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Mini Review

Implantation of Permanent Dual Pacemaker with Persistent Left Superior Vena Cava as Usual Procedure. Experience of One Beginner Surgeon

Zamudriakov SS[1]*, Ivanitskii EA[2] and Sakovich VA[3]

[1]Department № 2, Treatment of Cardiac Arrhythmias, "Federal Center of Cardiovascular Surgery" Ministry of Health, Russian Federation, Krasnoyarsk, Russia

[2]Doctor of Medical Sciences, Department № 2, Treatment of Cardiac Arrhythmias, Head of Department, "Federal Center of Cardiovascular Surgery" Ministry of Health, Russian Federation, Krasnoyarsk, Russia

[3]Doctor of Medical Sciences, Medical Chief, "Federal Center of Cardiovascular Surgery" Ministry of Health, Russian Federation, Krasnoyarsk, Russia

***Corresponding Author:** Zamudriakov SS, Department № 2, Treatment of Cardiac Arrhythmias, "Federal Center of Cardiovascular Surgery" Ministry of Health, Russian Federation, Krasnoyarsk, Russia

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Abstract

Implantation of antiarrhythmic devices is a routine treatment method in the practice of a doctor, who do a surgical treatment of cardiac arrhythmias. A dual chamber pacemaker is a main type of treating cardiac bradyarrhythmias. The classic technique of implanting electrodes in cardiac is not difficult for beginner and surgeons with experience. Patients who have a corrected congenital heart defects or anatomical features, may be a reason of some difficulty, like increase the duration of fluoroscopy, change of surgeon approach, heart and vascular damage. There are can be risk of complications in the postoperative period. Often, persistent left superior vena cava (PLSVC) is an anatomical feature of the patient, as a result of a violation of embryogenesis, and is a normal variant. In most cases, this feature is detected intraoperative, after puncture vein, and the entering of guidewire into the vascular, confirmed by venography. From 2021 to 2023, at the Federal Center of Cardiovascular Surgery in Krasnoyarsk Russia, were implanted 541 pacemakers, during the implantation of antiarrhythmic devices, the anatomical feature in the form of PLSVC was intraoperative identified in six patients (1.1%). These patients were successfully implanted with a dual-chamber pacemaker system.

Keywords: Pacemaker; Persistent Left Superior Vena Cava; Bradyarrhythmias

Introduction

Persistent left superior vena cava represents the most common congenital venous anomaly of the thoracic system, in 0.3% to 0.5% of individuals in the general population, and in up to 12% of individuals with other documented congenital heart abnormalities [1]. For the first time PLSVC described by Edwards and DuShane in 1950 [2]. The presence of PLSVC is commonly associated with other congenital cardiac anomalies such as atrial septal defect, Tetralogy of Fallot, aortic coarctation, ventricular septal defect and very rarely as isolated finding [3]. The developmental anatomy of the PLSVC is difficult process and, this viewed from the posterior aspect of the heart in Figure 1 [6]. Normally, the right internal jugular vein and the right subclavian vein unite to form the right brachiocephalic trunk, which by joining with left correspondent form the superior vena cava. In the case of the persistence of the left superior vena cava, the right brachiocephalic trunk joins the

left subclavicular vein and the left internal jugular vein and drains through PLSVC with opening through the coronary sinus ostium in the right atrium (Figure 2) [4]. When is isolated, PLSVC does not generate significant hemodynamic impact, this abnormality of the vein system often remain asymptomatic and may complicate the implant procedures of cardiac devices, such as pacemakers, ICDs, or cardiac resynchronization therapy [5].

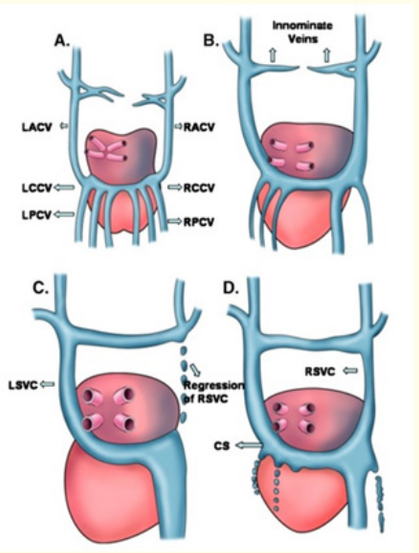

Figure 1: Developmental anatomy of the persistent left superior vena cava.

A: Pairs of anterior and posterior cardinal veins draining into the embryonic heart via the right and left common cardinal veins.

B: Development of bridging innominate vein connecting left and right anterior cardinal veins during 8th week of gestation.

C: Regression of the right-sided superior vena cava with persistence of left-sided superior vena cava as a single superior vena cava that drains the cephalic portion of the body including upper extremities.

