Right Ventricular Apical Pacing (RVAP) vs. Right Ventricular Septal Pacing (RVSP): short and intermediate-term effect on echocardiographic indices, left ventricular function and clinical outcome

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Right Ventricular Apical Pacing (RVAP) vs. Right Ventricular Septal Pacing (RVSP): short and intermediate-term effect on echocardiographic indices, left ventricular function and clinical outcome

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Abstract

Introduction. Right ventricular apical pacing (RVAP) has more “desynchronizing effect” than pacing from the interventricular septum (RVSP) and may be translated in worse outcomes in long run. The aim of the present study was to examine the short and intermediate-term effects of RVAP versus RVSP on echocardiographic features, left ventricular function and clinical outcome.

Material and methods. 467 patients between August 2014 to March 2018 without structural heart disease were prospectively randomized to RVAP (n = 226) or RVSP (n = 241) and were studied at baseline, 6 months and 12 month by echocardiography, biochemically (NT-proBNP) and clinically (6-minute walk test). LV 2D strain and tissue velocity images were analyzed to measure 18-segment time-to-peak longitudinal systolic strain and 12-segment time-to-peak systolic tissue velocity. Intraventricular dyssynchrony was calculated using Tissue Doppler velocity data by comparing the time to systolic peak velocity between segments in multiple apical views by their respective standard deviations. Interventricular dyssynchrony was measured as the temporal difference of LV pre-ejection period and RV pre-ejection period by pulse-wave Doppler (PWD) images. All the analysis was carried out by using statistical package for social service version 17.0 (SPSS Inc., Chicago, Illinois). The p-value < 0.05 was considered statistically significant.

Results. The commonest indication for pacemaker implantation was atrioventricular block (n = 311; 66.6%), followed by sinus node dysfunction (n = 138; 29.5%) and chronic bifascicular and trifascicular block (n = 18; 3.9%), all patients receiving single chamber pacemaker (VVI: n = 107; 22.9% and VVIR: n = 360; 77.1%). There were significant difference in NT-proBNP level (410 ± 254 pg/mL vs. 370 ± 168 pg/mL; p = 0.02), 6-MWT (442 ± 19 m vs. 482 ± 21 m; p = 0.01), mean QRS duration (164 ±
8.3 ms vs. 148 ± 10.6 ms; p = 0.02), intraventricular dyssynchrony (septal to lateral wall delay: 88.6 ± 24.2 ms vs. 43.7 ± 11.2 ms; p = 0.04), interventricular dyssynchrony (31.2 ± 22.8 ms vs. 19.4 ± 11.2 ms; 0 = 0.03), end diastolic volume (78.4 ± 15.6 mL vs. 72.8 ± 14.2 mL; p = 0.04), end systolic volume (30.2 ± 13.1 mL vs. 25.6 ± 11.7 mL; p = 0.05) at the end of 12 months between RVAP and RVSP respectively, though not significantly different at 6 months favouring RVS-paced group. However, no significant difference in ejection fraction (59 ± 5% vs. 61.5 ± 3.2%; p = 0.39) and NYHA class (1.29 ± 0.3 vs. 1.28 ± 0.4; 0.3) at 6 and 12 months follow up were noted.

**Conclusions.** Right ventricular septal pacing was associated with better outcome in terms of echocardiographic indices, left ventricular function and clinical outcome compared to patients with apical pacing over intermediate-term follow up.

