



Right Ventricular Septal Pacing to Produce Narrow QRS Duration in Patient with High Degree 2:1 AV Block

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Abstract: Prolonged right ventricular (RV) apical pacing has been recognized to be associated with progressive left ventricular (LV) dysfunction. This impairment of LV function resultant from RV apical pacing is a remodelling process consequent to abnormal ventricular activation and contraction. RV septal pacing theoretically is associated with a more physiological ventricular activation results in shorter electrical activation delay and consequently less mechanical dyssynchrony. We reported A-75-year-old woman presented to emergency department (ED) with dyspnea only on exertion in the last three weeks before admission, she also complaint near syncope episode while doing activities. Electrocardiogram (ECG) result was high degree AV block with 2:1 conduction with ventricular rate 40 beats per minute. PPM implantation was performed with VVIR mode, ventricle lead inserted into mid-septal RV. ECG post implantation showed pacing rhythm with narrow QRS duration. Pacemaker-related LBBB is associated with an adverse prognosis. RV septal pacing produces more synchronous contraction denoted by narrow QRS, preventing the deterioration of LV structure and function. RV septal pacing, although not as good as intrinsic conduction or His bundle pacing, may be more desirable for chronic RV pacing compared to the RV apex as a narrow QRS is associated with improved LV dynamics. RV septal pacing was safely done in this patient, but further study needed to evaluate its long-term effect.

Keywords: AV block; permanent pacemaker; septal; right ventricle

INTRODUCTION

Permanent cardiac pacing is a common procedure to treat bradycardia and conduction disorders in the heart. Prolonged right ventricular (RV) apical pacing has been recognized to be associated with progressive left ventricular (LV) dysfunction. Retrospective analysis of the MOST (Mode Selection Trial) study found that the risk of heart failure hospitalization and atrial fibrillation was directly related to RV pacing burden regardless of pacing mode.¹ In the Dual Chamber and VVI Implantable Defibrillator (DAVID) study in the group with RV pacing burden > 40%, the incidence of heart failure was found to be more than 30% within 18 months, whereas in the group with a lower RV pacing burden, the incidence of heart failure was less than 10%.² This impairment of LV function resultant from RV apical pacing is a remodelling process consequent to abnormal ventricular activation and contraction. RV septal pacing theoretically is associated with a more physiological ventricular activation results in shorter electrical activation delay and consequently less mechanical dyssynchrony.³

CASE DESCRIPTION

A-75-year-old woman presented to emergency department (ED) with dyspnea only on exertion in the last 3 weeks before admission, she also complaint near syncope episode while doing activities. She had a history of hypertension. Clinical examination in ED showed her blood pressure was 210/70 mmHg. Her electrocardiogram (ECG) result was high degree AV block with 2:1 conduction with ventricular rate 40 beats per minute (Fig. 1). Her echocardiogram showed an ejection fraction of 70% with no regional wall abnormality. The treatment plan was to implant permanent pacemaker (PPM). Implantation of PPM was performed with VVIR mode, The ventricular lead is modified with the posterior portion curved with posterior angulation to allow the lead to be positioned in the RV septal area (Fig. 2) which showed that output threshold was 0.6 v; current 0.8 mA; R wave 23.9 mV, impedance was 832 ohm and rate 60 bpm. ECG post implantation showed pacing rhythm with narrow QRS duration (110 msec) (Fig. 3). Patient was discharged on next day without any symptoms.

DISCUSSION

Cardiac pacemakers are an effective treatment for various bradyarrhythmias. Every year, one million patients worldwide undergo pacemaker implantation, and this number is increasing. However, chronic right ventricular (RV) pacing can be harmful, causing pacing-induced cardiomyopathy in 10-20% of patients after 2-4 years.¹ There is no consensus on the optimal positioning of the right ventricular (RV) pacing lead. Traditionally, the RV lead is placed at the apex; however, alternative locations have been examined, including pacing of the RV septum. The rationale behind septal pacing is that it may engage part of the intrinsic cardiac conduction system located nearby, thereby reducing QRS duration and subsequent ventricular dyssynchrony.² In this patient expected to be long term pacemaker dependent, to prevent pacing induced cardiomyopathy we aimed to do right ventricular septal pacing using our handmade stylet resemble Mond's stylet.

