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Case Report

Different vascular access approaches for permanent pacemaker in patients with bilateral subclavian vein stenosis: Reports of two cases

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ABSTRACT

Bilateral subclavian vein (SCV) stenosis is a common finding in patients requiring permanent pacemaker (PPM). The prevalence of bilateral SCV stenosis without catheter intervention is unknown. Alternative venous ways or interventional treatment may be necessary when the conventional method of PPM lead implantation via axillary, subclavian, or cephalic vein is not feasible. Hereby, we presented a 51-year-old female patient and an 81-year-old male patient with primary complaints of dizziness and weakness and were diagnosed with severe bilateral SCV stenosis. One of whom had chronic kidney disease. Different methods for PPM implantation were described in two cases of bilateral SCV stenosis.

Keywords: Internal jugular vein, permanent pacemaker, subclavian vein occlusion.

Implantation of a permanent pacemaker (PPM) is most commonly achieved using vascular access established at the upper limbs, subclavian, or cephalic veins.[1] The prepectoral region of the non-dominant arm is preferred for implantation. The cephalic vein is isolated by applying a standard prepectoral incision along the delto-pectoral groove. If cannulation of the cephalic vein is difficult or if larger areas are needed due to the number of leads, alternative access points include the subclavian vein, external jugular vein, internal jugular vein (IJV), iliac vein, or femoral vein.[2] However, in some cases, accessing these veins is still difficult due to occlusions or congenital anomalies (e.g. persistent vena cava superior). In such a situation, epicardial pacing or percutaneous balloon angioplasty can be used. When choosing between the methods, the clinical condition of the patient and the experience of the physician are important, since epicardial pacing is more invasive and has a higher risk of complications. Even if a minimally invasive technique is used, epicardial pacing is related to increased morbidity and perioperative mortality, prolonged hospital stays averaging 4-5 days, and a high risk of lead dislocation.[3]

In this report, the cases of two patients who had bilateral subclavian vein (SCV) stenosis occlusions but needed PPM are reported using two different techniques.

CASE REPORT

Case 1- A 51-year-old female patient was admitted to the emergency department with dizziness for 10 days and syncope during hemodialysis. She had had a history of hypertension and chronic kidney disease for 10 years. She underwent hemodialysis three times per week. The clinical examination revealed a blood pressure of 145/95 mmHg, heart rate of 70/min, normal cardiac and respiratory system examination, and a sternotomy scar. There were many arteriovenous fistula scars on multiple sites including femoral

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veins and there was a permanent dialysis catheter on the left SCV. Electrocardiography revealed a normal sinus rhythm. Holter electrocardiography revealed more than 3-second-sinus pause attacks. Laboratory analysis showed blood urea of 91.6 mg/dL, serum creatinine level of 5 mg/dL, potassium level of 3.7 mmol/L, and thyroid stimulating hormone level of 1.7 mU/mL. Transthoracic echocardiography and coronary angiography findings were normal. Right upper extremity venous angiogram was performed due to the presence of a permanent hemodialysis catheter in the left SCV. A total obstruction was detected in the right subclavian vein, as shown in Figure 1a. The right supra clavicular puncture was first tried under fluoroscopy by using a road map but it was not successful. As a second choice, epicardial pacemaker implantation by surgical method was offered but the patient refused to undergo the procedure. Thus, PPM implantation was performed via the right internal jugular vein (RIJV). After local anesthesia was administered to the neck and infraclavicular area, RIJV puncture was performed with the Seldinger technique. The PPM lead was inserted into the right ventricle apex and fixated to the subcutaneous area on the neck with synthetic non-absorbable ties. The pocket was opened to the right infraclavicular region with standard procedure and PPM lead was moved from the punction site to the pocket through a subcutaneous tunnel by means of a blunt dissection. A PPM VVI battery (Medtronic Inc., Minneapolis, MN, USA) was placed in the pocket after the lead connection. The pocket and the cut area were irrigated with 250 mg of no diluted rifampicin. The cut site and pocket were closed subcutaneously with an absorbable suture and cutaneously with a nonabsorbable suture, as shown in Figure 1b. The procedure was completed without any complication, as shown in Figure 1c on the puncture site and pocket in a week and a month of follow-up.

