# **CASE REPORT**

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# A rare phenomenon involving ventricular separation: a case report



Huayong Jin<sup>1</sup> and Yudan Wen<sup>2\*</sup>

# Abstract

**Background** Ventricular separation is a multipart, extensive disease of the heart that hinders the electrical conduction of the cardiac system ventricular muscle, causing a bidirectional conduction block. The occurrence of ventricular separation suggests that the myocardium is in a state of severe ischemia, and the prognosis is generally poor. Herein, we present arescue case in which the extremely rare phenomenon of ventricular separation developed and was documented in realtime.

**Case presentation** An 82-year-old man with syncope presented to the emergency departmentin a critical condition with no vital signs and was immediately treated via endotracheal intubation, mechanical ventilation, and cardiopulmonary resuscitation. The patient's electrocardiogram (ECG) showed two completely independent waveforms that were excited at their respective frequencies without interfering with one another, with the overall ECG resembling a third-degree atrioventricular block. A review of a previous ECG showed findings mimicking a first-degree atrioventricular block. Based on the patient's clinical manifestations, the ECG diagnoses were sinus arrest, ventricular escape rhythm, and ventricular separation. The patient was declared dead 30 min after rescue attempts failed. The ECG was variable in this case, and the original conduction-related ventricular wave showed complete separation that could easily have been misdiagnosed as an atrioventricular block. Since the patient was in a critical condition and his vital signs had disappeared, the ECG diagnoses supported ventricular separation.

**Conclusions** Ventricular separation is not a static condition, and as observed in this case, it can manifest a number of dynamic changes. Therefore, it is imperative to study this uncommon phenomenon in order to gain an improved understanding of the electrocardiac system.

Keywords Ventricular separation, Ventricle, Conduction

\*Correspondence: Yudan Wen yudan171717@163.com Full list of author information is available at the end of the article



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# Background

Throughout history, people have described and discussed the ECG patterns of the human heart during the final moments of life, especially in emergency rescue scenarios [1]. Although all types of arrhythmias can occur, recurring asystoles or ventricular standstills are the most common. With the increasing use of ECG in clinical practice, new ECG patterns during the end-of-life stage continue to be reported. When encountering such ECG patterns in clinical settings, we must avoid making hasty diagnoses. Ventricular separation is a multipart, extensive disease of the heart that hinders the electrical conduction of the cardiac system ventricular muscle, causing a bidirectional conduction block therein. The occurrence of ventricular separation suggests that the myocardium is in a state of severe ischemia, and the prognosis is generally poor. Herein, we present a rescue case in which the extremely rare phenomenon of ventricular separation developed and was documented in real-time; unfortunately, the outcome was patient death.

# **Case presentation**

An 82-year-old man with syncope presented to the emergency department. A physical examination revealed a pupillary diameter of 5 mm with a lack of pupillary light reflex. The patient's heart rate, blood pressure, and blood oxygen saturation could not be measured, and lung and heart sounds were not heard. He was immediately treated via endotracheal intubation, mechanical ventilation, and cardiopulmonary resuscitation (CPR). The patient's electrocardiogram (ECG) showed two completely independent waveforms that were excited at their respective frequencies without interfering with one another (Fig. 1). One form had a frequency of 35 beats/ minute (bpm), while the other had a frequency of 78 bpm. The overall ECG resembled a third-degree atrioventricular block. A physical examination was performed again, and it was found that the patient's heart sounds remained absent, and his blood pressure was undetectable.

A review of a previous ECG and the limb lead (Fig. 2) revealed that the "P-QRS" wave group occurred regularly with a frequency of 59 bpm, a relatively fixed shape, and clearly visible equipotential lines. These findings mimicked those of a first-degree atrioventricular (AV) block.

Based on the clinical manifestations of the patient, the ECG diagnoses weresinus arrest, ventricular escape rhythm, and ventricular separation. The patient was declared dead 30 min after rescue attempts failed.His history of underlying diseases and the cause of his unexpected sudden death remained unknown.

