Comparison between VDD and DDD Pacing in Symptomatic Second degree and Complete Heart Block

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Abstract

Background: VDD pacing provides the physiological benefits of atrioventricular synchronous pacing with the convenience of a single lead system, but is hampered by uncertainty regarding long term atrial sensing and development of sinus node disease.

Objective: To evaluate the efficacy and sensitivity of two different types of dual chamber pacemakers: (VDD and DDD pacemakers) by various electrophysiological and operative parameters in an attempt to determine whether VDD pacemakers are a viable alternative to DDD pacemakers in treatment of patients with 2nd and 3rd degree heart block with normal sinus node function.

Method: The study was conducted during the period between April 2006 to September 2007 on 48 patients with symptomatic 2nd degree and complete heart block, attending the Cardiac Care Unit in Al-Kadhimia Teaching Hospital. Those patients divided into two groups: VDD group and DDD group; each consisted of 24 patients. The VDD and DDD pacemakers were implanted in the patients and the tests of efficacy and sensitivity were done at implantation and in the follow up periods (2nd day of implantation, 10 days, 1 month, and 3 months after implantation) for both groups. These tests were: Atrial sensitivity, atrial lead impedance, P-wave amplitude, event histogram (% of atrio-ventricular synchronous pacing), duration of implantation, and duration of fluoroscopy. The outcomes of these tests were compared in both groups.

Results: Forty eight patients were implanted; half of them received DDD pacemakers, and the other 24 received VDD pacemakers. At the time of implantation and during the 3 moths of follow up, the DDD group showed significant higher efficacy and sensitivity than the VDD group. After implantation; the mean P-wave amplitude, atrial sensing threshold, atrial lead impedance, and % of AV synchrony were 3.42±1.1 mV; 3.46±1.3mV; 568±103.42Ω; 95%±7% respectively in DDD group, while they were 2.91±1.3 mV; 2.46±1.18mV; 624.2±136.26Ω; 90%±8% respectively in VDD group. Implant time was significantly reduced in VDD patients (61.82±14.6 min.) compared with DDD group (72.62±10.4 min.) ($p<0.05$). The exposure to radiation (fluoroscopy time) was significantly reduced in VDD patients (6.53±2.9 min.) in comparison with DDD patients (10.37±3.4 min.) ($p<0.05$).

Conclusion: the dual lead DDD pacing is superior to single lead VDD pacing for long term maintenance of AV synchronous pacing in symptomatic 2nd degree and complete heart block with preserved SA node function. The lower cost, high reliability, and abbreviated implantation time suggest that a VDD pacing is a viable alternative to DDD pacing.

Keywords: DDD pacemaker, VDD pacemaker, AV blocks, AV synchrony and atrial sensitivity threshold.

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Introduction

Most clinicians consider use of dual chamber DDD pacing for symptomatic AV block in order to maintain AV synchrony [7, 8, 12, 15].

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VDD pacing utilizing a single pass lead with far field atrial sensing bipoles is a potentially simpler approach to provide the physiological benefits of atrioventricular synchronous pacing block with a single lead system [3, 4, 7]. Despite this, VDD pacing is utilized in only one percent of patients receiving pacemakers in some countries like North America, though it is more widely used in other countries like Europe [5, 10, 11, 14]. This

may be related to concern regarding stability of atrial sensing or development of sinus node disease. However, a single lead system has the potential to reduce procedure time and complications, and reduce pacing cost compared to dual chamber pacing [1-4]. The comparison of implant and outcome of patients with symptomatic AV block managed with VDD versus DDD pacing system to assess the long term stability and viability of VDD pacing [6, 9, 13].

Patients and Methods

The study was conducted during the period between April 2006 to September 2007 on 48 patients (mean age 61.4±11.2 years) with symptomatic 2nd degree or complete heart block and normal sinus node function attending the Cardiac Care Unit in Al-Kadhimia Teaching Hospital. Patients were implanted between April 2006 and September 2007. Sinus node function was judged by in-patient monitoring or out-patient referral material. Those patients are divided into two groups: DDD group who were implanted with DDD pacemakers (St. Jude Veriy ADx XL DR Model 5356) and VDD group, who were implanted with VDD pacemakers (St. Jude Veriy ADx XL VDR Model 5456). Each group consists of 24 patients.

Devices were implanted using standard implant techniques with local anesthesia. The subclavian puncture technique was used for venous access. Atrial and ventricular pacing and sensing thresholds were determined at implant using a standard programming system analyzer. In general ventricular and leads were repositioned if ventricular sensing was less than 10 mV, or the pacing threshold was greater than 1.0 V. Atrial leads were repositioned if sensing was less than 2.0 mV, or the pacing threshold was greater than 1.0V. Implant time was defined as the time from patient entry into the implant room to patient departure. The fluoroscopy time was defined the summation of the total periods of X-ray radiation exposure. Both of them were measured. Standard pacemaker function was assessed after implantation and each follow up visit, including: Atrial sensitivity, atrial lead impedance, P-wave amplitude, event histogram (% of atrio-ventricular synchronous pacing).

