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Original Article

Pattern of Mitral Inflow Velocity due to Left Ventricular Diastolic Dysfunction among Impaired Glucose Tolerance Patients

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Abstract

Background: The pattern of mitral inflow velocity may vary due to left ventricular diastolic dysfunction among impaired glucose tolerance. **Objectives:** The purpose of the present study was to assess the pattern of mitral inflow velocity due to left ventricular diastolic dysfunction among impaired glucose tolerance. **Methodology:** This cross-sectional study was carried out in the Department of Cardiology at Bangabandhu Sheikh Mujib Medical University (BSMMU), Dhaka, Bangladesh, from July 2005 to June 2007 for a period of two (02) years. Patients with impaired glucose tolerance (IGT) patients attending the Bangladesh Institute of Research and Rehabilitation in Diabetes, Endocrine and Metabolic Disorders (BIRDEM), Dhaka, Bangladesh, who fulfilled the selection criteria were included in this study as group A. The apparently healthy persons without cardiovascular disease were taken as group B. All the study subjects underwent 2D and M-mode echocardiography for chamber enlargement, ventricular hypertrophy and ventricular systolic function according to the recommendation of the American Society of Echocardiography. **Results:** Doppler mitral inflow parameters between groups showed that E-wave 58.94±15.14 vs 71.14±10.60 cm/s, p<0.001, and E/A ratio 1.13±0.46 vs 1.48±0.36, p<0.001 significantly lower in group A, but A-wave 55.32±9.55 vs 49.54±6.93 cm/s, p<0.01 significantly higher in group A compared to group B subjects. Doppler mitral inflow parameters were also compared between LVDD present and absent groups, which showed that E-wave 45.58±5.46 vs 73.42+5.97 cm/s, p<0.001, E/A ratio 0.74±0.12 vs 1.56±0.26, p<0.001, significantly lower in LVDD present group, while A-wave 62.12±6.35 vs 47.96±6.46 cm/s, p<0.001, and DT 224.42±3.53 vs 192.79±8.54 msec, p<0.001) were significantly higher in LVDD present group. **Conclusion:** In conclusion the pattern of mitral inflow velocity is significantly different due to left ventricular diastolic dysfunction among impaired glucose tolerance patients. *[Journal of Current and Advance Medical Research, July 2024;11(2):62-67]*

Keywords: Pattern; Mitral Inflow Velocity; Left Ventricular Diastolic Dysfunction; Impaired Glucose Tolerance

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Introduction

Insulin resistance and subsequent myocardial changes are responsible for the development of diastolic dysfunction[1]. IGT is a predictor for future diabetes mellitus, and it is a strong risk factor for the development of premature cardiovascular disease, and so subsequent morbidity and mortality[2-3]. The National Diabetes Data Group (NDDG) of the National Institute of Health (NIH), USA, in collaboration with the World Health Organization (WHO) proposed the term impaired glucose tolerance (IGT).

Individuals with IGT decompensated to overt diabetes and had a higher mortality rate than those with normal glucose tolerance[4]. The macrovascular complications, such as coronary heart disease, hypertension, stroke, and so on, are present at a greater rate than in people with normal glucose tolerance. This increasing frequency of registration appears to be either increasing awareness of diabetes among people or a real increase in diabetes prevalence in the community[5]. Some small diabetes surveys, at the community level in different periods, proved an increasing prevalence of diabetes and IGT[6].

Epidemiological evidence supports hyperinsulinemia as a marker for CAD risk, though an aetiologic role has not been demonstrated[7]. Clinical, epidemiological, and pathological studies showed the increased occurrence of clinical CHF in IGT subjects attributed to diabetic cardiomyopathy, which take the form of systolic and/or diastolic left ventricular dysfunction. Left ventricular diastolic dysfunction may represent the first stage of diabetic cardiomyopathy[8-10]. Insulin resistance is common in Bangladesh in IGT subjects, but there are few studies about LVDD in this population. Therefore, the present study was carried out to find out the frequency of LVDD in IGT subjects and to find out the association of age and sex with LVDD in IGT. Studies have shown that diabetic cardiomyopathy can reverse and arrest the progression by intense diabetic control[11-12].

If we can detect the diastolic dysfunction at the early stage, we can take measures for the prevention of its progression or to reverse the process. With this background, the present prospective study, entitled "Detection of left ventricular diastolic dysfunction in impaired glucose tolerance" by Doppler echocardiography was undertaken. This present study was undertaken to assess the pattern of mitral inflow velocity due to left ventricular diastolic dysfunction among impaired glucose tolerance patients.

