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Stechnolock Journal of Case Reports

CASE REPORT

Successful Implantation of a Leadless Pacemaker in a Patient with Sick Sinus Syndrome and Persistent Left Superior Vena Cava: A Case Report

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Citation: Bo Zhou, Feng Xie, Xiao-li Tan, Sha-sha Wu, Chang-qing Yuet al. (2024) Successful Implantation of a Leadless Pace maker in a Patient with Sick Sinus Syndrome and Persistent Left Superior Vena Cava: A Case Report, Stechnolock J Case Rep 4: 1-8

Abstract

Background: Persistent left superior vena cava (PLSVC) is a rare congenital venous anomaly that can complicate pacemaker implantation due to altered venous anatomy.

Case Report: We present a case of an 87-year-old man with sick sinus syndrome (SSS) and PLSVC, where traditional transvenous pacemaker implantation was challenging. Instead, we opted for leadless pacemaker (LP) implantation via the right femoral vein. The LP was successfully anchored in the septum of the right ventricle, providing stable pacing parameters and favorable clinical outcomes at the 3-month follow-up. Leadless pacemakers offer a promising alternative in patients with challenging venous anatomy, eliminating the need for venous access and reducing the risk of lead-related complications.

Conclusion: LP implantation in patients with PLSVC and SSS is feasible and safe, suggesting it as a viable therapeutic option. This case underscores the potential of LP to overcome anatomical challenges and improve patient care in such scenarios.

Keywords: Persistent Left Superior Vena Cava; Sick Sinus Syndrome; Leadless Pacemaker; Case report

Introduction

Persistent left superior vena cava (PLSVC) is a congenital venous abnormality, occurring in 0.3 to 0.5% of individuals in the general population [1, 2]. Most cases are characterized by drainage into the coronary sinus (CS), typically accompanied by an enlarged coronary sinus. PLSVC is predominantly asymptomatic and often discovered as an incidental finding during various imaging procedures, central venous catheterization, or cardiac device implantation. Numerous reports have documented the successful implantation of permanent pacemakers in such cases [3, 4]. However, the insertion of a transvenous permanent pacemaker can pose challenges in patients with PLSVC due to their complex anatomy, The dilation of the CS can complicate the positioning of pacing leads from the left subclavian region, particularly the ventricular lead, often necessitating the placement of right ventricular leads at the apex. Instead, epicardial lead implantation via thoracostomy is commonly utilized despite its high invasiveness[5, 6], the leadless pacemaker(LP) implantation may be appropriate option for the patient due to its less invasive nature[7, 8]. To the best of our knowledge, this is the first reported case of LP implant atcion in a patient with PLSVC who presented with sick sinus syndrome.

Case Report

An 87-year-old man with a history of hypertension and diabetes was admitted to our hospital presenting symptoms of chest tightness and palpitations persisting for three years. Electrocardiography revealed significant bradycardia (heart rate 38 beats/minute) and a high-grade atrioventricular block (Figure 1A, 1B). Further confirmation of sinus pauses lasting 6.33 seconds was obtained through a twenty-four-hour dynamic electrocardiogram (Holter) (Figure 1C). A temporary epicardial pacemaker was promptly implanted, maintaining the heart rate at 50 beats per minute. Vital signs indicated a blood pressure of 135/73 mmHg. Echocardiographic assessment showed no structural abnormalities, and preserved left ventricular function, qualifying the patient as a suitable candidate for a DDD pacemaker implantation [9].

