All patients were diagnosed with an atrioventricular nodal rhythm with a mean cycle length of 668±74 msec and both antegrade and retrograde slow conductions were responsible for slow supraventricular arrhythmias. The AH and His to atrial intervals during the atrioventricular nodal reentrant rhythm were 434±50 and 234±81 msec, respectively. However, in our case, very slow antegrade conduction of the



SP was responsible for the slow rate of the arrhythmia, as the retrograde FP conduction velocity was within normal limits.

It can be questioned how a patient may become symptomatic with a heart rate of 95 bpm. As the atria and ventricles contract almost simultaneously during AVNRT, the intraatrial pressure rises and causes the sign known as the “frog sign”. On the other hand, sudden increases in the heart rate during rest, even at 95 bpm, can cause symptoms in a patient of this age.

Atrioventricular nodal reentrant tachycardia is typically induced with an antegrade block over the FP and conduction over the SP, with subsequent retrograde conduction over the FP. Rarely, a simultaneous conduction of a premature atrial complex is seen over the FP and SP to induce AVNRT. This phenomenon was first reported by Wu et al. in 1975 and can be seen in about 1% of patients with AVNRT.^[2,3] This type of nodal reentry implies two important electrophysiological features. The first is that a retrograde

block is present on the SP impeding its activation by the impulse coming down from the FP. The second is that the critical slowing of conduction in the SP allows the recovery of excitability of the FP retrogradely and thus initiates nodal reentrant arrhythmia. To date, a few case reports have been published showing the one for two phenomenon both occurring during atrial premature complex.^[2,3] In some cases, simultaneous FP and SP conduction to the ventricles can be seen during sinus rhythm which result in a tachycardia with a ventricular rate twice the atrial rate, often called “paroxysmal non-reentrant supraventricular tachycardia”.^[5-7] This situation can cause an irregular heart rhythm leading to an erroneous diagnosis of atrial fibrillation, although the patient is in sinus rhythm.^[8]

After the SP ablation, the tachycardia could no longer be induced with programmed single atrial stimulation, contrary to the situation before ablation. After the ablation procedure, there was no sign of SDNC and the A2-H2 interval (Fig. 1b) was nearly the same as the A2-H2 interval associated with SDNC during tachycardia induction before ablation (Fig. 1a), indicating that the “very SP” involved in the tachycardia circuit was successfully eliminated and still the same FP was involved in the anterograde AV nodal conduction. Since an A2-H2 interval of up to 200 or 220 msec is assumed to indicate conduction over the FP,^[9] the A2-H2 interval of 196 msec in our case was considered to be of FP origin. After the ablation, programmed single atrial extrastimulation at 500/330 msec reproducibly revealed an infra-His block without initiation of any arrhythmia. Normally, postablation atrial extrastimulation is expected to cause a supra-His block as determined by the effective refractory period of the FP or residual SP. The FP effective refractory period which was 500/280 msec after ablation could not be identified before ablation because the atrial extrastimulus of 500/340 msec constantly induced SDNC and AVNRT. However, after elimination of the very SP involved in the tachycardia circuit, even with shorter extrastimuli, the infra-His block could be displayed. The ERP of the FP is known to be shortened after SP ablation due to the loss of the direct effect of SP conduction on FP function.^[10] Even in this situation, the ERP of the FP is expected to be longer than that of the distal His bundle. In our case, however, after SP ablation, the ERP of the His-Purkinje system was unusually longer than that of the FP, resulting in an infra-His block during programmed atrial extrastimulation. This unusual finding of the His-Purkinje system ERP could not be elicited before ablation. However, this unique feature of the His-Purkinje system was not linked to SDNC.

In our case, ablation damage is another plausible cause for the infra-His block observed during atrial extrastimulation after SP ablation. However, the operators did not encounter any sign of AV or VA block during or after the procedure. If AV block had been present, it would have been noticed during the sinus rhythm, as well. Moreover, as the site of energy delivery was in the region of the compact AV node or proximal His bundle, an inadvertent block would have been expected to occur proximal to the His bundle.

In conclusion, AVNRT, the most frequent narrow-complex tachycardia with regular RR intervals in adults, can rarely present with an unusual rate of less than 100 bpm and with the unique electrophysiological feature of so-called one for two phenomenon. Our case differs with an infra-His block that could be observed only after SP ablation, which was assumed to be coincidental. As the presence of SDNC during induction of AVNRT does not require a modification in the ablation strategy, a standard approach targeting the SP resulted in complete abolishment of the arrhythmia.

Conflict-of-interest issues regarding the authorship or article: None declared

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Key words: Bundle of His; catheter ablation; electrocardiography; electrophysiologic techniques, cardiac; heart conduction system; tachycardia, atrioventricular nodal reentry.

Anahtar sözcükler: His demeti; kateter ablasyonu; elektrokardiyografi; elektrofizyolojik teknik, kardiyak; kalp iletim sistemi; taşikardi, atriyoventriküler nodal yeniden girişi.