Section: General Medicine

Original Research Article

A STUDY ON ELEVATED PULSE PRESSURE INDEX AS AN INDICATOR OF LEFT VENTRICULAR DIASTOLIC DYSFUNCTION

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Abstract

Background: Diabetes is one of the most common chronic diseases worldwide. Cardiovascular diseases, including coronary heart disease and heart failure, contribute to the mortality of patients with diabetes. This study aimed to investigate the relationship between the pulse pressure index and left ventricular diastolic dysfunction in individuals with type 2 diabetes and to explore its potential as an indicator of this condition in outpatient settings. **Materials and Methods:** This observational study was conducted in Govt. Rajaji Hospital and Medical College, Madurai, involving 50 patients with diabetes from August 2021 to November 2021. Echocardiographic evaluations included two-dimensional imaging, pulsed tissue Doppler imaging, and left ventricular ejection fraction (LVEF). Blood urea, serum creatinine, random blood sugar, urine albumin, urine sugar, urine protein, and complete blood count samples were collected, and 12 lead electrocardiograms were obtained for all patients. **Result:** Of the 50 patients, 35 were males, and 15 were female. The relationship between proton pump inhibitors (PPI), E/A, and E/e with left ventricular diastolic dysfunction (LVDD) among diabetic patients showed a positive correlation, which was statistically significant ($p<0.001$). PPI ≥ 0.373 was considered a predictor of LVDD in diabetic patients ($p<0.001$) with a sensitivity of 93%, specificity of 66% and an area under the ROC curve (AUC) of 0.944. **Conclusion:** This study concludes that the pulse pressure index and left ventricular diastolic dysfunction are directly related in patients with type 2 diabetes mellitus. Therefore, it may be a useful predictor of left ventricular diastolic dysfunction.

INTRODUCTION

Diabetes is one of the most common chronic diseases worldwide, affecting an estimated 6.4% of the adult population globally. The increase in the incidence and prevalence of type 2 diabetes can be attributed to the increase in population age, obesity, and physical inactivity.[1,2] The emergence of type 2 diabetes as a global pandemic is one of the major challenges to human health in the 21st century. Long considered a disease of affluent Western countries, type 2 DM has now spread to every corner of the world. Indeed, there are now more people with diabetes residing in emerging economies than in industrialised nations.[3,4]

Cardiovascular disease remains the main comorbid condition that contributes to mortality in patients with diabetes. This occurs most commonly in the form of coronary heart disease but also the incremental risk associated with diabetes for cerebrovascular disease, peripheral vascular disease, and heart failure. Heart failure (HF) is a common, costly, disabling, and potentially lethal condition. Approximately 2% of adults suffer from heart failure, but in those over the age of 65, this increases to 6–10%; the condition usually worsens with time.[5,6] Heart failure is the leading cause of hospitalisation in people older than 65 years. Although some people survive for many years, progressive disease is associated with an overall annual mortality rate of 10%.[7,8] Heart failure [HF] is classified as HF with decreased ejection fraction and HF with normal ejection fraction (DHF). DHF has a prevalence of almost 50% of total heart failure and is increasing in incidence every year, thus causing a high burden to the community and health care.[9] Even though earlier studies showed a better prognosis for DHF, recently concluded various studies have indicated morbidity and mortality similar to HF with decreased EF.[6,10,11] In addition to the traditional causes of DHF, such as hypertension, aortic stenosis, etc. Diabetes is a cause of diastolic dysfunction; hence, DHF has been increasingly recognised in recent years. Various studies have

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shown that the prevalence of diastolic dysfunction is 55–65% among diabetic individuals. With the increasing incidence of diabetes, longevity, sedentary lifestyle, and obesity, diabetes is a major cause of DHF. In particular, these individual risk factors most often co-exist.[12,13] With this background, the presence of diastolic dysfunction in patients with diabetes was studied in our hospital.

AIM

This study aimed to investigate the relationship between the pulse pressure index and left ventricular diastolic dysfunction in individuals with type 2 diabetes at Govt Rajaji Hospital and Madurai Medical College, exploring its potential as an indicator of the condition in outpatient settings.