Placing the pacemaker lead on the RV septal portion becomes difficult to do consistently unless the tip of the lead going to the pulmonary valve is directed posteriorly because this portion of the RV septum is posterior. If it is not directed posteriorly, the tip of the lead is more often attached anteriorly or to the RV free wall.³ Placing a pacemaker lead through the superior vena cava past the tricuspid valve requires a stylet whose tip is angulated posteriorly. Mond has developed a special shaped stylet (Mond's stylet) to make it easier to place the pacemaker lead in the interventricular septum area. This stylet from Mond has a curve of 5-6 cm in the distal area (primary curve) then at 2 cm at the end it is bent at an angle of 90° (secondary curve) from the main curve resembling the shape of a swan's neck. To date there are several stylets that have been developed modification from the Mond's stylet.⁵

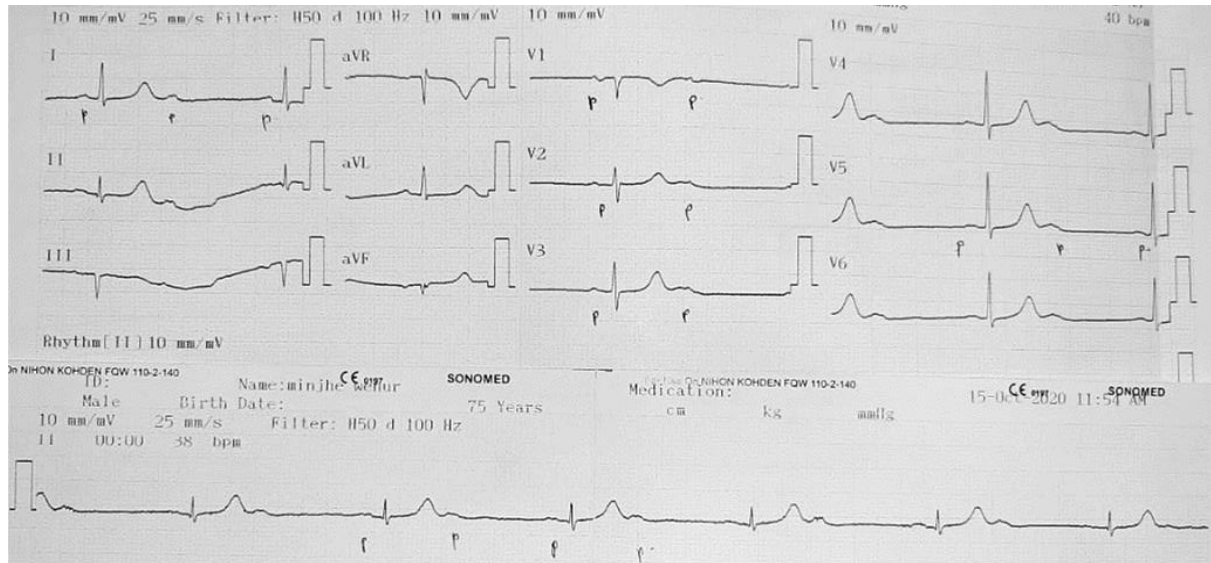


Figure 1.ECG preoperative

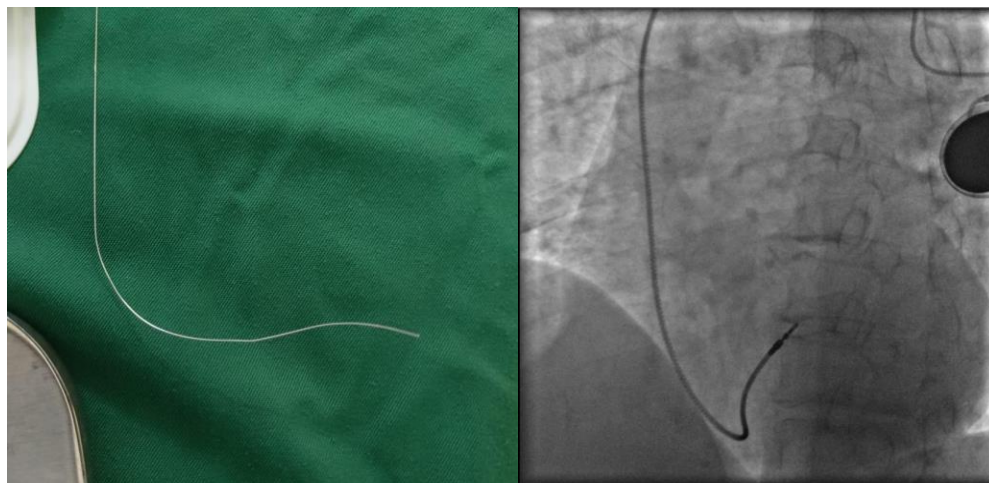


Figure 2. Hand modified stylet demonstrating the curve, bent distal portion & posterior angulation. Pacemaker implantation showed lead placement at mid septal.

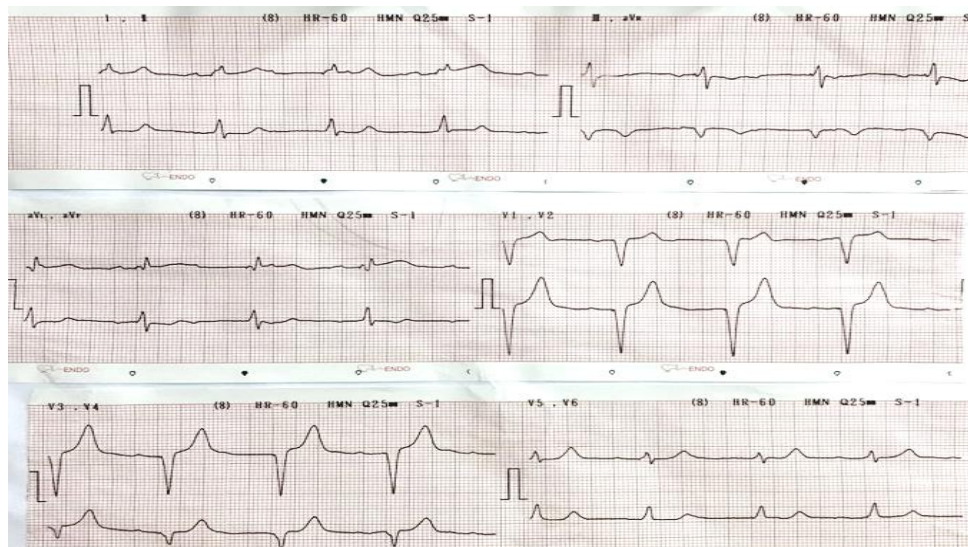


Figure 3. ECG after pacemaker implantation

The use of fluoroscopy with a postero-anterior projection is the initial image to guide the placement of the pacemaker towards the RVOT and mid RV. The differences between septal, anterior, and free wall RV can be differentiated using the left anterior oblique (LAO) projection. The interventricular septum is an oblique