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Dyslipidemia in Type II Diabetes and the Effect of Glycaemic Control on Type II Diabetes

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Lipid profile of Type II Diabetes patients was determined before and after treatment. The study was carried out on 180 (Male/Female: 91/89) treated patients who were registered in Chittagong Diabetic Hospital and 80 (Male/Female: 42/38) newly diagnosed diabetic patients who were selected randomly. 40 (Male/Female: 20/20) non-diabetic healthy subjects were selected for control. All the subjects included in this study were between the age of 40-70 years.

In the study, fasting plasma glucose (FPG), serum total cholesterol (TG), serum triglyceride (TG), high density lipoprotein-Cholesterol (HDL-C) were measured. Low density lipoprotein-Cholesterol (LDL-C) was also determined (using Friedwald's formula).

When the lipid profiles of untreated diabetic patients were compared with the control, an increase in TC, HDL-C, LDL-C and TG were found in the former. The increase in TC and LDL-C was highly significant (p<0.001), increase in TG was found significant (p<0.005) whereas increase in HDL-C was not significant.

When the lipid profile of treated patients was compared with the untreated patients, decrease in TC, TG and LDL-C in the former patients was found as highly significant (p<0.001) for all parameters, whereas, decrease in HDL-C was found to be less significant.

In untreated Type II Diabetes Mellitus, significant positive correlations were found between fasting plasma glucose (FPG) and (a) TC (r = + 0.21, p<0.01), (b) TG (r = + 0.26, p<0.01), (c) LDL-C (r = + 0.19, p<0.01) whereas, no significant correlation was found between glucose and HDL-C concentrations.

In Type II Diabetes Mellitus, subjects, after treatment, significant positive correlations were also found between fasting plasma glucose and (a) TC (r = + 0.21, p<0.01), (b) TG (r = + 0.26, p<0.01), (c) LDL-C (r = + 0.19, p<0.01), whereas no significant correlation was found between glucose and HDL-C concentrations.

It was evident from this study that lipid abnormalities exist in Type II Diabetes and significant improvement against lipid abnormalities occur after treatment. Lipid abnormalities were related to glycaemic control.

Keywords: Diabetes Mellitus, Glycaemic control, Total Cholesterol (TC), Triglyceride (TG), High density lipoprotein Cholesterol (HDL-C), Low density lipoprotein Cholesterol (LDL-C), FPG (Fasting Plasma Glucose).

Introduction

Diabetes Mellitus, particularly Type II affects large number of people of wide range of ethnic and economic levels in both developed and developing countries. Globally, 135 million adults with diabetes were estimated in 1995. By the year 2025, the projected figure risen to 300 million, an increase of approximately 120%. Whereas, the rise was projected to be of the order of 40% in the developed and 170% in the developing countries. As a result, more than 80% of persons were presumed to be diabetic in the developing countries by the year 2025¹. For both years' estimations (1995 and 2025), the populations with the
highest prevalence of diabetes are in India, China and the United States of America.

The effects of diabetes mellitus include long-term damage, dysfunction and failure of various organs with characteristic symptoms such as thirst, polyuria, blurring of vision, and may lead to stupor, coma and even death, if the patients remain untreated. The major change recommended in the diagnostic criteria for diabetes mellitus is the lowering of the diagnostic value of the fasting plasma glucose concentration to 7.0 mM (126 mg/dl)\(^5\), from the former level of 7.8 mM (140 mg/dl)\(^6\).

The current emphasis on fasting glucose to diagnose diabetes has led to a new term to accompany i.e. impaired glucose tolerance (IGT) – the impaired fasting glucose (IFG). The IFG [FPG 110-125 mg/dl (6.1-6.9 mM)] is a condition which is likely to progress to diabetes during follow-up as FPG deteriorate.

### Diabetes and Lipid Metabolism

Lipid and lipoprotein abnormalities are common in diabetes mellitus. Non-insulin dependent Type II Diabetes is frequently associated with elevated concentration of total serum triglycerides and total serum cholesterol as well as, reduced concentration of high density lipoprotein cholesterol.

