

## Sinoatrial Reentrant Tachycardia in a Yorkshire Cross Dog

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**Abstract :** An 8-year-old intact male Yorkshire cross dog (7.5 kg of body weight) was referred with the primary complaint of exercise intolerance and occasional syncope. Initial cardiological examination could not identify any abnormalities except mild mitral regurgitation. Exercise stress test revealed chronotropic incompetence. Furthermore the 1 hr-digital event recording found the sudden onset of paroxysmal sinus tachycardias (156-172 bpm) lasting few minutes and stopping abruptly. In addition, the tachycardia terminated by vagal maneuver and verapamil administration. Based on this finding, the case was diagnosed as sinoatrial reentrant tachycardia (SART). The dog was treated with diltiazem and enalapril. Although the dog still has exercise intolerance, no syncope has been observed after medication.

**Key words :** SND, sinoatrial reentrant tachycardia, SART, dog, sinus node dysfunction.

### Introduction

Sinoatrial reentrant tachycardia (SART) is a type of sinus node dysfunction characterized by a paroxysmal supraventricular tachycardia initiated by circus rhythm (later called reentry) inside or near the sinus node region (1,3,4,10,15,16).

Although it often caused to paroxysmal palpitations, dyspnea, dizziness, (near-) syncope, chest discomfort and other symptoms in humans (15,16), it has been rarely reported in dogs (11). The prevalence of SART has rarely been studied in small animals and even in humans, although it might be very low compared to other tachyarrhythmias such as atrial fibrillation (15,16). Even though clinical features of SART is similar to supraventricular tachycardias (e.g. atrial fibrillation, reentrant supraventricular tachycardia), there are some differences between these two types of tachyarrhythmias (9,15). Unlike supraventricular tachycardias, electrocardiographic features of SART are (i) abrupt onset and termination of tachycardias; (ii) similar p-wave morphology compared to regular sinus beat; (iii) initiation and termination of tachycardias by properly timed atrial premature depolarization introduced within a relatively narrow range of coupling intervals; and (iv) termination by vagal maneuvers or administration of adenosine or verapamil.

The aims of this case study are to provide clinical and diagnostic features of SART in a dog and to enrich our resources for rare cardiac conduction defects.

### Case

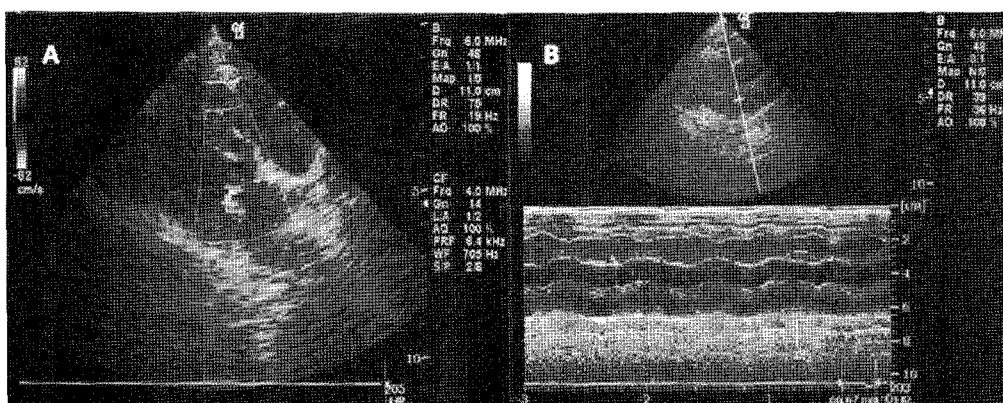
An 8-year-old intact male Yorkshire cross dog (7.5 kg of

body weight) was referred at Veterinary Teaching Hospital of Kangwon National University with the primary complaint of exercise intolerance and occasional syncope. The dog had several cardiac and neurological treatments for several years due to unknown syncopal episodes before the presentation. The dog was clinically normal at the first presentation, except mild regurgitation murmur at the left apex (grade II/VI systolic murmur). Complete blood cell count (CBC) and serum chemistry profiles have no significant abnormalities. His systolic blood pressure was 130 mmHg (Doppler method). On the day of presentation, electrocardiographic (ECG) studies revealed normal sinus rhythm (86 bpm). Surprisingly, his heart rate and blood pressure was not increased even after running 400 m track and his heart rhythm maintained sinus rhythm (chronotropic incompetence). Thoracic radiography revealed no significant abnormalities. In the color Doppler echocardiography in the right parasternal short axis view, there was mild mitral valvular regurgitation between left atrium and ventricle (Fig 1A) and mild left atrial dilation (LA:Ao ratio 1.4; Fig 1B). However, no further abnormalities were found.