MATERIALS AND METHODS

This observational study was conducted in the Govt. Rajaji Hospital and Medical College, Madurai, involving 50 patients with diabetes from August 2021 to November 2021. The study received approval from the institutional ethics committee before its initiation.

Inclusion Criteria

This study included patients diagnosed with type 2 diabetes mellitus for >5 years, aged < 50 years, and not taking any antihypertensive drugs.

Exclusion Criteria

Patients with systemic hypertension, valvular heart disease, restrictive cardiomyopathy, coronary artery disease, congestive heart failure, ejection fraction less than 50%, poor echo window, not in sinus rhythm, and diabetic macrovascular and microvascular complications were excluded.

The BP measurements were obtained only after the echocardiography examination with the patient in the supine position and after a rest period of at least 15 min. The BP measuring instrument used was an Omron digital BP apparatus using an oscillometric automatic measurement method. BP was measured twice for each patient; bilateral BP values were obtained in both arms, and a higher value was used for the analysis. Well-controlled BP was defined as Systolic BP < 140 mmHg and Diastolic BP < 90 mmHg, while poorly controlled BP was defined as systolic BP≥ 140 mmHg or diastolic BP>90 mmHg.

Echocardiographic evaluations were performed by a single trained and experienced cardiologist using transthoracic echocardiography. All patients breathed quietly and in the classical left-lateral position during echo assessment. Two-dimensionally guided M-mode and two-dimensional images were recorded. The probe was placed at the tips of the mitral leaflets to obtain the left ventricular inflow pattern and waveforms in an apical four-chamber view. A pulsed tissue Doppler image (TDI) was obtained with the probe placed at the septal and lateral corners of the mitral valve annulus in an apical four-chamber view. The study defined LVDD as an E to transmitral A wave velocity (A) ratio ≥0.9 or E/Ea (E/e') ≥15. Left ventricular ejection fraction was measured using the modified Simpson method.

Blood urea, serum creatinine, random blood sugar, urine albumin, urine sugar, urine protein, and complete blood count samples were collected, and 12 lead electrocardiograms were obtained for all patients.

Statistical Analysis

Statistical analyses were performed using IBM SPSS version 26 (SPSS Inc., Chicago, IL, USA). Descriptive statistics were computed. Data were tested for normality using the Shapiro-Wilk normality test. Due to skewed data levels, the Mann-Whitney U test was used for between-group analysis. The Kruskal–Wallis test was used to analyse the relationship between cholesterol levels and PPI. The chi-square test was used to analyse categorical variables. Spearman's rank correlation test was used to analyse the relationship between cholesterol and PPI. The receiver operating characteristic (ROC) curve was used to determine the marker's (PPI) cut-off point for predicting LVDD. Statistical significance was set at $p < 0.05$.

RESULTS

Of the 50 patients, 35 were males and 15 were female. There were no significant differences in age, systolic BP, RBS, and LVEF between the LVDD groups ($p>0.05$). A significant difference was observed in diastolic BP, pulse pressure, PPI, cholesterol, E/A, and E/e' between LVDD ($p<0.001$) [Table 1].

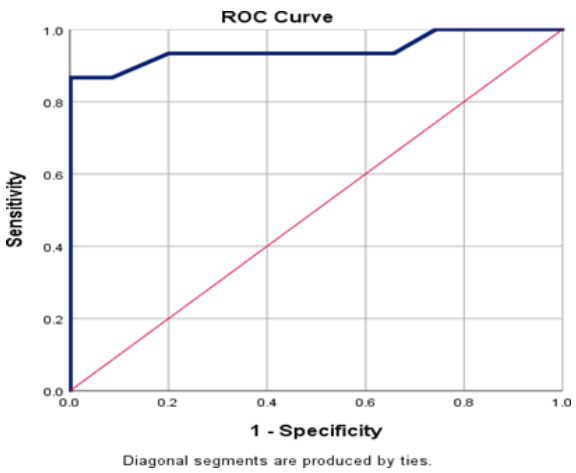

Figure 1: ROC curve for LVDD

This study showed that the mean age of patients with diastolic dysfunction was less than that of diabetic patients without diastolic dysfunction. The mean age of patients without diastolic dysfunction was 36 years, whereas the mean age of patients with diastolic dysfunction was 35.8.