Initial follow up was performed on the 2nd day, then on the 10th day, and after 1 month.

Failed atrial sensing was defined as P-wave amplitude not sensed by the pacemaker programmed threshold. Sinus node dysfunction was diagnosed if at least one of the following criteria was fulfilled: (1) sinus bradycardia below the pacemaker interventional rate of 45 beats/ min, (2) intermittent sinoatrial block, or (3) sinus arrest.

Results

Pacemakers were implanted in 48 patients. Those patients are divided into two groups: DDD group; which consists of 24 patients receiving DDD type pacemakers, and VDD group; which consists the rest of the patients who receiving VDD type of pacemakers.

Atrial sensitivity, atrial lead impedance, P-wave amplitude, event histogram (% of atrio-ventricular synchronous pacing), duration of implantation, and duration of fluoroscopy were used to compare the efficacy and sensitivity of DDD pacemakers in the DDD group with VDD pacemakers in the VDD group.

At time of implantation:

The mean values of mean P-wave amplitude, atrial sensing threshold, atrial lead impedance, and % of AV synchrony were 3.42±1.1 mV; 3.46±1.3mV; 568±103.42Ω; 95%±7% respectively in DDD group, while they were 2.91±1.3 mV; 2.46±1.18mV;

624.2±136.42Ω; 90%±8% respectively in VDD group. Implant time was significantly reduced in VDD patients (61.82±14.6 min.) compared with DDD group (72.62±10.4 min.) ($p<0.05$). The exposure to radiation (fluoroscopy time) was significantly reduced in VDD patients (6.53±2.9 min.) in comparison with DDD patients (10.37±3.4 min.) ($p<0.05$)

Table 1: Shows the mean values of mean P-wave amplitude, atrial sensing threshold, atrial lead impedance, % of AV synchrony, and %of failure of AV synchronous pacing of DDD group and VDD group at implant

The parameter	VDD group Mean±SD n=24	DDD group Mean±SD n=24	P value (t-test)
Mean P-wave amplitude (mV)	2.91±1.3	3.42±1.1	0.012
Atrial sensing threshold (mV)	2.46±1.18	3.46±1.3	0.001
Atrial Lead Impedance (Ω)	624.2±136.26	568±103.42	0.305
%AV Synchronous pacing	90%±8%	95%±7%	0.011
%of failure of AV synchronous pacing	10%±8%	5%±7%	0.01

On the next day of Implantation:

The mean values of mean P-wave amplitude, atrial sensing threshold, atrial lead impedance, % of AV synchrony and % of failure of AV synchronous pacing were as shown in the following table 2:

Table 2: Shows the mean values of mean P-wave amplitude, atrial sensing threshold, atrial lead impedance, % of AV synchrony, and %of failure of AV synchronous pacing of DDD group and VDD group on the next day of implant

The parameter	VDD group Mean±SD n=24	DDD group Mean±SD n=24	P value (t-test)
Mean P-wave amplitude (mV)	2.62±1.2	3.38±1.3	0.0039
Atrial sensing threshold (mV)	2.41±1.15	3.39±1.23	0.0014
Atrial Lead Impedance (Ω)	564.2±116.2	518±86.6	0.54604
%AV Synchronous pacing	90%±8%	95%±7%	0.011
%of failure of AV synchronous pacing	10%±8%	5%±7%	0.01

After 10 days:

The mean values of mean P-wave amplitude, atrial sensing threshold, atrial lead impedance, % of AV synchrony and % of failure of AV synchronous pacing were as shown in the following table 3:

Table 3: Shows the mean values of mean P-wave amplitude, atrial sensing threshold, atrial lead impedance, % of AV synchrony, and %of failure of AV synchronous pacing of DDD group and VDD group 10 days after implantation.

The parameter	VDD group Mean±SD n=24	DDD group Mean±SD n=24	P value (t-test)
Mean P-wave amplitude (mV)	2.53±1.01	3.31±1.01	0.00615
Atrial sensing threshold (mV)	2.26±1.12	3.19±0.93	0.0014
Atrial Lead Impedance (Ω)	492.2±113.2	518±89.6	0.3085
%AV Synchronous pacing	88%±7%	94%±7%	0.0091
%of failure of AV synchronous pacing	12%±7%	6%±7%	0.01

At 1 month follow up:

The mean values of mean P-wave amplitude, atrial sensing threshold, atrial lead impedance, % of AV synchrony and % of failure of AV synchronous pacing were as shown in the following table 4:

Table 4: Shows the mean values of mean P-wave amplitude, atrial sensing threshold, atrial lead impedance, % of AV synchrony, and %of failure of AV synchronous pacing of DDD group and VDD group at 1 month follow up.