**Key words:** Right ventricular apical pacing, Right ventricular septal pacing, NT-proBNP, 6-Minute walk test, Intraventricular dyssynchrony, Interventricular dyssynchrony

**Introduction**

With the advent of cardiac pacemakers since 1959 when Furman described the use of the transvenous route for pacemaker implantation, the right ventricular (RV) apex has been the elective site for placing endocardial pacing leads [1]. It causes electromechanical dyssynchrony mainly by an abnormal late activation of the lateral wall of the left ventricle, thereby increasing myocardial work, myocardial oxygen consumption and subsequently heart failure, atrial fibrillation (AF), thromboembolic events and premature deaths [2–6]. In order to minimize right ventricular pacing, prolonged atrophicventricular (AV) delay and minimal right ventricular pacing algorithms were used but it may not be possible in patients with AV conduction abnormalities or following AV node ablation. Therefore, there has been constant human endeavour to explore the alternate sites to pace right ventricle in order to minimize *intra* and *interventricular* dyssynchrony such as RV septum, His bundle (HB), para-hisian tissues, free wall, inflow tract and right ventricle outflow tract (RVOT), among which RV septum is the most explored one [7–14]. Furthermore, with the advent of screwing leads, preshaped stylet for lead positioning and Mond's modification of stylet, RV septum (RVS) is becoming the preferred site of pacing. However, trials assessing acute and medium-term hemodynamic changes with selective site pacing (SSP) have
provided conflicting results although have similar long term safety and lead performance [15–17].

**Material and methods**

**Design**

This was a prospective, single-centre study conducted in the Department of Cardiology, LPS Institute of Cardiology, GSVM Medical College, Kanpur, U.P, and India from August 2014 to March 2018. 467 consecutive patients with indication of permanent cardiac pacing with (a) Sinus node dysfunction, (b) Atrioventricular (AV) block- symptomatic congenital AV block, acquired symptomatic AV block, acquired asymptomatic complete heart block, symptomatic second-degree AV block regardless of its type, (c) Chronic bifascicular and trifascicular block with intermittent third-degree AV block, Type II second degree AV block and alternating bundle branch block were enrolled in whom pacemaker with VVVI/VVIR was implanted.

Exclusion criteria were (a). Indications of cardiac resynchronization therapy (CRT) or implantable cardioverter defibrillator (ICD) device (b). Those who were unable to perform 6 minute walk test (6MWT) due to musculoskeletal abnormalities, co-morbid conditions or respiratory diseases, (c). Patients with underlying left ventricular dysfunction. Enrolled patients underwent comprehensive clinical examination and investigations including electrocardiography, cardiac enzymes, viral markers, serum electrolytes, 2D- transrthoracic echocardiography. Those patients who were finally eligible for the study were randomized blindly into two groups i.e. right ventricular apical pacing (RVAP) and right ventricular septal pacing (RVSP). These two groups were matched with respect to age, sex, ejection fraction, QRS duration, baseline NYHA class, presence of arrhythmias, and mode of pacing, cardiovascular risk factors and baseline medications.

The study was undertaken with an objective to compare QRS duration, echocardiographic features (ejection fraction, left ventricular volumes and dyssynchrony parameters), NYHA functional class, NT-proBNP level and 6 minute walk test (6 MWT) at baseline, 6 months and 12 months interval.

**Permanent Pacemaker Implantation**

All the pacemakers were implanted using either cephalic cut down or subclavian puncture and bipolar, steroid eluting electrode were used. For septal positioning, either
a preshaped stylet (Mond stylet, St Jude) or preshaping the stylet with primary and secondary curve was used, similar to the design suggested by Vlay [13]. In case, when we could not reach septum directly, then withdrawal technique was applied i.e. stylet-lead assembly was advanced into the pulmonary artery/RVOT and withdrawn into the RV septum. The pacing site in the ventricular septum was determined by fluoroscopy. The posteroanterior (PA) view was used to position the lead into septum (Fig. 1). The 40° right anterior oblique (RAO)/ left anterior oblique (LAO) projection was used to prevent inadvertent positioning in the coronary sinus and great cardiac vein. Septal and free-wall sites were determined by a leftward orientation of the lead tip in the LAO 40° view as proposed by Mond (Fig. 2) [18]. The septal positioning was confirmed by three fluoroscopic views: PA, LAO 40° and RAO 30° (Fig. 3). In the RVAP group, the passive fixation electrodes were positioned toward the right ventricular apex which was confirmed in antero-posterior view (Fig. 4). Active fixation lead was screwed into the septum under fluoroscopic guidance for septal pacing. Pacing parameters, including pacing threshold, sensitivity, lead impedance, and percentage of ventricular pacing were assessed after implantation regularly as out-patients basis.