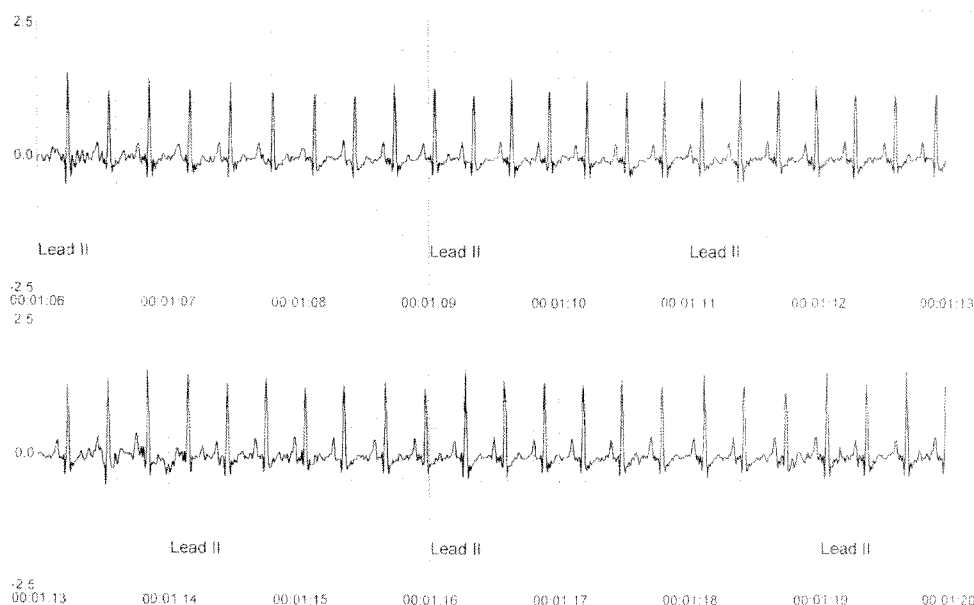
Because the dog had no clear evidence for structural heart diseases for exercise intolerance and syncopal episode (although the dog had mild mitral valvular degeneration due to aging), we decided to do 1 hour event ECG recording. On the event ECG recording, the dog showed the sudden onset of paroxysmal sinus tachycardias (156-172 bpm), which lasted few minutes and stopped abruptly (Fig 2). The R-R intervals were very irregular and were not consistent with respiratory cycles, although the rhythm itself was from sinus origin. Based on this finding, we initially suspected inappropriate sinus tachycardia (IST) and sinus node reentrant tachycardia (SART). To differentiate these two rhythm abnormalities, we decided to do vagal maneuver and verapamil response test.

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**Fig 1.** Doppler echocardiography of this case. A: The color Doppler echocardiography in the right parasternal short axis view showed the mild mitral valvular regurgitation between left atrium and ventricle. B: The M-mode echocardiography showed mild left atrium (LA) enlargement (LA/Ao ratio was 1.4; reference range 1.06–1.52).



**Fig 2.** Digital event recording of this case. The dog showed the sudden onset of paroxysmal sinus tachycardias (156-172 bpm), which lasted few minutes and stopped abruptly. The R-R intervals were very irregular and were not consistent with respiratory cycles, although the rhythm itself was from sinus origin.

