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Determination of Left Ventricular Mass by Echocardiography in Normotensive Type 2 Diabetic Patients

قياس كتلة البطين الأيسر للقلب بواسطة جهاز فحص القلب
بالموجات فوق الصوتية لمرضى داء السكري النوع الثاني من غير المصابين بارتفاع ضغط الدم

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Abstract:

Background: left ventricular hypertrophy (LVH) is often present in type 2 diabetics even in the absence of cardiovascular disease. Aim of study: to explore the presence of LVH in normotensive diabetic type 2 patients.Patients and method: twenty patients with type 2 DM (13 males and 7 females) recruited from the diabetic clinic in Assadir teaching hospital during six months period. All patients were normotensive type 2 diabetics. Twenty normotensive non-diabetic subjects were recruited as control. Echocardiography was performed to evaluate the LV mass (LVM) and LV mass index (LVMI) for each patient. Results: the study revealed a significantly high incidence of LVH in normotensive diabetics than the normal control subjects (p value <0.05). Four patients were found to have LVH (20%). Incidence of LVH was more common in females (28.5%) than in males (15%), but the difference was not statistically significant (p value >0.05). Older age group of patients is correlated significantly with LVH (p value <0.05). LVH didn't significantly correlate with duration of diabetes and fasting plasma glucose (p value >0.05).Conclusions: LVH can be seen in the Type 2 DM patients even in the absence of hypertension. These patients have a higher LVMI than the normal control subjects.

الخلاصة :

تضخم البطين الأيسر غالبا ما يوجد في مرضى داء السكري النوع الثاني من غير المصابين بارتفاع ضغط الدم. هذه الدراسة مصممة لبحث هذه الفرضية. تم اخذ عشرون مريضا بالسكري(١٣ ذكر و ٧ إناث) من مستشفى الصدر التعليمي في النجف خلال فترة ستة أشهر. عشرون شخصا سليما تم أخذهم كمجموعة ضبط للمقارنة مع مرضى السكري(١٢ ذكرا و ٨ إناث) . تم فحص القلب لجميع المشاركين بجهاز فحص القلب بالموجات فوق الصوتية لقياس كتلة البطين الأيسر. أظهرت الدراسة وجود أربعة مرضى لديهم تضخم البطين الأيسر (٢٠٪). كبار السن اظهروا علاقة أكثر من غيرهم بتضخم البطين الأيسر بينما لم تظهر مدة المرض , مقدار السكر في الدم أو جنس المريض تلك العلاقة.

Introduction

Diabetes mellitus is a state of increased oxidant stress and there is evidence that oxidation may play a role in the genesis of higher left ventricular mass[1]. The main forms of structural heart disease associated with diabetes are coronary heart disease and diabetic cardiomyopathy, which is characterized by left ventricular hypertrophy, left ventricular diastolic and systolic dysfunction. Asymptomatic structural heart disease is common and associated with a poor prognosis in patients with diabetes[2].

The prevalence of left ventricular hypertrophy (LVH), coronary artery disease, and subclinical cardiomyopathy in diabetic patients without known cardiac disease is unclear[3].In patients with diabetes mellitus, subclinical LV abnormalities are common and associated with poor diabetic control, advancing age, hypertension and metformin treatment, while angiotensin-converting enzyme inhibitor and insulin therapies appear to be protective[4].

Coronary artery disease is not the sole cause of cardiac death in diabetic patients; left ventricular dysfunction (LVD) and left ventricular hypertrophy (LVH) are also implicated and, unlike coronary

artery disease, are ideal targets for screening. The treatment of left ventricular abnormalities, even when these are asymptomatic, is associated with prognostic benefit[5,6,7] .

Hyperinsulinemia might be a determinant of LVH in the type 2 DM patients without hypertension. Multiple regression analysis showed that the LVMI was significantly correlated with plasma insulin levels only; in other studies LVMI correlated with blood pressure, plasma fasting glucose, HbA1c, or BMI in the type 2 DM[8].