**Echocardiographic assessment**

Images were obtained by the same single investigator using an iE33 model (Philips Medical Systems, Netherlands) with a 3.5-MHz transducer in the parasternal long axis (PLAX), short-axis (PSAX) views and apical (2, 3, and 4-chamber) views. Left ventricular end-diastolic (LVEDV), end-systolic volumes (LVESV) and ejection fraction (EF) were calculated using the biplane simpson's rule. *Inter*-ventricular dyssynchrony, the discordance between the times of RV and LV contraction, was assessed by measuring the interventricular mechanical delay (IVMD) using Pulse-wave Doppler (PWD) images of aortic and pulmonary flow velocities. Time to onset of LV ejection and RV ejection were derived by placing pulsed- Doppler sample volume at the left ventricular outflow tract (LVOT) in apical five-chamber view and by imaging RVOT in PSAX respectively. Therefore, LV and RV pre-ejection period (LVPEP/RVPEP) were calculated as time interval from onset of QRS complex to the onset of pulse-Doppler velocity curve in respective views (Fig 5A, B). *Intra*-ventricular dyssynchrony was derived as the difference of LVPEP and RVPEP.
dyssynchrony was calculated using Tissue Doppler velocity data by comparing the
time to systolic peak velocity between segments in multiple apical views (Fig. 6, 7).

**Analytical technique**

Tissue Doppler imaging (TDI) was performed in the apical four-chamber (A4C), two-
chamber (A2C) and long-axis views to image the long axis motion of the left
ventricle. Myocardial regional velocity curves were constructed from the digitized
images offline by using inbuilt software QLAB using curved M-line sampling method
for regional comparison, timing and function. Thus, time to peak systolic velocity was
displayed for as many sub-regions as required. In this way dyssynchrony between
septal to lateral, septal to posterior and anterior to inferior wall were calculated.

**NT-proBNP estimation**

Venous blood was withdrawn from an antecubital vein in vacutainer containing
potassium ethylene diamine tetraacetic acid (EDTA), centrifuged at 3000 rpm (15°C
for 10 min) and separated plasma was immediately assayed. Plasma natriuretic peptide
concentrations were measured with a specific immunoradiometric assay for human
NT-proBNP using commercially available, enzyme-linked immunoassay (Biomedica
Gruppe, Austria) and reported in pg/ml. It was analysed at baseline, 6 months and 1
year follow up.

**Six minute walk test (6MWT)**

The 6-MWT was performed indoor, along a long, flat, straight, enclosed corridor with
a hard surface around 100ft in length and was marked every 3 m. The object of this
test is to walk as far as possible for 6 minutes. Patient was instructed to walk back and
forth in the corridor and was permitted to slow down, to stop, and to rest as necessary.
It was explained to walk as far as possible for 6 minutes and total distance (6MWD)
covered was recorded in metres. 6MWT of patient with both RVAP and RVSP was
evaluated at baseline, 6 months and 12 month follow up.

**Statistical evaluation**

The continuous variables were expressed as the mean ± SD or range, while discrete
variables were expressed as frequency and percentage. The categorical variables were
compared using the $\chi^2$ test and continuous variables using either Student’s t-test when
normally distributed or Wilcoxon rank sum test when non-normally distributed. One-way analysis of variance (ANOVA) was used to compare the repeated measures of continuous variables between groups. The p-value <0.05 was considered statistically significant. All the analysis was carried out by using statistical package for social service version 17.0 (SPSS Inc., Chicago, Illinois).