structure located posteriorly. In the LAO projection, the tip of the septal lead will point towards the spine, whereas if the lead is on the free wall then the tip of the lead will point anteriorly and if the tip of the lead points upward then the lead will be on the anterior wall. Mond et al,⁴ suggested to use the left projection lateral as a specific projection to confirm the location of the lead in the RV septal position. If the lead was pointing posteriorly, this indicated that the lead was in the septal, whereas if the lead was pointing anteriorly then the lead was in the RV free wall. However, the use of left lateral projection could not be routinely carried out due to sterility problems. The use of a 40° LAO projection could be easily performed during pacemaker lead placement without disturbing the sterile operating field.⁴ In another study, Mond reported that angulation of the pacemaker lead tip when it was at 0 – 60° in a 40° LAO projection could indicate that the lead was installed in the septal area. Angulation at 80-100° is more indicative of a location on the anterior wall and 120-140° is more indicative of placement of the pacemaker lead on the RV free wall. Several studies have suggested that the LAO projection alone is not adequate to predict the location of the lead on the right ventricular septal. Margulescu et al,⁵ studied 50 patients undergoing right heart pacing using a 40° LAO projection to differentiate between septal or free wall and a 40° RAO projection to show the location of the lead in the RVOT, mid-ventricle, or at the right ventricular apex.