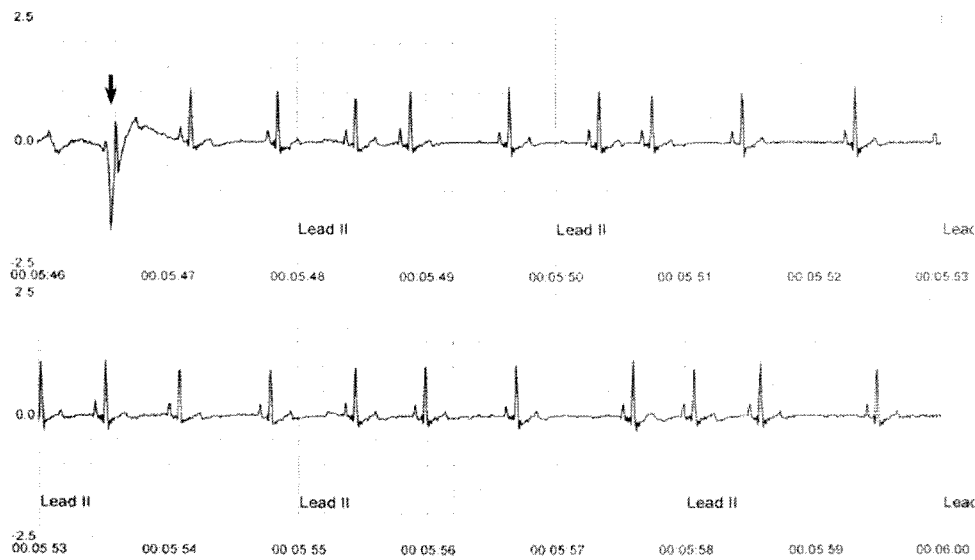
To do vagal maneuver to this dog, carotid sinus massage (compression of the carotid sinuses, located just caudal to the dorsal aspect of the larynx) was applied for 10 seconds. After vagal maneuver, the heart rate of the dog was returned to normal (86-92 bpm; Fig 3). For verapamil response test, 0.1 mg/kg verapamil (Isoptin, Ilsung Pharmaceuticals) was administered intravenously, while the dog was showing tachycardias. After verapamil was administered, the heart rate was abruptly decreased to 80-90 bpm (Fig 4). There was no rhythm change associated with vagal maneuver and verapamil administration. Based on the responses from vagal maneuver and verapamil administration, the case was diagnosed as sinoatrial reentrant tachycardia (SART).

The dog was released with prescription of 2 mg/kg (dilt-

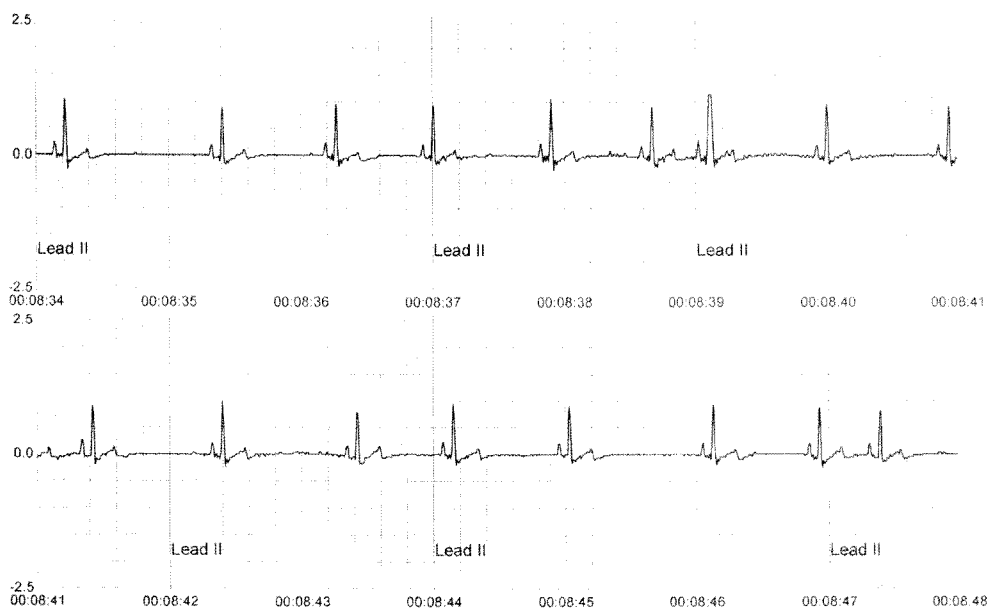
iazem (Diltiazem, Nelson Pharmaceuticals) and enalapril (Espron, Seoul Pharmaceuticals) twice per day orally and recommendation of exercise restriction for reducing the frequency of tachyarrhythmia. In the examination performed at one month after the first visit, the dog was clinically normal and healthy. Although the dog still has exercise intolerance, no syncope has been observed after medication.

## Discussion

Normal sinus arrhythmia (rate increases with inspiration and decreases with expiration) is commonly present in healthy dog (6). However, extreme degrees of sinus arrhythmia should be differentiated from pathologic sinus arrhythmias. Normal



**Fig 3.** Response from vagal maneuver. The heart rate was decreased to 86-92 bpm. The rhythm was sinus rhythm. The first QRS (arrow) was artifact which is formed from the patient movement during the ECG recording.



