SYSTOLIC TIME INTERVALS IN UNCONTROLLED YOUNG DIABETICS : RESPONSE TO ACUTE LOWERING OF BLOOD GLUCOSE BY INSULIN PUMP

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Introduction

Cardiac disease has been well documented as one of the major complications of diabetes mellitus and is a leading cause of death. In the past, high incidence of heart disease in diabetics was attributed to accentuated and more extensive coronary cardiac disease in diabetics. Recent studies point to the existance of a clinicopathologically specific diabetic heart disease termed as diabetic cardiopathy or diabetic cardiomyopathy 1, 2, 3. Hence study of myocardial function in diabetics without clinical evidence of coronary heart disease or other cardiovascular disease has been of recent interest.

Left ventricular function can be assessed by noninvasive methods using systolic time intervals which correlate well with the direct measures of cardiac performance. The present study aimed at measuring the systolic time intervals in uncontrolled young diabetics and also to find out if there could be changes in these parameters to acute lowering of blood glucose using insulin pump.

Materials and Methods

Seventeen uncontrolled diabetic men, age ranging from 16 to 27 years with duration of diabetes 6 months to 54 months with no clinical heart disease were taken in the study. Subjects with cardio-respiratory symptoms, E.C.G. and X-Ray evidence of cardiac abnormality, clinical evidence of significant renal, retinal or neurologic complication, any other systemic disease or ketosis were not included. Those who regularly or casualy smoked or consumed alcohol as well as overweight/obese or hypertensive subjects were excluded. Seventeen healthy volunteers were taken as controls.

All of the above were subjected to routine investigations including haematocrit, urinalysis, blood glucose, serum electrolytes and proteins, electrocardiogram and chest skiagram.

On the day of the the study blood samples were withdrawn on the morning of the study for fasting whole blood glucose estimation and patient swere subjected to simultaneous recording of carotid pulse, E.C.G. and phonocardiogram done at a paper speed of 100mm/sec with time markers at 0.01 sec. using Philips cardiopan 3 M model. Six of these patients so studied were put on continuous I. V. insulin infusion at the rate of 2 units/ hour and blood glucose was monitored hourly by Dextrostex and reflectance meter. Infusion was continued till the blood glucose value came down to around 140mg/dl when recordings of systolic time intervals were repeated.

The different parameters were calculated by one of us who was unware of the past history of the subjects. The total electromechanical systole (QS_2) was measured from the

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onset of the QRS complex of the electrocardiogram to the time high frequency component of the second heart sound. The left ventricular ejection time (LVET) was taken from the begining of the rapid upstroke of the carotid pulse to the nadir of the incisura. The difference between the QS_2 and LVET measured the pre-ejection phase (VEP). The indices of systolic time intervals i.e, QS_1, LVET I and PEP_1 were obtained from above measured values by applying rate correction.(Weissler).

Results were analysed and statistical significance of differences were assesed by student's 't' test.

Results

The indices of the systolic time intervals in controls and diabetic subjects are shown in Table-I.

Table 1
STI in controls and uncontrolled diabetics

STI (m/secs)	Controls (n - 17)	Diabetics (n =17)	'p' Value
QSI	546 + 14	535 ± 32.48	< 0.001
LVET1	413 ± 10	401.82 ± 34.47	NS
PEPI	131 ± 10	133.97 ± 13.86	< 0.001
PEP/LVET	0.345 ± 0.03	0.39 ± 0.02	< 0.001
FBG (mg/dl)	86 ± 11	237 ± 64	

It is observed that the means QS_2 I PEPI and PEP/LVET ratio are significantly higher ($P < 0.001$) than of control group, indicating the presence of left ventricular dysfunction in these diabetics.

Table 2

STI in diabetics (6) before and after insulin pump

STI (m/secs)	Before insulin infusion	After insulin infusion	'P' Value
QS_2I	523.4 ± 47.2	542.0 ± 36.8	NS
LVETI	398.26 ± 34.6	429 ± 26.3	NS
PEPI	125.13 ± 9.6	109.36 ±13.8	< 0.05
PEP/LVET	0.35 ± 0.03	0.27 ± 0.02	< 0.01
FBG (mg/dl)	245 ± 58	124 ± 21	

Table II shows the different indices of the systolic time intervals in the 6 diabetic subjects before and after insulin infusion. It is observed that there occurs a significant fall of PEPI ($P< 0.05$) and PEP/LVET ratio ($P< 0.01$) after acute lowering of blood glucose. The improvement in these parameters indicate improvement of left ventricular function.

An attempt is made to correlate the fasting blood glucose values with the different indices (Table III).

Table III
Correlation of fasting blood glucose with systolic time intervals.

FBG VRS	'r'	'p'
PEP/LVET	0.87	< 0.001
PEP I	0.72	< 0.001
LVET I	0.54	< 0.001
QS_2I	0.42	< 0.001

It is observed that best positive correlation exists between PEP/LVET ratio and blood glucose.