The recent recognition that diabetes involves more than abnormal glucose homeostasis provides important new opportunities to examine and understand the impact of complex metabolic disturbances on cardiac structure and function (Fig.1)[8]:-

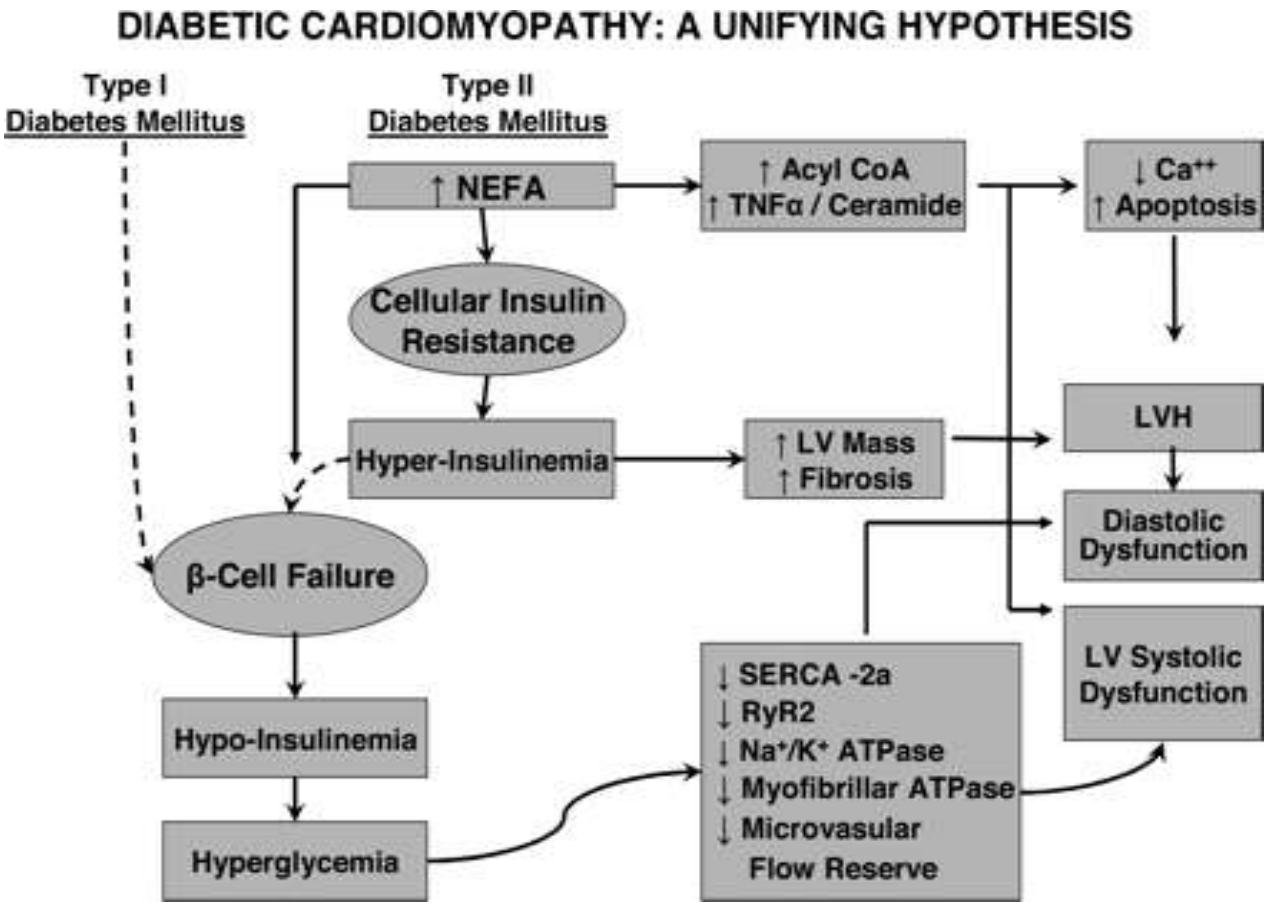


Figure-1. Schematic illustration of a unifying hypothesis that links NEFAs, hyperinsulinemia, and hyperglycemia to the structural and functional phenotypes in diabetic cardiomyopathy. [ryanodine receptor (RyR) , sarco(endo)plasmic reticulum Ca^{2+}-ATPase (SERCA2), nonesterified fatty acids (NEFAs), tumor necrosis factor alpha (TNF ά) . Poornima IG et al. Diabetic cardiomyopathy: the search for a unifying hypothesis.
Circ Res. 2006 Mar 17;98(5):596-605].

Screening of diabetic patients for diabetic cardiomyopathy is essential and can be achieved by echocardiography[6], albuminuria[10], blood test for brain natriuretic peptide[2], detection of retinopathy[11] and coronary artery calcium scoring and noninvasive angiography with computed tomography (CT) techniques[12,13].

