Study of echocardiography findings in patients with type II diabetes mellitus

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ABSTRACT

Introduction: Diabetes mellitus is an escalating public health problem globally. Cardiovascular disease is the major cause of morbidity and mortality among patients with diabetes. Diabetes mellitus is an established risk factor for congestive cardiac failure in which the diastolic function is impaired more than the systolic function.

Method: A cross-sectional study was conducted from 2018 to 2019. The sample size of the study was 60 respondents. An independent student t-test and a chi-square test were used to test the statistical significance between the two variables (with two categories) in quantitative and qualitative variables respectively. Significant results were defined as p-values less than 0.05 at 95% confidence intervals.

Result: Left ventricular diastolic dysfunction (LVDD) was found in 36 (60%) of the patients. Left ventricular systolic dysfunction (LVSD) was found in 11 (18.3%) of the patients. The correlation between LVDD and index of glycemic control i.e. HbA1c was statistically significant (P value 0.025). It was also found that prevalence of LVDD increased with the duration of diabetes (P value 0.007), also the frequency of LVSD increased with duration of diabetes (P value 0.009).

Conclusion: LVDD was more common in diabetic patients with poor glycemic control and prolonged duration of the disease. LVSD was less common in diabetic patient in comparison with LVDD, but the frequency of LVSD also increased as the duration of diabetes progressed.

Keywords: diabetes mellitus, diastolic dysfunction, echocardiography, systolic dysfunction

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INTRODUCTION

Diabetes Mellitus is a common metabolic disorder characterized by hyperglycemia and is either caused by immune mediated beta cell destruction resulting in absolute insulin deficiency (Type I DM) or by insulin resistance with relative insulin deficiency (Type II DM). According to World Health Organization (WHO) 463 million people have DM worldwide in the year 2019 and it is projected that 642 million individuals of the world will have diabetes by the year 2040. The development of type 2 diabetes as a major public health problem has been particularly rapid in much of South Asia and particularly in Nepal since 1990.[1]

Diabetes induces changes in the myocardium including metabolic, structural and functional alterations. It augments fatty acid metabolism, restrains glucose oxidation, and modifies intracellular signaling in cardiomyocytes, leading to inefficient energy production, derangements in excitation–contraction coupling, and increased susceptibility to ischemia/reperfusion injury. Microvascular dysfunction, remodeling of the extracellular matrix in the myocardium, myocardial fibrosis and myocardial steatosis are also engaged in systolic and diastolic dysfunction of diabetic hearts.[2]

Noninvasive echocardiography assesses the morphological and physiologic functioning of the myocardium, valves, pericardium, coronary arteries and great vessel on a quantitative and qualitative basis.[3] This procedure has become the second most common procedure in cardiology after electrocardiography. Doppler imaging has made it easier for clinicians to diagnose diastolic dysfunction more rapidly and with less discomfort.

Early identification of subtle changes in heart might allow preventive interventions and ultimately lead to lower rates of mortality. Altered ventricular myocardial dynamic is early manifestation of cardiac dysfunction even before appearance of any clinical symptoms and signs and can be quantified by conventional echocardiography.[4] Echocardiography findings in diabetic patients have been well documented in developed countries, but few studies have been reported in low to middle income countries, including Nepal. The aim of the study is to assess the effect of diabetes in the systolic and diastolic function of the heart.

METHOD

A cross-sectional study was conducted among the patients attending the Department of Internal Medicine at Nepal Medical College, Kathmandu between January 2018 and January 2019. The calculated Minimal sample size was 60 (considering prevalence of diabetes in Nepal as 19%)[5] which is calculated on basis of $N=Z^2pq/d^2$ formulae, where z=1.96 for 95% CI, p=19, q=100-p and d=0.1. Convenient sampling method was applied. Structured pro-forma was used and the data were collected.

The study included patients over the age of 18 with Type II DM, regardless of their glucose control or mode of treatment (Oral Hypoglycemic agents or insulin). Excluded from the study were patients with Type I DM, gestational diabetes, or steroid induced diabetes, patients with hypertension and chronic obstructive pulmonary disease, and those who declined to give consent.

Data collected in pro-forma was entered in Microsoft Excel, which was further imported into the Statistical Package for Social Science (SPSS) version 17.0 for analysis. Quantitative variables were calculated in terms of mean, median and standard deviation. For inferential statistics, chi square test was used to find significant differences. Significant results were defined as p-values less than 0.05 at 95% confidence intervals.

