

Interventricular Mechanical Dyssynchrony in Dilated Cardiomyopathy and Its Relation with Left Ventricular Systolic Dysfunction

Ahlam Kadhim Abbood, Haider Jabar Al-Ghizzi¹, Wissam S. Tajuldin²

Departments of Physiology and ¹Internal Medicine, University of Babylon, College of Medicine, ²Shaheed Al-Mihrab Center for Cardiac Catheterization, Babylon, Hillah, Iraq

Abstract

Background: Heart failure (HF) is a major problem worldwide, and despite the optimal medical treatment, still it carries high mortality. Ventricular dyssynchrony among patient with HF portends poor prognosis. **Aim of the Study:** The aim is to evaluate the prevalence of interventricular dyssynchrony in patients with dilated cardiomyopathy (DCM) patients and its relation to underlying etiology and the severity of systolic dysfunction. **Materials and Methods:** Fifty-eight patients with ischemic and nonischemic cardiomyopathy (ICM and NCM) were included in this study. Inclusion criteria include Type II–IV New York Heart Association patients with ejection fraction (EF) <35%. Mechanical dyssynchrony (interventricular dyssynchrony) was assessed by pulsed Doppler. Assessment of left ventricular (LV) systolic function was by EF and stroke volume. Evaluation of the prevalence of mechanical indices in DCM and their relation to underlying etiology and severity of LV systolic dysfunction was done. **Results:** The prevalence of interventricular dyssynchrony was more in NCM than ICM. There was a nonsignificant negative correlation between this dyssynchrony and LV systolic parameters. **Conclusion:** Mechanical dyssynchrony indices were affected by the underlying etiology and severity of LV systolic dysfunction associated with the existence of the mechanical dyssynchrony.

Keywords: Dilated cardiomyopathy, dyssynchrony, systolic dysfunction

INTRODUCTION

One of the major problems that affect about 10% of the population (with age >65 years) is heart failure (HF).^[1] Despite considerable progress in the medical treatment of HF, morbidity and mortality are still high with a bad prognosis in the presence of conduction abnormality.^[2] This conduction abnormality leads to dyssynchrony, which is a common finding in severe HF patients.^[3-5] Ventricular dyssynchrony among patients with HF portends poor prognosis.^[6] Ventricular dyssynchrony in these patients with HF, as a result of the left bundle branch block or interventricular conduction delays, leads to irregular ventricular activation which causes irregular wall motion with filling reduction^[7] and reduction in cardiac output.^[8]

MATERIALS AND METHODS

This study was performed in Marjan teaching hospital in Hilla city–Babylon province. From December 12,

2017, to April 25, 2018, 58 patients with ischemic and nonischemic cardiomyopathy (ICM and NCM), with mean age (63 ± 6 , 52 ± 10.2 , respectively), were recruited from Shaheed Al-Mihrab for cardiac catheterization and Marjan teaching hospital, after having their signed consent and approval from Ethical Committee at Babylon College of Medicine. Inclusion criteria include ICM and NCM patients with New York Heart Association functional Class II/IV HF and left ventricular (LV) ejection fraction (EF) $\leq 35\%$. ICM and NCM dilated cardiomyopathy (DCM) patients were categorized according to history (such as previous myocardial infarction, percutaneous transluminal coronary angioplasty, and coronary artery

Address for correspondence: Dr. Ahlam Kadhim Abbood, Department of Physiology, College of Medicine, University of Babylon, Babylon, Hillah, Iraq.
E-mail: udayjanabia@yahoo.com

This is an open access journal, and articles are distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.

For reprints contact: reprints@medknow.com

How to cite this article: Abbood AK, Al-Ghizzi HJ, Tajuldin WS. Interventricular mechanical dyssynchrony in dilated cardiomyopathy and its relation with left ventricular systolic dysfunction. Med J Babylon 2018;15:227-30.