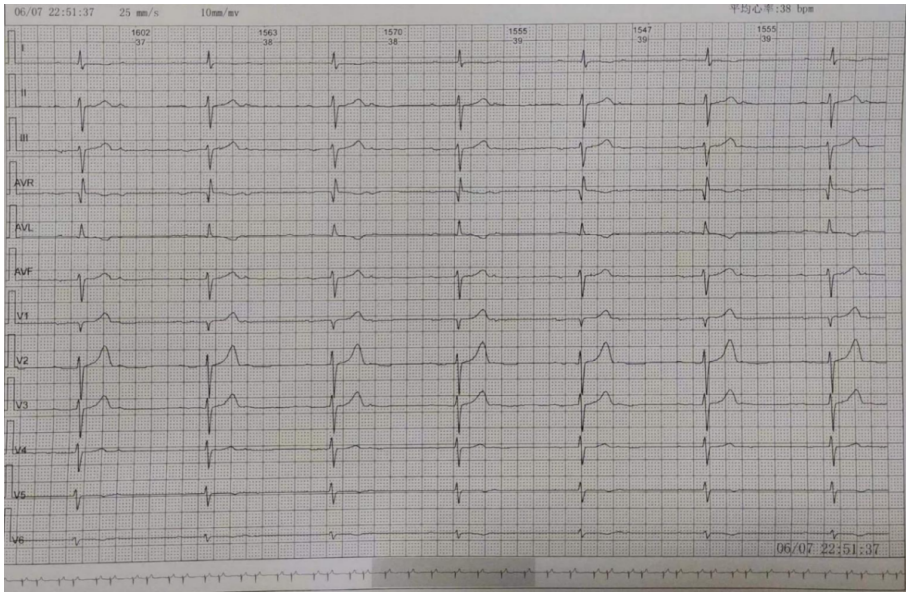
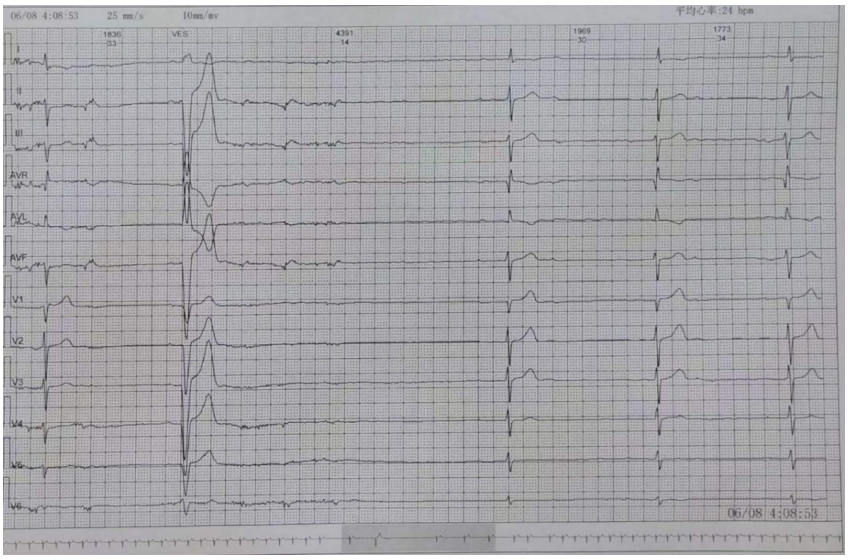


Figure 1A



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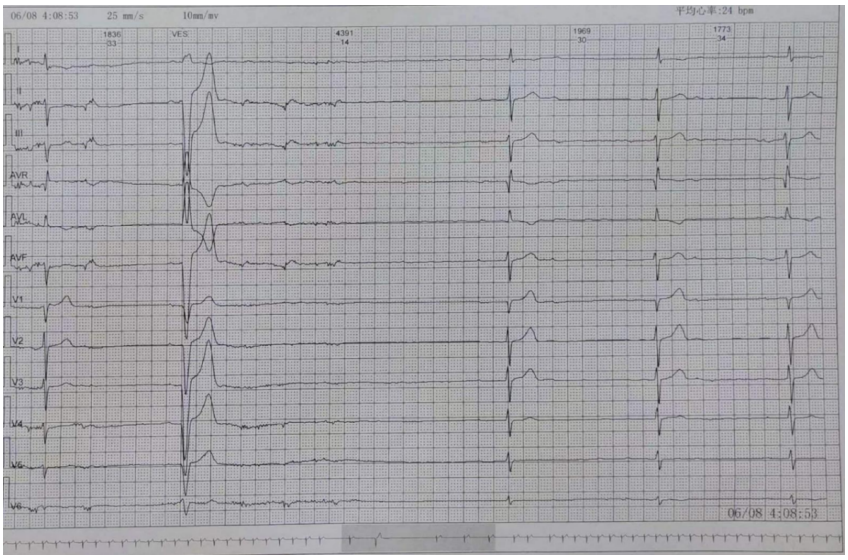