Results
Baseline characteristics (Table 1)
A total of 472 patients had single chamber pacemaker implantation (VVI: n = 107; 22.9% and VVIR: n = 360; 77.1%) between August 2014 to March 2016 who were randomised to RVAP and RVSP. At the end of 12 months period, data were available for 226 and 241 patients respectively and therefore these subjects were considered enrolled in the study (Fig. 8). The commonest indication for pacemaker implantation was atrioventricular block (n = 311; 66.6%), followed by sinus node dysfunction (n = 138; 29.5%) and chronic bifascicular and trifascicular block (n = 18; 3.9%).

Clinical & biochemical parameters of patients with their follow up (Table 2)
There was no significant difference among NYHA class at 6 month and 12 month’s period in either group although insignificant fall was noted in both groups. There were significant difference in NT-proBNP level (410 ± 254 pg/mL vs. 370 ± 168 pg/mL; p = 0.02) and 6-MWT (442 ± 19 m vs 482 ± 21 m; p= 0.01) at the end of 12 months between RVAP and RVSP respectively, though there were no significant difference at 6 months.

Echocardiographic parameters with their follow up (Table 3)
The mean QRS duration at baseline of patients with RVAP and RVSP were 136 ± 12.8 and 126 ± 13.7 ms respectively becoming 160 ± 8.3 ms and 146 ± 10.6 ms respectively, significantly higher (p = 0.02) among RVAP group at the end of 12 months interval, however there was no significant difference either at the baseline or at the end of 6 months interval. Similarly, there were no difference among echocardiographic parameters at baseline and 6 month period, there were significant differences at the end of 12 month except LVEDD, LVESD and EF, thus results favouring towards RVSP.
**Discussion**

The natural activation through the His-Purkinje system is the ideal way to depolarize the ventricular mass under any circumstances irrespective of underlying conduction or contractile disturbances. The physiological rationale behind pacing the septum rather than the apex is based on initiating the ventricular depolarization in the RV septal wall, across the base of the mitral septal papillary muscle, where the first activation vector normally is shorter than that with pacing from the apex, and the ventricular contraction in theory will be physiological. Therefore, the pacing from the apex has a more “desynchronizing effect” than pacing from the interventricular septum and if the patient is pacemaker dependent, more the stimulation which might be translated in worse outcomes [3, 4, 19–22].

Our study revealed that the QRS duration post pacemaker implantation at the end of 12 months was significantly shorter in the RVS-pacing group than in the RVA-pacing group, which probably indicates that RVS-pacing was associated with reduced electrical dyssynchrony, a finding similarly reported by of Cano et al [23], Leong et al [24], Tse et al [25], and Zhang et al [26]. Furthermore, pacing parameters (R-wave sensing, amplitude and impedance) remain stable over time in the RVS-pacing group with similar rate of lead dislodgement with that of RVA-pacing proving its safety and efficacy over intermediate term follow up. In our study, mean QRS duration increased in both the group but the difference was pronounced at the end of 12 months period which was more in RVAP, meaning by it induces more electrical dyssynchrony. Electrical dyssynchrony is a harbinger of mechanical dyssynchrony, nonetheless there was no left ventricular dysfunction in either group as it remained within the normal range but as study had an intermediate follow up, therefore it failed to draw a firm conclusion. As RVSP is physiologically more similar to normal intrinsic conduction, therefore it induces less mechanical dyssynchrony as difference in ejection fraction was not significant but still higher in patients with septal pacing. Similar finding has also been drawn by Zhang et al [26] in elderly with normal LV function where they considered QRS widening from baseline among patients with RVAP and right ventricular outflow tract pacing. In our study, baseline inter and intraventricular dyssynchrony was noted in patients with RVAP and RVSP although little higher in former group which may be possibly due to some degree of acute electrical stunning associated with both underlying atrioventricular block and the temporary right
ventricular apical pacing used preimplantation which may have disappeared over time in patients with RVSP but persisting in patients with RVAP.

