Journal of Cardiovascular Disease Research

ISSN: 0975-3583,0976-2833 VOL 15, ISSUE 10, 2024

Original research article

Short term outcomes with dual chamber versus single chamber pacing for atrioventricular block, an institutional based cross over study

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Received: 16-07-2024 / Revised: 21-09-2024 / Accepted: 29-10-2024

Abstract

Background: A serious type of atrioventricular (AV) block commonly results in symptomatic bradycardia and arrhythmias that can be dangerous. As a result, patients often need a pacemaker implantation. Even if, theoretically, dual-chamber pacing tries to keep the heart synchronized, the research has not proven it to be more effective than ventricular pacing in raising the quality of life in patients who have limited access to health resources.

Aim: We wanted to identify whether DDD or VVIR pacing helped patients with high-grade AV block more in terms of daily function, their quality of life and how much discomfort they felt.

Methodology: The study Between March 2023 and February 2024, a randomized, single-blind crossover study was carried out at the Indira Gandhi Institute of Cardiology, Patna. All patients in the study received a pacemaker implant for a high-grade block in their heart. Initially, patients reached a stable state on DDD mode, but after that, they were randomly assigned to receive either DDD or VVIR pacing. At 4 and 6 months, we tested the 6-minute walk distance,

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questionnaires about quality of life (WHOQOL-BREF), the NYHA class and the presence of pacemaker syndrome. The data were studied using SPSS v26, with only those findings where $p < 0.05$ considered significant.

Results: Similar walking trail distances (DDD: 399.98 ± 60.95 m / VVIR: 404.58 ± 53.48 m) were seen for both pacing modes, as were equal scores in every area of the WHOQOL-BREF questionnaire. There were no differences in NYHA class distribution be- tween groups and no cases of pacemaker syndrome were detected. More ventricular pacing was done in DDD mode, though the difference wasn't statistically important.

Conclusion: Patients treated with either DDD or VVIR pacing experienced no major differences regarding hammering in NYHA classification, capabilities or daily life quality in the first weeks after implantation. In areas where there are few resources, VVIR pacing is both inexpensive and suitable for use in cardiology. To better understand these issues, further, long-term, multicenter studies should be done.

Keywords: Atrioventricular block, Crossover studies, Dual-chamber pacing, Single-chamber pacing.

1. Introduction

AV block means that there is a problem with the way electrical signals pass between the atria and ventricles. Symptoms range from a mild delay in heartbeat conduction to a stop where blood cannot flow normally, so many patients eventually require pacemaker implantation to prevent dangerous heart rhythm diseases and support heart function. Worldwide, high-grade AV block, most notably third-degree or complete heart block is widely thought to need pacemaker therapy [1, 2]. In the past, the usual treatment to prevent heart rates that were too low or no heartbeat was single-chamber (VVIR) ventricular pacing. Studies suggest that using latent-chamber (DDD) pacing which causes the atrium and ventricle to beat together is more similar to the heart's normal function and seems to benefit blood flow [3-5]. Even though DDD pacing appears to be

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better in theory, VVIR pacing is still frequently discussed in terms of which are superior for survival, physical capacity and quality of life [6, 7]. In several randomized studies including the PASE [5], UKPACE [6] and CTOPP [7] studies, the results have shown either no significant difference in survival or serious heart events between the pacing modes, except dual-chamber pacing might lessen episodes of atrial fibrillation [8-9].

2. Methodology

2.1 Study Design

This study was carried out as a prospective, randomized, single-blind crossover trial in the Cardiology Department of Indira Gandhi Institute of Cardiology, Patna, Bihar, India. The purpose was to see how well short-term results differ between dual-chamber (DDD) and single-chamber (VVIR) pacing in those with high-grade atrioventricular (AV) block.

2.2 Study Duration

The organization carried out the study for one year, from March 2023 until February 2024.

2.3 Sample Size

In this study, we included 100 patients who needed their first pacemaker due to high-grade AV block. All participants who met the eligibility requirements were brought into the study after agreeing to written consent. Enrollment of patients was done in order, to avoid favoring any particular kind of patient.

Inclusion Criteria

- Patients aged 40 years and above.
- Patients undergoing first-time permanent pacemaker implantation for high-grade AV block.