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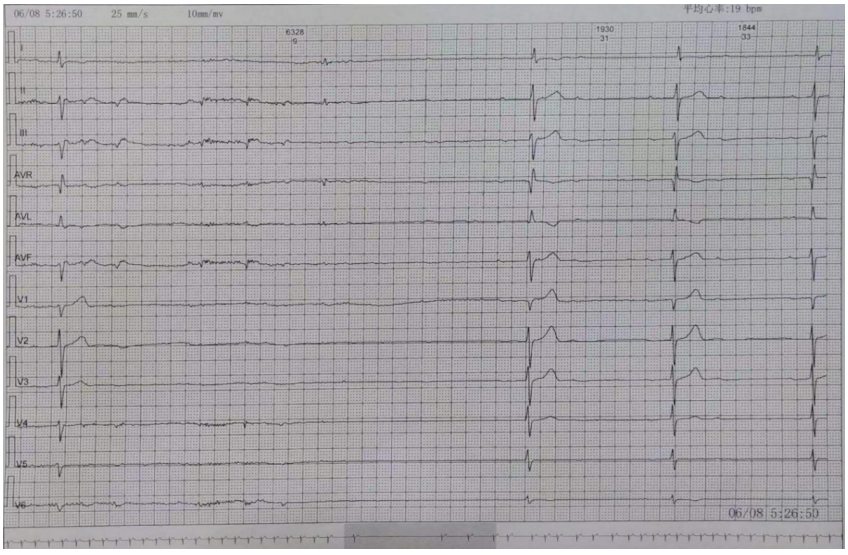

Figure 1D

Figure 1: An electrocardiogram reveals sick sinus syndrome of the patient in the hospital. A:Sinus bradycardia with HR 38bpm; B: high-grade atrioventricular block; C:sinus arrest

Computed tomography (CT) scan revealed an isolated persistent left superior vena cava (PLSVC). Venography of the left and right median cubital veins similarly confirmed the absence of the right superior vena cava, with the PLSVC draining into a dilated coronary sinus (CS) leading into the right atrium (Figure 2-3). Drainage of both the subclavian and jugular veins into the left superior vena cava further complicated the feasibility of transvenous endocardial pacemaker lead implantation. Consequently, the decision was made to proceed with leadless pacemaker (LP) implantation due to its minimally invasive nature.

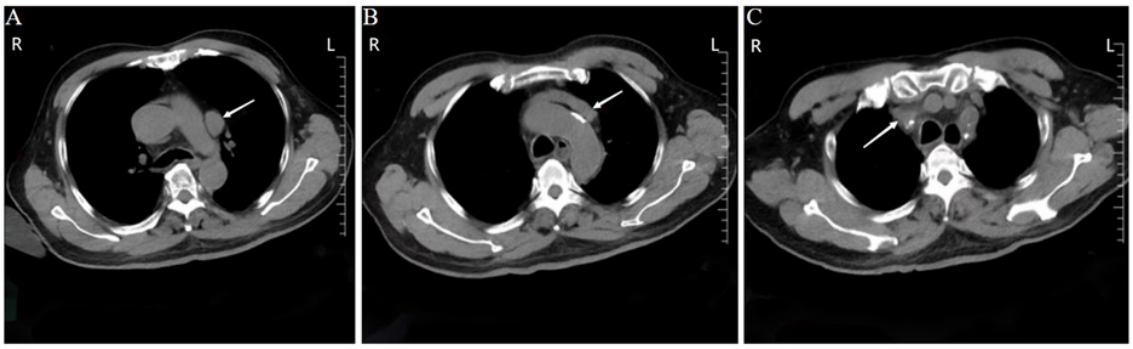

Figure 2: CT scan revealing a persistent left superior vena cava (LSVC). A: The confluence of the right subclavian vein and right jugular vein is visible on the right side of the brachiocephalic trunk (arrow), with no clear shadow of the right superior vena cava. B: A shadow of the superior vena cava is visible on the left side of the aortic arch (arrow). C: A shadow of the superior vena cava is seen on the left side of the main pulmonary artery and left pulmonary artery (arrow).