Methodology

Study Settings and Population: This present cross-sectional study was carried out in the Department of Cardiology at Bangabandhu Sheikh Mujib Medical University (BSMMU), Dhaka, Bangladesh, from July 2005 to June 2007 for a period of two (02) years. Patients with impaired glucose tolerance (IGT) attending the Bangladesh Institute of Research and Rehabilitation in Diabetes, Endocrine and Metabolic Disorders (BIRDEM), Dhaka, Bangladesh who fulfilled the selection criteria were included in this study.

Selection Criteria: Patients with the age group of 18 to 60 years, fasting blood sugar less than 7 mmol/L and 2 hours after 75 gm glucose 7.8 to 11.0 mmol/L with blood pressure of systolic less than 140 mmHg and diastolic less than 90 mmHg, sinus rhythm, and negative ETT were selected as the study population. Any evidence of pericardial, myocardial, or endocardial disease, valvular heart disease, congenital heart disease, known or suspected coronary artery disease, diabetes mellitus patients, atrial fibrillation, renal impairment, pregnant women, or patients with poor echocardiography windows were excluded from this study.

Study Procedure: The apparently healthy persons without cardiovascular disease were taken as group B. Informed consents were taken from each subject. History and clinical examination findings were recorded in a predesigned data collection sheet. ECG, chest X-ray, blood sugar (fasting and 2 hours after 75 gm glucose); fasting lipid profile and serum creatinine; urine for microalbumin level were analyzed and findings documented. An exercise tolerance test (ETT) was done in every case, and positive cases were excluded. Echocardiography, including Doppler with colour flow imaging study was done by cardiologists. Each study subject underwent a standardized 12-lead electrocardiographic evaluation. Any change in the ST, T-segment was carefully noted. Exercise tolerance test (ETT) was done using the Bruce protocol after proper evaluation, excluding contraindications in patients with normal ECG and highly suspicious for IHD. Symptoms of angina and ST-segment changes were carefully evaluated.

Measurements of Echocardiography Test: Echocardiography for this study was done by Siemens Acuson CV70 and ALOX-A Colour

Doppler SSD-1000, Japan, an ultrasound imaging system using a 2.5 MHz array phased transducer with ECG gating. All the study subjects underwent 2D and M-mode echocardiography for chamber enlargement, ventricular hypertrophy, and ventricular systolic function according to recommendations of the American Society of Echocardiography. Careful attention was paid on valvular, congenital, pericardial, and myocardial pathology. Special emphasis was given on wall motion abnormality and graded from normal to dyskinetic motion. LV systolic function was recorded. Doppler examination was performed with the study subjects at the left lateral decubitus position. Each valve was evaluated by the pulsed-wave and continuous-wave Doppler echocardiography, followed by colour-flow mapping. Main emphasis was given to different Doppler parameters related to LV diastolic function. The apical four-chamber view was used to assess the transmitral flow and pulmonary venous flow parameters. To observe the transmitral flow parameters, a pulsed Doppler sample volume (2.4 mm gate) was placed on the tip of the mitral valve leaflets, whereas a sample volume (3 mm gate) was placed 1 to 2 cm deep in the right upper pulmonary vein for the assessment of pulmonary venous inflow. Flow patterns across the mitral inflow, like E- and A-wave velocities, E/A ratio, deceleration time (DT), isovolumic relaxation time (IVRT), and duration of A-wave (AD) were measured. Measurements up to 3 cycles at end-expiration were averaged. Similarly, flow patterns across the pulmonary inflow, like S- and D-wave velocities, S/D ratio, atrial reversal (AR) and duration of AR (ARD) were measured. The AD/ARD ratio was calculated. Normal values for the Doppler parameters are mentioned above. Different stages of LVDD as absent, abnormal relaxation, pseudo-normalization, and restrictive pattern values, were recorded. Flow spectral was printed on Polaroid paper with a printer.

Statistical Analysis: All relevant information for each study subject were recorded on a predesigned data collection sheet. Collected data were compiled and statistical analyses were done using computer-based software, Statistical Package for Social Science (SPSS). To arrive at statistical significance, the Chi-square test and the unpaired Student's 't' test were applied. P-value < 0.05 was taken as the minimum level of significance.

