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CASE REPORT

INTERMEDIATE

CLINICAL CASE

Left Bundle Area Pacing for Tachycardia-Bradycardia Syndrome in a Patient With Dextrocardia

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ABSTRACT

We present the case of an 81-year-old woman with a background of situs inversus with dextrocardia who was successfully treated for tachycardia-bradycardia syndrome with left bundle area pacing. This report describes how this approach can circumvent the limitations of other pacing approaches to optimize patient outcomes. (**Level of Difficulty: Intermediate.**) (J Am Coll Cardiol Case Rep 2022;4:1213–1217) © 2022 The Authors. Published by Elsevier on behalf of the American College of Cardiology Foundation. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).

HISTORY OF PRESENTATION

An 81-year-old woman was referred to the emergency department with a 4-day history of intermittent dizziness. Physical examination revealed easily audible heart sounds on the right side of the chest but was otherwise unremarkable. On admission, the patient was noted to have sinus bradycardia but was hemodynamically stable, with a heart rate of 48 beats/min and blood pressure of 168/74 mm Hg.

LEARNING OBJECTIVES

- To evaluate the treatment options available for patients with adult congenital heart disease who require permanent pacemaker implantation.
- To consider the use of LBAP to achieve cardiac resynchronization in patients susceptible to pacing-induced cardiomyopathy.

PAST MEDICAL HISTORY

The patient had a background of situs inversus with dextrocardia, hypertension, and type A aortic dissection repaired with aortic valve resuspension and replacement of the ascending aorta to the hemiarch. Approximately 8 years before the current hospital admission, the patient presented to the cardiology clinic with presyncope secondary to orthostatic stress, which subsequently abated with cessation of antihypertensive medications. Serial Holter monitoring, arranged to investigate the presyncope further, discerned the presence of nocturnal pauses lasting <3 seconds. In the absence of symptoms, the patient was discharged from the clinic. Paroxysmal atrial fibrillation later developed, necessitating the commencement of anticoagulation

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ABBREVIATIONS AND ACRONYMS

AAIR = atrial-pacing atrial-sensing inhibited-response rate-adaptive (single-lead atrial) [pacemaker]

ACHD = adult congenital heart disease

DDDR = dual-chamber rate-adaptive [permanent pacemaker]

LBAP = left bundle area pacing

therapy and rate control therapy with bisoprolol, 2.5 mg once daily.

DIFFERENTIAL DIAGNOSIS

The major differential diagnosis considered was symptomatic bradyarrhythmia secondary to bisoprolol and/or sinus node disease.

INVESTIGATIONS

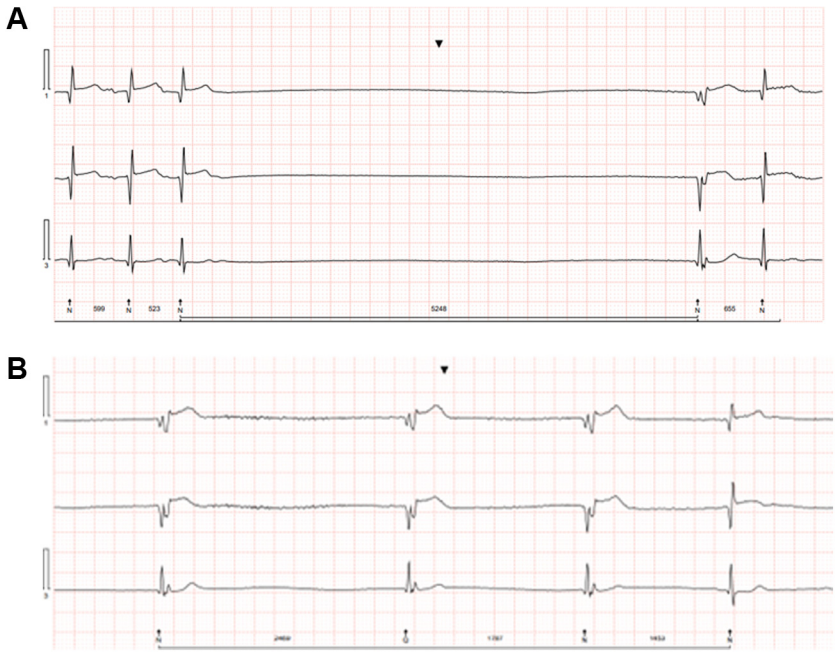
The admission electrocardiogram showed sinus bradycardia at 48 beats/min, marked right-axis deviation, a negative QRS complex, inverted P waves in leads I and aVL, and progressively decreasing R-wave amplitude across the precordial leads and normal intervals. The patient's β-blocker therapy was suspended, and cardiac monitoring was initiated. An echocardiogram demonstrated dextrocardia with concordant atrioventricular and ventriculoarterial connections and an estimated systemic (left) ventricular ejection fraction of 60% to 65%. The 24-hour Holter monitoring revealed a total of 37 pauses, with the longest being a sinus pause lasting up to 5.3 seconds (Figure 1A). The patient was also noted to have 140 bradycardic episodes, with the slowest heart rate documented as 16 beats/min (Figure 1B). These episodes of pauses and bradycardia occurred in conjunction with frequent supraventricular ectopic beats (10% burden).