Ethical Approval was taken from Institutional Review Committee (IRC) of Nepal Medical College (Reference Number: 21-074/075). Written informed consent was taken from each respondent with standard set of proforma.

RESULT

Sixty respondents were included in our study. The age of the respondents ranged from 36 to 87 years. The mean age of the participants was 53.95$\pm$13.16 years. Out of 60 respondents, 25 (42%) were male and 35 (58%) were female. The p-value of the cross-table distribution between age group and gender was 0.51, meaning that there is no significant difference between gender distribution in various age group.

The distribution of diabetes on the basis of duration is shown in Table 1. Two third of the participants enrolled in this study had diabetes for less than 5 years. Only 2 out of 60 respondents had HbA1c level less than 6.5%. Majority of respondents 36 (60%) had HbA1c level in between 6.5 to 10%. The total number of patients with poorly controlled diabetes i.e. HbA1c level more than 10% was 22 (36.7%).

Systolic dysfunction was found in 11 (18.3%) respondents while 36 (60%) respondents had diastolic dysfunction.

The association of LVDD in patients of T2DM with the duration of diabetes is shown in Table 2. The frequency of LVDD was 50% in participants with duration of diabetes less than 5 year. Those with duration of diabetes in between 5 and 10 year, 9 (64.2%) out of 14 participants had LVDD. However, as the duration of diabetes rises to more than 10 years, all 8 (100%) had LVDD. The association between LVDD and duration of diabetes was statistically significant (P value 0.007).

The association of LVDD with the control of blood glucose level in diabetic patient i.e. HbA1c level is shown in Table 3. When diabetes was well controlled (i.e. HbA1c <6.5%) not a single respondent had LVDD. When HbA1c level was in between 6.5 to 10 %, 19 (52.7%) respondents had LVDD. However, as we moved to the poorly controlled diabetics group (i.e. HbA1c >10%) 17 (77.2%) out of 22 respondents had LVDD. The association between LVDD and control of blood glucose level was statistically significant (P value 0.025).

Table 4 highlights the association of left ventricular systolic dysfunction with the duration of diabetes. Out of 38 participants with duration of diabetes less than 5 years of age, 4 (10.5%) had systolic dysfunction, while 5 (62.5%) out of 8 participants who had diabetes for more than 10 years had systolic dysfunction. The association of duration of diabetes with left ventricular systolic dysfunction was statistically significant (P value 0.009).

Table 5 demonstrates the association of left ventricular systolic dysfunction with HbA1c. Out of 2 patients with HbA1c level less than 6.5%, both had normal left ventricular systolic function. The association between left ventricular systolic dysfunction and control of blood glucose level in diabetes was not statistically significant (P value 0.657).

Table 1. Distribution of diabetes on basis of duration of diabetes

Duration of diabetes	Number of patients (n)	Percent (%)
<5 years	38	63.3
5-10 years	14	23.3
>10 years	8	13.3
Total	**60**	**100**

Table 2. Association of LVDD with duration of diabetes

Duration of DM	LV Diastolic dysfunction		Total	P value
	Present (%)	Absent (%)		
<5 years	19(50)	19(50)	38	
5-10 years	9(64.2)	5(35.8)	14	0.007
>10 years	8(100)	0	8	(P value<0.05)
Total	36	24	60	

Table 3. Association of LVDD with control of diabetes

HbA1c level	LVDD		Total	P value
	Present (%)	Absent (%)		
<6.5	0	2 (100)	2	
6.5-10	19 (52.7)	17 (47.3)	36	0.025
>10	17 (77.2)	5 (22.8)	22	(P value < 0.05)
Total	36 (60)	24 (40)	60	

Table 4. Association of LVSD with duration of diabetes

Duration of DM	LVSD		Total	P value
	Present (%)	Absent (%)		
<5 years	4 (10.5)	34 (89.5)	38	
5-10 years	2 (16.7)	12 (83.3)	14	0.009
>10 years	5 (62.5)	3 (37.5)	8	(P value <0.05)
Total	11 (18.3)	49 (81.7)	60	

Table 5. Association of LVSD with control of diabetes

HbA1c	LVSD		Total	P value
	Present (%)	Absent (%)		
<6.5	0	2 (100)	2	
6.5-10	7 (19.5)	29 (80.5)	36	0.657
>10	4 (18.1)	18 (81.9)	22	(P value > 0.05)
Total	11 (18.3)	49 (81.7)	60	

