Short Communication

Relationship of echocardiographic left ventricular dyssynchrony with QRS width on surface electrocardiogram in patients with systolic heart failure: An observational study

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A R T I C L E  I N F O

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A B S T R A C T

This study aimed to evaluate left ventricular dyssynchrony with QRS width on ECG in patients with systolic heart failure. 100 study patients were classified into two groups. Narrow QRS group-N- QRS (80–119 msec) and Wide QRS group-W- QRS (120–160 msec). Out of each 50 patients in W- QRS group, 38 (76%) had LV dyssynchrony and 18 (36%) in N- QRS group had ventricular dyssynchrony. Dyssynchrony in narrow QRS patients with heart failure also needs attention as a therapeutic target in future studies.

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1. Introduction

Left bundle branch block (LBBB), with wide QRS on ECG, is the most common cause of ventricular dyssynchrony in 30 %–50 % of patients with systolic heart failure (HF). Ventricular dyssynchrony is also seen in patients with narrow QRS complex. In this study, we have assessed the relationship between echocardiographic LV dyssynchrony and QRS width on surface ECG.

2. Aims & objectives

To determine the echocardiographic left ventricular dyssynchrony and correlation with QRS width on surface ECG in patients with systolic HF.

3. Methods

100 patients with symptomatic HF of NYHA functional class II–IV in sinus rhythm and LVEF 40 % or less were included and 12-lead electrocardiogram was obtained. Left ventricular end systolic, end diastolic diameters, ejection fraction were assessed by 2D-Echo. Intraventricular dyssynchrony was measured by taking maximum delay between peak systolic velocities among the basal lateral and basal septal regions and the basal anterior and basal inferior regions and interventricular dyssynchrony by measuring the time delay between the onset of flow in the right and left ventricular outflow tracts using Pulse wave Doppler velocities. Patients were classified into two groups. Narrow QRS group-N- QRS (80–119 msec) and Wide QRS group-W- QRS (120–160 msec).

4. Results

The mean age was 58.18 ± 10.41 years, ranging from 31 to 84 years. The clinical and demographic features depicted in Table- 1. The duration of heart failure ranged from 3 months to 7 years with mean of 2.54 ± 1.57 years. Majority were in NYHA functional class IV (52 %) and class III (45 %) respectively. 50 patients each were enrolled in W and N – QRS groups. The most common QRS morphology noted in W- QRS group was LBBB and in N- QRS group was intra ventricular conduction delay (IVCD) (Table- 2). The baseline echocardiographic parameters were shown in Table- 3. LV dyssynchrony by M-mode was noted in 38 (76 %) in W- QRS group and 18 (36 %) in N- QRS group. The mean septal to posterior wall

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motion delay measured by M-mode in W-QRS group was 180 ± 35 msec where as in N-QRS group was 70 ± 16 msec, septal to lateral wall delay was 74 ± 16 msec and 51 ± 8 msec and interventricular delay was 79 ± 11 msec and 30 ± 5 msec in W-QRS and N-QRS groups respectively (Table- 4). The number of patients with LV dyssynchrony on echocardiography in two thirds of W-QRS group and one third of N-QRS Group (Fig. 1).

5. Discussion

QRS duration may not always be related to mechanical dysynchrony and baseline QRS duration alone is not the best predictor of response to CRT. In our study the LV dyssynchrony was seen in 66 % (76 % of wide QRS group and 36 % of narrow QRS group) of HF patients. Up to 30 % of HF patients with normal QRS duration may have significant mechanical dyssynchrony, conversely 20 %–30 % of HF patients with wide QRS duration may not have mechanical dyssynchrony.2 Nelson et al, studied in 22 patients with dilated cardiomyopathy either wide (>120 ms) or narrow QRS (≤120 ms) with LV pacing induced change in QRS duration and found no

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**Table 1**

Clinical and demographic features of the study population.

| Clinical and demographic factors | Group-W QRS (120–160) ms N = 50 | Group-N QRS (80–119) ms N = 50 | p-value |
|---------------------------------|----------------------------------|---------------------------------|---------|
| Age(years)                      | 56±4                             | 57±3                            | 0.1605  |
| NYHA CLASS II                   | 2(4 %)                           | 1(2 %)                          | 1       |
| CLASS III                       | 20(40 %)                         | 25(50 %)                        | 0.421   |
| CLASSIV                         | 28(56 %)                         | 24(48 %)                        | 0.548   |
| Diabetes                        | 20(40 %)                         | 23(46 %)                        | 0.686   |
| Hypertension                    | 12(24 %)                         | 15(30 %)                        | 0.247   |
| H/O Myocardial infarction       | 11(22 %)                         | 10(20 %)                        | 1       |
| H/O PCI                         | 11(22 %)                         | 12(24 %)                        | 0.813   |
| H/O CAVG                        | 5(10 %)                          | 7(14 %)                         | 0.758   |
| NSVT ON HOLTER                  | 12(24 %)                         | 11(22 %)                        | 1       |
| H/O VT                          | 5(10 %)                          | 3(6 %)                          | 0.712   |

**Table 2**

Electrocardiographic features of patients with heart failure.

| ECG parameter                      | Group-W QRS (120–160msec) (N = 50) | Group-N QRS (80–119 msec) (N = 50) |
|------------------------------------|-------------------------------------|-------------------------------------|
| Mean QRS duration                  | 146.2 ± 10.27 msec                  | 97.8 ± 12.5 msec                    |
| LBBB morphology (complete/incomplete) | 42(84 %)                           | 15(30 %)                           |
| RVCD                               | 5(10 %)                            | 25(50 %)                           |
| QRSBBB morphology                 | 3(9 %)                             | 10(20 %)                           |
| Mean QRS axis                      | –40.23 ± 15.23                      | +96.4 ± 10.53                      |