MANAGEMENT

In view of the clinical presentation, Holter monitor result, and complex anatomy, the patient was referred for discussion at a tertiary center electrophysiology multidisciplinary team meeting to determine the optimal pacing strategy. A decision was made for dual-chamber rate-adaptive (DDDR) pacemaker implantation with a preprocedure venogram to delineate venous anatomy accurately. The patient's anatomical complexity, severity of sinus node disease, and requirement to reinstitute rate control therapy to treat atrial tachyarrhythmia resulted in a decision to proceed with implantation of a left bundle area pacing (LBAP) device.

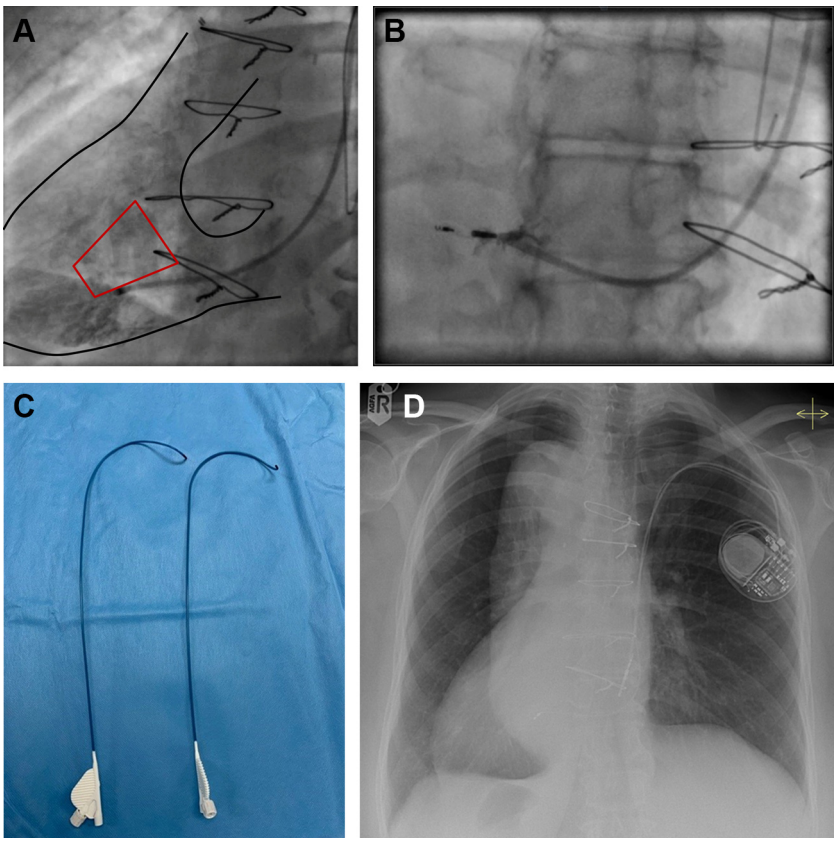
The procedure was carried out using local anesthesia. A right-sided venogram revealed obstruction of the right subclavian vein; hence ultrasound-guided left-sided axillary vein access was used. On the basis of the right ventriculogram (Figure 2A) with 10 mL of contrast material, an initial tunneling location was identified and confirmed with pace mapping. The 3830 lead was delivered through a Medtronic C315

FIGURE 1 Preprocedural Holter Monitoring



(A) Recording revealing a 5.25-second pause at 11:37:56. **(B)** Episode of bradycardia at 16 beats/min at 18:33:10 during Holter monitoring.

FIGURE 2 Pacemaker Implantation Procedure



(A) Right ventriculogram in the left anterior oblique plane. The **area outlined in red** represents the best area to start screwing in the left bundle area pacing lead based on the venticulogram. **(B)** Contrast material injection showing the lead deep in the interventricular septum in the right anterior oblique plane. **(C) (Right)** Original C315 sheath (Medtronic). **(Left)** Primary curve reversed so that the secondary curve is posteriorly (septally) angulated in a patient with dextrocardia. **(D)** Chest radiograph (posteroanterior) shows the final position of the pacing system.

sheath (Medtronic), reshaped manually to reverse the primary curve to align with the anatomical reversal of dextrocardia (Video 1). This technique enabled posterior angulation of the distal curve toward the septum in the dextrocardia anatomy (**Figures 2B and 2C**).

