Electrocardiogram and Clinical Characteristics Analysis of Sinus Conduction Caused by Hyperkalemia

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Abstract: Objective: This article aims to analyze the electrocardiogram and clinical characteristics of patients with hyperkalemia induced sinus conduction. Method: This study included 20 patients with hyperkalemia induced sinus ventricular conduction from April 2023 to April 2024. The patients underwent electrocardiogram examination and their clinical characteristics were observed. Result: The electrocardiogram characteristics of 20 patients were disappearance of P-waves and prolongation of P-R interval. QRS complex is broad and malformed, with basic regular ventricular rate, S-T segment changes, and Q-T interval prolongation. After treatment, all patients' serum potassium ion concentrations and electrocardiograms returned to normal. Conclusion: Patients with hyperkalemia induced sinus conduction have obvious electrocardiogram and clinical characteristics, and the cardiac conduction status of patients is related to serum potassium ion concentration.
***Keywords*:** hyperkalemia; sinus conduction; electrocardiogram; serum potassium ion concentration; clinical features

1. Introduction

Hyperkalemia is a common clinical disease that can cause electrolyte imbalance in the body, leading to cardiac conduction disorders. Electrocardiogram changes are caused by a series of changes at the cellular level. When serum potassium ion levels increase, the initial T wave also increases, and the interval is short, leading to conduction delay and arrhythmia. Hyperkalemia can lead to a decrease in transmembrane potassium ion concentration, resulting in a decrease in resting potential and a weakening of action potential phase 0 intensity, leading to conduction delay. Electrocardiogram, as an important indicator for diagnosing hyperkalemia, can predict the development of hyperkalemia. Hyperkalemia induced sinus conduction is not commonly seen in clinical practice. Sinus conduction is a malignant arrhythmia that can even pose a serious threat to the patient's life and health in severe cases, requiring timely diagnosis and treatment. In view of this, this study focuses on patients with hyperkalemia induced sinus ventricular conduction, and further analyzes the electrocardiogram and clinical characteristics of such patients, in order to provide reference for subsequent diagnosis and treatment. The details are as follows:

2. General Information and Development

2.1 General Information

This study selected 20 patients with hyperkalemia induced sinus conduction from February 2023 to February 2024, all of whom met the inclusion and exclusion criteria. The patients ranged in age from 47 to 75 years, with an average of (66.35 ± 5.32) years. There were 11 males and 9 females. At admission, all patients' laboratory tests showed serum potassium ion concentrations between 6.79-9.42mmol, and electrocardiograms showed sinus conduction block and hyperkalemia. 20 patients all have chronic renal dysfunction, of which 12 patients have been diagnosed with renal dysfunction and uremia. The primary diseases included 11 cases of chronic nephritis, 2 cases of rheumatic valvular disease, 5 cases of diabetes nephropathy, and 2 cases of liver cancer. There was no significant difference in general information among all patients ($P>0.05$).

2.2 Inclusion and exclusion criteria

Inclusion criteria: (1) Patients diagnosed with hyperkalemia causing sinus ventricular conduction; (2) Patients with complete clinical data; (3) Patients with normal communication skills; (4) Understand and sign the consent form for the patient.

Exclusion criteria: (1) Patients who do not meet the examination criteria; (2) Psychiatric patients; (3) Other important organs exhausted patients; (4) Patients with poor compliance; (5) Patients with cognitive dysfunction.

2.3 Methods

Use a 12 lead electrocardiograph to synchronously record changes in the patient's electrocardiogram, and use a fully

automated biochemical analyzer to measure serum potassium concentration; Assess the patient's condition and regularly perform electrocardiogram and serum potassium ion concentration testing based on its changes. Analyze in detail the changes in the patient's heart rate, rhythm, P wave, QRS complex, T wave, P-R interval, and Q-T interval, with a focus on analyzing the patterns of changes in P wave, QRS complex, and T wave; Explore the correlation between serum potassium ion concentration and electrocardiogram changes, and observe their clinical outcomes.

2.4 Diagnostic criteria

(1) The P-wave gradually disappears and the change image can be fully observed; (2) High peak T-wave, prone to occur between V3-V6; (3) The QRS complex presents as diffuse intraventricular block, and a few patients may experience abnormal changes in the QRS complex, but the duration remains unchanged. In addition, it is also important to observe the patient's condition and pay attention to the serum potassium ion concentration. The recording of electrocardiogram is beneficial for analyzing the relationship between the two.

3. Results

3.1 Electrocardiogram Characteristics

(1) P-wave disappearance

The amplitude of P wave in 20 patients decreased with the increase of serum potassium ion concentration, and the P wave disappeared. After treatment, the serum potassium level decreased and the P-wave returned to normal.

(2) P-R interval prolongation

Out of the 20 patients, 16 had already experienced first degree atrioventricular block before the formation of sinus ventricular conduction, which may be accompanied by mild atrioventricular delay during this course.

