ISSN 2307-8960 (online)

World Journal of *Clinical Cases*

World J Clin Cases 2022 July 16; 10(20): 6759-7186

Published by Baishideng Publishing Group Inc

World Journal of Clinical Cases

Contents

Thrice Monthly Volume 10 Number 20 July 16, 2022

OPINION REVIEW

MINIREVIEWS

ORIGINAL ARTICLE

Case Control Study

Retrospective Cohort Study

Retrospective Study

Observational Study

World Journal of Clinical Cases

Thrice Monthly Volume 10 Number 20 July 16, 2022

Contents

World Journal of Clinical Cases

Thrice Monthly Volume 10 Number 20 July 16, 2022

Contents

World Journal of Clinical Cases

Thrice Monthly Volume 10 Number 20 July 16, 2022

Contents

LETTER TO THE EDITOR

World Journal of Clinical Cases

Thrice Monthly Volume 10 Number 20 July 16, 2022

Contents

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Editorial Board Member of *World Journal of Clinical Cases*, Jie-Feng Huang, PhD, Associate Chief Physician, Associate Professor, Department of Orthopaedics and Traumatology, The First Affiliated Hospital of Zhejiang Chinese Medical University, Hangzhou 310006, Zhejiang Province, China. 40983285@qq.com

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RESPONSIBLE EDITORS FOR THIS ISSUE

Production Editor: *Hua-Ge Yu*; **Production Department Director:** *Xu Guo*; **Editorial Office Director:** *Jin-Lei Wang*.

NAME OF JOURNAL
World Journal of Clinical Cases

ISSN
ISSN 2307-8960 (online)

LAUNCH DATE
April 16, 2013

FREQUENCY
Thrice Monthly

PUBLICATION DATE
July 16, 2022

INSTRUCTIONS TO AUTHORS
https://www.wjgnet.com/bpg/gerinfo/204

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World J Clin Cases 2022 July 16; 10(20): 7090-7096

DOI: 10.12998/wjcc.v10.i20.7090

ISSN 2307-8960 (online)

CASE REPORT

Left bundle branch pacing in a ventricular pacing dependent patient with heart failure: A case report

Bing-Xue Song, Xia-Xia Wang, Yi An, Ying-Ying Zhang

Specialty type: Cardiac and cardiovascular systems

Provenance and peer review: Unsolicited article; Externally peer reviewed.

Peer-review model: Single blind

Peer-review report's scientific quality classification

Grade A (Excellent): 0
Grade B (Very good): 0
Grade C (Good): C, C, C
Grade D (Fair): 0
Grade E (Poor): 0

P-Reviewer: Lakusic N, Croatia; Patel L, United States; Pradhan A, India

A-Editor: Yao QG, China

Received: December 17, 2021
Peer-review started: December 17, 2021
First decision: February 21, 2022
Revised: March 3, 2022
Accepted: May 22, 2022
Article in press: May 22, 2022
Published online: July 16, 2022

Bing-Xue Song, Xia-Xia Wang, Yi An, Ying-Ying Zhang, Department of Cardiology, The Affiliated Hospital of Qingdao University, Qingdao 266000, Shandong Province, China

Corresponding author: Ying-Ying Zhang, MD, Staff Physician, Department of Cardiology, The Affiliated Hospital of Qingdao University, No. 16 Jiangsu Road, Shinan District, Qingdao 266000, Shandong Province, China. doczhangyingying@yeah.net

Abstract

BACKGROUND

Left bundle branch pacing (LBBP) is a physiological pacing method that has emerged in recent years. It is an ideal choice for patients with complete left bundle branch block who are in need of cardiac resynchronization therapy (CRT). Moreover, LBBP is superior in maintaining physiological ventricular activation and can effectively improve heart function and quality of life in patients with pacemaker-induced cardiomyopathy. However, LBBP in pacing-dependent patients who already have cardiac dysfunction has not been well assessed.

CASE SUMMARY

A 69-year-old male patient presented with symptoms of chest tightness, palpitation and systolic heart failure with New York Heart Association class III for 1 mo. The 12-lead electrocardiogram showed atrial fibrillation with third-degree atrioventricular block and ventricular premature beat. Holter revealed a right bundle branch block, atrial fibrillation with third-degree atrioventricular block, frequent multifocal ventricular premature beats, Ron-T and ventricular tachycardia. The echocardiogram documented an enlarged left atrium and left ventricle and a low left ventricular ejection fraction. Coronary angiography indicated a stenosis of 30% in the middle left anterior descending artery. Apparently, a CRT-D pacemaker was the best choice for this patient according to previous findings. However, the patient was worried about the financial burden. A single-chamber pacemaker with LBBP was selected, with the plan to take amiodarone and upgrade with dual-chamber implantable cardioverter-defibrillator or CRT-D at an appropriate time. During the follow-up at 3 mo after LBBP, the patient showed an improvement in cardiac function with slight improvement in echocardiography parameters, and the New York Heart Association functional class was maintained at I. Moreover, the patient no longer suffered from chest tightness and palpitation. Holter showed decreased ventricular arrhythmia of less than 5%.

