A case report of poor ventricular pacing

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Key Clinical Message

Wear or fracture of pacemaker electrode leads can cause poor pacing of pacemaker electrode, with subclavian crush syndrome being the most common cause. At present, reported cases of pacemaker implantation exacerbated by subclavian crush syndrome have increased threshold, and the great majority of patients experience substantial fluctuations in lead impedance, with lead fracture visible on chest radiographs. Pacemaker program control and chest radiographs, however, may not detect all patients with subclavian crush syndrome. Sometimes subclavian crush syndrome was further speculated only after the poor pacing of the electrode lead was improved by changing the polarity of the pacing electrode from bipolar to single stage.

Keywords: Poor pacing electrode; electrode wear or fracture; subclavian crush syndrome

Introduction

Subclavian vein puncture has a high success rate and multiple leads can be implanted. It is a common vein for the implantation of pacing leads. However, lead rupture occurs in 1%-4% of patients, causing subclavian crush syndrome [1-3]. Subclavian crush syndrome is typically characterized by an increased threshold, impedance fluctuation, and lead fracture visible on chest radiographs. In this paper, we reported a case of poor ventricular pacing. Although pacemaker program-controlled parameters were normal several times and no electrode fracture was found on chest radiographs, poor pacing did not occur again when the polarity of the ventricular electrode was changed from bipolar to a single stage. The patient was diagnosed with subclavicular compression syndrome caused by wear or even fracture of the anode ring of the subclavicular ventricular electrode.

Case Report
A 62-year-old female was admitted to the hospital on November 30, 2020, with the complaint of "paroxysmal syncope for 8 years, aggravated for 1 month". In 2012, the patient had no evident cause for sudden syncope and discomfort, accompanied by loss of consciousness, and she self-relieved for more than 10 seconds. The patient was diagnosed with a third-degree atrioventricular block in our cardiac clinic. After admission, Medtronic REDR01 dual chamber permanent cardiac pacemaker was implanted in the patient. The type of atrial electrode was 4574, and the type of ventricular electrode was 4074. The access vessel was the left subclavian vein. After multiple rechecks, the programmed pacemaker parameters were normal and the patient experienced no discomfort. The paroxysmal atrial fibrillation was recorded in 24h ECG. By the end of October 2020, the patient visited the cardiac clinic with the complaint of intermittent palpitations and dizziness. The battery of the pacemaker lasted for 6-20 months. The onset of atrial high-frequency events was common. Rivaroxaban 20 mg/day was administrated to the patient for anticoagulation of paroxysmal atrial fibrillation. The patient was asked to visit for a recheck after 3 months to change the pacemaker if necessary. However, the patient still suffered from intermittent palpitations and dizziness, which had nothing to do with body position and activity. The number of symptom attacks thereafter increased, i.e., 3-4 times a day. On November 30, 2020, the patient visited our cardiac clinic again. The ECG revealed lost intermittent ventricular pacing with a third-degree atrioventricular block (Figure 1). The parameters of the programmable pacemaker remained normal. Considering the insufficient battery power, the patient was hospitalized with a diagnosis of arrhythmia, third-degree atrioventricular block, paroxysmal atrial fibrillation, and pacemaker battery depletion after permanent dual chamber pacemaker implantation. A complete examination of patients was performed after admission. Considering the risk of cardiac arrest, the double chamber pacemaker was replaced the next day of admission. During the operation, the monitoring showed that the ventricular pacing was intermittent, with a heart rate of 40-60bpm. Moreover, the atrial and ventricular bipolar parameters were normal. The pacemaker replaced was Medtronic REDR01. During the postoperative hospitalization, multiple re-examinations of ECG indicated desirable pacing and perception functions.

After discharge, the patient complained of occasional palpitations. The pacemaker parameters were normal two months after the operation. But 4 months after the operation, palpitation and dizziness occurred again frequently, more than when sitting position changed into standing position, and they all improved in a few minutes. The patient visited our hospital again and we found that the pacemaker parameters remained normal. Further, a dynamic electrocardiogram examination was performed to establish the cause of dizziness. As a result, we found sinus rhythm, paroxysmal atrial fibrillation, frequent ventricular premature beats, intermittent ventricular poor pacing, and third-degree atrioventricular block (Figure 2), indicating poor ventricular pacing, but the perception function was good. Further chest radiography revealed no wear or fracture of the pacemaker electrode (Figure 3).

To solve the problem of poor pacing, the ventricular pacing polarity was adjusted from bipolar to single-stage, then the dynamic electrocardiogram was rechecked without any adverse pacing phenomenon. The patient also complained of no palpitation, dizziness, or other discomforts. After changing the pacing polarity of the ventricular pacing electrode from bipolar to single-stage, the patients were followed up for 3 months without palpitations, dizziness, and other discomforts. In April 2022, the patient was followed up again, and single-stage parameters of ventricular electrodes were normal. Figure 4 shows the chest radiograph results showing no obvious wear of electrodes. Based on the above characteristics, breaking the anode ring of ventricular electrode breaks resulted in poor ventricular intermittent pacing. Therefore, the patient was asked to immediately replace the pacemaker electrode. The patient and his family members stated that they would not consider it for the time being, and asked that they pay close attention to follow-up. If they feel uncomfortable, they should be diagnosed and treated as soon as possible.