Subsequently, the right atrial lead was implanted in a usual location in the right atrial appendage. The postimplantation chest radiograph demonstrated satisfactory lead positioning (**Figure 2D**). The device was programmed to AAI-DDD (Managed Ventricular Pacing) at a rate of 60 beats/min. Total procedure duration was 80 minutes, with 60 mL iodixanol contrast material used and a radiation dosage of 650 mGy/cm^2.

The postoperative period was uneventful, and the patient was restarted on β-blocker therapy. The electrocardiograms with LBAP and intrinsic conduction are shown in **Figures 3A and 3B.** A postprocedural pacing check performed the next day demonstrated normal device function, with a presenting rhythm of atrial pacing, ventricular sensing at 60 beats/min. Her underlying rhythm was sinus bradycardia with normal atrioventricular conduction. Frequencies of atrial and ventricular pacing were 74.9% and 0.4%, respectively. β-Blocker reintroduction proved effective because no atrial high-rate episodes were detected.

DISCUSSION

Our case demonstrates the feasibility of LBAP in patients with situs inversus dextrocardia. The patient we treated had sinus node disease. In such instances, bradycardia can be treated with either an atrial-pacing atrial-sensing inhibited-response rate-

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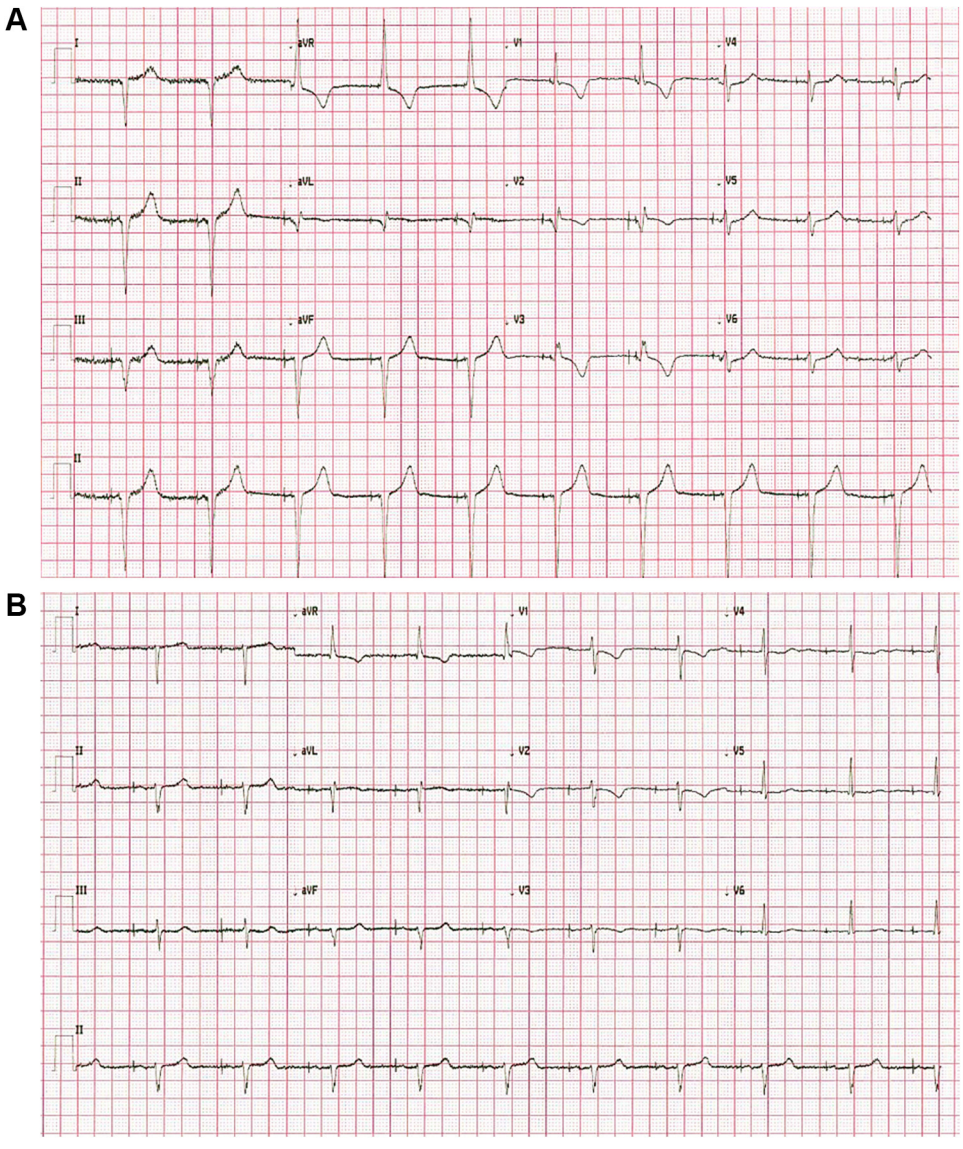
FIGURE 3 Postoperative Electrocardiograms



