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CASE REPORT

Verapamil-sensitive atrial tachycardia with a slow conduction zone near the noncoronary aortic sinus and His bundle

Osamu Inaba[1,2], Yasutoshi Nagata[1], Yasuteru Yamauchi[3], Takamichi Miyamoto[1], Masahiko Goya[2] & Kenzo Hirao[2]

[1]Department of Cardiology, Musashino Red Cross Hospital, Musashino-shi, Tokyo, Japan
[2]Heart Rhythm Center, Tokyo Medical and Dental University, Bunkyo-ku, Tokyo, Japan
[3]Department of Cardiology, Yokohama City Minato Red Cross Hospital, Yokohama-si, Kanagwa, Japan

Correspondence
Osamu Inaba, Department of Cardiology, Tokyo Medical and Dental University, 1-5-45 Yushima, Bunkyo-ku, Tokyo 113-0034, Japan. Tel: 81358035231; Fax: 81358030133; E-mail: oinbcvm@tmd.ac.jp

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Key Clinical Message

This report presents a verapamil-sensitive atrial tachycardia, mid-atrium septum activating the earliest. Concealed entrainment was obtained at noncoronary aortic sinus (NCS), where the local activation was delayed compared to mid-septum. The tachycardia was successfully ablated at NCS. The entrance of the slow conduction zone was located at NCS.

Keywords

Concealed entrainment, His bundle, noncoronary aortic sinus, slow conduction zone, verapamil-sensitive atrial reentrant tachycardia

Introduction

Atrial tachycardias (ATs) originating from an area adjacent to the atrioventricular node or atrial anteroseptal region have been reported and those ATs occasionally are sensitive to adenosine and verapamil [1, 2]. However, the mechanism of the ATs has been controversially explained as reentry or triggered activity [1, 2]. In the present report, we describe a case with adenosine and verapamil-sensitive ATs with a reentrant mechanism (VAAT) and a VAAT sequence, in which the positional and electrophysiological relationship between the noncoronary aortic sinus (NCS) and tachycardia circuit was identified by concealed entrainment.

Case Presentation

A 75-year-old woman without any previous history of heart disease had symptoms of palpitations with a sudden-onset and sudden-termination, and was referred to our hospital. The electrocardiogram detected a long R-P' narrow QRS tachycardia, and verapamil was effective for prophylaxis from this tachycardia. Verapamil was discontinued 7 days prior to admission, and an electrophysiological study was performed. Two decapolar electrode catheters were inserted into the coronary sinus and His-right ventricle region, and a quadripolar electrode catheter into the high right atrium via the right femoral vein. The filter settings for the bipolar recording were set at 30–500 Hz, and 3D-electroanatomical mapping (Ensite NavX Velocity, St. Jude Medical, St. Paul, MN) was performed. Programmed stimulation revealed a single retrograde and antegrade conduction with decremental properties, and a tachycardia was induced with a V-A-A sequence during ventricular stimulation with a tachycardia cycle length (TCL) of 480 msec. Atrial programmed stimulation could also induce a tachycardia without any prolongation of the AH interval or AH jump up phenomenon. The inferior leads exhibited negative P waves during the tachycardia. The earliest atrial activation site