**Fig 4.** Response from verapamil administration. The heart rate was abruptly decreased to 72-86 bpm. The rhythm was originated from sinus node.

sinus tachycardia (NST) is usually a physiologic phenomenon indicating an appropriate response to demands arising from exercise or anemia (6). NST in response to an appropriate stimulus exhibits a relatively rapid (but not usually abrupt) onset and a gradual slowing after removal of the provoking event (6). However, NST sometimes must be differentiated from pathological sinus origin tachyarrhythmias such as SART and IST. The SART (albeit rarely a sustained arrhythmia) has all the ECG features of NST. However, vagal maneuvers or administration of verapamil (calcium channel blocker) usually promptly terminates SART while having only a transient slowing effect on NST (10,15,16).

Inappropriate sinus tachycardia (IST) is an intractable non-physiologic sinus tachycardia, which is intertwined with the postural orthostatic tachycardia syndrome (POTS) in human (10). Although the basis for IST is not certain, abnormal enhanced automaticity within the sinus node or nearby atrial regions may be involved in the pathogenesis (10). Known causative factors in human are anemia or hyperthyroidism (10). Although it is difficult to differentiate from SART, the onset and termination of IST has more gradual than SART and IST usually has poor responses from vagal maneuver or verapamil administration.

In this case, the initial diagnosis was difficult to make,

because we were unable to find the definitive findings on the routine cardiological examination, although the dog had a mild mitral valvular degeneration. However, because there were no significant structural cardiac changes (e.g. left ventricular eccentric hypertrophy, left atrial dilation), it was hard to conclude mild mitral regurgitation could cause of clinical signs (exercise intolerance and occasional syncopal episodes) of this case. Chronotropic incompetence (poor response of sinus rate after sympathetic stimulation such as exercise) implied the dog had a certain type of sinus node dysfunction. ECG studies showed abrupt onset of sinus tachycardia, which terminated abruptly, suggesting SART rather than SVT or IST. In SVT, the heart rhythm should be atrial premature beat, which often occurred with overlapped with T-wave (buried P-wave or T+P' wave). Furthermore although the rhythm of IST also has features of sinus beats origin, IST has gradual onset and termination and is rarely terminated by vagal maneuver and verapamil administration. Therefore those findings helped us to differentiate SART from SVT and IST.

Verapamil is the choice of drug for medically managing SART (15,16), although the proper oral dosage has never been studied in dogs. Therefore we chose diltiazem (another type of calcium channel blocker) for long-term management for SART. After all, the condition of dog was sufficiently managed by the oral diltiazem therapy. In contrast to IST and SVT, SART rarely responds well to  $\beta$ -blocker therapy. Digoxin, calcium channel blockers are the drugs of choice. If the dog is refractory to medical therapy, a more curative invasive approach may be warranted. In humans, for the refractory cases, surgical excision of sinoatrial nodal region had been applied (5,7). However, because the outcome was not favorable, surgical modalities are no longer preferred in human. Epicardial or endocardial catheter ablation is the current choice of refractory SART cases in human (8,12-14). However, catheter based ablation has yet been applied in veterinary fields.

In conclusion, this case study described clinical and diagnostic features of rare SART in a dog, which is managed medically.

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## 요크셔테리어 잡종견에서 나타난 동방회귀성 빈맥증

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**요 약** : 8세령 수컷 요크셔테리어 잡종견(몸무게: 7.5 kg)이 운동불내성과 실신을 주증상으로 강원대학교 동물병원에 내원하였다. 초기 심장 검사에서 경미한 이침판 역류증외에 특별한 이상소견은 관찰되지 않았다. 운동내성검사에서 환자는 심각한 chronotropic incompetence 소견을 보였고, 1시간-디지털 심전도 검사에서 돌발적으로 발생하여 종료되는 발작성 동성 빈맥소견(심박수: 156-172회)을 보였다. 추가적인 미주신경 자극시험과 verapamil 반응시험에서 빈맥이 종료되는 소견을 보였다. 이러한 소견을 토대로 본 증례는 동방회귀성 빈맥증으로 진단내렸다. 환자는 diltiazem과 enalapril로 치료하였고, 한달 후 재검사에서 운동 불내성 소견은 지속적으로 보였지만, 추가적인 실신소견은 관찰되지 않았다.

**주요어** : SND, 동방회귀성 빈맥, SART, 개, 동결절 기능장애