Ethical Clearance: All procedures of the present study were carried out in accordance with the principles for human investigations (i.e., Helsinki Declaration 2013) and also with the ethical guidelines of the Institutional Research Ethics. Formal ethics approval was granted by the local ethics committee. Participants in the study were informed about the procedure and purpose of the study and the confidentiality of information provided. All participants consented willingly to be a part of the study during the data collection periods. All data were collected anonymously and were analyzed using the coding system.

Results

The present prospective study was carried out in the Department of Cardiology, Bangabandhu Sheikh Mujib Medical University (BSMMU), Dhaka. Fifty consecutive cases of IGT patients who attended BIRDEM hospital and fifty age, sex sex-matched non-IGT subjects, who fulfilled the selection criteria, were included in this study. The mean age of groups A and B was 49.92±8.96 and 40.42±9.31 years. The difference between group A and B was not statistically significant (p=0.785) (Table 1).

Table 1: Mean Age of the study subjects

Group	Mean Age± SD	P value
Group A	40.92±8.96	0.785
Group B	40.42±9.31	

Unpaired Student's 't' test

In this study 35(70.0%) and 39(78.0%) were male, and 15(30.0%) and 11(22.0%) were female in group A and B respectively. The difference between the male and female was not statistically significant (p=0.362) (Table 2).

Table 2: Gender Distribution of the study Population

Gender	Group A	Group B	P value
Male	35(70.0%)	39((78.0%)	0.362
Female	15(30.0%)	11(22.0%)	
Total	**50(100.0%)**	**50(100.0%)**	

Chi-square test

The mitral inflow velocity pattern showed significant differences between groups, i.e. peak E-wave (58.94±15.14 and 71.14±10.60 cm/s; p<0.001), peak A-wave (55.32±9.55 and 49.54±6.93 cm/s; P<0.01), E/A ratio (1.13±0.46 and 1.48±0.36, p<0.001), deceleration time (209.24±17.19 and 189.90±13.83 msec; p<0.001) and IVRT (102.80±9.84 and 92.86±7.82 msec; p<0.001) (Table 3).

Table 3: Mitral Inflow Velocity Pattern by

Doppler Echocardiography in the Study subjects (n=100)

Variables	Group A	Group B	P value
Peak E-wave (cm/s)	58.9±15.14	71.1±10.60	0.0001
Peak A-wave (cm/s)	55.3±9.55	49.5±6.93	0.001
E/A ratio	1.1±0.46	1.5±0.36	0.0001
Deceleration time (msec)	209.2±17.19	189.9±13.83	0.0001
IVRT (msec)	102.8±9.84	92.9±7.82	0.0001

IVRT=Isovolumetric relaxation time; Unpaired Student's 't' test was performed to see the level of significance.

The mean peak E-wave and E/A ratio were significantly lower but peak A-wave, deceleration time and IVRT were significantly higher in cases with LVDD. Mean (±SD) values with cases with and without LVDD, respectively, were peak E-wave 45.58±5.46 and 73.42±5.97 cm/s (P<0.001), peak A-wave 62.12±6.35 and 47.96±6.46 cm/s (p<0.001), E/A ratio 0.74±0.12 and 1.56±0.26 (p<0.001), deceleration time 224.42±3.53 and 192.79±8.54 msec (p<0.001), and IVRT 111.23±4.43 and 93.67±4.21 msec (p<0.001) (Table 4).

Table 4: Mitral inflow velocity pattern by Doppler echocardiography in cases with and Without Left Ventricular Diastolic Dysfunction

Variables	LVD Dysfunction		P value
	Present (n=26)	Absent (n=24)	
Peak E-wave (cm/s)	45.6±5.46	73.4±5.97	0.0001
Peak A-wave (cm/s)	62.1±6.35	48.0±6.46	0.0001
E/A ratio	0.7±0.12	1.6±0.26	0.0001
Deceleration time (msec)	224.4+3.53	192.8+8.54	0.0001
IVRT (msec)	111.2±4.43	93.7±4.21	0.0001

IVRT=Isovolumetric relaxation time; Unpaired Student's 't' test was performed to see the level of significance.

Discussion

There has been increasing interest, comprehension and appreciation regarding the contribution of left ventricular diastolic dysfunction (LVDD) to the signs and symptoms produced by cardiovascular disorders[13]. Abnormal left ventricular diastolic (LVD) performance has been observed both in conjunction with and absence of systolic dysfunction. The advent of Doppler velocity recording has provided a rapid, repeatable, noninvasive method by which LVDD is assessed[14-15].