Of the 35 males, seven patients had left ventricular diastolic dysfunction, and 28 did not. Of the 15 females, eight patients had left ventricular diastolic dysfunction. This study revealed that left ventricular diastolic dysfunction was common in females. Pulse

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pressure was lower in patients without left ventricular diastolic dysfunction. The Pulse Pressure Index was elevated in the patients with left ventricular diastolic dysfunction. The patients with a lower pulse pressure index did not have diastolic dysfunction.

The relationship between proton pump inhibitors (PPI) and left ventricular diastolic dysfunction (LVDD) among diabetic patients showed a positive correlation (r=0.646), which was statistically significant (p<0.001). The relationship between E/A and LVDD among patients with diabetes showed a positive correlation (r=0.536), which was statistically significant (p<0.001). The relationship between E/e' and LVDD among diabetic patients showed a positive correlation (r=0.626) which was statistically significant (p<0.001) [Table 2].

PPI equal to or greater than 0.373 was considered as a predictor factor for LVDD in diabetic cases (p <0.001**) with a sensitivity of 93% and specificity of 66%, and area under the ROC curve (AUC) of 0.944 [Table 3 and Figure 1].

Table 1: Age and biochemical parameters of the study population

	LVDD		P-value
	LVDD -ve	LVDD +ve	
Age	36±2.7	35.8±2.9	0.798
Systolic Bp	119.9±11.1	123.9±10	0.258
Diastolic Bp	79.3±9.3	67.2±6	0.001*
Pulse Pressure	40.7±7.5	56.8±7.3	0.001*
Pulse Pressure Index	0.3±0.1	0.5±0.0	0.001*
RBS	119.9±19	127.6±20.5	0.231
Cholesterol	142.1±18.2	188.2±16	0.001*
LVEF	59.6±4.1	59.7±4.1	0.839
E/A	0.8±0.1	1.2±0.2	0.001*
E/e'	13.5±1	18.6±2.6	0.001*

Table 2: Correlations between pulse pressure index, E/A, and E/e' of the study population

	Cholesterol	
Pulse Pressure Index	Pearson Correlation	.646**
	P value	0
E/A	Pearson Correlation	0.536**
	P value	0.001
E/e'	Pearson Correlation	.626**
	P value	0.001

Table 3: The area under the curve and ROC curve for early prediction of markers for LVDD of the study population

Area Under the Curve			Predictor marker		
Test Result Variable(s)	Area	P value	Cut Off value	Sensitivity (%)	Specificity (%)
PPI	0.944	0.001*	≥0.373	93%	66%

DISCUSSION

In our study, of the 50 patients, there were 35 males and 15 females. The mean pulse pressure index of the study was 0.3 in the LVDD-ve cases and 0.5 in the LVDD+ve groups. This study showed that the mean age of patients with diastolic dysfunction was less than that of diabetic patients without diastolic dysfunction. The mean age of patients without diastolic dysfunction was 36 years, whereas the mean age of patients with diastolic dysfunction was 35.8. Of the 35 males, seven patients had left ventricular diastolic dysfunction, and 28 did not. Of the 15 females, eight patients had left ventricular diastolic dysfunction. This study revealed that left ventricular diastolic dysfunction was common in females.

Systolic BP of the study population was compared between patients with and without left ventricular diastolic dysfunction. This study revealed that elevated SBP is common in left ventricular diastolic dysfunction patients with LVDD. Diastolic BP was compared in the study population in the presence and absence of diastolic dysfunction. This study revealed that diastolic blood pressure decreases in left ventricular diastolic dysfunction patients. Pulse pressure was compared in the study population between patients with and without diastolic dysfunction. This study revealed that pulse pressure is elevated in patients with left ventricular diastolic dysfunction and is lower in patients without left ventricular diastolic dysfunction.

The pulse pressure index was compared between patients with and without left ventricular diastolic dysfunction. This study found that the pulse pressure index was elevated in patients with left ventricular diastolic dysfunction. The patients with a lower pulse pressure index did not have diastolic dysfunction. This is consistent with the results of previous studies. The relationship between the pulse pressure index and left ventricular diastolic dysfunction among patients with diabetes showed a positive correlation (r=0.646), which was statistically significant (p<0.001).

