Research article

Correlation between diastolic dysfunction and global longitudinal strain imaging in patients with diabetes mellitus

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ABSTRACT

Introduction and Aim: Diabetes mellitus (DM) is a significant risk factor for cardiovascular diseases (CVD) on its own resulting in left ventricular volume overload which may further impair left ventricular (LV) function**.** The aim of the study is to evaluate the diastolic dysfunction and global longitudinal strain (GLS) imaging in patients which helps to predict the cardiovascular mortality.

Materials and Methods: This study included 45 patients over 50 years with their evidence of fasting blood sugar and PPBS level. E/A, E/E' and E' are measured by TDI and Traditional 2D echocardiography; the following parameters are assessed: IVRT, IVCT, pulmonary venous flow and hepatic vein flow. GLS and strain rate were measured in AP4C, AP3C and AP2C views.

Results: In our study 93% of patients had normal GLS and 7% of patients had reduced GLS 16% of patients had normal diastolic dysfunction (DD), 68% had grade I DD and 16% of patients had grade II DD. DD does not correlate with GLS in diabetes mellitus patients.

Conclusion: According to current guidelines, patients with diabetes mellitus frequently have diastolic dysfunction, but it can also be caused by other reasons. It should be aimed to detect pre-diabetic patients with DD and optimize their clinical management which can be improved by utilizing tissue doppler imaging due to its potential to fill current need for a reliable tool that can demonstrate the effectiveness of therapy in future studies for preventing insulin resistance, DM, and cardiovascular disease.

Keywords: Diabetes mellitus (DM); Global longitudinal strain (GLS); Diastolic dysfunction (DD); Left ventricle (LV).

INTRODUCTION

Heart failure incidence rates are comparable to those of a background population of people more than 10 years in type 1 diabetes mellitus (T1DM), and the risk of mortality from cardiovascular diseases (CVD) is increased six to twelve times (1,2) . The physiology of cardiac strain, the technical aspects of strain imaging with TDI and speckle tracking, their advantages and disadvantages, and potential current and future clinical applications are covered (3). Visual evaluation or Simpson's biplane approach is typically used to determine the LV systolic function. In heart failure patients and Ischemic heart disease impaired global longitudinal strain (GLS) has been linked to adverse outcomes and offers additional predictive information beyond standard echocardiogram (4-6). In the current study, we compared DM outpatient clinic patients with healthy control volunteers to examine the connection between GLS and diastolic dysfunction (DD) with echocardiography assessments E/A, E/E', E', IVRT, IVCT, pulmonary venous flow and hepatic vein flow. Several cardiovascular risk factors have emerged as a result of insulin resistance, including diabetes mellitus, are frequently linked to abdominal obesity(7,8). It is very interesting to learn how long-term diabetes mellitus leads to the development of impaired diastolic function(9,10). Doppler echo cardiography, which measures transmitral flow velocities, is a valuable method for determining diastolic function (11). Doppler echocardiography measurements of diastolic function have shown favourable comparisons to well-established methods like angiography or radioactive ventriculography (12,13).

METHODS AND MATERIALS

This study is a prospective observational study. The study was conducted in the cardiology department of Chettinad Super Specialty Hospital (CSSH). The institutional ethical committee gave their consent for the study**.**

Inclusion criteria

Patients with isolated diabetes mellitus, both male and female, aged above 50 years were included.

Exclusion criteria

Patients with HF, valvular heart disease, hypertension, hypothyroidism, other comorbidities other than DM, normal heart failure were excluded.

Patients were briefed about the trial. Informed consents were collected from the patients. In the questionnaire, relevant history was documented. All patients underwent investigations such as FBS, PPBS, echocardiography, and strain imaging. All diabetic individuals had standard and pulse wave doppler echocardiograms. The department of cardiology CSSH used a vivid S5 GE machine and an ESAOTE machine to do conventional echocardiography pulse wave doppler, tissue doppler, and colour doppler. To assess the left ventricle(LV) dimension, use M-Mode, as per the ASE standards. Measured the GLS and strain rate, all standard apical 4 chambers, 2 chambers, and 3 chambers were recorded.