Discussion

The patient had poor pacing prior to pacemaker replacement, but because pacing parameters were normal after several tests, and the detection threshold, as well as impedance trend, were normal, we misdiagnosed that poor pacing was caused by battery depletion. As a result, even after replacing the pacemaker, the patient
continued to experience pacing loss. After adjusting the pacing polarity to a single stage, the symptoms of patients improved and no poor pacing was found. Despite the absence of electrode breakage on the chest radiograph and the electrode parameters being normal, we thought that the patient had subclavian crush syndrome due to wear and breakage of the ventricular electrode anode ring. The venous entry route for the patient initially fitted with a pacemaker was the subclavian vein. The Subclavian is the most common site of wear and fracture of the pacemaker electrode. Prolonged compression of the electrode under the clavicle can lead to fracture of the anode ring. Pacing is normal when the rupture of the anode ring is in contact with each other, whereas poor pacing occurs when the rupture is separated due to changes in body position.

Currently, reported cases of pacemaker implantation complicated with subclavian crush syndrome have increased threshold; besides, the vast majority of patients have large fluctuations in lead impedance, particularly patients with pacemaker dysfunction. Therefore, for patients who are highly dependent on pacing, such as atroventricular block, the lead monitor should be changed from the default monitor to adaptive in the programmed setting of ventricular electrode pacing parameters. This is because in adaptive mode if the impedance of the pacing electrode increases, the pacing polarity will be automatically changed from bipolar to single-stage to avoid accidents caused by poor pacing. However, in our case, the pacing electrode parameters were normal in several measurements, and no obvious impedance fluctuation was found in the impedance measurement. Since the parameters of the pacemaker self-test and follow-up test are instantaneous, sometimes they cannot fully reflect the integrity of a long-term pacing system. X-ray chest films of such patients can often show damaged or broken wires, but no positive findings can be found in the early part. Therefore, it is impractical to identify all cases of subclavian crush syndrome after pacemaker implantation only through pacemaker programming and X-ray chest film. If a patient experience discomfort or the original symptoms recur, Holter and other examinations are recommended to determine whether there is abnormal pacing and perception. For patients with subclavian crush syndrome after pacemaker implantation, programming the faulty leads into monopolar pacing and monopolar sensing should be attempted, and bipolar leads can temporarily restore their functions. However, the lead will continue to wear, and patients will be at risk of malignant arrhythmia events, hence necessitating the need for timely lead replacement to avoid adverse events. Notably, replacement should be executed with extreme care to protect other fault-free wires. When replacing the lead or implanting the pacemaker, the axillary vein or cephalic vein should be selected as far as possible to avoid subclavian compression and reduce the occurrence of electrode breakage.

The subclavian crush syndrome after pacemaker implantation is a severe complication, which can cause sudden death, and early prevention is thus necessary. Primary prevention includes improving wire implantation path and patient education during operation; secondary prevention is primarily the standardized follow-up after the operation. When pacemaker leads are implanted, the incidence of breakage of axillary vein or cephalic vein leads becomes lower than that of subclavian leads, and the occurrence time is delayed. And compared to the cephalic vein path, the axillary vein route has a higher success rate of wire implantation and a lower incidence of wire failure. After pacemaker implantation, attention should be paid to the limb movement of the implanted side of the lead to avoid repeated pushing, pulling, lifting, and other actions.

Conclusion

By relying solely on pacemaker programming and chest radiograph, it is impossible to identify all patients with subclavian crush syndrome following pacemaker implantation. Subclavian crush syndrome should be diagnosed by combining patient symptoms, electrocardiogram, dynamic electrocardiogram, and imaging. After programming unipolar pacing and unipolar sensing, bipolar leads can temporarily restore their functions, but they should be immediately replaced. Lead implantation through the axillary vein or cephalic vein can effectively prevent this complication. Moreover, patient awareness and regular follow-up are important for their prevention.

Conflict of Interest

None declared.

Consent Statements
Confirmation that the author has obtained written informed consent from patient.

**Authorship**

Yurong Lian: Responsible for the implantation of the pacemaker, drafting the initial manuscript, and approving the final manuscript. Fang Wang: Assist in drafting and revising manuscripts. Xumin Duan: Performed pacemaker implantation and assisted in writing the manuscript. Chunxia Huang: performed PM implantation, and helped in drafting the manuscript.

**Reference**


**Figure 1**: Pacing ECG (bipolar), intermittent ventricular pacing loss, and third-degree atrioventricular block

![Figure 1](image)

**Figure 2**: 24-hour dynamic electrocardiogram (bipolar)
Figure 3: Chest radiograph of the patient
Figure 4 The X-ray results of follow-up