CONCLUSION
LBBP might be used in patients with heart failure and a high-degree atrioventricular block as an alternative to conventional CRT.

Key Words: Left bundle branch area pacing; Physiological pacing; Heart failure; Cardiac resynchronization therapy; Pacing-dependent; Case report

Core Tip: Left bundle branch pacing is a new and prospective pacing technique that is a promising alternative with the potential for similar outcomes in patients with complete left bundle branch block who need cardiac resynchronization therapy or for patients with pacemaker-induced cardiomyopathy. We present herein a patient with heart failure and high-degree atrioventricular block treated with left bundle branch pacing who received improved cardiac function during follow-up. This case highlights the possibility of left bundle branch pacing used in patients who already have heart failure and high-degree atrioventricular block as an alternative to conventional cardiac resynchronization therapy.

Citation: Song BX, Wang XX, An Y, Zhang YY. Left bundle branch pacing in a ventricular pacing dependent patient with heart failure: A case report. *World J Clin Cases* 2022; 10(20): 7090-7096
URL: https://www.wjgnet.com/2307-8960/full/v10/i20/7090.htm
DOI: https://dx.doi.org/10.12998/wjcc.v10.i20.7090

INTRODUCTION

Left bundle branch pacing (LBBP) is a new, prospective pacing technique that is more physiological than traditional right ventricular pacing (RVP)[1]. It is appropriate for pacing-dependent patients to prevent left ventricular mechanical asynchrony and to reduce the morbidity of heart dysfunction. A previous clinical study has already shown that LBBP is superior for maintaining physiological ventricular activation[2] and can effectively improve heart function and quality of life in patients with pacemaker-induced cardiomyopathy[3-5]. However, LBBP in pacing-dependent patients who already have cardiac dysfunction has not been well evaluated. Here, we report a case of a heart failure patient with atrial fibrillation and third-degree atrioventricular block who successfully received LBBP.

CASE PRESENTATION

Chief complaints

A 69-year-old male patient presented with symptoms of chest tightness, palpitation and exertional dyspnea.

History of present illness

The patient's symptoms started 1 mo prior with recurrent episodes of chest tightness, palpitation and exertional dyspnea. Dyspnea worsened the previous 3 d.

History of past illness

The patient had a history of atrial fibrillation and diabetes.

Personal and family history

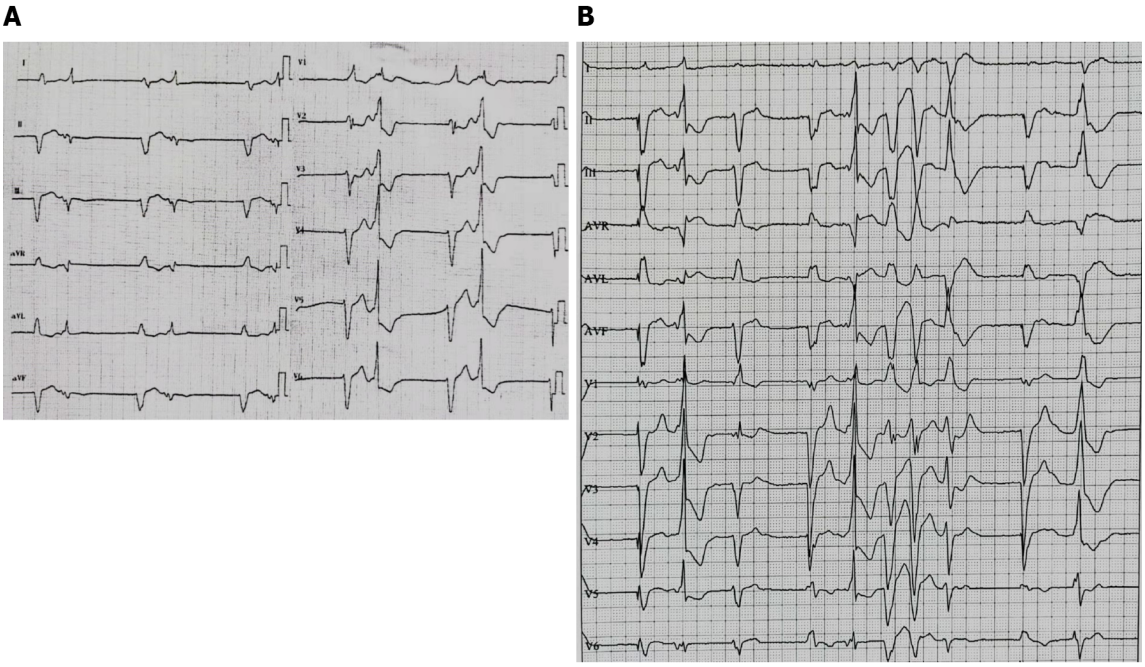
The patient had no family history.