Our findings also corresponds to the study reported by Flevari et al [11] conducted among 36 patients with atrioventricular block who were randomized to receive either apical pacing or lower septal pacing. They noted increases in LV volume and EF at 12 months follow up among the septal pacing group and assigned these late changes to changes in LV dyssynchrony imposed by pacing although we did not demonstrate any improvement in ejection fraction, nonetheless it was better preserved in septal pacing group. In contrast to our study, Ng et al [27] in their study of 55 subjects demonstrated septal pacing to be associated with more impaired circumferential strain and worse LV dyssynchrony than apical pacing and control group which was mainly attributed to heterogeneous group of different pacing sites as septal pacing site and different duration of follow up period.

A meta-analysis by Shimony et al [28] found that baseline LV function as an important predictor of the effect of pacing on LVEF. They found that patients with non apical pacing (RVNA) with lower ejection fraction ≤ 40–45% at baseline had improved EF after follow up >12 months although those who had normal EF at baseline had no difference at the end of follow up but still fared better than those with RVAP. However Tse et al [25] among 24 patients randomized to receive apical pacing and outflow tract pacing having normal LV function at baseline, noted worsening of LV functions in form of fixed perfusion defect and regional wall motion defect in apical pacing group at the end of 18 months follow up.

In our study NT- proBNP levels were less and 6 minute walk test was more in RVS-pacing group than that of RVA- pacing group, similar to the study by Cano et al [29]. The mechanical disarray in the former group leading to asynchronous cardiac contraction may be responsible for the same. The NT-proBNP levels had significant reduction from baseline to 12 month period in RVSP group although it e was also noted in RVAP group but did not reach the statistically significant value. Similarly, it had a significant fall at the end of 12 month between both the groups in our study. The echocardiographic evaluation revealed that patients in the RVAP group had more inter and intraventricular dyssynchrony than the RVSP and control groups, without differences in LV systolic function.

Considering the 6-minute walk, there was increment in both the group and it had significant difference at the end of 12 month suggesting better outcome among
septal pacing group. Our finding is similar as reported by Tse et al [25], Roshdy et al [30], and Occhetta et al [31]. This change has also been noted among those had an upgrade of pacemaker from RV apical pacing to septal pacing and that improvement continued 18 months after the upgrade although there was no upgrade in our study. In our study no serious complications related to the implantation was detected.

Conclusion
We have shown that after 1-year follow-up in persistently pacemaker-dependent patients with normal LV function, septal pacing is superior to the apical pacing. We observed significant improvements in clinical (6-minute walk test), echocardiographic and biochemical parameters (NT-proBNP).

Limitation of study
It was a single center study with an intermediate follow up of only 12 month. Larger study with more subjects, longer follow up and alternate site studies are needed.

Conflict of interest
None.

References


27. Ng ACT, Allman C, Vidaic J, et al. Long-term impact of right ventricular septal versus apical pacing on left ventricular synchrony and function in


**Figure legends**

**Figure 1.** Typical position of lead into septum in posteroanterior view (B), RVOT (A), and Apex (C)

**Figure 2.** Typical position of lead LAO 40° view (line A and B indicates free-wall and into septum respectively)

**Figure 3.** Typical position of lead into septum in Right anterior oblique 40° view (B), RVOT (A) and Apex (C)

**Figure 4.** Posteroanterior view showing position of the passive fixation electrodes into the right ventricular apex

**Figure 5.** Calculation of pre-ejection period as time interval from onset of QRS complex to the onset of pulse-Doppler velocity curve (A-LVPEP; B- RVPEP)

**Figure 6.** Intraventricular dyssynchrony among patients with RVAP by strain imaging using speckle tracking method (A: Septal to lateral wall delay of 117 ms in apical four
chamber view; B: Anterior to inferior wall delay of 102 ms in apical two chamber view

**Figure 7.** Intraventricular dyssynchrony among patients with RVSP by strain imaging using speckle tracking method showing delay of 32 ms between septal and lateral wall in apical four chamber view

