The Egyptian Heart Journal (2015) 67, 129–135

HOSTED BY

Egyptian Society of Cardiology

The Egyptian Heart Journal

www.elsevier.com/locate/ehj
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ORIGINAL ARTICLE

Comparison of early effects of right ventricular apical pacing on left ventricular functions in single and dual chamber pacemakers

Alaa Solaiman Algazzar [a,*], M.A. Moharram [b,*], Azza Ali Katta [a], Ghada Mohamed Soltan [b], Walaa Farid Abd ElAziz [b]

[a] *Cardiology Department, National Heart Institute, Egypt*
[b] *Cardiology Department, Faculty of Medicine, Menofia University, Egypt*

Received 2 May 2014; accepted 6 October 2014
Available online 29 October 2014

KEYWORDS

BNP;
Dyssynchrony;
Pacing

Abstract *Objectives:* Our study aimed to demonstrate the early negative impact of right ventricular apical pacing induced by single (VVI) and dual chamber (DDD) pacemakers on LV functions in patients with preserved EF. And to assess that single brain natriuretic peptide (BNP) after 2 months of implantation is correlated to ventricular dyssynchrony.
Methods: 40 patients with implanted VVI and DDD pacemakers were examined before implantation and again after 2 and 6 months of implantation for BNP, left ventricular (LV) systolic and diastolic functions by echocardiography and pulsed tissue Doppler. After 6 months, patients with DDD pacemakers were crossed over to VVI mode of pacing for 2 weeks with lower rate programed to 60 beat per minute then sample for BNP was collected again.
Results: There was no statistically significant difference in LV systolic and diastolic functions except for myocardial performance index (MPI) with (P value of 0.03). Mean BNP level in VVI pacing was higher than DDD pacing after two months with P value = 0.001 while comparison after 6 months showed P value = 0.023. There was a statistically significant difference between both groups in results of aortic preejection delay (APED) (P value of <0.05). BNP was correlated to APED (r = 0.651 and P value = 0.001) and pacing percentage (r = 0.687 and P value = 0.00).
Conclusion: Loss of atrioventricular synchrony in VVI mode leads to a significant difference in LV dyssynchrony between both groups. BNP level is correlated to LV dyssynchrony and pacing percentage.

1. Introduction

The cardiac pacing at any point of the ventricle alters the natural heart activation and contraction pattern, as stimulus conduction velocity is slower across ventricular myocardium,

* Corresponding authors at: Gharbia Governorate, Zaki Gomaa St, Aldalgamoon, Kafr Elzayat, Egypt. Tel.: +20 01148145561 (A.S. Algazzar). Faculty of Medicine, Menofia University, Yassin Abdelghaffar St., Shebin El-kom, Menofia, Egypt. Tel.: +20 01001260651 (M.A. Moharram).
E-mail addresses: goodminds@hotmail.com (A.S. Algazzar), ma_moharram@yahoo.com (M.A. Moharram).
Peer review under responsibility of Egyptian Society of Cardiology.

http://dx.doi.org/10.1016/j.ehj.2014.10.001

when compared to that resulting from the specialized His-Purkinje system.[1,2]

Right ventricular apical pacing can induce both interventricular dyssynchrony (between the right ventricle (RV) and the left ventricle (LV)), as well as intraventricular dyssynchrony (within the LV).[3] It has been demonstrated that the presence of ventricular dyssynchrony is associated with an increased risk of cardiac morbidity[4] and mortality[5] in heart failure patients. In addition, it has been suggested that the presence of mechanical dyssynchrony after long-term RV apical pacing is associated with reduced LV systolic function and deterioration in functional capacity.[3]

However, there are only a few studies that have demonstrated a direct relation between (pacing-induced) ventricular dyssynchrony and clinical heart failure. This suggests that an abnormal activation pattern (left bundle branch block during RV apical pacing) or ventricular dyssynchrony may be directly related to a deterioration of LV function. Therefore, assessment of ventricular dyssynchrony may provide important information in patients with permanent RV apical pacing.[6,7]

2. Subjects and methods

The study was carried out during the period between April 2012 and November 2013 and included 40 patients with implantation of single and dual chamber permanent pacemakers at the electrophysiology unit of national heart institute. Patients were enrolled into 2 groups, **Group A:** 20 patients with implanted single chamber pacemaker right ventricular pacing (VVI), **Group B:** 20 patients with implanted Dual chamber pacemaker (DDD).