Physical examination

The rhythm of heart auscultation was irregular.

Laboratory examinations

The 12-lead electrocardiogram showed atrial fibrillation with third-degree atrioventricular block and ventricular premature beat (Figure 1A). Holter revealed a right bundle branch block, atrial fibrillation with third-degree atrioventricular block, frequent multifocal ventricular premature beats (Figure 1B), Ron-T and ventricular tachycardia. The echocardiogram documented a large left atrium diameter (48



DOI: 10.12998/wjcc.v10.i20.7090

Figure 1 Patient's preoperative 12-lead electrocardiogram. A: Atrial fibrillation with third-degree atrioventricular block and ventricular premature beat; B: Electrocardiogram with frequent multifocal ventricular premature beats.

mm), large left ventricular end-diastolic diameter (62 mm), large left ventricular end-systolic diameter (54 mm), low left ventricular ejection fraction (38%), severe mitral regurgitation and moderate pulmonary hypertension (Table 1) The brain natriuretic peptide level was 451 pg/mL.

Imaging examinations

Coronary angiography indicated a stenosis of 30% in the middle left anterior descending artery.

FINAL DIAGNOSIS

Arrhythmia, atrial fibrillation with third-degree atrioventricular block, frequent multifocal ventricular premature beats, Ron-T, ventricular tachycardia, right bundle branch block, cardiomyopathy, coronary atherosclerosis, cardiac insufficiency (New York Heart Association class III) and diabetes.

TREATMENT

An optimal medical therapy with rivaroxaban, diuretic, sacubitril valsartan and dapagliflozin was chosen. Meanwhile, permanent pacemaker implantation was decided after optimal medical therapy for heart failure, and the patient signed informed consent.

Considering the low heart function and high risk of sudden cardiac death, a cardiac resynchronization therapy (CRT)-D pacemaker was the best choice for this patient according to previous findings [6]. However, due to the local insurance policy, the reimbursement ratio of pacemaker implantation is very low, and the cost of a CRT pacemaker is much more expensive than that of a single-chamber pacemaker. The patient was worried about the financial burden. A single-chamber pacemaker with LBBP was selected, with the plan to take amiodarone and upgrade to dual-chamber implantable cardioverter-defibrillator (ICD) or CRT-D at an appropriate time. We will still use the left bundle branch electrode as the RVP electrode and place the defibrillation electrode on the right ventricular apex with only the defibrillation function applied as the dual-chamber ICD. Similarly, we will use the LBB electrode combined with the right ventricular defibrillation electrode and the traditional left ventricular electrode as CRT-D, which comprises the left bundle branch optimized CRT-D that we are currently performing frequently.

The patient underwent implantation of a single-chamber pacemaker (RESR 1, Medtronic Inc., Minneapolis, MN, United States). A ventricular pacing lead (3830-69 cm, Medtronic Inc.) was implanted into the left bundle branch area using the transventricular septal method. In brief, the delivery sheath (C315HIS, Medtronic Inc.) and the 3830 lead were inserted through the left axillary vein and moved to

Table 1 Echocardiography parameters before and after the procedure

	LVEDD in mm	LVESD in mm	LVEF, %	MR	TR	PAP in mmHg	NYHA
Before procedure	62	54	38	Severe	Mild-moderate	57	III
Follow-up	56	45	41	Moderate	Mild-moderate	46	I

LVEDD: Left ventricular end-diastolic diameter; LVESD: Left ventricular end-systolic diameter; LVEF: Left ventricular ejection fraction; MR: Mitral regurgitation; TR: Tricuspid regurgitation; PAP: Pulmonary artery pressure; NYHA: New York Heart Association.

the ventricular side inferior to the septal leaflet of tricuspid valves under right anterior oblique fluoroscopy. The pacing lead was then screwed toward the left side of the interventricular septum. The pacing lead was successfully placed in the left bundle branch area (Figure 2). The pacing threshold was 0.7 V at 0.4 ms, and the electrocardiography mode had a right bundle branch conduction delay (Figure 3). The R wave amplitude was 12 mV.