(EAS) of all the electrodes was the para-Hisian region, and the atrial sequence during the tachycardia differed from that of the retrograde atrial propagation. Single ventricular stimuli during the refractory period of the His bundle did not affect the tachycardia. The interval between the single atrial stimulus and first beat of the tachycardia was inversely related, and progressive fusion was detected during entrainment pacing from the high right atrium. The tachycardia was terminated by an infusion of 3 mg of adenosine. As a result, this tachycardia was diagnosed as a VAAT and its mechanism could have been reentry as previously reported [1]. Conventional activation mapping of the right atrium revealed that the EAS was slightly lower area in the para-Hisian region with a centrifugal propagation. Entrainment pacing was performed from the para-Hisian region, but the postpacing interval (PPI) was 50 msec longer than the TCL, and the atrial sequence during entrainment was different from that during the tachycardia (Fig. 1). Next, the ablation catheter was inserted to the NCS via the right femoral artery, where a small local potential with a 10-msec delay compared to that of the para-Hisian region was recorded (Fig. 2A). However, entrainment pacing from the NCS with output of 10 mV revealed concealed fusion and the PPI was equal to the TCL with a long latency of >90% of the TCL from the stimulus to captured p wave (Fig. 2B), but the distance between the NCS and earliest activation in the para-Hisian region was 5 mm (Fig. 3A). A single radiofrequency application (25W, 43°C) was delivered at the NCS during the AT. Accelerated just after delivery of radiofrequency energy, the AT was terminated after first ablation. After the ablation, the AT could no longer be induced with any programmed stimulation and/or an isoproterenol infusion.

Discussion

A radiofrequency application at the EAS is reported to be effective for eliminating VAATs [1, 2]. In general, the EAS is thought to be the exit site of a reentrant AT and a previous report found that concealed entrainment can be observed at the EAS in VAAT cases [3]. The NCS has also