Accurate noninvasive assessment is crucial to the broad application and understanding of this common condition. Echocardiographic parameters have become the backbone of this noninvasive procedure[11]. The increased incidence of LVDD in patients the impaired glucose tolerance (IGT) patients explained by the presence of early diabetic cardiomyopathy[16-18]. Bajraktaria et al[12] found that 55.0% patients with IGT had LVDD. Our study has endeavored to find out such a recommendation.

Detection of LVDD at the entry point of IGT and diabetes mellitus is very important regarding the initiation of the mode of management, as an appropriate mode of management might arrest or reverse the process[11,17,19].

In this study, various grades of LVDD were evaluated in asymptomatic, normotensive, ETT-negative IGT patients, and these were compared with non-IGT age and sex-matched control subjects by Doppler echocardiography. Until now, there has been little data in Bangladesh regarding the LVDD in asymptomatic, normotensive, ETT-negative IGT patients by Doppler echocardiography. In the current study, an attempt has been made to compare the data of various relevant studies with that from the present study.

The age range in this study was 18 to 60 years, with a mean age of 49.92±8.96 years. The highest number of patients was 18(36%) in the 41 to 50 years group. The next age group was 31 to 40 years. Most of the people above the age of 60 years had LVDD due to aging; for this reason age range was 18 to 60 years. Bajraktaria et al[12] worked on diastolic dysfunction in normotensive NGT (normal glucose tolerance), type 2 diabetes, age range was 18 to 60 years; they had taken some samples above 60 years, which may give a higher frequency of LVDD due to age-related diastolic dysfunction. In the present study, only 10% control population had LVDD. All subjects were between 41 to 60 years of age. Zahurul[15] showed that 22.0% of the control group had LVDD in his study.

The majority of the study population was male, 35(70.0%), while females comprised of small part, 15 (30.0%). Male and female ratio was 2.3:1. In Bangladesh, almost all studies reported an overwhelming majority of male patients. For the detection of LVDD, Doppler mitral inflow

parameters and Doppler pulmonary venous parameters are crucial[7]. In Doppler mitral inflow parameters, the E/A ratio and deceleration time (DT) are very important parameters to measure, and in pulmonary venous parameters, the S/D ratio and PAR are very important[11].

Doppler mitral inflow parameters between case and control groups showed that E-wave and E/A ratio were significantly lower in the case group, but A-wave was significantly higher in the same group compared to control subjects, which signifies the presence or initiation of LVDD. During the start of LVDD, initially, left ventricular end-diastolic pressure is increased, and to maintain an adequate flow from LA to LV, LA pressure is increased and reflected by increased A-wave and reduced E-wave velocity, thus altered E/A ratio.

As we have taken the asymptomatic population, pseudonormal and restrictive filling abnormal groups of LVDD may be absent in our study as most of the persons of the pseudonormal and restrictive filling abnormal group are symptomatic[19-21]. Bajraktaria et al[11] showed that 55.0% of IGT cases, 27.6% of NGT cases, and 75.7% of type 2 diabetes mellitus cases had LVDD. None of the subjects was found to have pseudonormal or restrictive filling abnormality. In another study[17], it has been shown that 63% of the type 2 diabetes group had LVDD, and none of the subject was found to have pseudonormal or restrictive filling abnormality. This study is nearly similar to the present study; however, the frequency is slightly higher.

Conclusion

In conclusion, the pattern of mitral inflow velocity is significantly different due to left ventricular diastolic dysfunction among impaired glucose tolerance. The mitral inflow velocity pattern showed significant differences between groups. The mitral inflow velocity pattern showed significant differences between groups. Furthermore, the mean peak E-wave and E/A ratio were significantly lower, but peak A-wave, deceleration time and IVRT were significantly higher in cases with LVDD.

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None

Conflict of Interest
The authors have no conflicts of interest to disclose

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Data Availability
Any inquiries regarding supporting data availability of this study should be directed to the corresponding author and are available from the corresponding author on reasonable request.

Ethics Approval and Consent to Participate
Ethical approval for the study was obtained from the Institutional Review Board. As this was a prospective study the written informed consent was obtained from all study participants. All methods were performed in accordance with the relevant guidelines and regulations.

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