Exclusion Criteria

- History of acute coronary syndrome (ACS).
- Chronic obstructive pulmonary disease (COPD) with significant limitation of physical activity.
- Left ventricular ejection fraction (LVEF) < 50%.

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- Severe tricuspid regurgitation (TR).
- Associated valvular heart disease.
- Atrial lead malfunctions during follow-up.
- Patients unwilling to participate in the study.

2.4 Procedure

Candidates for the study had permanent dual-chamber pacemakers implanted according to usual clinical standards. We used lead types for both secure and loose connections and the RV lead was set at the RV apex, while its final placement was confirmed using several fluoroscopic angles. For the first two months, every device was set to DDD pacing mode while patients continued with their usual activities. When stable device function was confirmed, patients were randomly placed in one of two groups: Group I remained on DDD and Group II moved to VVIR pacing. All patients received follow-up exams at both four months and six months since their randomization. Every evaluation looked at 6-Minute Walk Distance, how much life is affected (using WHOQOL-BREF), electrical pacing, the NYHA class and the frequency of symptoms related to pacemaker syndrome.

2.5 Quality of Life Assessment

The WHOQOL-BREF questionnaire was used which covers four areas: physical health, psychology, social life and the environment, to assess quality of life. Calculating the WHOQOL-BREF scores was done with a web tool (neurotoolkit.com) and both types of scores for each category were produced (from 0 to 100).

2.6 Statistical Analysis

All the relevant data were placed in a Microsoft Excel sheet and analyzed with SPSS version 26.0 (IBM Corp., Chicago, IL, USA). The mean ± SD was used to describe continuous measures for both 6-Minute Walk Distance and QOL scores. Differences between DDD and VVIR groups were compared using Student's t-test. The Chi-square test was applied to rank-ordered data on frequencies and percentages for NYHA class and for occurrence of pacemaker syndrome. Results with a p-value of less than 0.05 were judged as statistically significant.

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3. Result

The demographic outlook of the patients is shown in Table 1. Patients involved in the study have a mean age of 56.58 years and show a variation of 9.83 years around the average age, so the group is made up of mostly middle-aged people. A greater number of females (53%) than males (47%) are included in the study. The average Body Mass Index (BMI) is 25.27 kg/m², with a standard deviation of 2.14 which means the majority of patients are classified as overweight by World Health Organization guidelines. Low back pain is common in patients and 34% have hypertension, as do 31% with diabetes mellitus. The study found that 5% of the subjects have Chronic Kidney Disease. Based on the findings, a big part of the population has disorders that have the potential to impact their health and could matter for the study.

Table 1: Demographic profile of patients

Parameter	Value
Mean age (years)	56.58 ± 9.83
Gender (Male/Female)	47% / 53%
Mean BMI (kg/m²)	25.27 ± 2.14
Hypertension (%)	34%
Diabetes Mellitus (%)	31%
CKD (%)	5%

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In Table 2, clinical and laboratory values are shown for all the patients studied. Among the group, blood pressure ranges: systolic is 129.16 mmHg with standard deviation 13.92 and diastolic is 79.02 mmHg ± 5.63, indicating that the overall blood pressure is well-regulated. It is found that the mean glucose ranges from 140 mg/dL to 184 mg/dL, so there is a large amount of variation in patients' blood sugar control. Serum creatinine is normally 0.98 mg/dL ± 0.54, so most individuals with this value may be seen as having healthy kidney function. On average, levels of haemoglobin are 11.12 g/dL ± 1.36 which is a little less than the adult standard, showing that the cohort has mild anemia. Most patients have a normal state of the left ventricle, indicated by a mean ejection fraction of 60.10% ± 4.08. As a whole, the data demonstrates that the patient's blood pressure and heart remain normal, but their blood sugar and hemoglobin fluctuate and may be low.