OUTCOME AND FOLLOW-UP

During the follow-up at 3 mo after LBBP, the patient showed an improvement in cardiac function: left ventricular end-diastolic diameter decreased from 62 mm to 56 mm, left ventricular end-systolic diameter decreased from 54 mm to 45 mm, left ventricular ejection fraction increased from 38% to 41%, pulmonary artery pressure decreased from moderate to mild, and New York Heart Association functional class was maintained at I. The brain natriuretic peptide level was downregulated to 81 pg/mL. Moreover, the patient was free from chest tightness and palpitations. Holter showed decreased ventricular arrhythmia of less than 5%.

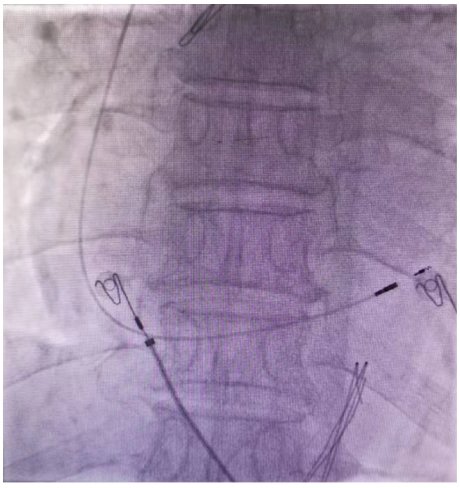
DISCUSSION

As a conventional pacing strategy, RVP is easy to access, well tolerated and stable. However, studies have indicated that chronic RVP may result in intraventricular and interventricular desynchrony, which is harmful to left ventricular function and is associated with heart failure and increased mortality[7]. Recognizing the deleterious effect of RVP, Deshmukh *et al*[8] first described the pioneering research of permanent His bundle pacing (HBP) in 2000. Since then, multiple studies have demonstrated the safety and feasibility of HBP. Compared with RVP, HBP is associated with a reduction in the combined endpoint of death and heart failure hospitalization[9]. Although HBP could be a physiological alternative to RVP, due to technical challenges and unstable and higher pacing thresholds, especially in patients with pathological disease in the conduction system, HBP has not become mainstream. Moreover, HBP has a lower R wave amplitude and a higher lead dislocation rate.

Huang *et al*[10] described a case of a patient with dilated cardiomyopathy and complete left bundle branch block (LBBB) who was treated with LBBP in 2017 and found improved cardiac function. The safety and feasibility of LBBP have been subsequently tested by multiple studies. Since then, LBBP has become a new pacing site because of its low threshold and narrow paced QRS duration[11]. During LBBP, the lead is fixed in the left bundle branch area, and the left ventricular His-Purkinje system is paced directly, which leads to a shorter paced QRS duration and better electrical synchrony compared to RVP.

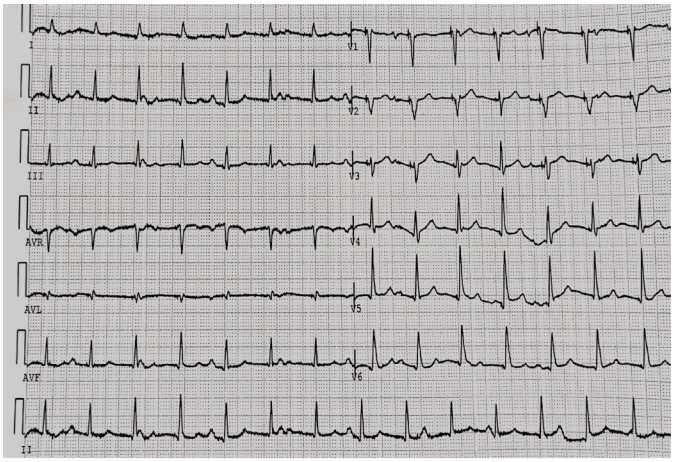
Recently, several studies have shown that left ventricular synchronization in the LBBP group is superior to that of right ventricular apical pacing, right ventricular outflow tract pacing and right ventricular septal pacing[12-14]. Compared with RVP, LBBP is associated with a reduced incidence of pacing-induced left ventricular dysfunction and hospitalization for heart failure[1,12-14]. In 2020, Wu *et al*[15] revealed that LBBP produced significantly greater reductions in QRS duration and resulted in significant improvements in the function of the left ventricle and clinical response compared to biventricular pacing in heart failure patients with typical LBBB.