D: Right-sided superior vena cava connected with the persistent left superior vena cava via innominate vein in the post-natal heart.

Abbreviations: CS: coronary sinus, LACV: left anterior cardinal vein, LCCV: left common cardinal vein, LPCV: left posterior cardinal vein, LSVC: left superior vena cava, RACV: right anterior cardinal vein, RCCV: right common cardinal vein, RPCV: right posterior cardinal vein, RSVC: right superior vena cava.

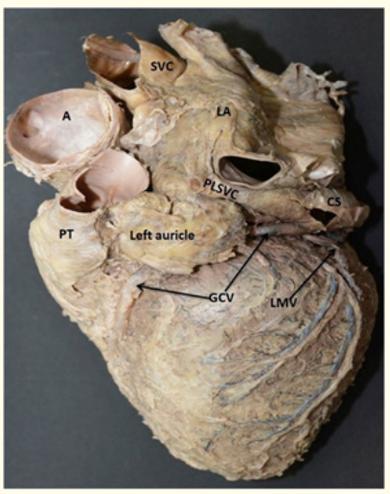

Figure 2: Showing persistent left superior vena cava and great cardiac vein draining into the coronary sinus. PLSVC, persistent left superior vena cava; GCV, great cardiac vein; CS, coronary sinus; LMV, left marginal vein; LA, left atrium; SVC, superior vena cava; A, aorta; PT, pulmonary trunk [3].

Methods

From 2021 to 2023, at the Federal Center of Cardiovascular Surgery in Krasnoyarsk Russia, were implanted 541 pacemakers, during the implantation of antiarrhythmic devices, the anatomical feature in the form of PLSVC was intraoperative identified in six patients (1.1%). By Holter monitoring rhythm disease detected in the form of sick sinus syndrome - 3 patients, and with atrioventricular block of different grades - 3 patients. Also, patients had clinical complaints with weakness and dizziness, which were indications for implantation of a dual-chamber pacemaker. In preoperative preparation, have a diagnostic protocol as: physical examination, laboratory diagnostics in the form of a general blood test, biochemical, blood group and Rh factor. Instrumental diagnostics have electrocardiographic examination, Holter monitoring, echocardiography. Before pacemaker implantation, two patients were diagnosed with corrected congenital cardiac anomalies in the form of Tetralogy of Fallot, and atrial septal defect. Preoperatively, patients had heart failure NYHA II - 4 patients, NYHA III – 2 patients. Left ventricular ejection fraction 53.3% ± 5.3; final diastolic volume of the left ventricle 99.5 ml, ± 25.1; systolic pressure in the pulmonary artery mm Hg 45.5 ± 10.8; right atrium volume 57.8 ml, ± 33.9; left atrium volume 88.5 ml, ± 41.9. The surgical intervention is performed under local anesthesia, surgical approach is performed in the left subclavian region, the length of the skin incision is about 5 cm, parallel to the clavicle, the surgeon dissects the tissue layer by layer to the fascia of the pectoralis major muscle, a pocket is formed for the future pacemaker and electrodes. The next step is vascular approach to the subclavian or axillary vein, according to the Seldinger technique. After successful puncture of the vein, the guidewire is located into the venous system, with fluoroscopy control. Surgeon meet the abnormal position of the guidewire in the heart shadow, avoid the Innominate vein and the superior vena cava. After this, make a venography, as the results the anatomical anomaly in the form of PLSVC. With this situation surgeon implants the atrial and ventricular electrodes using non-classical maneuvers for fixing into the chambers of the heart, because in the heart none the previous anatomical angle in the venous system. The electrodes are comes into the right ventricle without help of a stylet, because the surgeon needs go through such anatomical parts as the coronary sinus and tricuspid valve. As for fixing the electrode for the free wall in the right atrium, stylets are used. Our clinic uses active fixation electrodes from different manufacturers. The use of active fixation leads with special curved stylet may help in overcoming this technical difficulty [7]. During implantation, are tested the parameters, such as stimulation threshold, impedance, and sensitivity. We are use test with 10 V stimulation to avoid diaphragmatic stimulation, and tests with a deep breath and cough for the stability of the electrode position in the endocardium. As a result, of the six procedures, all atrial electrodes were implanted in the area of the free wall of the right atrium. Ventricular electrodes were implanted in the apex region in two patients, and in the ventricle septum region in four patients (Figure 3). The surgical intervention time was 77.5 minutes ± 45.5; with fluoroscopy time 12.3 min ± 16.12. Intraoperative parameters of stimulation were adequate. The right ventricular pacing threshold was 1.6 V ± 0.4; sensitivity 10.8 mV ± 2.4; impedance 821.8 Om ± 80.2. The right atrium pacing threshold was 1.1 V ± 0.5; sensitivity 2.4 mV ± 0.9; impedance 565.8 ± 77.1. In the early postoperative period, on X-ray control, the dislocation of the atrial electrode was detected in one patient. This patient had a repositions electrode with a satisfactory clinical effect (Figure 4).