Table 2: Clinical and laboratory parameters

Parameter	Mean ± SD
Systolic BP (mmHg)	129.16 ± 13.92
Diastolic BP (mmHg)	79.02 ± 5.63
Random Blood Sugar (mg/dL)	142.09 ± 53.44
Serum Creatinine (mg/dL)	0.98 ± 0.54
Haemoglobin (g/dL)	11.12 ± 1.36
Ejection Fraction (%)	60.10 ± 4.08

The results of patients using DDD or VVIR pacing modes are presented in Table 3. Patients using VVIR pacing had a 6-Minute Walk Distance (6MWD) of 404.58 ± 53.48 meters which was roughly equal to that of DDD pacing (399.98 ± 60.95 meters), so this difference did not

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reach statistical significance (p = 0.372). In QOL assessment in all four areas—physical, psychological, social and environmental—there was no statistically meaningful difference between the two pacing modes. There was no significant difference in the physical scores between DDD (mean ± standard deviation 49.92 ± 10.94) and the VVIR (50.91 ± 9.15; p = 0.476), while both groups scored similarly on psychological scales (DDD – 53.12 ± 11.86 and VVIR – 54.41 ± 8.54; p = 0.291). On social measures, the mean score was higher in DDD mode (54.86 ± 14.72) than in VVIR mode (52.33 ± 7.57), but the difference was not significant (p = 0.347). The domain scores for evaluating the environment were 56.48 ± 11.30 for DDD and 53.94 ± 8.74 for VVIR (p = 0.573). As these results show, whether patients have DDD or VVIR pacing modes does not lead to any significant difference in both functional outcomes and quality of life.

Table 3: Comparison of functional outcomes between DDD and VVIR modes

Outcome	DDD mode (Mean ± SD)	VVIR mode (Mean ± SD)	p-value
6-Minute Walk Distance (m)	399.98 ± 60.95	404.58 ± 53.48	0.372
QOL Physical domain	49.92 ± 10.94	50.91 ± 9.15	0.476
QOL Psychological domain	53.12 ± 11.86	54.41 ± 8.54	0.291
QOL Social domain	54.86 ± 14.72	52.33 ± 7.57	0.347

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QOL Environmental domain	56.48 ± 11.30	53.94 ± 8.74	0.573

You can see in Table 4 how patients using DDD and VVIR pacing modes fall in various NYHA groups and pacing percentages. Both groups show the same pattern, with most patients falling into NYHA Class I and only a few in Class II or Class III, so most in both groups have only minor difficulties with physical activity. This means that ICDs work the same in different pacing situations. Even though the mean pacing rate for the DDD group (98.14% ± 3.54) is slightly higher than for the VVIR group (88.90% ± 10.84), this difference is not significant (p = 0.503). Although DDD pacing may provide a little better ventricular pacing, it doesn't seem to have any noticeable effect on your ability to function.

Table 4: NYHA class and ventricular pacing percentage

Parameter	DDD mode (%)	VVIR mode (%)	p-value
NYHA Class I	84%	84%	—
NYHA Class II	13%	13%	—
NYHA Class III	3%	3%	—
Ventricular pacing (%)	98.14 ± 3.54	88.90 ± 10.84	0.503

4. Discussion

Our purpose with the present research was to find out if there was a difference in short-term success between DDD and VVIR pacing in those with high-grade AV block, by assessing

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functional capacity, QOL, NYHA class and pacemaker syndrome, Dretzke J, et al. 2004. [10]. We found that patients using either pacing mode experienced similar improvement in 6-minute walk distance and their quality of life and symptom scores were the same. In both groups, there were no signs of pacemaker syndrome. The findings agree with other studies from around the world showing that the benefit of DDD pacing for this patient group over VVIR has not been demonstrated, mainly at short-term follow-up periods. The PASE trial [5] compared QOL, daily life and mortality in 407 patients using either DDD or VVIR pacemakers for one year. It found no important differences between the two groups. The results we obtained correspond with PASE results, as 6MWD and WHOQOL-BREF scores for each pacing mode were similar.

In a similar way, the UKPACE trial [6] of elderly patients with AV block did not show any difference in all-cause mortality or heart events between DDD and VVIR pacing over a 5.5-year period. Although there was a trend of lower atrial fibrillation with DDD pacing, UKPACE did not find these patients enjoyed better survival or health. There was no significant difference in one-month NYHA class or medical outcomes in our study and no atrial arrhythmias were noted during follow-up, yet we still need long-term results to check this further.

CTOPP [7-18] supported that DDD mode did not significantly cut the risk of stroke or death compared to VVIR, although it achieved a decrease in atrial fibrillation. Similarly, our short-term results indicate that using DDD pacing to achieve AV synchrony may not greatly improve a patient's exercise capacity or quality of life.