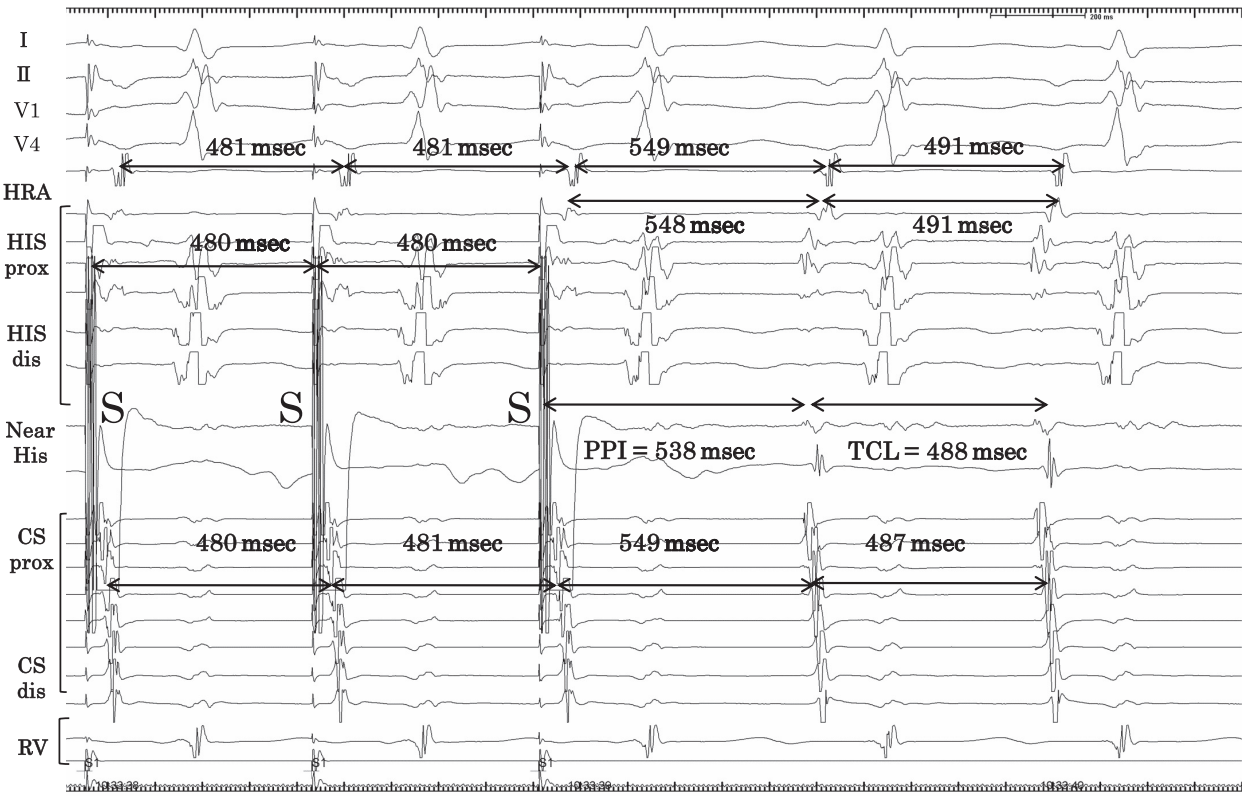

Figure 1. Entrainment in the para-Hisian region. Entrainment pacing near the His bundle region is shown. The earliest activation is near the His region, but the postpacing interval is 50 msec longer than the tachycardia cycle length, and the electrocardiogram sequence of the atrium during the entrainment pacing slightly differs from that during the tachycardia, especially in the distal CS. This indicates that concealed entrainment was not possible from the para-Hisian region. HRA, high right atrium; prox, proximal; dis, distal; CS, coronary sinus; RV, right ventricle; PPI, postpacing interval; TCL, tachycardia cycle length.