Case 2- An 81-year-old male patient was admitted to the emergency department with dizziness and weakness. He had a non-obstructive atherosclerotic coronary artery disease detected a year ago. The patient was followed up closely for five days after successful coronary angiography. An electrocardiogram revealed a normal sinus rhythm with 70 bpm. Laboratory examination showed blood urea of 30 mg/dL, serum creatinine level of 1.8 mg/dL, potassium level of 4.5 mmol/L, and thyroid stimulating hormone level of 1.7 mU/mL. Twenty-four-hour Holter electrocardiography was performed, and intermittent total atrioventricular block was detected. Because of an unsuccessful puncture of the left subclavian vein, left upper extremity venography was performed. A severe stenosis was detected in the left subclavian vein. Right upper extremity venography was performed for the right subclavian approach and severe stenosis on the junction with RIJV was also detected, as shown in Figure 2a. Hence, percutaneous balloon angioplasty was performed on the right subclavian vein. After the right axillary vein puncture, 6F sheet was placed with the Seldinger technique. A 0.038-inch stiff guide-wire Amplatz super stiff (Boston Scientific Bloomington, IN, USA) was left at the vena cava superior, and a 9.0×40 mm balloon Phantom glide balloon (Endocor, Hamburg, Germany) was inflated at 16 atm pressure to the stenosis in the subclavian vein, as shown in Figure 2b. Routine PPM implantation was performed via the subclavian vein puncture after maintenance of adequate venous opening without any complication, as shown in Figure 2c.

DISCUSSION

Permanent pacemaker is conventionally inserted through the upper limb veins, for example, the axillary, subclavian, or cephalic vein. Achieving venous access through the axillary, subclavian, or cephalic veins is straightforward, requiring minimal dissection, and is associated with a low incidence of complications. This method of access also allows for the placement of the pacemaker generator in the infraclavicular region, an ideal location due to its minimal movement, easy accessibility, relative cleanliness, and patient comfort. However, venous occlusion or thrombosis is a common finding in patients undergoing device implantation or revision.[4] Occlusion or thrombosis is common in patients who have undergone previous pacemaker implantation or who have a history of central venous cannulation that causes inflammation and fibrosis. The incidence of occlusion or thrombosis is estimated to be as high as 13.7% in de novo implants and 26-64% in system upgrades.[5] Venous thrombosis is more common in patients with chronic kidney disease because of repeated