The most common lipid abnormalities in diabetes mellitus are hypertriglyceridemia and reduced HDL cholesterol concentration\(^7\). The concentration and metabolism of plasma lipoproteins in diabetes is influenced by several factors, namely, type of diabetes, degree of glycemic control, type of treatment, presence or absence of diabetic complications, presence of concomitant primary and other secondary causes of hyperlipidemia, diet and obesity\(^8\). Serum level of low density lipoprotein (LDL) varies and tends to be raised in poorly controlled diabetic patients\(^9\). Diabetes can affect LDL metabolism in several ways. Diabetes Mellitus is associated with altered LDL lipid composition. In Type II Diabetes, LDL enrichment with triglyceride has been detected and LDL isolated from patients with hypertriglyceridemia showed decreased LDL receptor binding and less ability to down regulate LDL receptor activity and sterol synthesis\(^9\). Hypercholesterolemia and altered LDL composition are mostly associated with coronary heart disease in Type II Diabetic patients\(^8\). Plasma HDL-cholesterol level reduces to below normal in Type II Diabetic patients\(^8\) and non-diabetic subjects. Mild to moderate elevation of LDL-cholesterol levels has been found in studies of diabetic subjects.

Accelerated atherosclerosis of the characteristic of diabetes mellitus. TI insulin dependent and non-insulin dependent subjects, and contributes to an increase in the quantity and composition of lipid plays major role in the pathogenesis of this disease.

### Materials and Methods

**Study subjects:** This study was total of 300 (M/F: 153/147) non-insulin dependent subjects attending the Chittagong E Khulshi, Chittagong, Bangladesh treated for 40-70 years. Among them, 80 (M/F: 4) diagnosed (according to 1999 WHO criteria), 40 (M/F: 20/20) non-diabetic 40-70 years were randomly selected.

**Estimation of Plasma Glucose**

Samples were taken and placed in fluoride. The plasma was separated and a few hours of collection. Plasma glucose was determined using a Technicon (2) Auto-analyzer using enzymatic colorimetric method\(^10\).

**Estimation of Serum Lipids**

Serum was collected from fresh blood centrifugation at 2500 rpm for 10 min at 4°C until analysis within one week. Serum cholesterol was detected by using RA-50 Cholesterol-E employing enzymatic method\(^11\).

**Estimation of Serum Total Cholesterol**

Total cholesterol was detected by R. Determine analyzer by using enzymatic procedure of the cholesteryl ester by cholesteryl oxidation of free cholesterol by cholesteryl ester.

**Estimation of Serum HDL-Cholesterol**

Serum HDL-Cholesterol was determined using “cholesterol enzymatic reagents”\(^11\). 500 mixed with 50 μl of HDL-Cholesterol tube and was kept on stand for 10 min centrifuged for 15 minutes at 3000 rpm HDL-cholesterol was carried out from by using enzymatic reagent and Auto-analyzer.

**Estimation of Serum LDL-Cholesterol**

Cholesterol was calculated from the triglycerides, total and LDL-Cholesterol Friedewald’s formula\(^12\).

### Statistical Methods

All data were presented as the I


concentrations of untreated diabetic (Type II) and control subjects studied are presented in Table 2 and shown in Fig. 1. An increase in the lipid profile, TC, HDL-C, LDL-C and TG was found in untreated diabetic subjects. The increase in TC and LDL were highly significant (p<0.001), whereas increase in TG was significant (p<0.005). However, there were no significant changes observed in the HDL level.

**Comparison of Serum Lipids between Diabetic Subjects Before and After Treatment**

When treated diabetic subjects were compared with untreated diabetic subjects as presented in Table 3 and shown in Fig. 1, the serum triglycerides, total and LDL-Cholesterol levels were significantly reduced (p<0.001 for all the parameters) but there was noted a less significant change in case of serum HDL-Cholesterol level.

**Correlations of Glycaemic Control and Serum Lipids in Diabetic Subjects**

The correlation of glycaemic control and plasma lipids is shown in Table 4. Only the fasting plasma glucose levels of the study subjects strongly correlated (positively) with serum triglycerides.