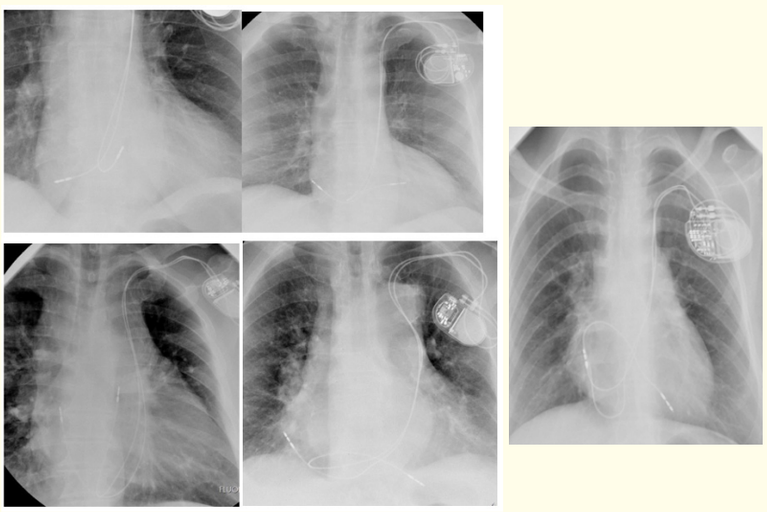

Figure 3: Showing persistent left superior vena cava and great cardiac vein draining into the coronary sinus. PLSVC, persistent left superior vena cava; GCV, great cardiac vein; CS, coronary sinus; LMV, left marginal vein; LA, left atrium; SVC, superior vena cava; A, aorta; PT, pulmonary trunk [3].

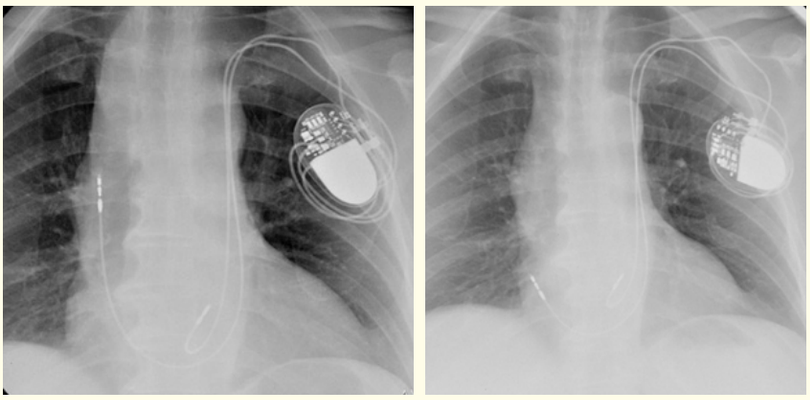

Figure 4: Example of atrial electrode dislocation on the left; and example of electrode reposition after dislocation on the right.

Discussion

In this way, implantation of antiarrhythmic devices with using a standard left-sided approach is possible, even if patient has PLSVC and anomaly of the venous system. It is important to understand that the patient with previously corrected congenital heart disease can have the PLSVC. It recommended to not change the approach on contralateral side, in view to avoid an infectious complications, and it also increase the area of surgical aggression for the patient. It also eliminates complications with puncture of veins near the arteries and lung on contralateral area. Dislocations of electrodes are possible, even doctor use other methods and technique [8]. The use of electrodes with active fixation let the place, and fix electrodes at any chambers of the heart, it possible to fix in the ventricle septum, or in apical positions for cardiac stimulation. With standard left-sided implantation, it is possible to achieve adequate stimulation parameters. The anatomical bends in heart chambers with PLSVC are not typical for leads, compare with classical anatomy, surgeon should use the big loops, because it may decrease big tension on a lead, it helps avoid of electrode dislocations. In the world literature there are have reports, about successful implantation of left ventricular leads through PLSVC. Sometimes this technique can use, if the anatomy has comfortable veins angles in coronary sinus for lead implantation. If this conditions are have, this method possible in practice for biventricular pacemakers [9,10]. If this method don't possible, surgeon should use alternative techniques, as right-side implantation or use epicardial leads.

Conclusion

The Implantation of a dual-chamber pacemaker is a routine method of treating cardiac arrhythmias. A doctor, who meet with this method, should always remember about anomalies of the venous and cardiac system, he must be prepare to decide this problem, without doubt.

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