Access this article online

Quick Response Code:



Website:
www.medjbabylon.org

DOI:
10.4103/MJBL.MJBL_61_18

bypass graft surgery), electrocardiography (ECG) findings, echocardiographic study (distinguishing features of an ICM include a relatively greater degree of regional heterogeneity of systolic function often with areas of frank scar or aneurysm formation, and when either area of scar conforming to a well-defined coronary territory or LV aneurysm is noted, the likelihood of an ICM etiology is high).^[9] Angiographic finding was recorded if coronary artery disease was defined as $\geq 50\%$ stenosis of the left main coronary artery or $\geq 70\%$ stenosis of one or more of the three major epicardial arteries.^[10]

These patients were divided into two groups according to QRS width – patients with QRS duration ≥ 120 ms and those with QRS duration < 120 ms.

The patients underwent complete resting conventional echocardiography by measuring as follows:

- The EF by modified Simpson method
- LV dimensions and end diastolic volume by parasternal long-axis and apical views
- Measurement of the diameter of the LV outflow tract (LVOT) by parasternal long-axis view, and tracing aortic flow (apical five-chamber view with applying pulse Doppler on LVOT) to get velocity time integral (VTI). Measurement of the hemodynamic parameters was done according to the following equations:^[11]

Stroke volume (SV) = $0.785 \times D^2 \times VTI$ where D is the LVOT diameter and VTI is the velocity time integral.

Evaluation of mechanical dyssynchrony

Interventricular dyssynchrony can be assessed by measuring the time from the beginning of the QRS complex on the ECG to beginning of the pulmonary and aortic flow (by PW Doppler in parasternal short-axis and apical five-chamber views, respectively). If the difference between the onset of aortic and pulmonary flow is ≥ 40 ms, this means significant dyssynchrony and this is the cutoff value of interventricular dyssynchrony^[12] [Figure 1].

Statistical analysis

All values are expressed as mean $\pm$ standard deviation. Data were analyzed by SPSS and Microsoft Excel. Categorical variables were analyzed by Chi-square test. The relation between different variables was done by Pearson's correlation coefficient.^[13] $P < 0.05$ was considered statistically significant.

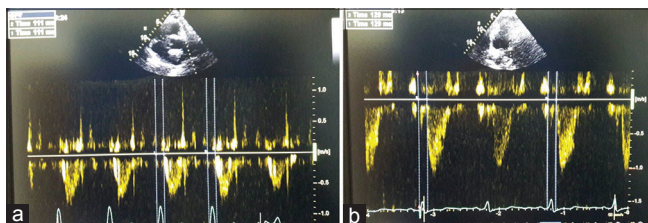


Figure 1: Evaluation of interventricular dyssynchrony by the difference of pulmonary and aortic preejection period (a and b, respectively). (a) Pulmonary preejection period (ms). (b) Aortic preejection period (ms)

RESULTS

The demographic data, ECG, and conventional echocardiographic measurements were presented in Table 1.

Percentage of interventricular mechanical delay (IVMD) evaluated by the difference between aortic pep and pulmonary pep is 48.2% in total patients (ICM and NCM). It is higher in NCM patients in comparison with ICM (50%, 47%, respectively) [Figure 2].

Assessment of the association of interventricular dyssynchrony with underlying etiology (NCM versus ICM) was as follows: the Chi-square statistic is 4.228. The $P = 0.039754$. This result is significant at $P < 0.05$.

Correlation study of EF and IVMD of total (ICM and NCM) patients shows significant negative correlation ($r = -0.38$), at $P < 0.05$, [Figure 3].

Correlation study of SV and IVMD of total (ICM and NCM) patients shows nonsignificant negative correlation ($r = -0.23$), at $P < 0.05$, [Figure 4].

