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Original article

Cardiac Resynchronization Therapy: A 4-Year Review of Our Experience

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Abstract

Introduction: Cardiac Resynchronization therapy (CRT) is very significant in the management of Heart Failure with significant electrical dyssynchrony. This dyssynchrony is measured using QRS duration on the ECG. CRT has been shown to reduce mortality and improve symptoms in heart failure. The objective of the study is to review 4-year experience in CRT implantation, complications and challenges of implantation. ***Methods and materials:*** This was a retrospective study. We searched cath labs of Bayelsa Specialist Hospital, Cardiocare Hospital and retrieve all the CRT implanted within 1st January, 2018 and 30th June, 2022. Data collected were indications, duration of implant, complications, failure of implant and reason for the failure. ***Results:*** A total of 32 CRT were implanted during the review period. There were 20 men who received the device. CRT-D implanted were twenty-eight, with four CRT-P implanted. The mean implant duration was 2 hours 40 minutes. ***Conclusion:*** CRT is now commonly implanted with very high success rate. The complication ranges from non to mild and there is dramatic patient improvement.

Keywords: ***cardiac resynchronization, therapy, review.***

Introduction

Cardiac resynchronization therapy (CRT) is one of the main treatment pillars for heart failure patients with reduced left ventricular ejection fraction and with electrical dyssynchrony [1]. Cardiac Resynchronization therapy is key in the management of Heart Failure with significant electrical dyssynchrony. This dyssynchrony manifests as delay in conduction through the ventricles with conduction abnormalities and broad QRS complex [1]. Dyssynchrony may be measured using QRS duration on the ECG. CRT has been shown to reduce mortality and improve symptoms in heart failure [2].

Cardiac resynchronization therapy is delivered by biventricular pacemakers (CRT-P) or by biventricular pacemakers with additional defibrillator capability (CRT-D) [3]. The objective of the study is to share our experience in CRT implantation, indications and complications in these 4 years.

Methods

Patient population

This was a two-centers (Cardiocare Multispecialty Hospital and Bayelsa Specialist Hospital, Yenagoa, Nigeria), retrospective study that included subjects of CRT-D between 1st January, 2018 and 30th June, 2022. The echocardiography obtained two months after the implantation were used to define response. We use definition of super-response (being normalization of EF) to minimize risk of lowering the specificity of super-responder status. Clinical information documented as part of routine clinical care was collected from the manual patients' files and electronic medical records.

Data collected were indications, complications, failure of implant and reason for the failure.

Inclusion criteria

1. Age 18 years and above
2. All those with indication(s) for the CRT:

a) first implant: ECG with suggestive features with QRS > 130ms, LBBB, Ejection fraction less than 35%
b) Upgrade to CRT
c) Box change

Exclusion criteria

1. EF more than 35%
2. ECG features not qualified
3. Patients with incomplete data

Grouping

The age of the patients were grouped as follows: (Group I - < 40 years, Group II- 40 to 49 years, 50-59 years, 60-69 years and above 70years).

Echocardiography

Echocardiography parameters recorded included the following

1. Left ventricular (LV) ejection fraction (LVEF) (calculated using modified Simpson's formula),
2. LV end-diastolic diameter (LVEDD) (measured with M-mode or 2D echocardiography),
3. LV end-systolic diameter (LVESD), LV end-diastolic volume (LVEDV) (calculated using the Teichholz formula),
4. LV end-systolic volume (LVESV) (calculated using the Teichholz formula),

5. Pulmonary artery systolic pressure (PASP, estimated from the tricuspid regurgitant velocity and an estimate of right atrial pressures), and
6. Mitral valve regurgitation (MR) grade (0, none; 1, trivial/mild; 2, moderate; 3, severe) (based on jet characteristics and/or PISA method), and right ventricular (RV) dysfunction (semi-quantitative grading scale: 0, normal; 0.5, borderline; 1, mild; 1.5, mildmoderate; 2, moderate; 2.5, moderate-severe; 3, severe dysfunction).

Cardiac resynchronization therapy

Device implantation was performed under local anesthetic with or without conscious sedation. Commercially available devices [Medtronic and St Jude]. The position of the LV lead was prioritized as posterolateral/middle cardiac whenever possible as dictated by pacing thresholds, diaphragmatic stimulation, and ability to cannulate the veins.

Implantable cardioverter defibrillator programming

Devices were programmed to monitor and give therapy. The primary prevention settings were as follows:

- Medtronic (duration 18/24 intervals) and St Jude (duration 12 beats) devices. The detection rate only was changed and was increased to 200 bpm for two manufactures. Therapy was programmed to one cycle of anti-tachycardia pacing (ATP) during ICD capacitor charge, followed by shock delivery.