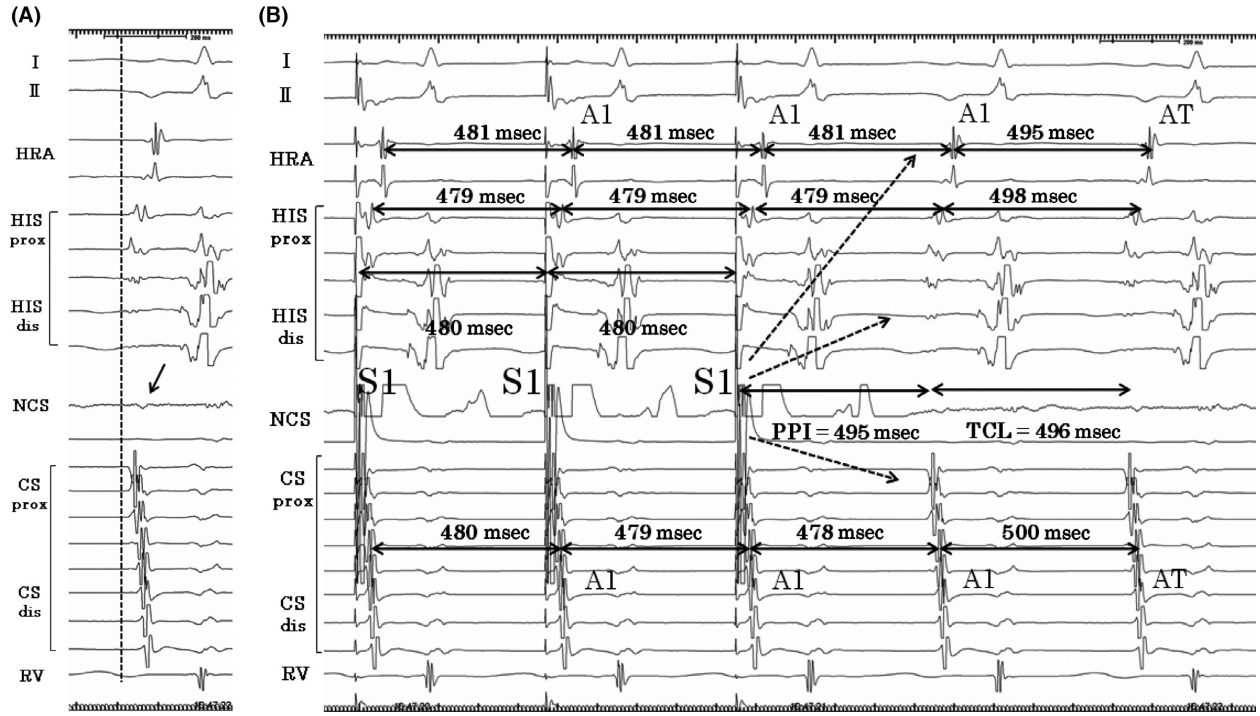

Figure 2. Activation and entrainment at the noncoronary aortic sinus. (A) A small and dull potential is detected at the NCS and is delayed 10 msec (arrow) compared to that in the para-Hisian region (dashed arrow). (B) Entrainment from the NCS exhibited concealed entrainment with a long latency of the stimulus-P wave interval. The P wave of last paced beat stand with long latency after last pacing spike.(arrow, dashed arrow). NCS, noncoronary aortic sinus. The other abbreviations are as in Figure 1.

been reported as a target ablation site of ATs originating from the para-Hisian region or anterior atrial septum. In most case reports, the NCS was the EAS during the AT, and the NCS is recognized as the exit site of para-Hisian VAATs [4–7].

In the present case report, NCS was not activated the earliest, but the AT was successfully ablated at NCS interestingly. Mid-septum close to the area detected His potential was activated the earliest in right atrium, and also earlier than NCS, but entrainment pacing showed PPI was longer than TCL. It indicated that mid-septum might be closer to the exit site of the AT than NCS, but not on the circuit. Further, concealed entrainment was observed at the NCS, where the local activation compared to that of the para-Hisian region was seemingly "delayed" and where the PPI was longer than the TCL. The measurement of the A-A interval in Figure 2B shows that the stimulus-P interval (not stimulus-QRS) covered almost the full TCL and that result indicated that the NCS was located at the entrance of the slow conduction zone of the AT circuit and not at the exit (Fig. 3B). This finding might also indicate that the AT seemed to be a microreentrant AT, but the circuit of the AT spread near the NCS, similar to a localized reentry.

The proximity of the slow conduction zone could also be targeted for the ablation of a VAAT, which would be the exit site. Yamabe et al. reported a useful method, using manifest entrainment, to estimate the approximate area for an effective ablation at sites without the occurrence of atrioventricular block [8]. However, no concealed entrainment was shown in that report and it may still be unclear where the slow conduction zone is located. To the best of our knowledge, the present case is the first report to show that concealed entrainment was detectable at the NCS in a case with a para-Hisian VAAT, and in which the NCS was determined to be the entrance of the slow conduction zone of the circuit. In this case, a very slow conduction zone might have been localized to a small region, between the NCS and para-Hisian region. This result indicated that the NCS could be a target for ablation even if the local activation time of the NCS is delayed compared to that of the para-Hisian region in VAATs, although pacing sometimes cannot capture the local potentials of the NCS and entrainment at the NCS was unavailable in those cases. However, the entire understanding of the slow conduction zone and exit of the circuit was still unclear in this case due to some limitations. First, in our study of the case, we could not find the