In this study we investigate the presence of increased left ventricular mass (LVM) and left ventricular mass index (LVMI) as measures of LVH in a group of diabetic patients without cardiovascular risk factors by echocardiography.

Patients and Methods :

The study was conducted in Assadir Teaching Hospital in Najaf over a period of six months, from February to August 2007.

The study group included twenty patients with type 2 diabetes from outpatient diabetes clinic. Diabetes mellitus was diagnosed according to the National Diabetes Data Group and World Health Organization diagnostic criteria for type 2 DM[14]:-

■Symptoms of diabetes plus random blood glucose concentration ≥11.1 mmol/L (200 mg/dL)

or

■Fasting plasma glucose ≥7.0 mmol/L (126 mg/dL)

or

■Two-hour plasma glucose ≥11.1 mmol/L (200 mg/dL) during an oral glucose tolerance test

Normal blood pressure was diagnosed according to The Joint National Committee on Prevention, Detection, Evaluation and Treatment of Hypertension (JNC-7)[15]:-

Category	Blood pressure level, mm Hg Systolic		Diastolic
Normal	<120	and	<80
Prehypertension	120-139	or	80-89
Hypertension			
Stage 1	140-159	or	90-99
Stage 2	≥160	or	≥100

None of the subjects had received antihypertensive treatment, had no history of cardiovascular disease or significant Q wave in ECG. All the patients had no evidence of renal dysfunction by renal function test (blood urea, serum creatinine and creatinine clearance by Cockcroft and Gault equation).

A detailed history, especially the age, sex and duration of diabetes mellitus with thorough cardiovascular examination was performed for each patient.

Twenty normotensive non-diabetic subjects were selected as controls according to previous criteria[14,15] .

To evaluate LVM, two-dimensional echocardiographic, M-mode measurements were performed, in the left lateral decubitus position, twice for each subject by one examiner with an ultrasound imager (Logiq 3, GE, 2004). The end-diastolic LV diameter, end-systolic LV diameter, the thickness of the interventricular septum and LV posterior wall thickness were obtained.

LVM (g) was calculated according to the following formula[16] :-

$$\text{LV mass} = 0.8\,(1.04\,([\text{LVIDd} + \text{PWTd} + \text{IVSTd}]^3 - [\text{LVIDd}]^3)) + 0.6 \text{ g.}$$

Where: LVIDd = Left Ventricular Internal Diameter in Diastole

PWTd = Posterior Wall Thickness in Diastole

IVSTd = Interventricular Septum Thickness in Diastole

LVMI (g/m^2) was calculated by dividing LVM by the body surface area of each subject.

LVH was present if LVMI was ≥ 131 g/m^2 in men and ≥ 113 g/m^2 in women[16].

The data were analyzed using Chi square test with a level of significance (P value) being < 0.05.

Results :

Twenty diabetic patients ranging in age between 35-75 year (mean age 55.35+11.83 year) were included in this study. The systolic and diastolic blood pressure was not significantly different