**Figure 8.** Flow chart of patients enrolled in the study and their follow up (n = 467)

**Table legends**

**Table 1.** Baseline characteristics of patients (n = 467)

**Table 2.** Clinical & biochemical parameters of patients with RVAP and RVSP at baseline and on follow up (n = 467)

**Table 3.** Echocardiographic indices of patients with RVAP and RVSP at their follow up (n = 467)
Figure 1: Flow chart of patients enrolled in the study and their follow up (n=467)

Baseline-

RVAP (n=233)

Deaths (Non Pacemaker related, n=3)

RVSP (n=249)

Deaths (Non Pacemaker related, n=5)

6-Month follow up-

RVAP (n=230)

Lost follow up (n=4)

RVSP (n=244)

Lost follow up (n=3)

12- Month follow up

n=226

n=241
Table 1: Baseline characteristics of patients (n=467)

<table>
<thead>
<tr>
<th>Variables</th>
<th>RVAP (N; %) (N=226)</th>
<th>RVSP (N; %) (N=241)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>65.4±11.2</td>
<td>64.7±9.6</td>
<td>0.32</td>
</tr>
<tr>
<td>Sex (M;F)</td>
<td>145(64)/81(36)</td>
<td>149(62)/92(38)</td>
<td>0.5</td>
</tr>
<tr>
<td>NYHA Class (N)</td>
<td>1.3±0.9</td>
<td>1.2±0.8</td>
<td>0.42</td>
</tr>
<tr>
<td>Ejection fraction (%)</td>
<td>63.6± 5</td>
<td>64.3±6</td>
<td>0.35</td>
</tr>
<tr>
<td>HTN (N)</td>
<td>42(18.5)</td>
<td>47(19.5)</td>
<td>0.6</td>
</tr>
<tr>
<td>Type II diabetes (N)</td>
<td>27(11.9)</td>
<td>29(12.3)</td>
<td>0.19</td>
</tr>
<tr>
<td>Hypercholesterolemia (N)</td>
<td>18(7.9)</td>
<td>17(7.5)</td>
<td>0.28</td>
</tr>
<tr>
<td>AF (N)</td>
<td>19(8.4)</td>
<td>21(8.7)</td>
<td>0.4</td>
</tr>
<tr>
<td>Pacing indication</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. Sinus node dysfunction (SND)</td>
<td>66 (29.2)</td>
<td>72 (29.8)</td>
<td>0.18</td>
</tr>
<tr>
<td>b. Atrioventricular (AV) block</td>
<td>154(68.1)</td>
<td>157 (65.2)</td>
<td>0.16</td>
</tr>
<tr>
<td>c. Chronic BFB and TFB</td>
<td>06 (2.7)</td>
<td>12(5)</td>
<td>0.2</td>
</tr>
<tr>
<td>Pacing mode</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>a. VVI</td>
<td>49 (21.7)</td>
<td>58 (24.1)</td>
<td>0.3</td>
</tr>
<tr>
<td>b. VVIR</td>
<td>177(78.3)</td>
<td>183 (75.1)</td>
<td>0.23</td>
</tr>
<tr>
<td>Procedural complications-</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Lead dislodgement</td>
<td>3(1.3)</td>
<td>1(0.4)</td>
<td>0.04</td>
</tr>
<tr>
<td>2. Temponade</td>
<td>0(0)</td>
<td>0(0)</td>
<td></td>
</tr>
<tr>
<td>3. Pneumothorax</td>
<td>1(0.4)</td>
<td>1(0.4)</td>
<td>0.35</td>
</tr>
<tr>
<td>4. Local site complications</td>
<td>2(0.8)</td>
<td>2(0.8)</td>
<td>0.4</td>
</tr>
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</table>

AF-Atrial fibrillation; BFB-Bifascicular block; DM- Diabetes Mellitus; EF-Ejection Fraction; HTN-Hypertension; NYHA-New York Heart Association; RVAP- Right Ventricle Apical Pacing; RVSP- Right Ventricular Septal Pacing; TFB- Trifascicular Block
Table 2: Clinical & biochemical parameters of patients with RVAP and RVSP at baseline and on follow up (n=467)