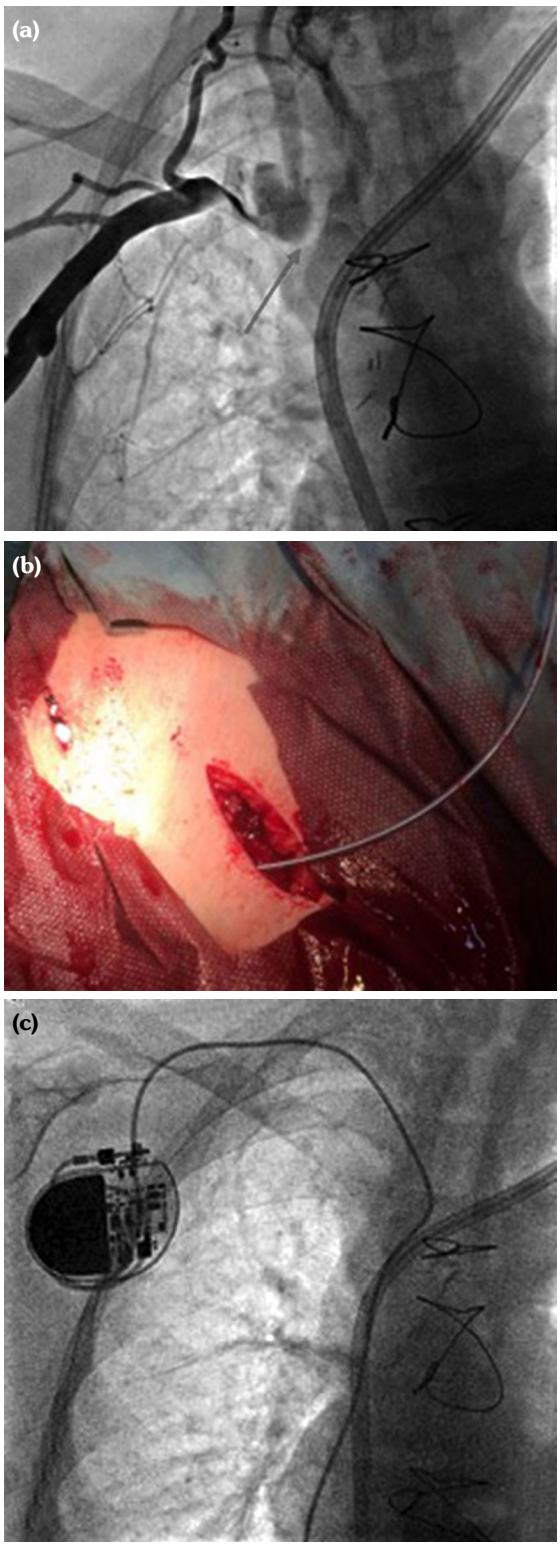

Figure 1. (a) Total occlusion of the right subclavian vein. **(b)** Permanent pacemaker lead from the right internal jugular vein to the right infraclavicular region trough subcutaneous tunnel. **(c)** Final of the procedure. Pulse generator located to the infraclavicular region and permanent pacemaker lead located to the right ventricle.

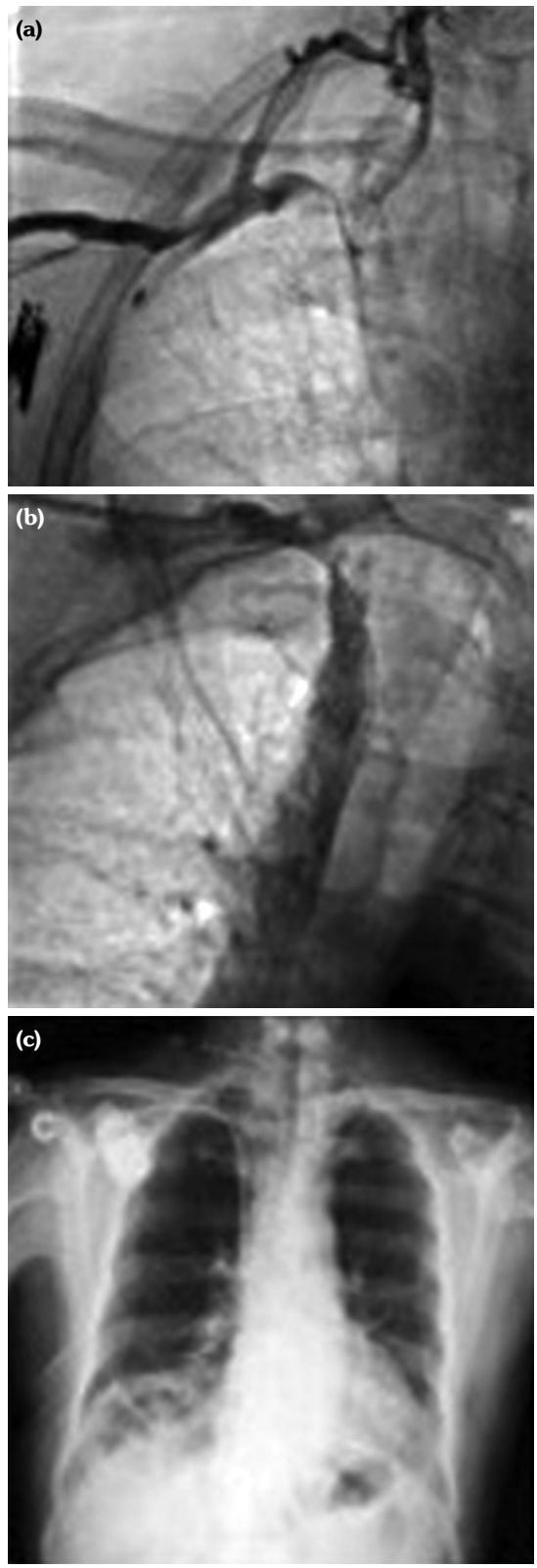

Figure 2. (a) A severe stenosis of the right subclavian vein. **(b)** Balloon dilatation to the subclavian vein. **(c)** Successful permanent pacemaker implantation after the ballooning.

venous interventions. Bilateral obstruction of the SCV is rare and usually asymptomatic but may cause edema on the face, upper extremities, and chest.[6] When the upper extremity is not feasible for PPM implantation, other vascular access options and percutaneous interventions should be considered. In our cases, we managed to perform implantation with the most ideal method successfully. In case of difficult PPM implantation, some alternative methods can be considered.

Epicardial pacing by way of thoracotomy has long been used as an alternative method, but it is more invasive and has a higher risk of complications. Moreover, epicardial also leads to higher pacing thresholds with a greater incidence of lead fractures compared to transvenous leads.[7] Therefore, epicardial pacing is not preferred because of these limitations.