DISCUSSION

The global diabetes pandemic has been referred to as a "tsunami", with the potential to exert inexorable and unsustainable pressure on health costs. More than 70% of diabetic patient die of cardiovascular events, leading to an epidemic of diabetic related cardiovascular diseases.[6] Early identification of subtle changes in heart might allow preventive interventions and ultimately lead to lower rates of mortality. Altered ventricular myocardial dynamic is early manifestation of cardiac dysfunction even before appearance of any clinical symptoms and signs and can be quantified by conventional echocardiography.[7] By detecting subtle changes in the heart, preventive interventions might be possible. This study examined the prevalence of left ventricular dysfunctions in Nepalese diabetic patients and correlated them with their clinico-demographic and risk factors.

The finding of the study titled "Abnormal echocardiography in patients with type 2 diabetes and relation to symptom and clinical characteristics" by Jorgensen et al [8] was that 129 (12.5%) out of 1030 diabetic patients had systolic dysfunction. Similarly, in another study which was done by Raev D,[9] in Bulgaria in the year 1994 reported 18 (11.5%) out of 157 diabetic patients had lower ejection fraction i.e. they had left ventricular systolic dysfunction. In this study, 11 (18.3%) out of 60 diabetic patients had systolic dysfunction. Patients with abnormal echocardiography were older, had poor blood glucose control, and had longer duration of diabetes, which is a finding consistent with our study. However, the finding of study done by Shrestha NR et al[10] showed no patients out of 100 asymptomatic diabetic patients had LV systolic dysfunction which was in contrast with the results of this study.

Diastolic dysfunction in diabetic patients has been reported by numerous authors and prevalence of diastolic abnormalities varies from 21 to 100% in the literature.[11,12] The result of this study was that LVDD was the major finding in patients with T2DM. Our study found diastolic dysfunction was thrice as common as systolic dysfunction. In another study done in a tertiary care center of eastern Nepal by Shrestha NR et al[10] diastolic dysfunction was found in 71 (71%) out of 100 asymptomatic diabetic patients. The result of our study was also verified by the result of the study done by Verma RK et al[13] in north India, where LVDD was present more in diabetic patients.

In our study it was found that the frequency of LVDD increased with duration of diabetes. The study demonstrated significant association between LVDD and duration of diabetes (P value 0.007). This result was consistent with the result of the study done by Raev DC[9] who concluded that frequency of LVDD strongly increased with the duration of diabetes (P value<0.001). In a study titled "Echocardiographic evaluation of diastolic function in asymptomatic type 2 diabetes" by Shrestha NR et al[10] it was concluded that duration of diabetes more than two years was associated with a two times higher risk for developing diastolic dysfunction. Similarly, in another study done by From AM, et al.[14] conclusion was made that diabetes duration of more than 4 years was independently associated with LVDD.

The relationship between diastolic dysfunction and glycemic control is still a matter of debate. The study by Shrestha NR et al[10] did not find any difference between the fasting blood glucose level and prevalence of LVDD. Porier, et al concluded that fasting blood glucose levels did not correlate with the presence of diastolic dysfunction in patients with T2DM.[14] The result of both of these studies is in contrast with the findings in our study. However, in the review article published by Negishi K[16] in 2018, it was reported that LV diastolic dysfunction is associated with poor diabetic control. Holzmann and colleagues demonstrated that the presence of diastolic dysfunction is related to the concentrations of fasting blood glucose.[17] These findings are in agreement with the result in our study which showed significant association of LVDD with control of diabetes (P value 0.02).

This study has several limitations. First, this study was a single centered, cross sectional investigation with a limited sample size. Therefore, drawing an

absolute conclusion for the generalization from this study alone is challenging, and it is crucial to conduct a multicenter trial to validate the result. Angiography to exclude coronary artery disease was not performed due to its non-availability at the study center, however the absence of clinical and electrocardiographic evidence make it unlikely.

CONCLUSION

The prevalence of left ventricular diastolic dysfunction in patients with T2DM was 60% in this study. We can conclude that patients with T2DM without cardiac disease do have left ventricular diastolic function as well as left ventricular systolic dysfunction and this dysfunction increases with duration of diabetes mellitus, and higher HbA1c levels. High prevalence of LVDD in diabetic patients implies that all diabetics require echocardiographic evaluation even those who are free of clinically detectable heart disease.

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Conflict of interests

None

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