Pulse wave doppler

The accuracy and precision of the diagnosis procedure utilized to determine whether systolic or diastolic impairment is detected. Tissue doppler imaging shows LV has relationship with E' and E/E' and adherence measures, whereas the myocardial systolic speed compared to ejection fraction, S is a more accurate predictor of systolic function. In TDI, the myocardium reflected low-frequency and high-amplitude ultrasonic pulses are utilized, which is a reliable and repeatable ultrasound technique. The regional LV function is represented in the myocardial long axis motion velocity during systole which is represented as S' early diastole which is represented as E' and late diastole in cm/s.

Declaration time (DT)

The time taken from the maximal E point to baseline is measured using pulse wave doppler. DT is the period of time between peak inflow velocity and conclusion of rapid early filling phase.

Isovolumetric relaxation time (IVRT)

IVRT is defined as the time period between closure of AV and the beginning of MV filling. Delay in the opening of the MV and higher IVRT when relaxation extended. When atrial pressure is high, the mitral valve opens earlier, resulting in a shorter IVRT. PWD is used to measure from Apical 5 chamber perspective.

Pulmonary venous flow

At the confluence of the pulmonary veins and the LA, pulmonary venous flow velocity can be measured. Normal pulmonary venous flow has systolic and diastolic components, with a transient reversal of flow during atrial systole. There are three main components: an antegrade systolic wave (S) with two peaks (S1 & S2), a diastolic wave (D), and a retrograde wave (Ar).

Hepatic vein flow

Hepatic vein velocities reflect change in pressure, volume and compliance of the right atrium. It consists of 4 components: S = Systolic forward flow, D = Diastolic forward flow, Sr = Systolic flow reversal, Dr = Diastolic flow reversal.

Global longitudinal strain (GLS)

Strain images were obtained at 60-80 frames per second and one cardiac cycle of LV was recorded in a cine loop with synchronized ECG. Longitudinal strains were noted in AP4C, AP3C, AP2C views. The software detects and tracks the myocardial motion and Average strain value was calculated and strain EF was generated automatically from tracking. It detects earlier than the usual 2D conventional echocardiography. In order to measure the longitudinal strain on the LV images from the AP4C, AP3C, AP2C views are required, whereas PSAX at the basal, mid and apical levels are required for the measurement of radial and circumferential strain. Regional and global cardiac mechanical performance can be evaluated using strain and strain rate and they seem to be particularly useful in the diagnosis and treatment of CAD and its consequences, but they are not yet routinely used in clinical practice. However, pulsed TDI is more sensitive than strain and strain rate in detecting diastolic dysfunction, which is essential because, particularly in CAD diastolic dysfunction typically comes before systolic dysfunction. Global longitudinal strain measures twist and torsion pattern during LV contraction, LV relaxation, LV filling. The systolic heart failure patterns differ from those in diastolic heart failure, and they need to be clarified.

Diastolic function is determined by cardiovascular risk factors

Rapid left ventricular filling is a sensitive sign of myocardial injury, which is not affected by age and myocardial ischemia. Decreased diastolic function is seen in risk factors, including a sedentary lifestyle and obesity. Notably, the reversibility of myocardial abnormalities associated with the metabolic syndrome and diabetes is good news for patients and their doctors, and it aligns with the UK prospective diabetes follow-up study's recent message that the most effective treatment is started early in the disease's course.

RESULTS

Among the whole studied sample (45 patients), 42 patient (93%) had normal GLS and 3 patients (7%) had reduced GLS. In classification of diastolic dysfunction, among all these 45 patients around 16% of the people had normal DD, 68% of people had Grade I DD and 16% of people had Grade II DD(Fig.1). In normal GLS – Normal diastolic dysfunction has 7 patients, Grade I diastolic dysfunction has 30 patients and Grade II diastolic dysfunction has 5 patients. In reduced GLS – grade I diastolic dysfunction has 1 patient and grade II

diastolic dysfunction has 2 patients (Fig. 2). The P value of normal with GLS is 0.7325, Grade I with GLS is 0.2683 and Grade II with GLS is 1 (Table 1). There is no correlation between DD and G LS.