Clinical follow-up

After implantation and discharged, patients presented to the outpatient clinic at 2 weeks, 3months, 6th months and then yearly. The device was interrogated to ensure normal function. Electrogram review, where indicated, was performed by a trained device nurse and cardiac electrophysiologist. AV and VV optimization were performed.

Data analysis

The data analysis was carried out with SPSS. Continuous variables will be expressed as mean plus standard deviation (SD). Student's t-test was performed to compare means. Categorical variables were compared with the Chi square test or Fisher's exact, as appropriate.

Definition of terms

1. Non-responsiveness to CRT, described as lack of reverse cardiac chamber remodeling, leading to lack to improve symptoms, heart failure hospitalizations or mortality, is common, rather unpredictable
2. Nonprogressors do not show a benefit of CRT, but also do not follow their predicted natural course of deterioration as a result of CHF (dashed line) like non-responders.
3. Negative responders demonstrate clinical worsening of their disease after CRT implantation
4. Super responders: Patients were classified as non-super responders and super-responders based on the post-CRT EF of <50% and >_50%, respectively

Results

There were 32 patients over the 4 years review. The mean age was 61.87+12.205 (see table1). There were 22 males and 10 females (Table2). The mean BMI is 33+4.927. this is shown in table 3. Heart failure men duration 3.853+ 1.253, with minimum and maximum being 2 and 7 respectively (table4). The patients were in NYHA class III and IV ambulatory. Nineteen were in class III and 13 pts in class IV ambulatory. 20 males had CRTD, 10 female had CRT-p and 30-CRTD. Thirty patients had first implant one had upgrade and 1 with battery replacement (Table5). 31 patients had implantation from the left side while 1 had the implantation from the right. The reason for the right implant was due to persistent left SVC on venogram. In 3 patients, LV leads were position in the middle cardiac vein while in 29 patients, LV leads means in posterolataul vein.

All the patients had been on follow up for at least 3 months to 4 years with various degree of responses.

9 subjects had super response, with improved ejection fractions, 12 had response, 4 had non response and 1 negative response

Table 1: Descriptive Statistics of Age (years)

	Age
Mean	61.875
Std. Deviation	12.205
Minimum	35.000
Maximum	80.000

Note: n = 32

Table 2: Frequency distribution of gender in the population

Sex	Frequency	Percent
Female	10	31.250
Male	22	68.750
Total	32	100.000

Table 3: Descriptive Statistics of anthropometric parameters

	Weight (kg)	Height (m)	BMI (kg/m^2)
Mean	95.969	1.708	33.059
Std. Deviation	12.635	0.094	4.927
Minimum	69.000	1.500	23.100
Maximum	120.000	1.890	48.100

Note: n = 32

Table 4: Descriptive Statistics of heart failure duration (years)

	Heart failure duration
Mean	3.853
Std. Deviation	1.253
Minimum	2.000
Maximum	7.000

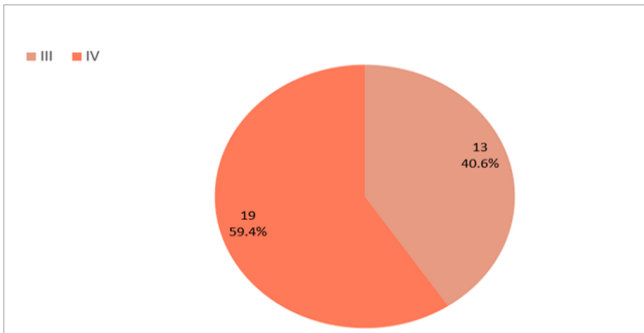

Fig 1: Distribution of NYHA heart failure class in the population (n=32)

Table 5: Distribution of procedure type, implantation side, and device manufacturer (n = 32)

Variable	Category	Frequency	Percent (%)
Procedure type	First device implantation	30	93.8
	Battery replacement	1	3.1
	Upgrade	1	3.1
Implantation side	Left	1	96.9
	Right	31	3.1
Device Manufacture	Medtronic	31	96.9
	St. Jude	1	3.1

Note: access route for all procedures was via the subclavian vein.

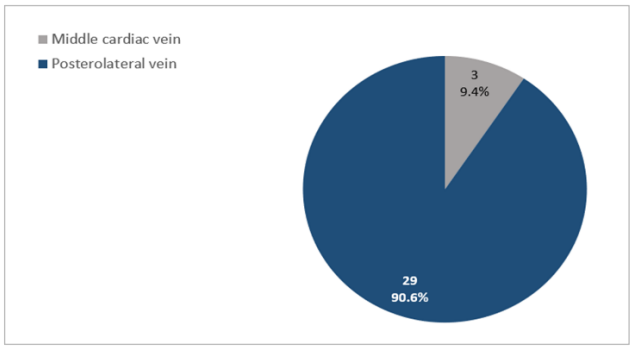

Fig 2: Distribution of LV lead placement (n=32)