Discussion

A group of young male patients with uncontrolled diabetes was selected to study myocardial function by evaluating systolic time intervals. Our study shows a significant prolongation of PEPI and PEP/LVET ratio ($P< 0.001$) in the uncontrolled diabetic compared to control subjects, indicating the existance of left ventricular dysfunction in them. Similar observations were made by Ahmed et al (1975)[4]. They also noted the abnormal function to be independent of apparent duration of diabetes. Echocardiographic abnormalities in left ventricular function has also been shown to exist in some asymptomatic adult diabetics6 and also in children[6] with Type-I diabetes mellitus, free of chronic complications. Shapiro et al (1981)[7] in their study on left ventricular function in a series of diabetics concluded that in diabetes, abnormalities of left ventricular function are related to duration of the disease and complications and that a specific heart muscle disorder occurs frequent1y in patients with severe microvascular complications. Basie et al (1977)[8] reported impaired left ventricular function in diabetics with microangiopathy where as those with uncomplicated diabetes had normal left ventricular function. Their findings support the existance of a specific diabetic cardiopathy due to microangiopathy rather than the metabolic defect.

After acute lowering of blood glucose in six of our diabetic subjects, using insulin pump, significant reduction ($P< 0.001$) in PEPI & PEP/LVET was noted indicating improvement in left ventricular function. Shapiro et al (1980)5 in their study on a series of untreated maturity onset diabetics observed in a sub group of the diabetics, a fall in PEP/LVET ratio 2 months after treatment with oral hypoglycemic agents. The change in these sub-group of subjects were thought to be a result of improvement in blood glucose, as the correlation between the blood glucose before treatment and PEP/LVET ratio was lost with reduction of blood glucose. Improvement in left ventricular function was also shown by Kanan et al[9] in a group of diabetics after conventional insulin treatment.

Our findings suggest that at least a part of cardiac dysfunction in diabetic cardiomyopathy is metabolic in origin.

Summary Systolic time intervals (STI) were determined from simultaneous high speed recording of the electrocardiogram phonocardiogram and carotid pulse tracing in 17 young male uncontrolled diabetics of less than 5 years duration and in 6 of them after control of blood glucose using insulin pump. Seventeen age matched healthy males acted as control. STI in uncontrolled diabetics were characterized by significant prolongation of the pre-ejection period (PEP I = + 2.9 m secs, P< 0.001), increase in PEP/LVET ratio (to 0.39, P< 0.001 and reduction of electromechanical systole (Qs 21 = -11 m secs, P< 0.001). Significant correlations were found when fasting blood glucose levels were compared with PEPI (r= 0.72, P < 0.001). LVET I (r=0.54, P< 0.001) and PEP/LVET ratio (r=0.87, P < 0.001).) On making the patients euglycemic using insulin pump, a significant decrease in PEP I (P< 0.05) and PEP/LVET ratio (P< 0.001) was observed. These observations suggest that reversible myocardial dysfunction may result from hyperglycemia per se.

Reference

1. Regan. T.J., Etinger, P.O., Khan, M.I., Jesrami, M.U., Lynons, M.M., Odlewurtel, H.A. and Weber M. : Altered myocardial function in chronic diabetes mellitus without ischaemia in dogs. Circ. Res. 35:222, 1974.

2. Regan. T.J., Ahmed, S.S., Levinson, G.E., Odlewurtel, H.A., Ahmed, H.R., Harder, B., and Lyons, M.M. : Cardiomyopathy and regional scar in diabetes mellitus. Tran. Assoc. Am. Physicians, 88:217, 1975.

3. Regan. T.J., Lynos, M.M., Ahmed, S.S., Levinson, G.E., Odlewurtel, H.A., Ahmed, M.R. and Heider, B : Evidence of cardiomyopathy in familial diabetes mellitus. J. of Clin. Inv. 60:855, 1977.

4. Ahmed S.S., Jaferi G.A., Narang R.M., Regan. T.J. : Pre-clinical abnormality of LV function in diabetes mellitus. Am. H.J. 89:153, 1975.

5. Shapiro, L.M. et al : Prospective study of heart disease in untreated maturity onset diabetics. Br. Heart Jr. 44:342, 1980.

6. Friedman N.E. et al : Echocardiographic evidence of impaired myocardial performance in children with Type-I Diabetes mellitus. Am. J. Med. 73, 846, 1982.

7. Shapiro L.M. et al. Left ventricular function in diabetes mellitus II. Relation between clinical features and left ventricular function. Am. Med. Jr. 45:129, 1981.

8. Basie I.B. Seneviratine, Diabetic cardiomyopathy : The pre-clinical phase. B.M.J. 1844, 1977.

9. Kanan. K., Personal Communication.