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Optimization of Coronary Sinus Lead Position in Cardiac Resynchronization Therapy guided by Three Dimensional Echocardiography

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ABSTRACT

Background: Cardiac resynchronization therapy (CRT) is now an established effective treatment for patients with advanced heart failure.

One approach to improve CRT outcome may be determination of the degree of dsynchrony before CRT as a predictor for CRT response. Conversely, the focus may be on an improved positioning of CRT left ventricular (LV) lead.

AIM of the study: We aimed at our study to define the rule of three-dimensional echocardiography in determining the optimal site of LV pacing lead.

Patients and Methods: The current study was conducted on 30 patients with heart failure who had received CRT in Ain Shams University Hospitals in the period from 2012 to 2014.

All patients were subjected to thorough history taking, complete general and local examination, conventional 2D echo and 3D echo analysis. The latest wall to reach the minimal volume was determined. The patients were classified after CRT insertion into group A with concordance between the delayed LV area and LV lead position and group B with discordance between them. Our patients were followed up for 6 months duration.

Results: Our findings demonstrated that the response to CRT resulted in improvement of NYHA class **(p-value 0.04)**, LV EF by 2D and 3D echocardiography **(P value <0.001 for both)** with significant increase in LV 3D SV **(p value 0.001)**, and significant reduction of LA diameter **(p-value 0.03)**, LVESD diameter, 2D and 2D LVESV **(P value 0.026, 0.026 respectively)**, however there was **no any statistically significant difference** between both groups.

Conclusions: No additional benefit of selecting LV lead position pre CRT insertion to be concordant with the latest myocardial segment in reaching the minimal systolic volume assessed by 3D echocardiography

Keywords: CRT, LV lead, 3D echo, Dyssynchrony.

INTRODUCTION

Cardiac resynchronization therapy (CRT) is now an established effective treatment for patients with advanced heart failure. [1] Apart from clinical benefits, improvements of left ventricular (LV) systolic function and associated LV reverse remodeling have been well reported.

The rate of approximately 30% of inadequate responders remains an unsolved problem. [2] To improve outcome of CRT, three different and complementary approaches have been proposed: optimization of patient selection; optimization of LV lead placement and optimization of the programming of the CRT device. [3] The importance of 3DE in optimal LV pacing lead position was discussed in several studies comparing response to CRT in patients with the LV pacing lead at the segment with the maximum mechanical delay to patients with the LV pacing lead at other segments. [4]

Aim of the study: to define the rule of three dimensional echocardiography in determining the optimal site of LV pacing lead.

Patients and Methods:

The current study was conducted on 30 patients with advanced congestive heart failure who had received CRT in Ain Shams University Hospitals in the period from 2012 to 2014 according to ESC guidelines. [5,6]

All patients were subjected to: thorough history taking with particular stress on age, gender, risk factors, history of

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previous tachyarrhythmia, symptoms including dyspnea assessment, they underwent general and local examination including heart rate, blood pressure measurements. They were followed up 6 months after the therapy.

We made a detailed analysis of the 16 segments of the LV times to reach the minimal volume and determined the latest wall (by having at least 2 delayed segments) to reach the minimum volume, the CRT was inserted blindly to our results and the patients were classified into two groups (A and B). Group A: Patients LV lead implantation in the coronary sinus vein, which corresponding the latest contracting segment of the LV identified by preprocedural 3DE. Group B: Others with LV lead implantation in any coronary sinus vein.

Data were collected, verified, revised and edited, then statistically analyzed.

RESULTS

The LV lead was placed in our study patients in the posterior- lateral vein in 20 patients who represented 67% and in posterior vein in 3 patients who represented 10 %, lateral vein in 4 cases who represented 13%, and in anterolateral vein in 3 patients who represented 10 % of cases.

In our study, the priority was to achieve a stable LV lead position with suitable threshold and with absence of diaphragmatic pacing. No intraoperative hemodynamic evaluation was carried out.

After CRT implantation biplane fluoroscopy in two orthogonal views (left anterior oblique at 60° and right anterior oblique at 30°) was performed. These images were analyzed to determine the anatomic location of the LV lead position in comparison to the 3D delayed area.