In untreated Type II Diabetes Mellitus patients,

**TABLE 1**
Clinical and glycaemic characteristics of the subjects studied

<table>
<thead>
<tr>
<th>Groups</th>
<th>Age (Years) (Mean ± SD)</th>
<th>BMI (kg/m²) (Mean ± SD)</th>
<th>Fasting Plasma Glucose (mM/L) (Mean ± SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal control</td>
<td>50.03 ± 9.11</td>
<td>21.20 ± 2.05</td>
<td>4.66 ± 0.39</td>
</tr>
<tr>
<td>Untreated Type II diabetes</td>
<td>47.25 ± 7.01</td>
<td>22.56 ± 3.30</td>
<td>10.39 ± 3.46***</td>
</tr>
<tr>
<td>Treated Type II diabetes</td>
<td>49.88 ± 8.75</td>
<td>25.14 ± 4.37</td>
<td>3.90 ± 2.36**</td>
</tr>
</tbody>
</table>

BMI : Body mass index.
Significance of difference when compared with normal control *** p<0.001
Significance of difference when compared with untreated NIDDM ** p<0.001
### TABLE 2
Comparison for serum lipid concentrations (Mean ± SD) between untreated NIDDM and normal controls

<table>
<thead>
<tr>
<th>Serum lipids mg/dl</th>
<th>Untreated Type II diabetes N=80</th>
<th>Normal Control N=40</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Cholesterol</td>
<td>224.68 ± 37.95</td>
<td>204.57 ± 24.78</td>
<td></td>
</tr>
<tr>
<td>Triglycerides</td>
<td>176.69 ± 77.81</td>
<td>148.57 ± 51.39</td>
<td></td>
</tr>
<tr>
<td>HDL-Cholesterol</td>
<td>43.19 ± 16.36</td>
<td>39.92 ± 7.55</td>
<td></td>
</tr>
<tr>
<td>LDL-Cholesterol</td>
<td>143.43 ± 44.83</td>
<td>135.03 ± 28.12</td>
<td></td>
</tr>
</tbody>
</table>

NS= Not significant.

### TABLE 3
Comparison for serum lipid concentrations (Mean ± SD) between untreated and treated NIDDM

<table>
<thead>
<tr>
<th>Serum lipids mg/dl</th>
<th>Untreated NIDDM N=80</th>
<th>Treated NIDDM N=40</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Cholesterol</td>
<td>224.68 ± 37.95</td>
<td>202.03 ± 38.31</td>
<td></td>
</tr>
<tr>
<td>Triglycerides</td>
<td>176.69 ± 77.81</td>
<td>162.46 ± 83.24</td>
<td></td>
</tr>
<tr>
<td>HDL-Cholesterol</td>
<td>43.19 ± 16.36</td>
<td>37.36 ± 10.25</td>
<td></td>
</tr>
<tr>
<td>LDL-Cholesterol</td>
<td>143.43 ± 44.83</td>
<td>127.32 ± 38.03</td>
<td></td>
</tr>
</tbody>
</table>

N.S: Not significant.

### TABLE 4
Correlations of glycaemic control (fasting plasma glucose) and serum lipids in diabetic subjects (only statistically significant correlations are shown)

<table>
<thead>
<tr>
<th>Serum lipids</th>
<th>Untreated NIDDM Fasting plasma glucose Level of significance</th>
<th>Treated NIDDM Fasting plasma glucose Level of significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Serum Total Cholesterol</td>
<td>r = +0.01</td>
<td>p&lt;0.01</td>
</tr>
<tr>
<td>Serum Triglycerides</td>
<td>r = +0.07</td>
<td>p&lt;0.01</td>
</tr>
<tr>
<td>HDL-Cholesterol</td>
<td>NS</td>
<td></td>
</tr>
<tr>
<td>LDL-Cholesterol</td>
<td>r = +0.04</td>
<td>p&lt;0.01</td>
</tr>
</tbody>
</table>

NS = No Significant correlation.
Fig. 1
Bar diagram showing the Mean (±) SD serum lipids in diabetic patients and normal control.

TG = Triglycerides
TC = Total Cholesterol
HDL-C = High Density Lipoprotein-Chol.
LDL-C = Low Density Lipoprotein-Chol.

T = SD
significant positive correlations were found between fasting plasma glucose and (a) TC (r = +0.01, p<0.01), (b) TG (r = +0.26, p<0.01), (c) LDL-C (r = +0.19, p<0.01), whereas no significant correlation was found between glucose and HDL-C concentrations.