(3) QRS complex hypertrophy anomaly

Twenty patients had a QRS complex lasting more than 0.12 seconds, with reduced amplitude of the R wave and thickening of the S wave, and no bundle or branch stagnation in the QRS wave. After treatment, the serum potassium ion concentration returned to normal and the QRS complex also returned to normal.

(4) Basic rules of ventricular rhythm

Among the 20 patients, 18 patients did not show any abnormalities in the R-R interval and had normal ventricular rhythm.

(5) S-T segment change

Twenty patients showed tent like changes in T waves, and after treatment, T waves and serum potassium ion levels returned to normal.

(6) Q-T interval prolongation

All 20 patients had Q-T intervals greater than 0.44 seconds, with 15 cases returning to normal after disappearance of sinus conduction.

3.2 Clinical outcomes

After receiving treatment in the hospital, 17 patients showed improvement after hemodialysis, and 3 patients showed improvement after medication. Both electrocardiogram and serum potassium ion concentration have returned to normal.

4. Discussions

Hyperkalemia is a common clinical disease that belongs to severe ion metabolism disorders. The increase in serum potassium ion concentration can affect the electrophysiological characteristics of patients, leading to changes in their electrocardiogram. In severe cases, sinus ventricular conduction may occur, causing ventricular fibrillation and posing a serious threat to the patient's life and health. Therefore timely treatment is necessary. The normal human serum potassium ion concentration should be between 3.5-5.0 mmol/L. About 98% of potassium ions in the body are distributed inside the cell, while the rest are distributed in the extracellular fluid, including blood. Hyperkalemia is mainly manifested as restlessness, palpitations, muscle weakness, etc., and is not specific. Most patients are found in blood tests, and some patients may experience symptoms such as arrhythmia as the condition worsens. The electrocardiogram of patients with moderate to mild hyperkalemia is characterized by a decrease in P-wave and an increase in T-wave peak; Patients with severe hyperkalemia are prone to sinus conduction, increased QRS complex, and string like changes in electrocardiogram. Sinus ventricular conduction is mainly characterized by atrial muscle paralysis, diffuse atrioventricular block, and ventricular repolarization changes in hyperkalemia. Some patients experience disappearance of sinus conduction after undergoing high potassium

adjustment therapy. The sinus conduction caused by hyperkalemia is related to serum potassium ion concentration, but the clinical characteristics of electrocardiogram vary among patients with the same serum potassium ion concentration. The key to treating this disease is to rapidly reduce the serum potassium ion concentration in the body, preventing it from transforming into malignant arrhythmias such as ventricular flutter and ventricular fibrillation. Continuous hemodialysis is the preferred method for treating sinus conduction caused by hyperkalemia, and it is also the fastest treatment method to reduce serum potassium ion concentration in the body. Through diffusion movement, serum potassium ions in the body are diffused into dialysate with low potassium ion concentration, causing a rapid decrease in serum potassium ion concentration. At the same time, drug therapy can serve as an adjuvant therapy for sinus conduction, reducing myocardial damage caused by high blood potassium antagonism and preventing the occurrence of malignant arrhythmias . The results of this study showed that the electrocardiogram characteristics of 20 patients were disappearance of P wave, prolongation of P-R interval, widened QRS complex deformity, basic regularity of ventricular rate, changes in S-T segment, and prolongation of Q-T interval. After treatment, both serum potassium ion concentration and electrocardiogram returned to normal. Indicating that serum potassium represents the potassium concentration in extracellular fluid and cannot timely and accurately reflect changes in intracellular potassium concentration. In addition, the effect of serum potassium ion concentration on myocardium is also related to other electrolytes and the rate of concentration increase.

A study has found that different types of myocardial fibers, such as atrial muscle, new ventricular muscle, and internodal bundle, affect the sensitivity of patients with hyperkalemia, but the sensitivity varies. Therefore, it can be concluded that in patients with hyperkalemia, the sinoatrial node can still function according to its own rhythm even when atrial electromyographic activity is inhibited or ventricular conduction is blocked. At the same time, visceral Purkinje fibers also have conduction function. The sinoatrial node is not sensitive to hyperkalemia, resulting in a more normal rhythm of ventricular frequency in sinoventricular conduction. So medical staff should be vigilant and closely observe the patient's condition and metabolic disorder electrocardiogram characteristics when treating and caring for them. In cases where elevated blood potassium directly affects the ventricle or ventricular fibrillation, it is necessary to fully utilize rich clinical experience and professional knowledge to promptly detect abnormal sinus ventricular conduction and protect the patient's life and health as quickly as possible. Understand the characteristics and clinical conditions of various types of sinus conduction, providing reference for the treatment of sinus conduction caused by hyperkalemia in the future.

5. Conclusion

In summary, hyperkalemia is a common clinical disease that induces sinus ventricular conduction and arrhythmia. Due to the rarity of sinus conduction in clinical practice and its characteristic of abnormal cardiac rhythm changes, it is easily overlooked or misdiagnosed by medical personnel, which affects timely treatment of patients. Therefore, vigilance must be maintained during treatment, and patients' electrocardiograms and metabolic disorders must be observed to ensure their overall health and facilitate their recovery.

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