**Table 3**

Echocardiographic parameters among patients with heart failure.

| Echocardiographic parameters               | Group-W QRS(120–160msec) (N = 50) | Group-N QRS (80–119 msec) (N = 50) | P-Value |
|-------------------------------------------|-----------------------------------|-----------------------------------|---------|
| 2-D echo LVEF (teichholz’s method)        | 32.13 ± 4.62 %                    | 33.2 ± 3.22 %                     | 0.1822  |
| 2-D echo LVEDD                            | 5.777 ± 0.66 cm                   | 5.54 ± 1.02 cm                    | 0.1721  |
| 2-D echo LVEDSD                           | 4.92 ± 0.62 cm                    | 4.77 ± 0.86 cm                    | 0.3196  |
| 2-D echo LA size                          | 3.657 ± 0.51 cm                   | 3.42 ± 0.68 cm                    | 0.0515  |
| 2-D echo peak TR jet velocity             | 2.598 ± 0.67 m/sec                | 2.34 ± 0.48 m/sec                 | 0.0292  |
| 2-D echo Pulmonary artery systolic pressure | 40.46 ± 11.91 mmHg              | 36.46 ± 8.05 mmHg                 | 0.0519  |

**Table 4**

Echocardiographic parameters of LV dyssynchrony using M-mode, Pulse wave., Doppler and Tissue Doppler imaging (TDI).

| Echocardiographic parameters               | Group-W QRS (120–160) msec | Group-N QRS (80–119) msec |
|-------------------------------------------|-----------------------------|----------------------------|
| Onset of QRS to maximum of septal motion on M–mode | 110 ± 30                    | 40 ± 11                     |
| Onset of QRS to maximum of posterior wall motion on M-mode | 300 ± 12                    | 110 ± 15                    |
| Difference of two M-mode motions          | 180 ± 35                    | 70 ± 16                     |
| Onset of QRS to peak of basal septal velocity | 60 ± 10                     | 140 ± 6                     |
| Onset of QRS to peak of basal lateral wall velocity | 145 ± 9                     | 190 ± 12                    |
| Difference of two TDI                     | 74 ± 16                     | 51 ± 8                      |
| Onset of QRS to peak of basal anterior wall velocity | 105 ± 11                    | 170 ± 12                    |
| Onset of QRS to peak of basal inferior wall velocity | 70 ± 16                     | 122 ± 10                    |
| Difference of two TDI                     | 85 ± 12                     | 48 ± 7                      |
| Left ventricular pre ejection period (Aortic PEP) | 90 ± 15                     | 53 ± 12                     |
| Right ventricular pre ejection period (Pulmonary PEP) | 65 ± 10                     | 24 ± 6                      |
| Difference of two PW Doppler velocities   | 79 ± 11                     | 30 ± 5                      |
| Mean diastolic filling period for A-V delay | 34 ± 8(%)                   | 50 ± 7(%)                   |
correlation between QRS width with hemodynamic response.  

Therefore, QRS duration is not closely related to mechanical dysynchrony, and baseline QRS duration is not the best predictor of response to CRT. In our study the most common QRS morphology was LBBB in W-QRS group and IVCD in the N-QRS group. Linde C et al demonstrated favorable one year results in exercise tolerance, quality of life and decrease in HF related hospitalisation by CRT in patients with severe HF and IVCD.  

In our study apart from W-QRS group, significant LV dysynchrony was also seen in about one third of N-QRS group, but further studies are needed to target its correction as a treatment modality.

### 6. Conclusions

In patients with systolic heart failure, dyssynchrony is significantly more common in those with a wide QRS. However, about one-third of those with a NQRS (especially with IVCD and QRBBB) do have echocardiographic dyssynchrony as noted in our study and this may be a therapeutic target for future studies.

### 7. Limitations

Small sample size.

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Table 5: Total number of patients with LV dyssynchrony on M-mode, Tissue Doppler Imaging (TDI) and Pulse wave Doppler in each group.

| Echocardiographic parameters | Group-W QRS (120–160) ms | Group-N QRS (80–119) ms | Total (n = 10) | P-value |
|-----------------------------|--------------------------|-------------------------|----------------|--------|
| Difference of M-mode motion of septum to posterior wall < 130 ms | 12/24 (%) | 32/64 (%) | 44/44 (%) | 0.005 |
| Difference of TDI values between basal septal and lateral wall velocities < 65 ms | 20/40 (%) | 40/80 (%) | 60/60 (%) | 0.004 |
| Difference of TDI values between basal anterior and inferior wall velocities < 65 ms | 30/60 (%) | 10/20 (%) | 40/40 (%) | <0.001 |
| Difference in aortic pre-ejection period and pulmonary pre-ejection period <40 ms | 18/36 (%) | 38/76 (%) | 56/56 (%) | 0.005 |
| Diastolic filling period (atrio-ventricular delay) < 40 % and below | 32/64 (%) | 12/24 (%) | 44/44 (%) | <0.001 |
| >40 % | 9/18 (%) | 34/78 (%) | 43/43 (%) | |

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Fig. 1. Incidence of LV dyssynchrony on M mode echocardiography among patients with heart failure.