Table 1: The demographic data, electrocardiography, and conventional echocardiographic measurements

Parameter	Total patients (n=58)	ICM (n=32)	NCM (n=26)	P
Age	58 $\pm$ 10.4	63 $\pm$ 6	52 $\pm$ 10.2	0.000*
BSA	1.86 $\pm$ 0.22	1.86 $\pm$ 0.11	1.82 $\pm$ 0.3	0.242
HR	88.2 $\pm$ 22.5	81.3 $\pm$ 7	77.4 $\pm$ 13	0.094
QRS duration	120.1 $\pm$ 33.2	126 $\pm$ 30	123 $\pm$ 31.4	0.299
EF (%)	28.02 $\pm$ 6.1	27.98 $\pm$ 8.11	27.2 $\pm$ 7.9	0.176
VTI (cm)	13.88 $\pm$ 4.3	12.77 $\pm$ 3	15.6 $\pm$ 8.2	0.116
SV (ml)	43 $\pm$ 13.6	41.8 $\pm$ 13	43.7 $\pm$ 15.3	0.361
IVMD (ms)	39.45 $\pm$ 26.4	35.26 $\pm$ 23.4	40.57 $\pm$ 28	0.205

*Statistically significant at $P < 0.05$. IVMD: Interventricular mechanical delay, SV: Stroke volume, VTI: Velocity time integral, EF: Ejection fraction, BSA: Body surface area, HR: Heart rate, ICM: Ischemic cardiomyopathy, NCM: Nonischemic cardiomyopathy

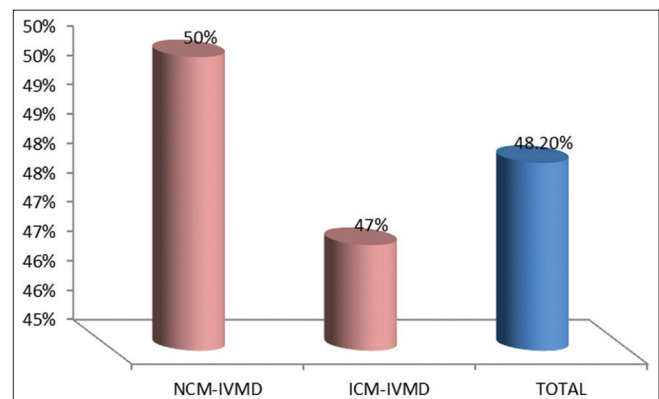


Figure 2: The prevalence of interventricular mechanical dyssynchrony in nonischemic cardiomyopathy and ischemic cardiomyopathy, and in total patients. interventricular mechanical dyssynchrony

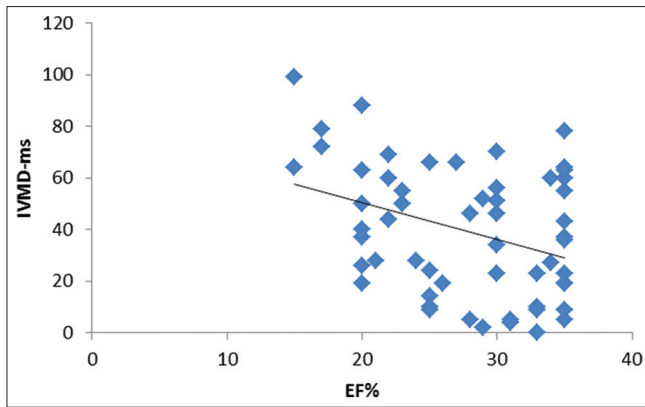


Figure 3: Correlation study of ejection fraction % and interventricular mechanical delay of ischemic and nonischemic cardiomyopathy

DISCUSSION

This study shows the high prevalence of interventricular dyssynchrony in DCM patients (48.2%) (NCM and ICM: 50% and 47%, respectively). These percentages are close to other studies, such as Anzouan-Kacou *et al.*,^[14] where the prevalence of inter-VD was 47.5% in their study. It was significantly greater in NCM than in ICM, which means that etiology influences interventricular dyssynchrony occurrence, and this agreed with other studies such as Montazeri *et al.* study in 2011.^[15] The relation of interventricular dyssynchrony with LV systolic function (demonstrated by EF and SV) was a negative correlation, and this results match the results of Kerwin *et al.* study in 2000^[16] who concluded that the degree of interventricular dyssynchrony presented a significant negative correlation with the left ventricular ejection fraction (LVEF), but against panel Fauchier *et al.* 2002^[17] who demonstrated an impairment of the cardiac function demonstrated by EF not correlated with interventricular dyssynchrony. The results of this study support the hypothesis that DCM with ventricular conduction delay is associated with significant ventricular contraction abnormalities and one level is the interventricular level.^[16] The interventricular dyssynchrony is represented as an asymmetric right ventricular/LV phase pattern, and dyssynchrony at this level is related to the site of bundle branch block. Kerwin *et al.* 2002^[16] concluded that the lowest LVEF, the worse interventricular dyssynchrony. Moreover, the degree of improvement in interventricular synchrony during cardiac resynchronization therapy (CRT) correlated significantly with improvements in LVEF. All these go with our finding of negative relation of this dyssynchrony and severity of LV systolic dysfunction. Cheuk-Man *et al.* (2010) suggested that interventricular dyssynchrony is the major factor associated with contractile diminishing and is affected by CRT.^[18]

