Case Report

Paradoxical ventriculophasic sinus arrhythmia during 2:1 atrioventricular block

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Summary Ventriculophasic sinus arrhythmia is a particular phenomenon commonly observed in patients with complete atrioventricular (AV) block. Typically, the PP intervals which contain a QRS complex are shorter than the PP intervals which do not contain it. This phenomenon is present in more than 40% of cases with complete AV block and less common in the setting of second-degree AV block. We present a case with paradoxical ventriculophasic sinus arrhythmia during 2:1 AV block, in which the PP intervals containing a QRS complex are longer than the PP intervals without an intervening QRS complex. The possible mechanisms regarding this unusual phenomenon are also discussed.

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Introduction

Ventriculophasic sinus arrhythmia is a particular phenomenon commonly observed in patients with complete atrioventricular (AV) block. Typically, the PP intervals which contain a QRS complex are shorter than the PP intervals which do not contain it. This phenomenon is present in more than 40% of cases with complete AV block and is less common in the setting of second-degree AV block [1–3]. We present a case with paradoxical ventriculophasic sinus arrhythmia during 2:1 AV block, in which the PP intervals containing a QRS complex are longer than the PP intervals without an intervening QRS complex.

Case report

A 56-year-old woman was referred for further evaluation of type II Mobitz AV block by her primary physician. She complained of chest discomfort and shortness of breath during walking and denied syncope or near-syncope. She was not receiving any medications with AV node-blocking effects. Blood pressure was 120/62 mmHg, heart rate was 40 beats per minute, and the oxygen saturation was normal. The 12-lead electrocardiogram (ECG) (Fig. 1) demonstrated sinus rhythm with second-degree AV block and 2:1 AV conduction. Paradoxical ventriculophasic sinus arrhythmia was found during 2:1 AV block. Note that the PP intervals con-
The 12-lead electrocardiogram shows sinus rhythm with second-degree atrioventricular (AV) block and 2:1 AV conduction. Note that the PP intervals containing a QRS complex are longer than the PP intervals not encompassing a QRS complex.

Figure 1  The 12-lead electrocardiogram shows sinus rhythm with second-degree atrioventricular (AV) block and 2:1 AV conduction. Note that the PP intervals containing a QRS complex are longer than the PP intervals not encompassing a QRS complex.

taining the QRS complex are longer than the PP intervals not encompassing the QRS complex, which are completely opposite to the typical ventriculophasic sinus arrhythmia.

Discussion

Ventriculophasic sinus arrhythmia is a common finding in the presence of complete heart block. The PP intervals which contain a QRS complex are shorter than the PP intervals without an intervening QRS complex. This phenomenon was first described by Erlanger and Blackman in an experimental study of chronic AV block in dogs in 1910 [4]. Later, other investigators also observed this phasic variation in over 40% of patients with complete AV block [1—3]. It has been also described in the setting of second-degree AV block [2] and patients with ventricularly paced rhythms [5]. In a comprehensive review, Rosenbaum and Lepeschkin [1] also proposed that a paradoxical effect was seen in 3.5% of the patients with complete AV block, in which the PP intervals containing a QRS complex are longer than those not containing one.

Although the potential mechanism of this phenomenon is still not fully understood, the most plausible explanation is two-phase chronotropic effects proposed by Rosenbaum and Lepeschkin [1]. The positive chronotropic (accelerating) effect is related to early appearance of a P wave following a QRS complex and shortening of the PP interval which contains a QRS complex.

Two potential mechanisms have been proposed regarding the positive chronotropic effect. First, atrial stretch by the mechanical effects of ventricular systole may hasten the discharge of normal sinus node impulses. Second,
ventricular contraction may increase sinus node blood supply and improve the perfusion of sinus node [6,7], which leads to an earlier sinus node discharge and a P wave following a QRS complex. Rosenbaum and Lepeschkin [1] also found the maximum positive chronotropic effect appeared during the relatively shorter QP intervals (between 0.3 and 0.4 s). On the other hand, a negative chronotropic (decelerating) effect may result in the next longer PP interval without an intervening QRS complex. A possible mechanism that explains the negative chronotropic effect involves arterial baroreceptor-mediated changes in vagal tone. In detail, elevated arterial blood pressure caused by ventricular ejection activates the arterial baroreceptors, which produce a vagal reflex to slow the firing of sinus node and lengthen the following PP interval without a QRS complex. The maximum negative chronotropic effect occurs during the relatively longer QP intervals (between 0.6 and 1.0 s) and slow ventricular rate.

Paradoxical ventriculophasic sinus arrhythmia during 2:1 atrioventricular block has not been described in the literature thus far. Our particular case can also be explained by two-phase chronotropic effect mechanisms. In general, the interplay of these two-phase effects determines whether the PP intervals containing a QRS complex will be shorter or longer than those not containing one. Note that the QP interval is relatively long (620 ms) (Fig. 1) in our case. This may represent a more negative than positive chronotropic effect, which causes the paradoxical effect observed in our case.

References