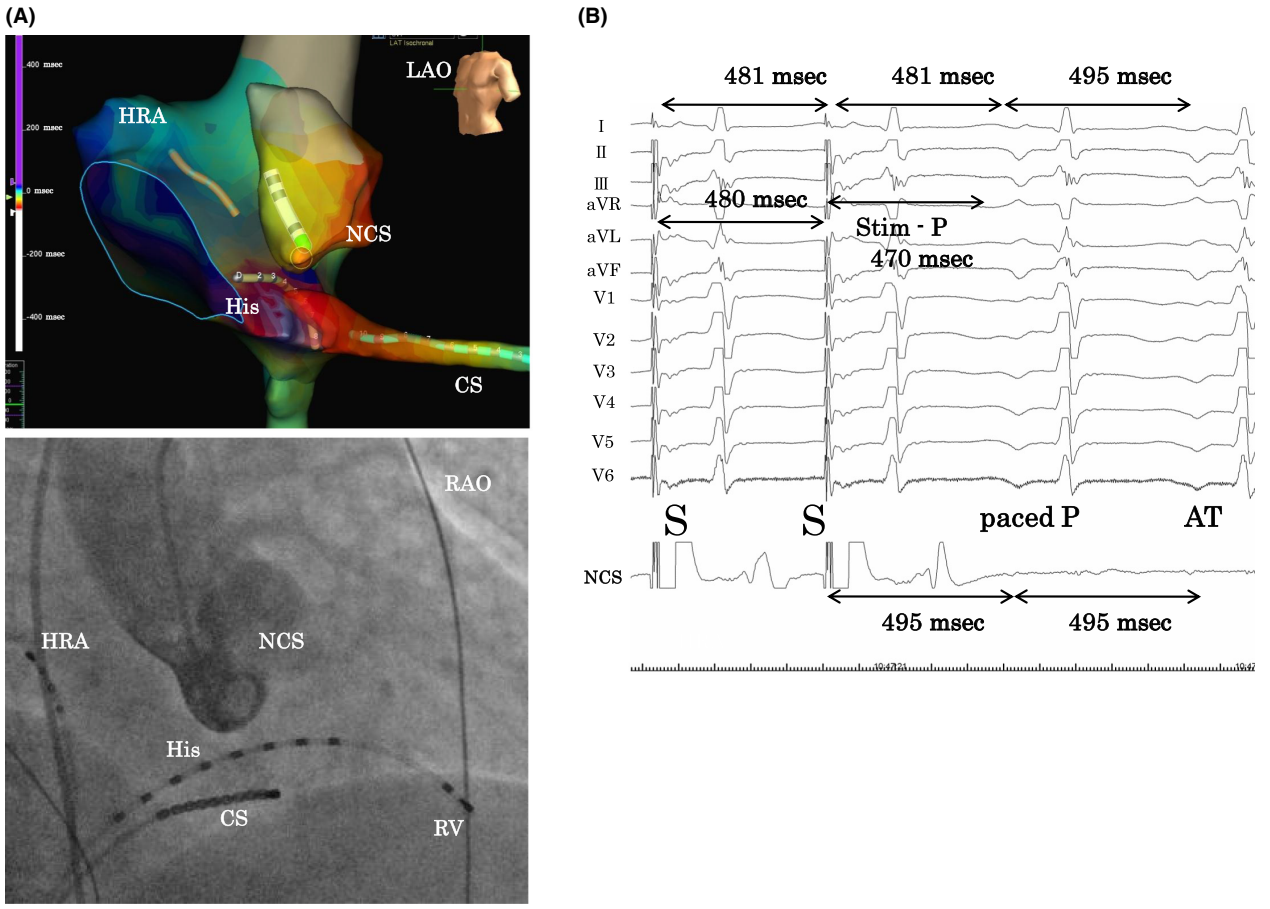

Figure 3. Anatomical and electrophysiological location of the NCS and area near the His bundle. (A) Location of the NCS and His bundle on the 3D electroanatomical map. A centrifugal activation pattern is shown. The distance between the NCS and His bundle was only 5 mm. (B) The paced P wave indicated there was concealed fusion. The stimulus-P wave interval covered >90% of the tachycardia cycle length. This result indicated that the NCS was located at the entrance of the slow conduction zone. LAO, left anterior oblique; RAO, right anterior oblique. The other abbreviations are as in Figure 2.

earliest activation site with concealed entrainment in right atrium, coronary sinus and aortic sinuses, expected as the exit of the slow conduction zone. The exit possibly was located in left atrium, but activation mapping of the left atrium was not performed and any implications of the left atrium associated with the VAAT were unknown. The second limitation was associated with the filter settings and size of the electrodes. The local electrogram at the NCS was small and dull, but was captured by entrainment pacing. Other settings of the filters or a change in the electrode size might have improved the detection of the electrocardiograms in the slow conduction zone.

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Conflict of Interest

None declared.

Authorship

OI: involved in designing and writing the Article, analyzing the tracing, and treating of the patients. YN, YY, TM, and KH: involved in analyzing the tracing and revision of the article.

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