DCM is characterized by structural abnormalities of ventricular myocardium, disturbing both ventricular stimulation and mechanical contraction.^[19,20] The electrical stimulation of ventricular parts may be delayed subsequent to the pathological involvement of the ventricular conduction system or due to inhomogeneous spread of excitation wavefronts across

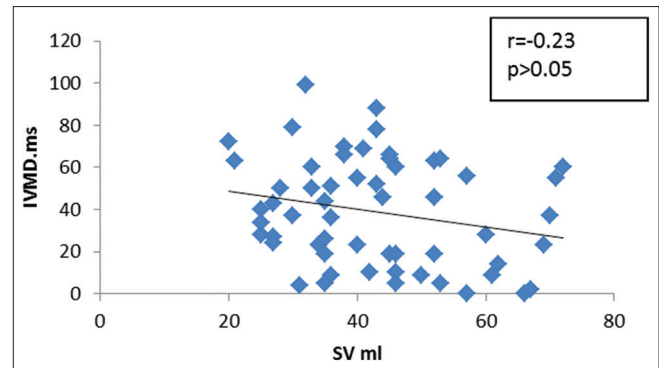


Figure 4: Correlation study of stroke volume and interventricular mechanical delay of ischemic and nonischemic cardiomyopathy

the scarred tissue.^[21] This alteration in cardiac structure and function results in regions of early and late contraction, which disrupts cardiac contraction and decreases pumping effectiveness.^[22]

CONCLUSION

The study concluded that mechanical dyssynchrony indices were affected by the underlying etiology and severity of LV systolic dysfunction associated with the existence of the mechanical dyssynchrony.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

REFERENCES

- Hunt SA, Baker DW, Chin MH, Cinquegrani MP, Feldman AM, Francis GS, *et al.* ACC/AHA guidelines for the evaluation and management of chronic heart failure in the adult: Executive summary A Report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (Committee to revise the 1995 guidelines for the evaluation and management of heart failure): Developed in collaboration with the International Society for Heart and Lung Transplantation; Endorsed by the Heart Failure Society of America. *Circulation* 2001;104:2996-3007.
- Serri K, Lafitte S, Amyot R, Sauvé C, Roudaut R. Echocardiographic evaluation of cardiac dyssynchrony. *Can J Cardiol* 2007;23:303-10.
- Yu CM, Lin H, Zhang Q, Sanderson JE. High prevalence of left ventricular systolic and diastolic asynchrony in patients with congestive heart failure and normal QRS duration. *Heart* 2003;89:54-60.
- Ghio S, Constantin C, Klersy C, Serio A, Fontana A, Campana C, *et al.* Interventricular and intraventricular dyssynchrony are common in heart failure patients, regardless of QRS duration. *Eur Heart J* 2004;25:571-8.
- De Sutter J, Van de Veire NR, Muyldermans L, De Backer T, Hoffer E, Vaerenberg M, *et al.* Prevalence of mechanical dyssynchrony in patients with heart failure and preserved left ventricular function (a report from the Belgian Multicenter Registry on dyssynchrony). *Am J Cardiol* 2005;96:1543-8.
- AlJaroudi W, Alraies MC, Menon V, Brunken RC, Cerqueira MD, Jaber WA. Predictors and incremental prognostic value of left ventricular mechanical dyssynchrony response during stress-gated positron emission tomography in patients with ischemic cardiomyopathy. *J Nucl Cardiol* 2012;19:958-69.
- Aranda JM Jr, Schofield RS, Leach D, Conti JB, Hill JA, Curtis AB.