Subsequently, a number of studies have shown that in heart failure with LBBB, LBBP-related complications and adverse clinical outcomes, including heart failure hospitalization and mortality, were not significantly different compared to CRT[16]. Therefore, LBBP could be a superior alternative to CRT in patients with typical LBBB. In the 2021 European Society of Cardiology Guidelines on cardiac pacing and cardiac resynchronization therapy, CRT-P is highly recommended for patients with heart failure and high-degree atrioventricular block to reduce morbidity, including patients with atrial fibrillation[6]. However, whether LBBP is an ideal choice for heart failure patients with high-degree atrioventricular block lacks evidence. Moreover, in patients who are candidates for an ICD and who have CRT indications, implantation of CRT-D is highly recommended[6].



DOI: 10.12998/wjcc.v10.i20.7090

Figure 2 Fluoroscopic imaging after implantation of the left bundle branch area pacing lead.



DOI: 10.12998/wjcc.v10.i20.7090

Figure 3 Twelve-lead electrocardiogram after the procedure. The capture threshold of left bundle branch area pacing was 0.7 V/0.4 ms.

As a traditional pacemaker implantation method, right ventricular apical pacing has been widely used to date, but this method can lead to electrical and mechanical asynchrony, which increase the risk of atrial fibrillation, heart failure and even death[17]. Subsequently, right ventricular outflow tract and right ventricular septal pacing have been developed to reduce these potential adverse consequences, but their long-term results have not proved to be better than right ventricular apical pacing. Cardiac resynchronization therapy through biventricular pacing is another pacing method for the treatment of heart failure.

Clinical studies have shown that CRT can promote left ventricular reverse remodeling and exercise tolerance and reduce the incidence rate and mortality of heart failure patients[6]. Although the benefits of CRT have been fully demonstrated, the nonresponse rate of this therapy is very high (30%-40%). In addition, biventricular pacing is a nonphysiological method that requires two leads to activate the ventricular myocardium rather than a specialized conduction system. Therefore, the physiological pacing technology of directly activating the conduction system has become the focus of attention.

LBBP is achieved through the transventricular septal approach, which can directly excite the left bundle branch area, and the QRS duration is narrowed due to the rapid activation of the left ventricle. At present, this method has been extended to treat some patients with heart failure and ventricular dyssynchrony caused by LBBB. According to the current research, with the increase in clinical application, the clinical development of LBBP is in an early but encouraging stage. However, there is a need to develop standardized procedures with improved delivery tools and pacing leads as well as long-term efficacy and safety studies[18].

In our case, the patient had an indication for CRT-D implantation. However, due to economic factors, LBBP was the best choice. It remains unclear whether LBBP was the best choice to avoid further deterioration of cardiac function or whether the patient should receive an ICD to prevent sudden cardiac

death. Recent studies have shown that upgrading to LBBP can effectively improve heart function and quality of life in patients with pacing-induced cardiomyopathy[3-5]. However, LBBP in patients with cardiac dysfunction and high-degree AVB lacks evidence. In our case, there was an increased left ventricular ejection fraction and decreased left ventricular end-diastolic diameter and left ventricular end-systolic diameter 3 mo after LBBP implantation. In addition, with drug therapy and cardiac function recovery, ventricular arrhythmia was significantly decreased. Therefore, future work should focus on exploring the advantage of LBBP in patients with heart failure and high-degree atrioventricular block, as it may obtain more benefit than CRT with less cost.

CONCLUSION

We present the case of a heart failure patient with atrial fibrillation and third-degree atrioventricular block who successfully received LBBP. After LBBP for 3 mo, there was an improvement in left ventricle function and a reduction in left ventricular size. This case shows the possibility of using LBBP in patients with heart failure and high-degree atrioventricular block as an alternative to conventional CRT.

FOOTNOTES

Author contributions: Song BX and Wang XX were the patient's bedside clinicians, reviewed the literature and contributed to manuscript drafting; An Y reviewed the literature and contributed to the manuscript; Zhang YY was responsible for the revision of the manuscript for important intellectual content; Song BX, Wang XX and Zhang YY performed the operation; All authors issued final approval for the version to be submitted.

Informed consent statement: The informed consent has been signed by the patient.

Conflict-of-interest statement: The authors declare that they have no competing interests.

CARE Checklist (2016) statement: The authors have read the CARE Checklist (2016), and the manuscript was prepared and revised according to the CARE Checklist (2016).

Country/Territory of origin: China

ORCID number: Bing-Xue Song bingxuesong@126.com; Xia-Xia Wang xiaxiawang1214@163.com; Yi An anboshiqd@126.com; Ying-Ying Zhang doczhangyingying@yeah.net.

S-Editor: Chang KL
L-Editor: Filipodia
P-Editor: Chang KL

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