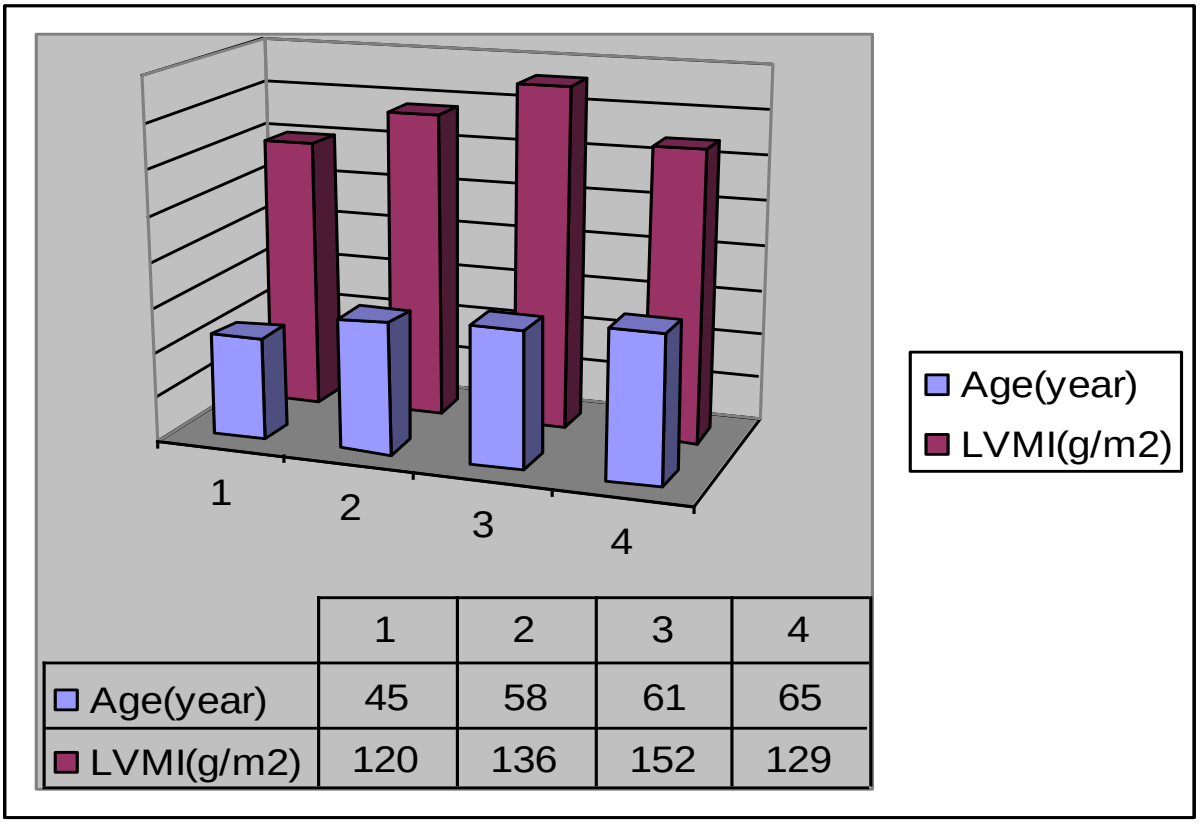
between the type 2 diabetics and the control subjects (p value >0.05). Four (20%) of them had LVH, 2 females (28.5%) and 2 males (15%), while none of the control group was found to have LVH which was statistically significant (p value <0.05) as shown in table-1.

There was statistically significant correlation between age of the patients and LVH as shown in figure-2. No significant difference was found between LVH with fasting plasma glucose and duration of diabetes (p value >0.05) as shown in figure -3 and 4 respectively. Although females had LVH more than males, the difference was not statistically significant (p value >0.05) as shown in figure-5.

Table -1- The Clinical and Echocardiographic Profiles of Diabetic and Control Subjects