- Ventricular dyssynchrony in dilated cardiomyopathy: The role of biventricular pacing in the treatment of congestive heart failure. *Clin Cardiol* 2002;25:357-62.
8. Bleeker GB, Bax JJ, Steendijk P, Schalij MJ, van der Wall EE. Left ventricular dyssynchrony in patients with heart failure: Pathophysiology, diagnosis and treatment. *Nat Clin Pract Cardiovasc Med* 2006;3:213-9.
 9. William FA, Thomas R. Dilated cardiomyopathy: Feigenbaum's echocardiography. *Textbook of Echocardiography*. 7th ed., Ch. 18. Philadelphia, New York, London: Wolter Kluwer, Lippincott Williams and Wilkins; 2007. p. 507.
 10. Aghasadeghi K, Aslani A. Differentiation of ischemic and dilated cardiomyopathy on electrocardiograms. *Asian Cardiovasc Thorac Ann* 2008;16:103-6.
 11. Andrew RH. The left ventricle and its systolic function. *Making Sense of Echocardiography. A Hands-on Guide*. 2nd ed., Ch. 15. CRC Press; Taylor and Francis Group; 2013. p. 128-9.
 12. Niu H, Hua W, Zhang S, Sun X, Wang F, Chen K, *et al.* Prevalence of dyssynchrony derived from echocardiographic criteria in heart failure patients with normal or prolonged QRS duration. *Echocardiography* 2007;24:348-52.
 13. Daniel WW. *Biostatistics: A Foundation for Analysis in the Health Sciences*. New York: Jone Wiley and Sons; 1983.
 14. Anzouan-Kacou JB, Ncho-Mottoh MP, Konin C, N'Guetta AR, Ekou KA, Koffi BJ, *et al.* Prevalence of cardiac dyssynchrony and correlation with atrio-ventricular block and QRS width in dilated cardiomyopathy: An echocardiographic study. *Cardiovasc J Afr* 2012;23:385-8.
 15. Montazeri M, Rezvanfard M, Kazemisaeid A, Lotfi Tokaldany M, Mardanloo AS, Darabi F, *et al.* Assessment of left ventricular dyssynchrony in heart failure patients regarding underlying etiology and QRS duration. *J Tehran Heart Cent* 2011;6:193-201.
 16. Kerwin WF, Botvinick EH, O'Connell JW, Merrick SH, DeMarco T, Chatterjee K, *et al.* Ventricular contraction abnormalities in dilated cardiomyopathy: Effect of biventricular pacing to correct interventricular dyssynchrony. *J Am Coll Cardiol* 2000;35:1221-7.
 17. Fauchier L, Marie O, Casset-Senon D, Babuty D, Cosnay P, Fauchier JP, *et al.* Interventricular and intraventricular dyssynchrony in idiopathic dilated cardiomyopathy: A prognostic study with Fourier phase analysis of radionuclide angioscintigraphy. *J Am Coll Cardiol* 2002;40:2022-30.
 18. Cheuk-Man Y, Sanderson JE, Gorcsan J 3rd. Echocardiography, dyssynchrony, and the response to cardiac resynchronization therapy. *Eur Heart J* 2010;31:2326-37.
 19. Brutsaert DL. Nonuniformity: A physiologic modulator of contraction and relaxation of the normal heart. *J Am Coll Cardiol* 1987;9:341-8.
 20. Katz AM. Cardiomyopathy of overload. A major determinant of prognosis in congestive heart failure. *N Engl J Med* 1990;322:100-10.
 21. Josephson ME, editor. In: *Clinical Cardiac Electrophysiology: Techniques and Interpretations*, Intraventricular conduction disturbances. Malvern, PA: Lea & Febiger; 1993. p. 117-49.
 22. Grines CL, Bashore TM, Boudoulas H, Olson S, Shafer P, Wooley CF, *et al.* Functional abnormalities in isolated left bundle branch block. The effect of interventricular asynchrony. *Circulation* 1989;79:845-53.

