Pacemaker Lead Failure due to Subclavian Crush Syndrome: A Case Report

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Abstract

Background: Lead insulation failure or lead fracture due to crush injury is one of the potential complications of cardiac implantable electronic device (CIED) implantation. It usually occurs after medial intrathoracic puncture of the subclavian vein and results in damaging of the lead body by entrapment within the costoclavicular ligament and/or the subclavian muscle. We are presenting a case of a pacemaker lead failure due to subclavian crush syndrome that occurred twice, and it led to the acquisition of new pacing lead entry site.

Case: A 50-year-old male patient with a history of symptomatic bradycardia due to sick sinus syndrome. He was a manual worker and right-handed. He underwent dual chamber pacemaker implantation initially in the left pectoral area, but it was removed a year later due to infection complicating traumatic hematoma to the pacemaker pocket. He underwent implantation of a new pacemaker system on the right side with leads insertion through a percutaneous right subclavian vein puncture (SVP). He developed right atrial (RA) lead failure about 11 years later due to subclavian crush syndrome. He underwent a new RA lead implantation from the same site. He again had an RA lead malfunction about two years later due to the same mechanism. He eventually underwent a new pacemaker system implantation via the right cephalic vein.

Discussion: The cardiac pacing leads are prone to dislodgement, insulation failure, and conductor fracture. Lead fractures are seen with an incidence rate of 0.1 to 4.2% per patient-year. The cephalic vein cut down (CVC) and axillary vein puncture (AVP) approaches show better long-term efficacy and lower lead complication rates than the SVP approach for permanent pacemaker implantation.

Conclusion: Subclavian crush syndrome is one of the recognized causes of CIEDs lead failure, and it occurs mostly with SVP. Alternative approaches such as CVC down and AVP have been associated with better outcomes and fewer incidences of subclavian crush syndrome in comparison with the SVP approach.

Keywords
Subclavian Crush Syndrome; Pacemaker; Lead failure; Cephalic vein cutdown; Axillary vein puncture

Introduction

Cardiac implantable electronic devices (CIEDs) such as pacemakers, implantable cardioverter-defibrillators, and cardiac resynchronization therapy devices are essential tools in managing patients with bradycardia and tachyarrhythmia. Lead insulation failure or lead fracture due to crush injury is one of the potential complications of CIED implantation [1]. It usually occurs after medial intrathoracic puncture of the subclavian vein and results in damaging of the lead body by entrapment within the costoclavicular ligament and/or the subclavian muscle [1,2]. Here we are presenting a case of a pacemaker lead failure due to subclavian crush syndrome that occurred twice, and it led to the acquisition of a new pacing lead entry site.

Case

A 50-year-old male patient with a history of symptomatic bradycardia due to sick sinus syndrome. He was a manual worker and right-handed. He underwent dual chamber pacemaker implantation in July 1997 on the left pectoral area with leads insertion through a percutaneous puncture of the left subclavian vein, using standard techniques (pacemaker; Telectronics Meta DDDR 1256, right ventricular (RV) lead; Medtronic 5034, and right atrial (RA) lead; Medtronic CapSureFix 4568). He had a direct trauma to the pacemaker site about one year later, and it was complicated with hematoma and then pocket infection, so the pacemaker system was removed.
He underwent implantation of a new pacemaker system on the right side with leads insertion through a percutaneous puncture of the right subclavian vein in October 1998 (pacemaker; Medtronic Kappa 401 DR, right ventricular (RV) lead; CapSure SP 4024, right atrial (RA) lead; CapSureFix 4568).

He subsequently underwent pacemaker generator change using Medtronic E2DR01 pulse generator in 2006 due to battery depletion. The RA and RV leads were functioning normally (RA lead parameters: P wave 2.1 Millivolts (mV), pacing threshold 0.7 Volt (V) at 0.5 milliseconds (ms), and pacing impedance 511 ohms and RV lead parameters: R wave 8.7 mV, pacing threshold 0.8 V at 0.5 ms, and pacing impedance 501 ohms).

Upon follow up in April 2009, the RA lead was noted to have increasing pacing impedance from 462 to 1265 ohms, and failure to capture. His pacemaker was programmed to VVIR. Chest X-ray showed fractured RA lead at the medial puncture site of the subclavian vein (Figures 1 a-d).

The patient lost to follow up for about six years. On follow up in August 2016, the pacemaker battery was depleting, so he underwent insertion of a new RA lead (CapSureFix Novus MRI SureScan 5076) using the right subclavian approach as the pocket was medial, and it was not possible to access the axillary vein, and pacemaker generator was changed using Medtronic Adapta ADDR01 pulse generator (Figure 1b).