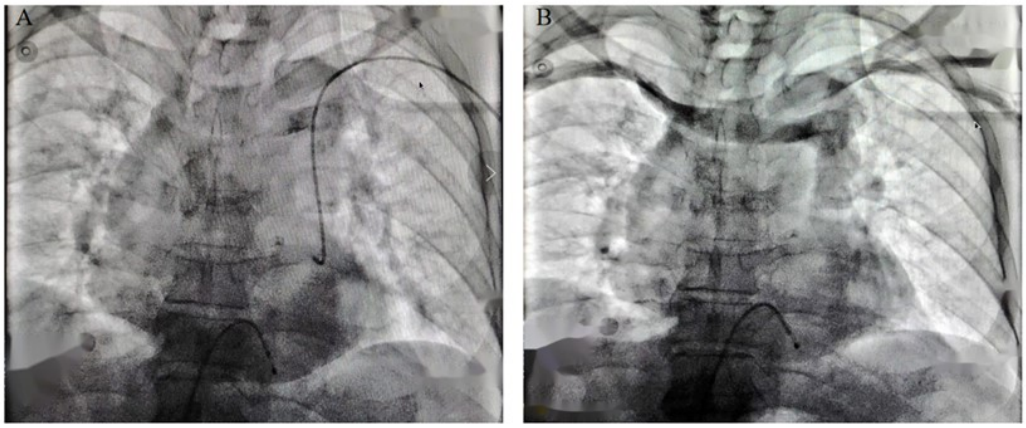

Figure 3: Venography showing the absence of the right superior vena cava, with the left superior vena cava (LSVC) draining into a dilated coronary sinus (CS) and its outlet into the right atrium (RA). A: Venography depicting the absence of the right superior vena cava and the LSVC draining into the dilated CS. B: Outlet of the dilated CS into the RA.

LP implantation was performed via the right femoral vein using the Micra Transcatheter Pacing System (Medtronic Inc, Minneapolis, MN). A temporary pacing lead was initially inserted into the apex of the right ventricle through the left femoral vein. The LP was successfully anchored in the septum of the right ventricle, as confirmed by right ventricular angiography and echocardiography (Figure 4A, 4B, 4C). Device stability was verified through gentle traction under fluoroscopic guidance. Favorable pacing parameters were observed, with RV sensing at 3.7 mV, electrode impedance at -1040 Ohms, and pacing threshold at 0.38V, programmed amplitude/pulse width at 2.0V/0.24ms.

At the 3-month follow-up, the patient remained asymptomatic, with no reported incidents of heart failure, infection, or pacemaker dislodgement symptoms. Stable electrical parameters were confirmed by the device, while echocardiographic evaluation showed no deterioration in ventricular function (LVEF 53% vs 68%), and maintained low levels of brain natriuretic peptide.

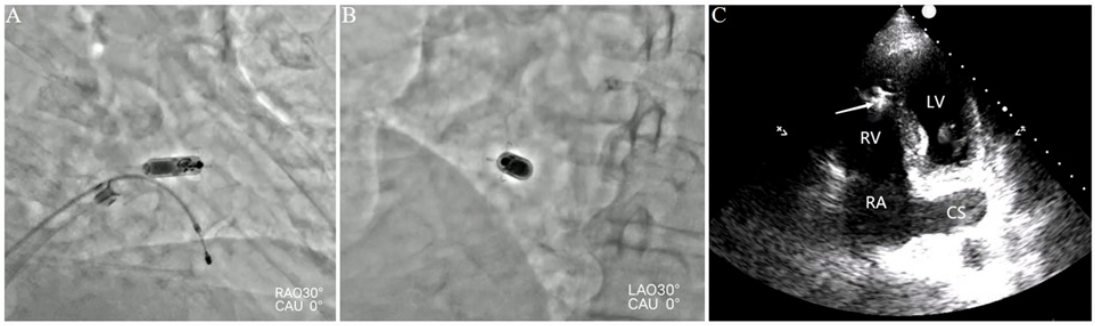

Figure 4: X-ray radiography showing the placement of a leadless pacemaker and transcatheter pacing system in the right ventricle. A: Right anterior oblique view at 30°with caudal 0°. B: Left anterior oblique view at 30°with caudal 0°. C: The LP is fixed in the septum of the RV, as confirmed by echocardiography (arrow). Abbreviations: LP: leadless pacemaker, RV: right ventricle, LV: left ventricle, RA: right atrium, LA: left atrium.

Discussion

We report a case of LP implantation in a patient with PLSVC who presented with sick sinus syndrome(SSS). PLSVC is a rare congenital venous anomaly characterized by the persistence of the left superior vena cava into adulthood [10]. It is typically asymptomatic and often discovered incidentally during medical imaging or surgical procedures. However, its presence can pose challenges in certain clinical scenarios, particularly during invasive procedures such as pacemaker implantation [11]. In this discussion, we will discuss from the following aspects.

