JMS 2022; Vol5 (3): 25-29
UDC:616.12-089.843:615.817]-06
DOI:10.55302/JMS2253025m

SUBCLAVIAN CRUSH SYNDROME AND INAPPROPRIATE SHOCKS IN PATIENTS WITH IMPLANTABLE CARDIOVERTER DEFIBRILLATOR

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Abstract

Subclavian crush syndrome may occur when the lead from the cardiovascular implantable electronic device (CIED) is trapped between the clavicle and the first rib, the insulation layer is damaged, or the conductor has been fractured. This complication carries an even greater risk if it involves a defibrillation electrode.

Case report

We describe a case of a 68-year old male patient with a sudden onset of Implantable cardioverter defibrillator(ICD) activation- shocks delivery, more than ten times in the period of two hours, right before admission to the emergency unit department. His ECG on admission shows the rhythm of the pacemaker with normal ventricular capture.

The device interrogation revealed 53 episodes of ventricular fibrillation- false detection and delivery of multiple inappropriate shocks. Low impedance was detected of pace/sense electrodes<200Ω, rise in shock impedance, ventricular oversensing episodes, and high pacing threshold. Due to InappropriateICD therapy, the detection was turned off.

Radiography findings have shown interruption of electrode – continuity in a position corresponding to subclavian crush syndrome, thereby implantation of the new system was indicated. The intervention of a new system implantation was performed without any complication in a standard procedure, using the left axillary vein approach.

We inserted a new ventricular single coil defibrillation electrode and a new ICD device. The patient was discharged in good clinical condition.

Physicians must demonstrate an excellent understanding of lead designs, the mechanism of lead fracture, diagnosis, and management, in order to make the best decision for every individual patient. Inappropriate shocks are a medical emergency and must be treated immediately. Individual approaches for each patient should be mandatory.

Keywords: subclavian crush syndrome, Implantable cardioverter defibrillator, lead fracture

Introduction

The most commonly used approaches for transvenous implantation of pacing systems are cephalic, subclavian, or axillary veins. Although the use of the cephalic vein allows visual inspection of the electrode insertion, and thus the least number of complications, operators often take the subclavian vein as the first option, due to the speed of access and the simplicity of the procedure.

When using the Seldinger technique, the risk of the following complications is possible with subclavian vein access: pneumothorax, hemothorax, undesirable arterial puncture, and injury to the brachial plexus. In the long term, a lead fracture may occur as a complication of subclavian vein access, more frequently (5,6%) than if access is obtained through cephalic vein cutdown (2,3%), or axillary vein puncture (1,2%), according to a study published in 2017[1].

Subclavian crush syndrome may occur when the lead is trapped between the clavicle and the first rib and the insulation layer is damaged or the conductor has been fractured. This complication carries an even greater risk if it involves a defibrillation electrode.

Case report

We describe a case of a 68-year old male patient with a sudden onset of Implantable cardioverter defibrillator(ICD) activation- shocks delivery, more than ten times in the period of two hours, right before admission to the emergency unit department. His ECG on admission shows the rhythm of the pacemaker with normal ventricular capture. (Figure1.12 -lead ECG on admission – showing unipolar pacing artefacts and ventricular capture)

From his previous medical history, the patient has ischemic cardiomyopathy, previous myocardial infarction, and LAD-stent implantation 10 years ago, re-infarction 2 years ago, and an episode of ventricular tachycardia, due to which a defibrillator wasimplanted as secondary prevention of sudden cardiac death. The previous echocardiographic findings revealed hypokinesiaof the midventricularand the apical segment of the posterior wall and the apical segment of the inferior wall, severely reduced global left ventricular systolic function (EF 20%) with a functional mitral and tricuspid valve regurgitation.

The biochemical analyses(blood count, biomarkers of hepatic and renal function, electrolytes in serum, cardiac troponin) were in normal ranges. The device interrogation revealed 53 episodes of ventricular fibrillation- false detection and delivery of multiple inappropriate shocks. Low impedance was detected of the pace/sense electrodes < 200**Ω**, rise in shock impedance, ventricular sensing failure, and high pacing threshold.

Due to the inappropriate ICD therapy,the detection was turned off.(Figure 2)We attempted to solve the problem by changing the lead polarity from bipolar to unipolar, which resulted in better impedance and a normal pacing threshold. Radiography findings have shown interruption of electrode – continuity in a position corresponding to subclavian crush syndrome,therebyimplantation of the new system was indicated. (Figure 3)

The intervention of the new system implantation was performed without any complication in standard procedure, using the left axillary vein approach. We inserted a new ventricular defibrillation electrode, single coil, and active fixation(stabile testing parameters: threshold 1.0V/O.40 msec. and impedance 727 ohms).