In treated Type II Diabetes Mellitus subjects, significant positive correlation was also found between fasting plasma glucose and (a) TC (r = +0.21, p<0.01), (b) TG (r = +0.26, p<0.01), (c) LDL-C (r = +0.19, p<0.01), whereas no significant correlation was found between glucose and HDL-C concentrations.

Discussion

This prospective study has looked into lipid abnormalities in newly diagnosed NIDDM patients and the effect of glycaemic control of the patients with appropriate treatment.

Uusitupa et al., found higher serum triglyceride and lower HDL-Cholesterol concentrations in newly diagnosed untreated patients with NIDDM compared to non-diabetic subjects. But serum total cholesterol levels were similar in diabetics and controls. Mahatab et al. found an increase in serum triglyceride but a decrease in HDL-cholesterol in untreated newly diagnosed diabetics as compared with normal control. Serum total cholesterol levels were similar in diabetics and control subjects. In this study, untreated newly diagnosed Type II diabetic subjects had highly significant LDL-Cholesterol value than their normal counterpart. For TG, untreated diabetic subjects showed significantly higher value than the control subjects did, but increase in serum HDL-cholesterol in the untreated diabetic subjects was not significant as compared to the normal control. Briones et al. also found that there was significantly increased triglyceride, low HDL-Cholesterol and normal total cholesterol levels in diabetics as compared to control.

Elevation of serum triglyceride level in uncontrolled Type II diabetic subjects was the most common lipid abnormality. Results obtained from present study are also in agreement with those observations showing elevated TG levels.

Das et al. and Miah et al., found significantly higher concentration of serum triglyceride, total and LDL-cholesterol. Our findings were similar to their observations except for HDL-cholesterol. Such difference in results might be due to a variety of reasons such as case selection criteria, nature of control population, treatment and severity of diabetes and degree of diabetic control.

The levels of VLDL-triglyceride are elevated in the compared with obese control. It is of triglyceride declines to normal sulfonyl urea and diet control (Siu treatment, plasma triglyceride level 50% (Dunn et al.)

Increased LDL-Cholesterol found in patients with Type II E study period, we also observed a plasma glucose and LDL-cholesterol untreated [LDL-C (r = +0.04), p<0.01] during the association of LDL-cholesterol further mentioned in section of related glycemic control.

The high HDL-Cholesterol in diabetic subjects both before and much consistent with the findings of carried out on treated and untreated patients.

The HDL-cholesterol levels in patients with maturity onset did not related to diabetic control (K), was very common in non-insulin (Nikkila et al., Bergman et al.) cholesterol level was lowered in b Diabetic patients before treatment, there was an elevation of HDL-cholesterol in diabetics and there was no remarkable cholesterol level in Type II Diabetes. Study we had a higher value in untreated condition but there was a reduction of HDL-cholesterol further research in this regard is needed.

Relationship between the Lipid and Glycemic Control

The relationship between the fasting glucose level was investigated taking blood samples before and after and untreated Type II Diabetes Mellitus correlation was found between total cholesterol (p<0.01), triglyceride (p<0.01) and no significant correlation found between glucose and HDL-C.
eset Mellitus subjects, significant positive correlations
are also found between fasting plasma glucose and
total cholesterol (p<0.01), triglyceride (p<0.01), LDL-
cholesterol (p<0.01) and no significant correlation was
found between glucose and HDL-cholesterol. Studies on
non-ketotic diabetic subjects both before and after control
of carbohydrate metabolism showed a high degree of
correlation between hemoglobin A1C concentrations and
serum triglyceride levels (Peterson et al.23). Schmidt et al.26
found significant positive correlation of HbA1
with serum triglyceride, total and LDL-cholesterol, but a
slight negative correlation with HDL-cholesterol in normal
weight Type II Diabetics. Kennedy et al.23 found no
correlation between HDL-cholesterol levels and HbA1,
which was similar to our present study. So there is a
wide scope for conducting further research in this area
which can lead to utilization of diagnostic values of
lipid profile in understanding extent of the disease.
Parameters-based demographic studies in this context
shall also be helpful in improving health status of given
populations.

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