For our study purpose a resized 16-segment schema15 was projected onto the left anterior oblique Fluoroscopic image to confirm our classification. In addition, the right anterior oblique level was divided into basal, medial, and apical sections.

All LV leads were positioned in the mid LV segment in the RAO projection as in our protocol we avoid apical insertion of LV lead.

After retrograde classification of our groups 13 patients were classified as group A and 17 patients as group B.

There was no significant difference between both groups as regards patient's age, CV risk factors, baseline NYHA Class and medications. Our findings demonstrate that the response to CRT resulted in significant improvement of NYHA class **(p-value 0.04)**, significant increase in LV EF by 2D and 3D echocardiography **(P value <0.001 for both)** with significant increase in LV SV measured by 3D echocardiography **(p value 0.001),** however there was no any statistically significant difference between groups.

LV internal dimensions showed improvements post CRT in both groups, however these reduction in the LVESD and LVEDD were irrespective of the LV lead concordance with the delayed myocardial segment as analyzed by comparing the percentage of change between both groups which showed no significant difference between both groups (P value 0.0.6, 0.5).

As regards the 2D echo derived parameters there were no significant differences in the percentage of changes in the EF, ESV and EDV between group A and B (P value 0.74, 0.75, and 0.88 , respectively)

We found a significant positive correlation between LV EF by 3D echo and the standard 2D biplane Simpson methods (P value 0.01).

We found a significant increase in LV EF by 3D echocardiography in both groups, the baseline EF was (22.6±6 and 24±6) in group A and B respectively and increased to (26±8 and 31±9) in group A and B respectively with a p value 0.03 and 0.002 in group A and B, respectively).

The LVESV and LVEDV showed no significant changes in both groups either before or after CRT insertion; however there was a significant improvement in the SV in the overall study groups and especially in group B after CRT insertion (P value 0.13, 0.003 in groups A and B, respectively).

These 3D echo derived volumetric parameters (EF, ESV, EDV and SV) showed with no significant differences in the percentage of changes between both groups, P value 0.5, 0.85, 0.92, 0.79, respectively.

DISCUSSION

The results of our study revealed improvement of NYHA functional class with both groups compared to baseline, improvement in the NYHA functional class was evident in both groups with no statistically significant difference between them and this was consistent with previous multiple trials.[7-9]

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These results were consistent with ***Becker et al.***[4], whom study was performed on 44 patients with almost similar demographic data and followed up for 6 months, However our results differ from those obtained from ***Deplagne et al***.[10] they found a significant difference between their two study groups.

There was no significant differences in M-mode parameters included EF, FS, ventricular wall thickness, LA diameter and Aortic diameter that showed no significant differences in both groups either in baseline, after follow up period, or in the percentage of change.

These results were consistent with ***Becker et al.*** [4], however was in contradiction to the results obtained from ***Deplagne et al*** .[10] The differences in the study design may explain these differences.

Our results are consistent with the results of ***Becker et al.***[4] as they did not demonstrate any significant difference in LVEF, SV by 3D echocardiography in their study groups.

Our study assessed the possible favorable impact of targeting the most delayed LV region. However, we did not demonstrate an increased benefit.

We concluded the absence of additional benefit of selecting LV lead position pre CRT insertion to be concordant with the latest myocardial segment in reaching the minimal systolic volume assessed by 3D echocardiography.

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Table (1): Comparison of the delta changes of 2D echocardiographic parameters between the study groups

Item	Δ change (Mean Rank)		Mann- Whitney Test	
	Group A	Group B	Z	P-value
EF (M-mode)	15.6	15.4	-0.06	0.95
LVEDD	14.4	16.3	-0.59	0.56
LVESD	14.5	16.2	-0.50	0.62
EF (SIMPSON)	14.8	15.9	-0.33	0.74
LVEDV	15.2	15.7	-0.15	0.88
EDVI pre	16.6	14.6	-0.61	0.54
LVESV	16.0	15.0	-0.31	0.75
ESVI	16.8	14.4	-0.73	0.46

Table (2): Comparing delta changes of different 3D echocardiography findings in the two groups