CONCLUSION

The study concludes that the pulse pressure index and left ventricular diastolic dysfunction are directly

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related in patients with type 2 diabetes mellitus. Therefore, it may be a useful predictor of left ventricular diastolic dysfunction.

Limitations

The pulse pressure index is a new concept, which is nascent, and the study population is small. No large general population studies have been conducted, and there is poor literature support. The American Heart Association (AHA) recommends using four parameters for assessing Diastolic Dysfunction: Left Atrial Pressure, E/A, E to A wave ratio, Deceleration Time, and E/e'. The AHA recommends measuring all four parameters and diagnosing LVDD only when two or more parameters are met. In this study, only E/e' (E/Ea) was used.

REFERENCES

1. Balakumar P, Maung-U K, Jagadeesh G. Prevalence and prevention of cardiovascular disease and diabetes mellitus. Pharmacol Res 2016;113:600–9. https://doi.org/10.1016/j.phrs.2016.09.040.
2. Zheng Y, Ley SH, Hu FB. Global aetiology and epidemiology of type 2 diabetes mellitus and its complications. Nat Rev Endocrinol 2018;14:88–98. https://doi.org/10.1038/nrendo.2017.151.
3. Standl E, Khunti K, Hansen TB, Schnell O. The global epidemics of diabetes in the 21st century: Current situation and perspectives. Eur J Prev Cardiol 2019;26:7–14. https://doi.org/10.1177/2047487319881021.
4. Unnikrishnan R, Pradeepa R, Joshi SR, Mohan V. Type 2 diabetes: Demystifying the global epidemic. Diabetes 2017;66:1432–42. https://doi.org/10.2337/db16-0766.
5. Ogah OS, Stewart S, Onwujekwe OE, Falase AO, Adebayo SO, Olunuga T, et al. Economic burden of heart failure: Investigating outpatient and inpatient costs in Abeokuta, Southwest Nigeria. PLoS One 2014;9:e113032. https://doi.org/10.1371/journal.pone.0113032.
6. Hines RL, Marschall KE. Heart Failure and Cardiomyopathies. Handbook for Stoelting's Anesthesia and Co-Existing Disease, Elsevier; 2013, p. 63–76.
7. Groenewegen A, Rutten FH, Mosterd A, Hoes AW. Epidemiology of heart failure. Eur J Heart Fail 2020;22:1342–56. https://doi.org/10.1002/ejhf.1858.
8. Schwinger RHG. Pathophysiology of heart failure. Cardiovasc Diagn Ther 2021;11:263–76. https://doi.org/10.21037/cdt-20-302.
9. Wood P, Piran S, Liu PP. Diastolic heart failure: Progress, treatment challenges, and prevention. Can J Cardiol 2011;27:302–10. https://doi.org/10.1016/j.cjca.2011.02.008.
10. Lupón J, Díez-López C, de Antonio M, Domingo M, Zamora E, Moliner P, et al. Recovered heart failure with reduced ejection fraction and outcomes: a prospective study. Eur J Heart Fail 2017;19:1615–23. https://doi.org/10.1002/ejhf.824.
11. Iorio A, Senni M, Barbati G, Greene SJ, Poli S, Zambon E, et al. Prevalence and prognostic impact of non-cardiac co-morbidities in heart failure outpatients with preserved and reduced ejection fraction: a community-based study. Eur J Heart Fail 2018;20:1257–66. https://doi.org/10.1002/ejhf.1202.
12. Bouthoorn S, Valstar GB, Gohar A, den Ruijter HM, Reitsma HB, Hoes AW, et al. The prevalence of left ventricular diastolic dysfunction and heart failure with preserved ejection fraction in men and women with type 2 diabetes: A systematic review and meta-analysis. Diab Vasc Dis Res 2018;15:477–93. https://doi.org/10.1177/1479164118787415.
13. Fajarini IA, Sartika RAD. Obesity as type 2 diabetes common comorbidity: Study of type 2 diabetes patients' eating behaviour and other determinants in Jakarta, Indonesia. Kesmas Natl Public Health J 2019;13:159. https://doi.org/10.21109/kesmas.v13i4.2483.

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