The ECG of this case was variable, and the original conduction-related ventricular wave showed complete separation that could easily have been misdiagnosed as an atrioventricular block. Since the patient was in a critical condition and his vital signs had disappeared, the ECG diagnoses supported ventricular separation.

# **Discussion and conclusions**

Ventricular separation is a multipart, extensive disease of the ventricle that hinders the electrical conduction of the cardiac conduction system and ventricular muscle,



Fig. 1 An electrocardiogram (ECG) obtained 23 min after the initiation of cardiopulmonary resuscitation (CPR)

causing a bidirectional conduction block in the ventricular muscle in the block circle. The pace point of the block circle and the other pace points are controlled separately, and under normal conditions, the unilateral or partial ventricular muscles are excited at their respective frequencies without interfering with one another [2]. In the cases presented here, ECG showed progressive changes. It can be speculated that prolonged myocardial ischemia and hypoxia may have caused severe myocardial damage, which in turn significantly reduced the membrane potential of the surrounding local myocardial cells, significantly delaying or even leading to loss of conduction. With further aggravation of ischemia and hypoxia, the original homologous ventricular separation visible on ECG progresses to complete ventricular separation, which has an extremely poor prognosis.



Fig. 2 An ECG obtained immediately after the initiation of CPR

Homologous ventricular separation is a single-source type of ventricular separation [3], referring to ventricular activation through the left and right bundle branches to depolarize the left and right ventricles and produce two non-interfering QRS waves. It can be divided into fixed homologous ventricular separation and partial homologous ventricular separation. Partial homologous ventricular separation can occur in the following two ways: 1) ventricular persistent partial depolarization, where only part of the QRS wave appears on the ECG; and 2) arising from the complete blockage of the interventricular septum, where the ventricles on both sides of the block area form the ventricular separation of the pacing points. Ventricular separation is more common in patients with end-stage or severe organic heart disease [4, 5]. Some researchers have reported homologous ventricular separation in patients with ventricular tachycardia following substrate ablation or acute myocardial infarction. Fragmentation waves occur at different levels in the myocardium and manifest as the dispersion of myocardial depolarization. Some researchers believe that ventricular separation is only a manifestation of the imminent disappearance of cardiac electrical activity preceding death. The occurrence of ventricular separation suggests that the myocardium is in a state of severe ischemia, as well as a poor prognosis. However, very few cases are caused by drugs (such as digitalis, quinidine, and antibiotics). Since the patient's vital signshad disappeared, an intracardiac electrophysiological study could not be conducted to confirm this rare electrocardiographic phenomenon;this limitation is a noted shortcoming of the case.

Ventricular separation is a rare electrocardiac phenomenon that often occurs immediately preceding death. It is not a static condition; as is illustrated in this case, it can manifest a number of dynamic changes. It is imperative to understand and master this uncommon phenomenon in order to gain an improved understanding of the electrocardiac system.

#### Abbreviations

- CPR Cardiopulmonary resuscitation
- ECG Electrocardiogram
- Bpm Beats/minute
- AV Atrioventricular

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#### Authors' contributions

Huayong Jin wrote the main manuscript text and Yudan Wen prepared Figs. 1 and 2. All authors reviewed the manuscript.

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#### Data availability

No datasets were generated or analysed during the current study.

## Declarations

#### Ethics approval and consent to participate

This study was approved by the Ethics Committee of Shaoxing People's Hospital[NO.2024–001].

# **Consent for publication**

The families of the patients provided informed consent for the publication of this report.

#### **Competing interests**

The authors declare no competing interests.

#### Author details

<sup>1</sup>Department of Electrocardiology, Shaoxing People's Hospital, Shaoxing, China. <sup>2</sup>Department of Electrocardiology, The Third Affiliated Hospital of Wenzhou Medical University, No.108 WansongRoad, Wenzhou 325200, People's Republic of China.

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