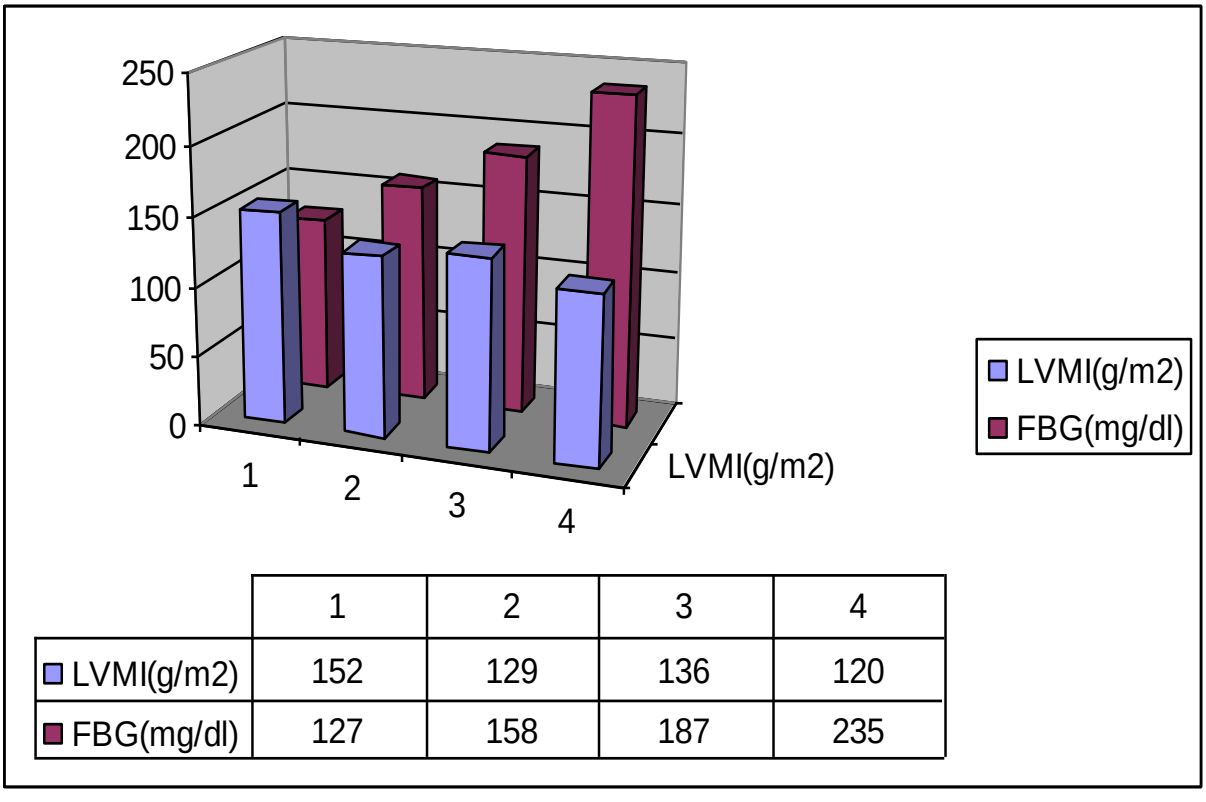
	Diabetic Patients (n=20)	Control Subjects (n=20)
AGE (year)	Mean+SD 55.35+11.83	43.95+7.20
30-40	3	6
41-50	4	11
51-60	5	3
61-70	6	0
71-80	2	0
SEX		
Male	13	12
Female	7	8
FASTING BLOOD SUGAR (mg/dl)	189.5+58.10	89.4+10.04
70-110	2	20
111-150	2	0
151-190	8	0
191-230	3	0
231-270	3	0
271-310	1	0
311-350	1	0
LEFT VENTRICULAR HYPERTROPHY		
With ↑ LVMI	4	0

Without ↑ LVMI	16	20
SBP mmHg	119.25+9	117.25+11.86
DBP mmHg	71+10.33	69+10.33



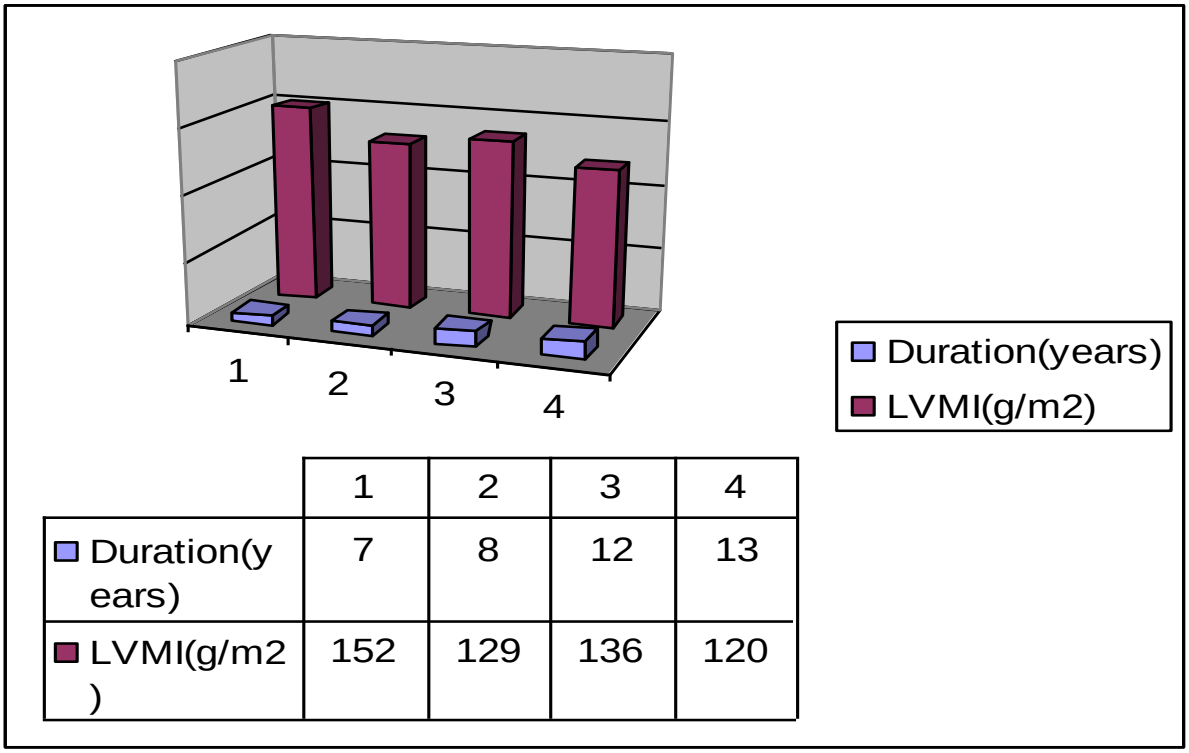
	1	2	3	4
Age(year)	45	58	61	65
LVMI(g/m2)	120	136	152	129