The parameter	VDD group Mean±SD n=24	DDD group Mean±SD n=24	P value (t-test)
Mean P-wave amplitude (mV)	2.46±1.01	3.21±1.00	0.00525
Atrial sensing threshold (mV)	2.09±1.02	3.05±0.83	0.0004
Atrial Lead Impedance (Ω)	462.31±106.2	508±106.4	0.0853
%AV Synchronous pacing	86%±7%	93%±7%	0.0099
%of failure of AV synchronous pacing	14%±7%	7%±7%	0.01

At 3 months follow up:

The mean values of mean P-wave amplitude, atrial sensing threshold, atrial lead impedance, % of AV synchrony and % of failure of AV synchronous pacing were as shown in the following table 4:

Table 4: Shows the mean values of mean P-wave amplitude, atrial sensing threshold, atrial lead impedance, % of AV synchrony, and %of failure of AV synchronous pacing of DDD group and VDD group at 1 month follow up.

The parameter	VDD group Mean±SD n=24	DDD group Mean±SD n=24	P value (t-test)
Mean P-wave amplitude (mV)	2.49±1.09	3.2±1.00	0.0125
Atrial sensing threshold (mV)	2.16±1.15	3.00±0.89	0.0014
Atrial Lead Impedance (Ω)	447.54±113.8	491±103.14	0.0631
%AV Synchronous pacing	87%±8%	93%±7%	0.0119
%of failure of AV synchronous pacing	13%±8%	7%±7%	0.0166

In the VDD group, the value of mean P-wave amplitude was significantly different when compared to that of the DDD group ($p<0.05$). The % o AV synchronous pacing and % of failure of AV synchronous pacing were significantly different when compared to that of DDD group ($p<0.05$), whereas there was no significant difference in the value of lead impedance when compared to the atrial lead impedance of the DDD group ($p>0.05$). On the other hand, the value of atrial sensing threshold in the VDD group showed a highly significant differences when compared to that of DDD group ($p<0.01$).

Discussion

Despite the introduction of single pass leads capable of dual sensing and ventricular pacing over 20 years ago, VDD pacing remains underutilized pacing approach in patient with AV block [5-7].

VDD pacemakers have a single pacing lead which has two floating ring electrodes located on the portion of the lead that is present in the right atrium and these electrodes are responsible for sensing intrinsic atrial P-wave unlike DDD pacemakers which employ a separate atrial pacing lead for sensing of intrinsic atrial P-waves and atrial pacing [5, 11, 13].

The advantages of using VDD pacemakers is obvious in patients with second degree or third degree heart block having normal sinus node function who do not require atrial pacing, which is offered by DDD pacemakers [3,4,9]. In addition the use of a single pacing lead reduces the time needed for implantation of the pacemaker and also reduces the time the patient is exposed to X-ray during fluoroscopy and it is also cheaper for such patients than DDD pacemakers. VDD pacing provides reliable chronic atrial sensing to permit maintenance of atriovenricular synchrony. VDD pacing may reduce the frequency of implant and long term complications because of the reduced number of leads involved [1, 2, 10].

The disadvantages of VDD pacemakers in comparison with DDD

regarding the long term efficacy, sensitivity and stability of atrial sensing as the atrial sensing electrodes of the VDD pacing lead is floating in the right atrium and not fixed to the endocardium as in the atrial lead of DDD pacemakers, and as a result changes in the posture, activity, ect. can cause changes in he atrial sensing [12, 14].

Despite the decrease in the atrial signal amplitude the VDD pacing, adequate AV synchrony was maintained in almost all patients with programming changes to maintain atrial sensing. In addition, patient selection resulted in a very low incidence of chronic atrial fibrillation or sinus node disease, a context where atrial based pacing may be beneficial in both sensing and pacing. This finding is in keeping with the previous observation by Anderson et al, who found little association of sinus node disease with AV block in patients undergoing atrial based pacing for sinus node disease who presented with intact AV node function [8, 10].

Longer term follow up may have permitted further detection and development of sinus node disease and atrial fibrillation, potential limitations of VDD pacing. Conversely, longer follow up is likely to detect "degenerative" lead related problems, including the potential need for lead replacement or extraction. The latter would have contributed to greater cost and complications in the DDD group [7, 9, 11].

Increased utilization of VDD pacing could realize significant cost savings. Although there is minimal difference in generator capabilities and cost between pacing modes, reduced lead costs may contribute to significant savings [6, 13].

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