(A) Postimplantation electrocardiogram. QRS complex duration, 110 ms; left ventricular activation time (LVAT) in lead V_6, 60 ms.
(B) Electrocardiogram showing intrinsic atrioventricular nodal conduction. QRS complex duration, 100 ms.

adaptive (single-lead atrial) (AAIR) pacemaker or a DDDR pacemaker. AAIR pacing does not protect against atrioventricular block. In this patient, the risk of atrioventricular block development may have been heightened with β-blocker reintroduction. AAIR pacing has also been associated with a higher incidence of paroxysmal atrial fibrillation and an increased risk of pacemaker reoperation.[1] These factors led to the decision to proceed with DDDR pacemaker implantation.

For ventricular lead placement, traditional right ventricular apical pacing is widely used but is limited by the risk of electrical and mechanical dyssynchrony. This is a major concern in patients with adult congenital heart disease (ACHD), whose incidence of pacing-induced cardiomyopathy may be higher.[2] The patient's β-blocker was reintroduced to treat atrial tachyarrhythmia. Unfortunately, this may have increased the likelihood of pacing-induced cardiomyopathy development through an increase in right

ventricular pacing burden. It was postulated that conduction system pacing could mitigate this risk. Furthermore, the Holter monitor recording revealed multiple pauses and episodes of bradycardia that may have exacerbated the long-term requirement for pacing. The postprocedural pacing check revealed the ventricular pacing percentage to be 0.4%, perhaps reflective of the fact that intrinsic conduction is promoted through Managed Ventricular Pacing because the frequency of atrial pacing was found to be higher.

Numerous approaches are available to achieve conduction system pacing. His bundle pacing is an approach with confirmed clinical benefits.[3] However, its application can be limited by issues pertaining to high pacing thresholds and low R-wave amplitudes.[4] In addition, the conduction system course is often variable in dextrocardia,[5] meaning that the anatomical location of the His bundle may not be easily accessible.

An alternative approach is LBAP. This has been demonstrated to result in nearly physiologic pacing parameters.[6] This finding was observed in this case, where the patient's paced QRS complex duration was 110 milliseconds (**Figure 3A**). The patient's anatomical complexity necessitated a unique approach to lead delivery. The use of LBAP in dextrocardia has previously been described.[7-9] Our study adds to this evidence base demonstrating the utility of LBAP, particularly when tachyarrhythmia warrants pharmacologic treatment, thus increasing the likelihood of ventricular pacing.

FOLLOW-UP

The patient remained clinically stable in the immediate postprocedural phase. At 6 weeks after pacemaker implantation, the patient was reviewed in the pacing clinic, where she reported marked improvement in her symptom of dizziness. Interestingly, the pacing check revealed frequencies of atrial and ventricular pacing to be 85.9% and 1.6%, respectively. β-Blockade continued to prove effective because no atrial high-rate episodes were detected. Her underlying rhythm was sinus rhythm with intact atrioventricular conduction at a rate of 50 beats/min. The patient's repeat echocardiogram demonstrated preserved left ventricular systolic function.

CONCLUSIONS

This case demonstrates the feasibility of LBAP as a treatment option in patients with situs inversus dextrocardia who require pharmacologic treatment of atrial tachyarrhythmia. LBAP may mitigate the risk of pacing-induced cardiomyopathy, a troublesome consequence of pacing in patients with ACHD. This case highlights how LBAP can circumvent the limitations of other pacing techniques to optimize outcomes. Although further study is required to ascertain long-term benefit, our study demonstrates this technique to be feasible, safe, and effective in the short term in this unique patient cohort.

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The authors have reported that they have no relationships relevant to the contents of this paper to disclose.

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KEY WORDS dextrocardia, left bundle area pacing, sinus node disease, situs inversus

APPENDIX For a supplemental video, please see the online version of this article.