	% of change				Mean rank		Mann- Whitney Test	
	Group A		Group B					
	Median	IQR	Median	IQR	Group A	Group B	Z	P-value
EF (3D)	6.90	35.85	36.84	64.33	14.31	16.41	-0.65	0.52
EDV	0.85	25.24	1.21	39.16	15.31	15.65	-0.10	0.92
ESV	-3.33	28.13	-0.97	32.14	15.85	15.24	-0.19	0.85
SV	25.00	62.54	22.89	88.68	14.50	15.35	-0.27	0.79

Table (3): Comparing 3D echocardiography findings in the two groups before and after CRT insertion

	Mean±SD		Paired Differences		Paired Samples Test	
	Pre	Post	Mean	SD	t	P-value
EF (3D)	23.6±5.9	29.1±9.0	-5.5	7.0	-4.308	**<0.001***
EDV	218.8±117.8	231.6±108.2	-12.8	42.4	-1.651	0.109
ESV	169.9±101.3	170.2±96.6	-0.2	33.3	-0.038	0.970
SV	47.1±18.9	59.9±21.8	-12.8	18.4	-3.752	**0.001***

Table (4): Comparing 2D echocardiography findings in study patients before and after CRT insertion

	Mean±SD		Paired Differences		Paired Samples Test	
	Pre	Post	Mean	SD	t	P-value
M-mode EF %	30.0±6.8	34.3±10.6	-4.3	6.9	-3.4	**0.002***
FS %	14.9±3.4	17.1±5.6	-2.1	3.6	-3.2	**0.003***
LVEDD mm	71.2±10.2	68.9±11.9	2.2	7.5	1.6	0.116
LVESD mm	60.5±10.6	57.2±13.5	3.3	7.7	2.3	**0.026***
EF(SIMPSON) %	25.3±6.5	33.0±9.5	-7.7	6.5	-6.3	**<0.001***
LVEDV ml	232.7±101.9	221.8±92.7	10.9	51.4	1.1	0.254
LVEDVI ml/m²	120.0±51.6	110.9±46.3	9.0	30.7	1.6	0.116
LVESV ml	177.6±92.7	156.0±82.9	21.6	50.5	2.3	**0.026***
LVESVI ml/m²	91.5±47.3	78.0±41.4	13.5	30.0	2.4	**0.020***
LA mm	46.9±5.5	44.9±5.6	2.0	4.8	2.2	**0.033***
Aorta mm	31.7±2.7	30.7±3.1	1.0	2.0	2.7	**0.010***
RV-PEP ms	123.3±27.3	144.7±38.7	-22.8	36.7	-3.0	**0.005***
LV-PEP ms	157.5±39.2	156.7±43.3	-7.5	47.1	-0.8	0.431
Septal to post wall mm	142.9±94.6	107.6±77.8	-3.2	91.8	-0.1	0.908
RVSP mmHg	39.2±13.6	29.5±5.8	9.7	12.4	4.2	**<0.001***

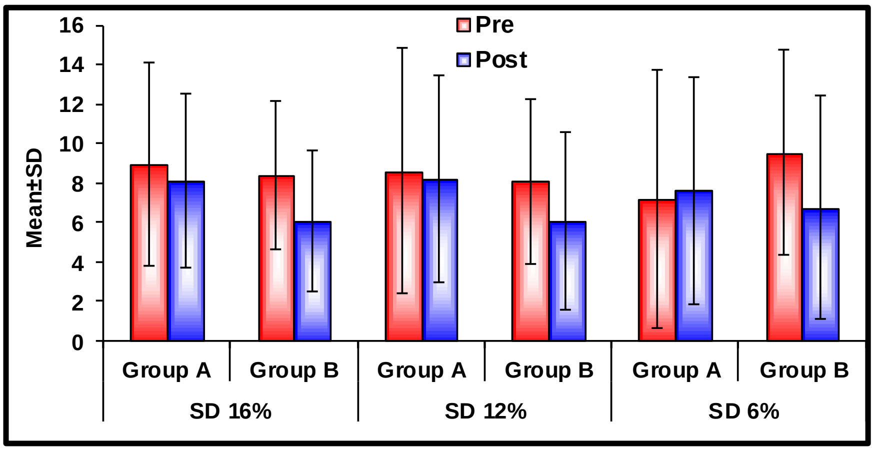

Fig. (1): Comparing 3D echocardiography SDI in each group before and after CRT insertion