This study compared the early effects of right ventricular (RV) apical pacing on LV functions in VVI and DDD pacemakers using echocardiographically determined parameters of systolic and diastolic functions. Also we assessed if brain natriuretic peptide (BNP) after 2 months of implantation is correlated to ventricular dyssynchrony in different cardiac pacing mode.

2.1. Inclusion criteria

The inclusion criteria are adult patients with age less than 75 years with indication for permanent pacing, patients with normal structural hearts and normal left ventricular functions, body mass index less than 30 Kg/m^2, and patients enrolled in the study after 2 months of implantation if they have more than 60% pacing dependence and ventricular lead should be in the right ventricular apex.

2.2. Exclusion criteria

The exclusion criteria are patients with poor echo window, patients with symptoms of overt heart failure, previous cardiac surgery or structural heart diseases (eg. Dilated cardiomyopathy, valvular heart diseases, congenital cardiac anomalies and prosthetic valves). Also we excluded patients with documented chronic heart dysrhythmias, patients with previous coronary artery disease detected by evidence of LV regional wall motion abnormalities at the echocardiogram or pathological Q waves in electrocardiogram, or any form of acute coronary syndrome within the past 4 weeks, patients with history of chronic obstructive lung disease, pulmonary hypertension or recent pulmonary embolism, renal impairment, pregnancy, and patients with terminal co-morbidities such as end stage malignancy, end stage renal or liver diseases.

After written informed consent and full history taking with history of the medications, complete general and local examinations were done for all patients. Patients were also subjected to measurements of QRS duration, Chest X-ray to verify the position of the ventricular lead-electrode, Urea and creatinine level and Pacemaker analysis.

BNP samples were obtained after 2 months and 6 months by direct venipuncture of an antecubital vein after the patient had been placed in supine position for at least 15 min. Venous blood sample was collected in tubes containing potassium EDTA. After 6 months, patients in group B were crossed over to VVI mode of pacing by programing for a period of 2 weeks with lower rate programed to 60 beat per minute then a venous blood sample was collected again for BNP to test the effect of right apical pacing in VVI mode on the heart. These patients were programed again to DDD mode after taking the blood sample.

Echocardiographic studies were done using a commercially available system (Samsung Medison EKO 7, Samsung Medison Building, 1003 Daechi-dong Gangnam-gu, Seoul 135-280 Korea) with a 2.5–3.5 MHz transducer. Patients were examined before implantation and again after 2 months and 6 months of implantation for left ventricular dimension, left ventricular systolic and diastolic functions. Myocardial performance index (MPI). Pulsed tissue Doppler imaging (TDI) was used to obtain septal and lateral velocities for both E and S waves.

Mechanical dyssynchrony was assessed after 2 months and 6 months by the following defined conventional parameters:

(i) Aortic pre-ejection delay (APED) by pulsed wave (PW)-Doppler is measured between the onset of QRS complex and the beginning of the aortic flow by pulsed wave Doppler. Intraventricular dyssynchrony is defined by an APED of 140 ms or more.[8,9]
(ii) Interventricular mechanical delay (IVMD) by PW-Doppler. To calculate the IVMD, time from onset of the QRS to onset of pulmonary flow was measured at the parasternal short-axis view, using pulsed-wave Doppler and the difference between it and APED resulted in the IVMD. Interventricular dyssynchrony is defined by an IVMD of 40 ms.[8,9]
(iii) Septal-posterior wall motion delay (SPWMD) by identifying the time delay from peak inward septal motion to peak inward posterior wall. Intraventricular dyssynchrony is defined by an SPWMD of 130 ms.[8,9]

3. Statistical analysis

The collected data were tabulated and statistically analyzed using SPSS version 20.0 for Windows (SPSS Inc, Chicago, IL, USA). Comparisons between the groups were performed using the unpaired Student's t test. Comparisons within the group were performed using the paired Student's t test. A probability value of 0.05 was considered statistically significant. DDD pacing as compared with VVI pacing, was assessed using one-way analysis of variance (ANOVA) for repeated measures. Partial correlations were used to measure the linear