Two years later, the device analysis showed RA pacing impedance of 396 ohms (it was 562 ohms previously), pacing threshold 1.0 V at 0.4 ms and P wave of 1.0 mV which was previously 5.6 mV. Chest X-ray showed partial thinning and damage to the atrial lead body at the medial puncture site of the subclavian vein (Figure 1c).

After discussion with the patient, the decision was made to go for a new pacing system implantation. The left arm venogram showed an occluded left subclavian vein likely from previous venous cannulation, so the left pectoral area could not be used. With the opening of the old right pectoral pocket, the RA lead was noted to have insulation breach (Figure 2). The recent two-years-old RA lead was removed completely and the remnant of the old RA lead which was still on the floor of the pacemaker pocket was also removed. The new RA lead was inserted through the right cephalic vein with standard cut down technique (Figure 1d).

The patient is currently on regular follow up in the pacemaker clinic with proper pacing parameters.

**Discussion**

The transvenous leads are considered the weakest component in the transvenous CIEDs. They are prone to dislodgement, insulation failure, and conductor fracture. Lead fractures are seen with an incidence rate of 0.1 to 4.2% per patient-year [3]. The lead fracture may occur at the site of entry (40%), the area between the entry site and generator (28%), close to the generator site (23%), or intravascularly (7%) [3].

The venous access for transvenous CIEDs can be achieved by subclavian vein puncture (SVP), axillary vein puncture (AVP), or cephalic vein cutdown (CVC).

In a recent survey in European countries, CVC and SVP are the two most commonly used approaches as they are preferred as the first approach in 60% and 40% of the participating centers respectively [4]. In the case of the subclavian approach, 52% using intra-thoracic access, and 48% of the centers reported using an extra-thoracic (axillary vein) access [4].

However, the SVP with intra-thoracic puncture technique is associated with complications such as lead fracture, insulation injury, brachial plexus injury, pneumothorax and hemothorax. Looking to old venous access techniques, the lead fractures tend to occur

**Figure 1:** Posteroanterior (PA) chest X-ray showing:
- Impending fracture of the right atrial (RA) lead at the right subclavian vein entry point (Red arrow)
- Pacemaker generator change with insertion of new RA lead (RA2)
- Fracture of the old right atrial (RA1) lead at the right subclavian vein entry point (red arrow) and partial thinning of the new RA lead (RA2) (blue arrow)
- The new RA lead (RA2) via cephalic vein (red arrow) and the abandoned old RA lead (RA1)
more commonly with the internal jugular approach compared to the external or cephalic vein approach [5].

Data from a recently published meta-analysis demonstrates a lower risk for pneumothorax and lead failure associated with CVC as compared to SVP. Hence, CVC was suggested to be the preferred venous access [6].

Another approach is via the extra-thoracic SVP or the AVP. The axillary vein terminates at the outer border of the first rib, immediately beneath the clavicle. The anatomical location makes it a favorable venous access with easy feasibility and allows the insertion of multiple leads [7]. The AVP approach shows better long-term efficacy and lower lead complication rates than the SVP approach for permanent pacemaker implantation [8,9].

Our patient presented with RA lead failure twice due to subclavian crush syndrome. The first RA lead fracture occurred about 11 years after pacing system implantation, and the second RA lead had a partial thinning with lead insulation breach in only two years, likely due to the presence of three leads in the same narrow space. Medial puncture site for venous access and excessive right arm movement are believed to be the major contributing factors. The new (third) RA lead was inserted via CVC to minimize the risk of lead failure.

The symptoms of a pacemaker lead fracture may vary from being completely asymptomatic, in non-pacer dependent patients, to the symptoms of chest discomfort, dizziness, palpitations, pre-syncope, or syncope. In order to determine the presence of a lead fracture, ECG and pacemaker analysis are often diagnostic but other imaging modalities such as a chest X-ray or fluoroscopy may be required.

The treatment options of lead fracture are typically individualized. The usual treatment is to place a new lead without extraction of the old one, to avoid the potentially serious complications of lead extraction. However, there are no controlled clinical studies that compare the benefits of lead abandonment in comparison to extraction [10]. In our patient, the initial management with first lead fracture was implantation of a new lead without lead extraction. However, in the second time, the old RA lead was removed from the pocket, and the relatively new RA lead was removed.

Conclusion

Subclavian crush syndrome is one of the recognized causes of CIEDs lead failure, and it occurs mostly with SVP. Alternative approaches such as CVC down and AVP have been associated with better outcomes and fewer incidences of subclavian crush syndrome in comparison with the SVP approach.

Conflicts of Interest

The authors declare no conflict of interest related to this manuscript.

References