(Fig.2) the Relation between Age of Patients and LVMI
(P <0.05)



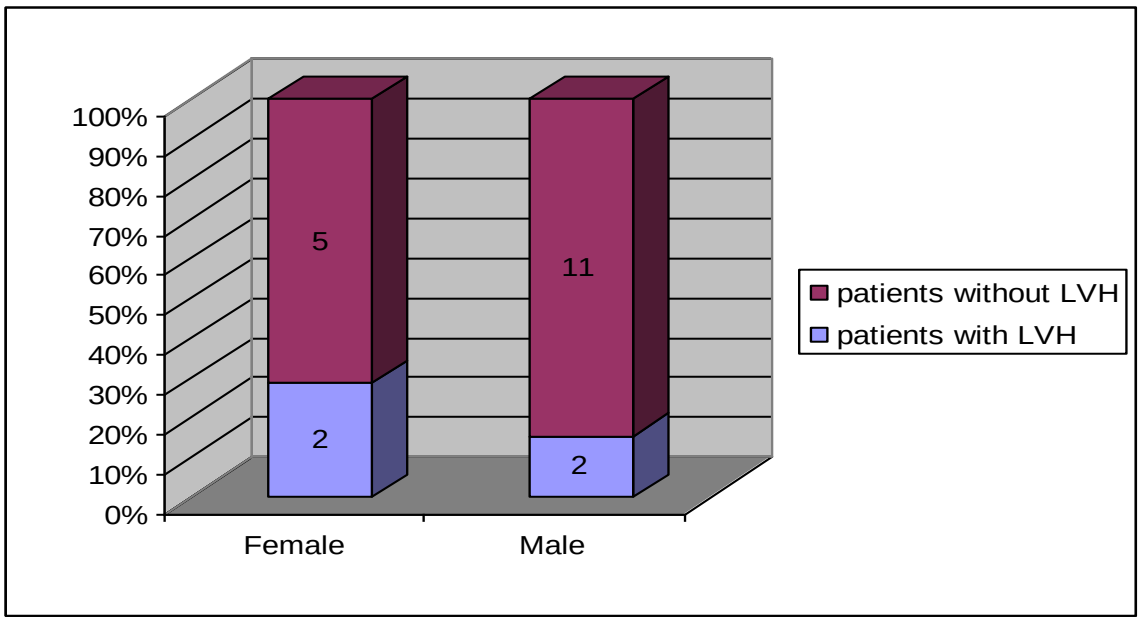
	1	2	3	4
LVMI(g/m2)	152	129	136	120
FBG(mg/dl)	127	158	187	235

(Fig.3) the Relation between Fasting Blood Glucose and LVMI
(P value >0.05)



	1	2	3	4
Duration(years)	7	8	12	13
LVMI(g/m2)	152	129	136	120

(Fig.4) the Relation between Duration of DM and LVMI
(P value >0.05)



(Fig.5) the Relation between Sex and LVMI of Diabetic Patients
(P value >0.05)

Discussion and Conclusion :

Left ventricular hypertrophy in diabetic patients without hypertension was present in our study which was consistent with Rabkin et al study[17]. They found that an increased LVM as a result of increased thickening in both the interventricular septum and posterior wall compared with the control subjects due to direct effect of insulin on collagen synthesis in the vascular smooth muscles and hepatic stellate cells. The increased sympathetic nervous system activity caused by insulin may also stimulate proliferation of myocardial cells leading to increase LVM.

There was significant correlation between LVM and elderly diabetic patients, so age should be considered in assessment of cardiac disease. Conversely, sex showed no significant correlation to the development of LVH in our normotensive diabetics.