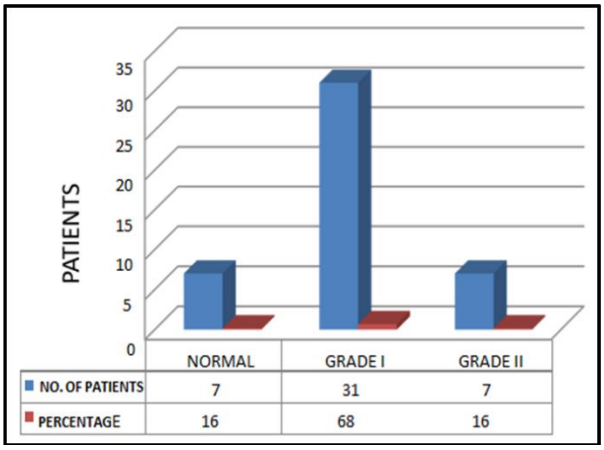

Fig. 1: Diastolic dysfunction

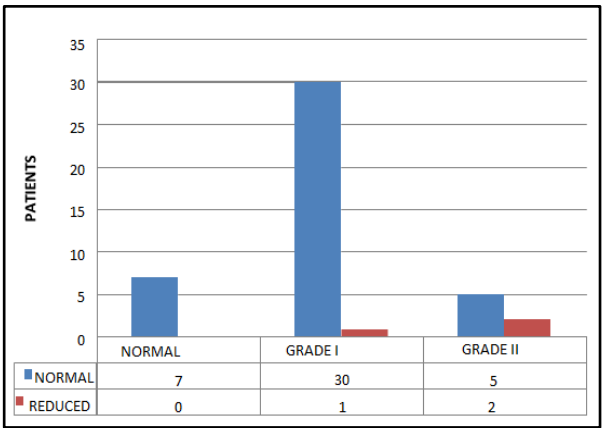

Fig. 2: Diastolic dysfunction with GLS

Table 1: Correlation of normal and reduced GLS

Data analysis	Normal With GLS	Grade I with GLS	Grade II with GLS
Spearman's RHO correlation	-0.15954	0.2059	0
p- value	0.7325	0.2683	1

DISCUSSION

In the current study, 55 non-diabetic control subjects were compared with 45 DM patients who had no history of heart disease from the OP clinic at Chettinad Hospital and Research Education. The discovery that cardiac systolic function is decreased in DM patients with albuminuria in everyday clinical situations highlights the significance of preventing, diagnosing, and treating DM patients with kidney disease. It is well established that albuminuria in DM is linked to higher mortality and that it is a significant risk factor for the occurrence of heart disease. Additionally, it appears that people with DM who do not have albuminuria have a prognosis equivalent to that of the general population(14,15). Given that DD is frequently cited as initial symptom of diabetic cardiomyopathy, this finding is intriguing (16).Therefore, in patients with varying albuminuria as compared to a control, speckle-tracking echocardiography was employed to identify any potential loss in systolic function not evident by echocardiogram. Additional speckle-tracking measurements, such as strain rate and circumferential strain, may increase the mechanics of the heart in DM (17). But GLS seems to have the highest repeatability among traders and might thus reliably measure effects in systolic function in the routine context (18). In a comprehensive cardiac evaluation, GLS may be used in addition to traditional echocardiography to identify specific alterations in myocardial function. It has previously been demonstrated that GLS is more accurate than traditional echocardiography at predicting prognosis in patients with myocardial infarction. Several Researchers have demonstrated that even in diabetic patients, anomalies of LV diastolic function are prevalent without any symptoms of heart failure(19). The most non-invasive approach can determine LV diastolic filling in Doppler echocardiography (20-22).

CONCLUSION

Assessment of LV diastolic dysfunction and global longitudinal strain through 2D Doppler echocardiography in male and female patients with diabetes mellitus was carried out. E/A ratio and E/E can be early and easy parameters for diagnosing diastolic dysfunction in patients with diabetes mellitus. The P value of normal with GLS is 0.7325, Grade I with GLS is 0.2683 and Grade II with GLS is 1. Of all these 45 patients around 16% of the people had normal diastolic dysfunction, 68% of people had GI DD and 16% of people had GII DD. In our study, longitudinal strain value was significantly reduced in diabetes mellitus patients which shows significant subclinical or intrinsic LV diastolic dysfunction. TDI has potential in future preventive studies including insulin resistance, DM, CVD. Therefore it is used to identify (pre-) diabetic individuals with DD and optimize their clinical management.

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CONFLICT OF INTEREST

Authors declare no conflicts of interest.

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