Related to ECG markers, RV apical pacing will produce an ECG with a features of left bundle branch block. RV septal pacing will produce a narrow monophasic R wave in the inferior leads with an earlier precordial transition, while the R wave will be wider and smaller in amplitude accompanied by notching if the pacemaker is in the RV free wall. Morphology of the QRS complex in lead I in cardiac pacing carried out in the septal and free wall areas, if the pacemaker is located in the right and posterior area it will produce a positive QRS wave (r wave), if the pacemaker is located in the left and anterior area it will produce negative QRS wave (qs wave). The location between the anterior and posterior will produce a biphasic QRS morphology (qr/qs pattern) or isoelectric line. Pacing the heart from the anterior wall will produce a narrow QRS complex but will result in a slower precordial transition. Pacing the RVOT free wall will result in a wide, notched QRS complex in the inferior leads and a slow precordial transition.⁶ In this patient ECG after pacemaker implantation showed narrow duration of QRS wave (110msec) and R wave in the inferior leads that resemble normal ECG

The RV Outflow Versus Apical Pacing (ROVA) study was a randomized study that aimed to look at the quality of life of patients after installing a pacemaker in the apical and septal areas. This study was conducted on a population of 103 patients with heart failure, left ventricular dysfunction (EF<40%) and chronic atrial fibrillation. RVOT pacing and dual site RV pacing narrowed QRS duration, but within 3 months there was no improvement in quality of life or other outcomes compared to apical pacing.⁷

Zou et al, evaluated the outcomes of RVOT pacing in a retrospective analysis in 80 patients with total AV block and normal heart function. Then the patients were followed for 2 years. In the group with apical pacing there were 6 patients who experienced new atrial fibrillation, while in the group who received septal pacing only 1 patient experienced new atrial fibrillation. In the group with septal pacing, the QRS complex duration and intraventricular mechanical deceleration were shorter, as well as a smaller increase in left atrial volume. In addition, the group with septal pacing had better fractional ejection function compared to the group who received apical pacing.⁸

The protection of LV function during RV Pacing (PROTECT-PACE) study, is a prospective multicenter randomized study that analyzes differences in changes in left ventricular ejection fraction function in groups with apical RV pacing versus high-septal RV pacing followed for 2 years with different results. The main outcome of this study was changes in left

ventricular ejection fraction function. Secondary outcomes from this study include death, hospitalization, atrial fibrillation, changes in brain natriuretic peptide, 6 minute walk test, and lead related adverse events. Of a total of 240 patients, with an average age of 74 years with high degree AV block with preserved left ventricular ejection fraction (LVEF). The study was divided into two groups, namely, the group that received apical RV pacing with RV septal pacing. The results of this study did not show significant differences in terms of hospitalization rates due to heart failure, atrial fibrillation, or mortality in the two groups. In this study, which was followed for 2 years, there was no advantage in those who underwent cardiac pacing in the septal area compared to the apical one, even in the group who underwent septal pacing, which required a longer procedure time and fluoroscopy time.⁹

Pacemaker-related LBBB is associated with an adverse prognosis. RV septal pacing produces more synchronous contraction denoted by narrow QRS, preventing the deterioration of LV structure and function.¹⁰ Successful reduction in QRS duration can be achieved with cardiac resynchronization therapy. His bundle pacing is an alternative strategy to produce normal QRS duration but faces many technical challenges. RV septal pacing, although not as good as intrinsic conduction or His bundle pacing, may be more desirable for chronic RV pacing compared to the RV apex as a narrow QRS is associated with improved LV dynamics.¹¹

CONCLUSION

We reported a case of right ventricular septal pacing in a 75-year-old female which produced narrow paced QRS wave after pacemaker implantation. Narrow paced QRS wave showed to be more physiological and synchronous ventricular activation. RV septal pacing was safely done in this patient, the detrimental effects of long-term RV apical are significant enough to suggest that it is time to leave the RV apex.

Conflict of Interest

The authors affirm no conflict of interest in this study.

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