Table 6: Mean comparison of percentage (%) LV paced activity across responsiveness category

	n	Mean	Std. Deviation	Minimum	Maximum
Negative-responder	1	98.0	Na N	98.0	98.0
Non-progressor	4	100.0	0.0	100.0	100.0
Non-responder	4	96.6	1.2	97.0	100.0
Responder	12	99.2	0.7	97.9	100.0
Super-responder	9	99.8	1.2	97.0	100.0

F (1.834); df(4); P(0.154). *Note: n = 30.*

Discussion

Cardiac resynchronization therapy (CRT), also known as biventricular pacing or multisite ventricular pacing, involves simultaneous pacing of the right ventricle (RV) and the left ventricle (LV) [4]. In addition to a conventional RV endocardial lead, CRT involves an additional coronary sinus lead placed for LV pacing. Access to the CS for implantation of the LV lead may be achieved via the axillary, subclavian, or cephalic vein [5]. All the patients with first or upgrade were done via extra-thoracic subclavain vein.

Healthy individuals with normal sinus rhythm without conduction abnormalities have their electrical activation relatively synchronous [6]. This is the ventricular activation taking about 70 ms. Activation first occurs in the left ventricular (LV) septal endocardium and the latest in the epicardium of the LV lateral wall[6].

Sex difference

In the ESC 2021 guidelines for 2021 ESC Guidelines on cardiac pacing and cardiac resynchronization therapy, complication rates differ between male and female. In female patients, the rate of procedure-related adverse events is significantly higher, corrected for age and type of device [7]. This was not noticed in our study, probably due to the few numbers of patients in the study. This higher rate is driven mostly by pneumothorax, pericardial effusion, and pocket haematomas [7]. There were no complications among the patients recruited in the study, even though one patient had a re-do procedure before the CRT was successful.

Possible explanations for this are a smaller body size in women and anatomical differences, such as smaller vein diameters and RV diameters.

Indications for Cardiac Resynchronization therapy

CRT is recommended for symptomatic patients with heart failure (HF) in sinus rhythm with LV ejection fraction (LVEF) ≤35%, QRS duration ≥150ms, and left bundle branch block (LBBB) QRS morphology [7]. CRT should be considered for symptomatic patients with HF in sinus rhythm with LVEF ≤35%, QRS duration 130-149ms, and LBBB QRS morphology [7]. CRT should be considered for patients with HF in sinus rhythm with LVEF ≤35%, QRS duration ≥150ms, and non-LBBB QRS morphology [7]. CRT should be considered for patients with HF and LVEF ≤35% in NYHA class III or IV if they are in atrial fibrillation (AF) and have intrinsic QRS ≥130ms, provided a strategy to ensure biventricular capture is in place. AV junction ablation should be added in the case of incomplete biventricular pacing (<90-95%) due to conducted AF [7]. These patients in this 4-year review were in New York association class III and IV ambulatory. They were in sinus rhythm with complete LBBB. The ejection fractions of our patients were less than 35%.

Responders to CRT

Cardiac Resynchronization Therapy reverses remodeling in systolic left ventricular dysfunction (REVERSE) trail. The Multicenter Automatic Defibrillator Implantation Trial With Cardiac Resynchronization Therapy (MADIT-CRT) showed extended observed benefit to patients with less advanced (New York Heart Association [NYHA] class I/II) signs and symptoms [8-10]. Although most treated patients respond to CRT, approximately one third are considered non-responders in clinical trials using a variety of measures of clinical responsiveness [11-14].

About 30–50% of patients fail to respond to transvenous and CRT. This group are classified as non-responders although no unifying definition of response to CRT exists. However, we dilinated the various definitions to explain how the patient response to the therapy. Response can be measured in a variety of different clinical, functional and structural endpoints and patients can fail to respond for a variety of different reasons. The clinical and echocardiography parameters were used to define response in our study. Response rates tend to be higher when clinical measures, such as subjective assessments of symptoms are used but are much lower when remodeling or outcome measurements are employed. In the present study, we used clinical measurements of heart failure and echocardiographic dimension and ejection fraction in response assessment.

The presence of left bundle branch block morphology is a strong predictor of response to CRT [15]. In addition, LBBB activation is not exclusively associated with electrical conduction delay [16-18]. In one analysis, up to a third of patients with LBBB who underwent electromechanical or non-contact mapping [17,18]. All our patients had complete LBBB

Conclusion

CRT is an important therapy of heart failure and is now readily available in Nigeria. Non-response to CRT is a multifactorial issue. Improving patient selection and post implant device troubleshooting remain the cornerstone of optimizing patient outcomes.

Limitations

Our study is retrospective with inherent limitations. The number of super-responders is small.

Disclosures

No conflict of interest to disclose.

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