The patient was discharged in good clinical condition after 8 days, with a recommendation for medical treatment and a medical check-up after one month**.**

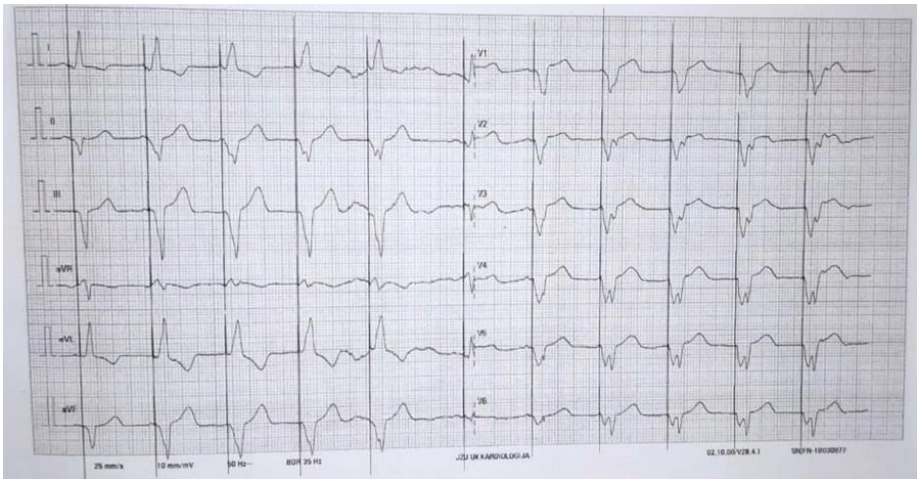

Figure 1.12-lead ECG on admission – showing unipolar pacing artefacts and ventricular capture

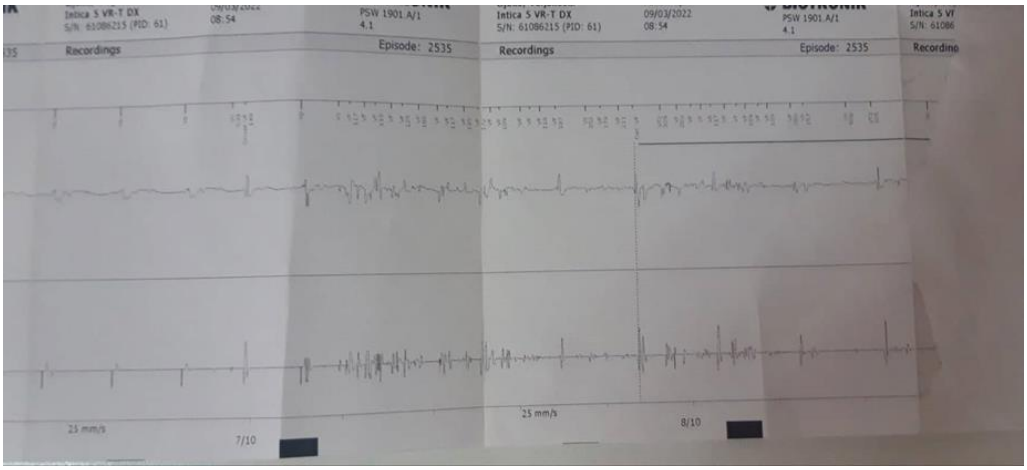

Figure 2. Impedance changes and noise recorded on stored intracardiac electrograms from the implantable cardioverter-defibrillator (ICD)

