CASE REPORT

Paradoxical Ventriculophasic Arrhythmia in a Patient with 2:1 Atrioventricular Block: A Rare Phenomenon

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Ventriculophasic arrhythmia is a phenomenon commonly seen in patients with complete atrioventricular (AV) block. The usual observation is that the PP intervals containing the QRS complex are shorter in duration than the PP intervals without an intervening QRS complex. And also an inverse relation is seen between the QP interval and the subsequent PP interval without a QRS complex. We report a case of paradoxical ventriculophasic arrhythmia in an 85-year-old patient presenting with 2:1 AV block, wherein the PP intervals containing the QRS complex are longer than the PP intervals without a QRS complex.

CASE REPORT

An 85-year-old woman was admitted to our facility with a 4-day duration of fatigue and progressive worsening of shortness of breath on exertion. She denied any chest pain, palpitations, and syncope. She was not on any medications. On admission, she was registering a blood pressure of 160/68 mmHg, heart rate of 40 beats per minute, and oxygen saturation of 95% on 2 liters of oxygen. The 12-lead electrocardiogram (Fig. 1) showed sinus rhythm, left bundle branch block, and second-degree AV block with 2:1 AV conduction. The PP intervals containing the QRS complex are longer (800 milliseconds) than the PP intervals without a QRS complex (720 milliseconds) which is the paradox of ventriculophasic arrhythmia. Also to be noted that the QP interval is also quite prolonged at 620 milliseconds. She received a dual-chamber pacemaker for symptomatic high-grade AV block.

DISCUSSION

Ventriculophasic arrhythmia is most commonly observed in patients with complete heart block. It has been also reported in patients with second-degree heart block, paroxysmal atrial tachycardia with block and ventricular paced rhythms. The usual observation is that the PP intervals containing the QRS complex are shorter in duration than the PP intervals without an intervening QRS complex. This phenomenon was first observed and described by Erlanger and Blackman in an animal study on chronic AV block.¹ Further studies reported 40–50% incidence of this phenomenon in patients with complete heart block and paced rhythms.^{2–4} A paradoxical effect in which PP intervals containing the QRS complex are longer than the PP intervals without a QRS complex has been seen in 3.5% of cases with complete heart block.

Dadu and McPherson proposed a quantitative definition of ventriculophasic phenomenon based on a study on ventriculophasic response and its clinical correlations in complete heart block patients with pacemaker.⁴ They observed that the shortening of PP interval mainly occurred when the interposed QRS occurs in the first 60% of the anticipated PP interval. They defined ventriculophasic response as being present during heart block when an interposed QRS occurring in the first 60% of the anticipated PP interval results in a greater than 3% shortening of % PP interval surrounding the QRS compared to the preceding PP interval. The exact mechanism of this phenomenon is still unclear. The proposed mechanisms include

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Figure 1. The 12-lead electrocardiogram shows sinus rhythm, left bundle branch block, and second-degree AV block with 2:1 AV conduction. Note that the PP intervals containing a QRS complex are longer than the PP intervals without a QRS complex.

(1) changes in baroreceptor output resulting from the stroke volume caused by ventricular contraction, (2) stretch of the right atrium and sinus node with ventricular contraction that augments sinus node automaticity, and (3) alteration of sinus rate due to changes in sinus node blood supply in response to ventricular contraction.

Rosenbaum and Lipeschkin proposed a positive and negative chronotropic effect to explain this phenomenon.² The positive chronotropic effect leads to an early sinus nodal discharge of a P wave following a QRS resulting in shortening of the PP interval containing the QRS. They thought that this effect is most likely the result of stretch of the right atrium and sinus node by the ventricular contraction that augments sinus node automaticity. An earlier sinus node discharge and alteration of sinus rate due to changes in sinus node blood supply in response to ventricular contraction is another proposed mechanism.^{5,6} They observed maximum positive chronotropic effect with relatively shorter QP intervals of 0.3 to 0.4 second. The

negative chronotropic effect results in prolongation of the next PP interval without an intervening QRS complex. This can be explained by the rise in arterial blood pressure caused by ventricular systole activating the arterial baroreceptors, which in turn produce a reflex slowing of sinus node firing by increased vagal tone leading to prolongation of the PP interval without a QRS complex. Lipeschkin observed the maximum negative chronotropic effect with slow ventricular rate and relatively longer QP intervals of 0.6 to 1 second.

The late negative chronotropic effect that appears 0.6 to 1 second after the beginning of the QRS, which is especially more pronounced at slow ventricular rates, may account for the paradoxical phenomenon. Here, the PP intervals containing QRS will be still affected by the negative chronotropic effect, thus allowing the blocked P wave to appear under the influence of the maximum negative chronotropic effect. Hence, the PP interval containing the QRS will be longer than the following PP interval that does not contain a

QRS complex. The prolonged QP interval of 0.62 second in the setting of slow ventricular rate of 40 beats per minute explains the occurrence of paradoxical ventriculophasic arrhythmia in our patient. To our knowledge this is the second such case of paradoxical ventriculophasic arrhythmia during 2:1 AV block reported in the literature thus far.⁷

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