Bertoni[18] found an association between fasting plasma glucose and left ventricular hypertrophy in diabetics with four years follow-up. This result was not consistent with our study and could be explained by the small number of patients studied and the short duration of follow-up didn't show left ventricular hypertrophy.

In agreement with Hiroyoshi Hirayama[9] study we found that there was no correlation between the duration of diabetes and LVH.

In conclusion, DM type2 is a cause of LVH in absence of hypertension. Echocardiography is recommended as a screening test for diabetic patients to detect any left ventricular abnormality.

References:

1. Pan NH, Lee TM, Lin MS et al. Association of gliclazide and left ventricular mass in type 2 diabetic patients.
Diabetes Res Clin Pract. 2006 Nov;74(2):121-8. Epub 2006 May 2.
2. Somaratne JB, Whalley GA, Bagg W et al. Early detection and significance of structural cardiovascular abnormalities in patients with Type 2 diabetes mellitus. Expert Rev Cardiovasc Ther. 2008 Jan;6(1):109-25.
3. Fang ZY, Schull-Meade R, Leano R et al. Screening for heart disease in diabetic subjects.
Am Heart J. 2005 Feb;149(2):349-54.
4. Fang ZY, Schull-Meade R, Downey M et al. Determinants of subclinical diabetic heart disease.Diabetologia.2005 Feb;48(2):394-402.Epub 2005 Jan 8.
5. Dawson A, Struthers AD. Screening for treatable left ventricular abnormalities in diabetic patients.
Expert Opin Biol Ther. 2003 Feb;3(1):107-12.
6. Dawson A, Morris AD, Struthers AD. The epidemiology of left ventricular hypertrophy in type 2 diabetes mellitus.
Diabetologia. 2005 Oct;48(10):1971-9. Epub 2005 Aug 11.
7. de Simone G, Gottdiener JS, Chinali M et al. Left ventricular mass predicts heart failure not related to previous myocardial infarction: the Cardiovascular Health Study.
Eur Heart J. 2008 Jan 19.
8. Indu G. Poornima, Pratik Parikh, Richard P. Shannon. Diabetic cardiomyopathy: the search for a unifying hypothesis.
Circ Res. 2006 Mar 17;98(5):596-605.
9. Hirayama H, Sugano M, Abe N et al. Determination of left ventricular mass by echocardiography in normotensive diabetic patients.
Jpn Circ J. 2000 Dec;64(12):921-4.
10. Ratto E, Leoncini G, Viazzi F et al. Inappropriate left ventricular mass is associated with microalbuminuria independently of left ventricular hypertrophy in primary hypertension.
J Hypertens. 2008 Feb;26(2):345-50.
11. Ohno T, Takamoto S. Retinopathy as a useful guide for selecting an appropriate coronary revascularization treatment in patients with diabetes mellitus.

Am J Cardiol. 2007 Oct 15;100(8):1330.
12. Bax JJ, Young LH, Frye RL et al. Screening for coronary artery disease in patients with diabetes.
Diabetes Care. 2007 Oct;30(10):2729-36.
13. Beller GA. Noninvasive screening for coronary atherosclerosis and silent ischemia in asymptomatic type 2 diabetic patients: is it appropriate and cost-effective?
J Am Coll Cardiol. 2007 May 15;49(19):1918-23
14. Alvin C. Powers. Diabetes mellitus.p.2153. Kasper et al. Harrison's principles of internal medicine ;16th.
15. Michael J. Hogan, MD, MBA. Hypertension.p.741. Joseph G. Mayo Clinic Cardiology;3rd edition;2007..
16. Roberto M. Lang, Michelle Bierig, Richard B et al.
Recommendations for Chamber Quantification: A Report from the American Society of Echocardiography's Guidelines and Standards Committee and the Chamber Quantification Writing Group, Developed in Conjunction with the European Association of Echocardiography, a Branch of the European Society of Cardiology.
J Am Soc Echocardiogr 2005;18:1440-1463.
17. Rabkin SM. Serum insulin, IGF-I, IGF-II and growth hormone , and LVM in NIDDM. Can J Cariol 1996;12:264-270.
18. Bertoni AG, Goff DC Jr, D'Agostino RB Jr et al. Diabetic cardiomyopathy and subclinical cardiovascular disease: the Multi-Ethnic Study of Atherosclerosis (MESA).
Diabetes Care. 2006 Mar;29(3):588-94.