<table>
<thead>
<tr>
<th>Variables</th>
<th>Baseline</th>
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<td>RVSP (n=241)</td>
<td>p value</td>
<td>RVAP (n=226)</td>
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<td>p value</td>
<td>RVAP (n=226)</td>
<td>RVSP (n=241)</td>
</tr>
<tr>
<td>NT-proBNP (pg/ml)</td>
<td>574±278</td>
<td>563±236</td>
<td>0.6</td>
<td>496±301</td>
<td>410±241</td>
<td>0.19</td>
<td>410±254</td>
<td>370±168</td>
</tr>
<tr>
<td>6-MWT (m)</td>
<td>423±14</td>
<td>429±22</td>
<td>0.35</td>
<td>435±16</td>
<td>465±17</td>
<td>0.4</td>
<td>442±19</td>
<td>482±21</td>
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<tr>
<td>NYHA Class</td>
<td>1.34±0.9</td>
<td>1.32±0.2</td>
<td>0.42</td>
<td>1.32±0.7</td>
<td>1.29±0.7</td>
<td>0.5</td>
<td>1.29±0.3</td>
<td>1.28±0.4</td>
</tr>
</tbody>
</table>

6-MWT - 6- minute walk test; NT-proBNP- N-terminal pro brain natriuretic peptide; NYHA- New York heart association functional class; RVAP- Right ventricular apical pacing; RVSP- Right ventricular septal pacing
Table 3: Echocardiographic indices of patients with RVAP and RVSP at their follow up (n=467)

<table>
<thead>
<tr>
<th>Variables</th>
<th>Baseline</th>
<th>6 Month</th>
<th>12 Month</th>
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<th>P value</th>
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<tr>
<td></td>
<td>RVAP</td>
<td>RVSP</td>
<td>RVAP</td>
<td>RVSP</td>
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<tr>
<td>QRS Interval (ms)</td>
<td>136±12.8</td>
<td>129±13.7</td>
<td>148±9.6</td>
<td>134±8.4</td>
<td>0.4</td>
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<tr>
<td>LVEDV (ml)</td>
<td>85.2±17.6</td>
<td>82.5±13.8</td>
<td>83±14.4</td>
<td>81.2±11.5</td>
<td>0.15</td>
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<tr>
<td>LVESV (ml)</td>
<td>33.4±11.4</td>
<td>32.3±12.6</td>
<td>31.5±9.8</td>
<td>31.7±10.4</td>
<td>0.15</td>
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<tr>
<td>LVEF (%)</td>
<td>63.6±4.4</td>
<td>64.3±2.1</td>
<td>60.4±6.8</td>
<td>62.6±4.7</td>
<td>0.19</td>
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<tr>
<td>Interventricular delay(ms)</td>
<td>25.6±17.1</td>
<td>17.8±11.3</td>
<td>27.7±21.2</td>
<td>18.1±13.7</td>
<td>0.29</td>
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<tr>
<td>Septal-LWD(ms)</td>
<td>46.7±29.8</td>
<td>45.2±28.2</td>
<td>49.1±31.2</td>
<td>44.7±18.2</td>
<td>0.37</td>
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<tr>
<td>Septal-PWD(ms)</td>
<td>42.4±31.8</td>
<td>47.8±32.4</td>
<td>43.4±31.8</td>
<td>47.8±32.4</td>
<td>0.36</td>
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<tr>
<td>Anterior-IWD(ms)</td>
<td>40.4±24.8</td>
<td>44.2±18.7</td>
<td>46.6±22.8</td>
<td>48.7±14.2</td>
<td>0.43</td>
</tr>
</tbody>
</table>

LVEDV- Left ventricular end diastolic volume; LVESV- Left ventricular end systolic volume; EF-Ejection fraction; IWD-Inferior wall delay; LWD-Lateral wall delay; PWD-Posterior wall delay; RVAP-Right ventricular apical pacing; RVSP-Right ventricular septal pacing