Supraclavicular venous access puncture is made over the clavicle, more medially, approximately at the junction of the IJV. This technique is applicable in cases with distal obstruction of the SCV. The supraclavicular approach has advantages over the standard infraclavicular technique. The area is not only wider but also a shorter distance to the vein. The risk of complications is lower due to the longer distance of the puncture point to the lung.[8] On the other hand, the IJV is in close relationship to the carotid artery and nerves in the vicinity such as the vagal, phrenic, and recurrent laryngeal nerves, which makes access challenging.[9,10] The external jugular vein is usually small in caliber, tends to join the SCV at a sharp angle, and is often tortuous. Trans-venous pacing can be performed using either the trans-iliac or trans-femoral approach. Studies involving a trans-iliac approach for implantation report high complication rates with a significant number of lead dislodgements (7-21%).[11] The femoral vein may be safer than the iliac vein because of its extraperitoneal location; hemostasis can be more easily reached. This technique requires a longer lead, but lead dislocation has been reported to be 11-21% for atrial leads and 5-7% for ventricular leads. In this method, the pulse generator is placed on the abdominal wall or in the thigh.[12]

Percutaneous balloon angioplasty is the basic intervention technique in the treatment of central vein lesions in hemodialysis and other patients. In rare cases, if balloon angioplasty cannot provide adequate enlargement of the lesion, stenting is required. When choosing between methods, the suitability of the patient to the method to be chosen and the experience of the center to perform the procedure are important.

In our first case, a hemodialysis catheter was located in the left SCV, and there were multiple arteriovenous fistula scars, including in the femoral sites. Therefore, venography was performed to the right upper venous system before PPM implantation, and occlusion was detected at the left SCV. Hence, epicardial pacemaker implantation by surgical method was offered since it has been traditionally viewed as the "bail-out" option. However, the patient refused the procedure. The supraclavicular puncture was not successful due to a distal obstruction. Femoral veins were bilaterally obstructed because of hemodialysis catheter interventions. Therefore, PPM implantation via RIJV was performed because of the anatomy of the vessel and the patient's risks, as well as our experience. Restoring the SCV is an important option for PPM implantation in SCV stenosis. Balloon angioplasty is the first choice for hemodialysis-related central venous obstructions. Stenting is indicated in cases in which the balloon is unsuccessful, in cases with restenosis after balloon angioplasty, or in cases of chronic total occlusion.[13,14] Horita et al.[15] reported endovascular treatment success rates of 96.8% in central vein stenosis and 87.8% in chronic total occlusion in their study which included 221 patients.

Percutaneous interventions have some limitations, Despite its usefulness and acceptable results. Balloon angioplasty is contraindicated without thrombectomy in the presence of a large, recent thrombus. Left brachiocephalic vein lesions may be organic in origin due to the compression of the big arteries or sternum. Therefore, stenting is not recommended in these cases.

In chronic total occlusion cases, retrograde access from the femoral or other SCV is necessary to ensure the technique is the true lumen or inside-out technique. The inside-out technique has been reported in a limited number of cases with good success rates

and without major complications.[16] Recently, Aye et al.[17] described a hybrid laser-assisted technique using excimer laser intervention from the retrograde access and then used the knuckle wire technique. They reported that balloon dilation after crossing the occlusion was successfully performed simultaneously with antegrade venography.

In our first case, left SCV intervention was inappropriate and risky since the femoral veins and left SCV were occluded. Perforation and dissection are more risky in this situation. Meanwhile, in the second case, the right SCV is totally occluded, and the left SCV is partially obstructed, hence percutaneous balloon angioplasty was performed on the SCV and ultimately placed the PPM.

In conclusion, alternative vascular access or balloon angioplasty to the SCV can be useful and feasible if bilateral subclavian venous access is not possible because of stenosis or the presence of a hemodialysis catheter. Venography may be appropriate before starting the PPM procedure not only for patients with a history of multiple vascular procedures but also for elderly patients who may have asymptomatic SCV stenosis. Vascular access options should be evaluated according to the vascular condition of the patient. In both of our cases, after PPM implantation, they did not have any problems in follow-up their medical treatments were arranged and they were discharged without any additional complaints.

Patient Consent for Publication: A written informed consent was obtained from the patients.

Data Sharing Statement: The data that support the findings of this study are available from the corresponding author upon reasonable request.

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