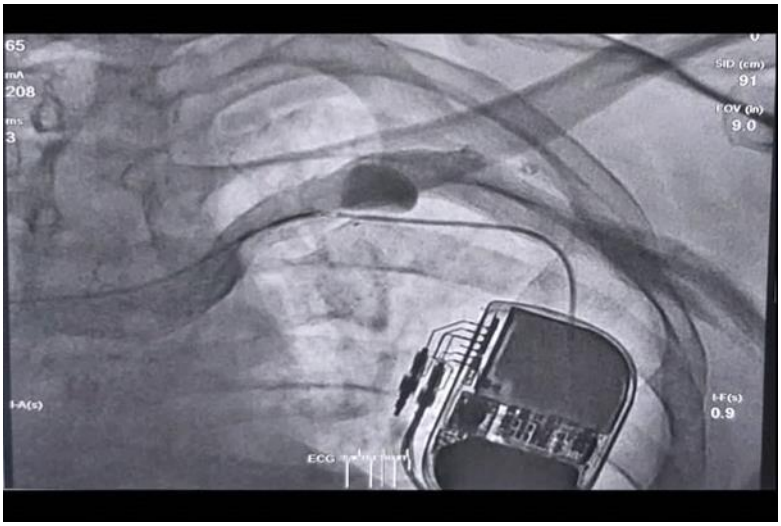

Figure 3. PA chest X-ray showing fractured lead

Discussion

Diagnostic criteria for lead fracture

The most common symptoms that may occur when a patient is having a pacing lead fracture are syncope, dizziness, palpitations, chest discomfort, and hiccups, or the patient may remain asymptomatic. The diagnostic criteria from device interrogation are EGM (electrogram), episodes of oversensing, and impedance change. X-ray examination usually identifies the place of the fracture.

If not diagnosed and treated on time, serious and fatal consequences can occur. Pace-sense malfunctions may also present a loss of capture, under-sensing, or abrupt decreases in the R-wave amplitude.

Noise recorded on intracardiac electrograms is caused by failure of the pace/sense conductor of the lead. When the implanted device is an ICD, this lead noise is eventually mistaken as a ventricular activity and inappropriate shock therapy may begiven [11,5].

Oversensing alert is one of the primary diagnostics for pace/sense parts of defibrillation leads; sensing is measured continuously, and, on the other hand, impedance is measured intermittently. Oversensing refers to the sensing of signals other than the QRS complex. Impedance is the ratio of voltage to current in an electrical circuit. Impedance increases with a lead fracture and decreases with an insulation breach. Well-defined indicators of an ICD problem, either lead failure or any connection problem, manifest a 50% to 75 % increase in pace/sense impedance. On the other hand, a gradual impedance increase without oversensing usually occurs at the electrode–myocardial interface, and lead replacement is not indicated unless pacing or sensing is compromised [7,6,4].

Lead dysfunction

Lead fracture or insulation failure is the main cause of lead dysfunction. In case of lead dysfunction, the lead can be abandoned or extracted. Lead extraction is a complex procedure, but if the implantation has been done 2 years before, the simple traction technique has a high success rate according to the ELECTRA Registry[2].

In our case, we have chosen to leave the lead because the risk of infectionduring lead extraction is higher and the implantation of the ICD was made 3 years previously.

Subclavian crush syndrome is associated with the type of the lead and patient's risk factors. It happens to be more frequent when multiple leads are involved, such as with ICD and dual chamber pacemakers.

On the other hand, patients under the age of 50,as they perform intense physical activity, will have a higher risk for lead fracture. Also, patients with lower BMI, have a higher risk for lead fracture[15].

According to the ELECTRA registry, lead dysfunction is the second and the most common reason for lead extraction, in 38.1% of cases[14].

A meta-analysis of 25 CRT trials noted mechanical complications in 3.2% (including coronary sinus dissection or perforation, pericardial effusion or tamponade, pneumothorax, and hemothorax), other lead problems in 6.2%, and infections in 1.4%. Peri-implantation deaths occurred in 0.3%, according to the 2021ESC Guidelines for cardiac pacing.

Determining the best approach

According to the experience and training of the doctor, the choice of approach is individual depending on the major advantage of the procedure. As preferred, venous access is cephalic cutdown, in addition to reducing the risk of lead fracture as well as avoiding needle injury to nearby structures. This access is not always acceptable for all patients because of the small size of the vein and tortuosity, and sometimes it might be difficult to isolate the vein or it can be absent. [9,10].

Fluoroscopic guided axillary vein cannulation has a 50% shorter venous access time (5.7 minutes) and 30% shorter total procedural time (34 minutes) compared to a cephalic cut-down, according to a prospective randomized study published in 2017. [12,13].

However, using cephalic cut-down and axillary vein approaches come up with very good outcomes. A higher procedural successful rate is associated with the axillary vein access.

When using the subclavian vein access, there is a higher risk of pneumothorax, hemothorax, undesirable arterial puncture, and injury to the brachial plexus.

Conclusion

Physicians must demonstrate an excellent understanding of diagnosis andmanagement, oflead fracture mechanisms and designs in order to make the best decision for every individual patient. There is a need for device interrogation and reprogramming if ICD failure is present with inappropriate shocks, as well as an individual approach when the lead fracture occurred. Management in every case needs to be individualized. One of the most commonly reported causes of lead fracture is the subclavian crush syndrome.

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