Challenges of PLSVC in Pacemaker Implantation

The presence of PLSVC can complicate pacemaker implantation due to the altered anatomy of the venous system. Traditional transvenous pacemaker implantation relies on accessing the right atrium and ventricle through the superior vena cava and right atrium [12]. However, in the presence of PLSVC, the usual route for lead placement may be obstructed or distorted. The enlarged coronary sinus, often associated with PLSVC, can further hinder the placement of pacing leads, particularly the ventricular lead [13]. Moreover, the absence of the right superior vena cava (RSVC) in some cases of PLSVC presents additional challenges. Without the RSVC, accessing the right heart chambers for lead placement becomes even more complex. The lack of a direct route to the right ventricle necessitates alternative strategies, such as navigating through the coronary sinus or utilizing unconventional approaches, which may increase procedural difficulty and risk[14]. To overcome this problem, various techniques using custom- or ready made stylets or a coronary sinus cannulation sheath have been previously reported[11, 15, 16]. Invasive techniques, such as thoracotomy for epicardial lead placement, have been employed in patients with PLSVC and concurrent indications for pacemaker implantation [3, 17]. However, these approaches are associated with thrombosis formation, infection, abnormal upper limb movement, longer recovery times, and higher rates of complications compared to transvenous approaches [15, 18].

Rationale for Leadless Pacemaker Implantation

Leadless pacemakers offer a compelling alternative in patients with challenging venous anatomy, such as those with PLSVC. Unlike traditional pacemakers, which require transvenous leads and a subcutaneous pulse generator, leadless pacemakers are self-contained devices that are directly implanted into the myocardium. This eliminates the need for venous access and reduces the risk of lead-related complications, such as lead dislodgement, infection, and venous thrombosis [19, 20].The smaller size of leadless pacemakers also facilitates implantation in patients with limited venous access or complex anatomy. In cases of PLSVC, where traditional lead placement may be difficult or impossible, leadless pacemakers offer a minimally invasive solution that bypasses the challenges associated with venous access and lead positioning. Additionally, leadless pacemakers have demonstrated comparable efficacy and safety to traditional pacemakers in clinical trials and real-world studies[20]. The advent of

leadless pacing technology has expanded the treatment options for patients with challenging venous anatomy and has the potential to improve patient outcomes and quality of life.

The potential benefits and considerations associated with LP implantation

Leadless pacemaker implantation offers several potential benefits in patients with PLSVC and indications for pacing therapy. Firstly, it eliminates the need for venous access, reducing the risk of venous injury, thrombosis, and infection associated with transvenous leads [21]. This is particularly advantageous in patients with limited venous access or venous anomalies, such as PLSVC, where traditional lead placement may be impractical or impossible. Moreover, leadless pacemakers have been shown to have a lower rate of complications compared to traditional pacemakers. Clinical studies have demonstrated a significant reduction in the incidence of lead-related complications, such as lead dislodgement, venous stenosis, and infection, with leadless pacing systems [22]. Furthermore, results from the Micra Coverage with Evidence Development (CED) Study showed that patients implanted with a leadless Micra TPS experienced a 66% reduction in chronic complications at 6 months compared with patients who received a traditional transvenous pacemaker leads [23, 24]. Micra does not require leads or a surgical "pocket" under the skin, so potential sources of complications related to leads and pockets are eliminated. In this case, a 87- year-old man was diagnosed SSS simultaneous presence of the PLSVC, For the reasons mentioned above, we decided for a leadless systems.

Conclusion

Leadless pacemaker implantation represents a valuable therapeutic option in patients with challenging venous anatomy, such as persistent left superior vena cava (PLSVC), and indications for pacing therapy. By bypassing the challenges associated with traditional transvenous lead placement, leadless pacemakers offer a minimally invasive and effective solution for pacing therapy. to the best of our knowledge, this is the first report of LP implantation in a SSS patient with PLSVC. The method we described above could be a new therapeutic approach with high feasibility and safety in patients with such venous anomalys.

Funding

The present study was supported by a Chongqing Science and Health Joint Medical Research Program in grant to Yan Qingkai (grant no. 2021MSXM148).We thank the patient for permitting us to publish this case.

Author Contributions

Bo Zhou: Conceptualized and designed the case report; performed the literature review; drafted the initial manuscript. Feng Xie: Participated in the clinical management of the patient; contributed to data acquisition and manuscript preparation. Xiao-li Tan: Involved in the patient's clinical care and follow-up; provided input on data interpretation; contributed to manuscript revision. Sha-sha Wu:Assisted in the clinical procedures; contributed to data collection and interpretation; reviewed the manuscript for important intellectual content. Chang-qing Yu: Assisted with the literature review; reviewed and revised the manuscript. Qing-kai Yan: Supervised the entire study; provided critical feedback on the manuscript; acted as the corresponding author and secured funding for the study.All authors have read and approved the final version of the manuscript.

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