Similarly, our results match those found in the meta-analysis performed by Dretzke et al. [19] on 26 randomized controlled trials comparing dual- and single-chamber pacing. The results showed similar QOL and heart failure outcomes, even though DDD pacing cut down the risk of atrial fibrillation and improved the heart's left ventricular function for some patients. Because our group of patients mostly had preserved heart function, it was not surprising that there was little difference in short-term function between the pacing methods used.

No notable differences in 6MWD were seen between the DDD (399.98 ± 60.95 m) and VVIR groups (404.58 ± 53.48 m), matching the findings of Kruse et al. [11], confirming that improvement in heart function due to DDD pacing may not always improve exercise ability in

ISSN: 0975-3583,0976-2833 VOL 15, ISSUE 10, 2024

patients with normal ventricular function. Boon and colleagues [3] found just a mild improvement in blood pressure and symptoms for patients treated with DDD.

Our research found no obvious differences in quality of life values between different pacing methods, as tested using the WHOQOL-BREF instrument. The results are similar to those from researchers Lamas et al. [15] and Connolly et al. [7], who observed similar QOL irrespective of the pacing modulation used. Our outcomes reinforce the concept that in people with solid ventricular function and no severe heart problems, how the pacemaker works has minimal effect on how patients evaluate their early well-being.

Surprisingly, our study found that no pacemaker syndrome occurred, regardless of how the pacemakers were programmed. These findings are consistent with earlier observations by Epstein et al. [17] and Clarke et al. [16], who explained that the likelihood of pacemaker syndrome among AV block patients is much reduced when VVIR devices are used appropriately. The low number of cases reported in recent studies may be due to better methods for placing the leads, improved algorithms and a careful selection of patients.

Although our study discovered that the percent of ventricular pacing was greater in the DDD group (98.14 ± 3.54%) than in the VVIR group (88.90 ± 10.84%), this difference did not reach statistical significance. In some studies, ongoing ventricular pacing is connected to lasting negative changes in heart structure, but this was not assessed in our short-term analysis and should be studied further.

Our conclusions should be understood alongside certain restrictions. First, the study happened at one facility, looked at just a few patients and lasted for only 6 months. More extensive experiments are needed to see how different pacing modes affect atrial fibrillation, the course of heart failure and death. Also, while the WHOQOL-BREF is widely recognized and used, it might not be able to detect less noticeable differences in pacemaker symptoms in the same way that QOL tools for heart disease are equipped to do. Though not studied systematically in this research, the impact of resource scarcity on finances in India is a main factor to keep in mind in mode selection.

Even with these limitations, our study brings additional information to the limited literature from India. Dual-chamber pacing is the main type chosen in developed countries for 80-85% of

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pacemakers, yet in India, VVIR pacing is used most often due to expense [9, 8]. We conclude that, in areas where equipment is limited, single-chamber pacing can safely work as an alternative for patients with AV block for the short term. In short, the results indicate that both DDD and VVIR pacing after high-grade AV block lead to the same degree of functional capacity, quality of life and NYHA class. There were no reports of pacemaker syndrome in either group. Even when healthcare resources are tight and costs matter, VVIR pacing could keep being beneficial without lowering the patient's quality of care. Even so, further extensive studies involving multiple centers over a long period are necessary to specify how pacing mode can benefit these patients.

5. Conclusion

The aim of this study was to assess and compare standard outcomes after short-term use of dual-chamber (DDD) and single-chamber ventricular (VVIR) pacing in high-grade atrioventricular (AV) block patients. Both pacing modes led to similar improvements in how far participants could walk in 6 minutes and also their quality of life, as found using the WHOQOL-BREF questionnaire. The NYHA functional class and pacemaker syndrome results were similar for all groups. No one in either group was found to develop pacemaker syndrome while being followed. Although dual-chamber pacing was expected to help maintain synchrony between the two chambers, this did not lead to any gains in exercise tolerance or quality of life by the end of six months. We have found the same results as PASE, UKPACE and CTOPP which demonstrate that double-chamber pacing does not result in a greater improvement early after implantation when compared to single-chamber pacing in identical patients. Because VVIR pacemakers are much less costly than DDD pacemakers, this research once again highlights that VVIR pacing is both beneficial for patients and a smart choice for healthcare budgets in places like India. Yet, we need more extensive long-term research to investigate if there are differences in atrial fibrillation, heart failure worsening and survival between the types of pacing used.

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