Studies on serum lipids, lipoproteins and high sensitive C-Reactive protein in type 2 diabetes

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Abstract

The aim of the study was to determine the association of lipid profile with high sensitivity C-reactive protein (hs-CRP), obese, hypertensive in type 2 diabetes in north Chennai area, Tamil Nadu, India. Nearly 300 blood sample were collected from patients in JPM diagnostic centre, north Chennai, Tamil Nadu and grouped them into diabetic (n=150) and non diabetic (n=150). Behavioral characters were calculated by using the data from the questionnaire like age, sex, height, weight, food habits, obesity, blood pressure (BP), family history, alcohol and smoking habits were correlated for interpretation. The systolic and diastolic blood pressure was measured by using standard mercury sphygmomanometer. Hypertension was diagnosed as per the criteria provided by the WHO (1959 & 1978). The body weight was calculated by taking weight in kg and height was measured in cms. The body mass index was calculated from the formula BMI = weight in kg/(height in meters)^2 Patients were taken as obese if their body mass index was 29.9. All biochemical analyses were done on a semi autoanalyser (RA 50). hs-CRP levels were measured with Elisa reader (Star Fax 325). The lipid concentration level was significantly higher in diabetic patients compared with non diabetic patients, serum total cholesterol mean ± SD 209.57±26.56 (P<0.001), serum triglycerides mean ± SD 184.78±49.10 (P<0.001), serum LDL - cholesterol mean ± SD 165.27±29.43,(P<0.001) and decrease in serum HDL-cholesterol levels mean ± SD 42.30±7.12, (P<0.001), and total cholesterol/HDL ratio, mean ± SD 5.13±1.27 (P<.001), Regression analysis revealed obese to be strongly associated with diabetes observed. BMI mean±SD 26.93±3.10 (P<0.001). hs-CRP values increased with increase of obese mean ± SD 6.71±2.78 (ANOVA P<0.001) and HbA1c mean± SD 8.54±1.07 (ANOVA P<0.001). Lipid concentration is elevated in hypertensive with diabetes serum total cholesterol mean ± SD 211.61±26.21 (P<0.001) and compared with hypertensive with non diabetic subjects. Lipid concentration level increased (Total cholesterol, LDL, TGL & VLDL) and decreased (HDL) in diabetes subjects. Lipoprotein particles significantly higher in diabetic female, compared to diabetic male. hs-CRP, increased in obese diabetes when compared with non obese diabetics, and obese non diabetics. hs-CRP strongly associated in obese with diabetes. Lipid concentration elevated in hypertensive with diabetes. The risk factors such as obesity, smoking, alcohol consumption, hypertension, food habits and family history were found to promote the development of type 2 diabetes.

Keywords: Lipid profile, lipoprotein C-reactive protein, type 2 diabetes, obese, hypertension, hyperlipidaemia,

Abbreviation: hs-CRP: high sensitivity C-reactive protein; TGL: Triglycerides; HDL: high density lipoprotein; LDL: low density lipoprotein; VLDL: very low density lipoprotein; BMI: body mass index; CAD: coronary artery disease; WHO: world health organization; ESR: erythrocyte sedimentation rate; BP: blood pressure.

Introduction

Diabetes mellitus is a disorder characterized by hyperglycemia and occurs due to impaired insulin secretion. Type 2 usually occurs in adult over 35 years old. The National institute of Health stated that 95% of all diabetes cases are type 2 (2001). The risk factors for type 2 diabetes is obesity, poor diet, sedentary lifestyle, increased age, 21% of people over 60 has family history diabetes and also as metabolic syndrome (Carlsson et al., 2003). Though diabetes mellitus is a metabolic disease, it may leads to coronary artery disease (CAD), peripheral vascular disease (PVD) and cerebrovascular disease (CVD). Indeed CAD accounts for more than 50% of the mortality among type 2 diabetic subject (Kannel et al., 1987; Haffner et al., 1998). A marked increase in diabetes worldwide was revealed (King et al., 1998) along with prevalence of CAD (Abbot et al., 1998). There is a clustering of several metabolic disorders like dyslipidemia, hypertension, hyperglycemia and obesity which has been shown to predict death in type 2 diabetic subjects (Lehto et al., 2000). Excess cholesterol can be deposited in blood vessel walls that can leads to atherosclerosis or hardening of the arteries and cardiovascular disease. Factors such as age, sex, and genetic influence the lipid profile. Certain aspects of the lifestyle, including the diet, physical activity, diabetes control level, alcohol consumption, smoking status and obese also affect the lipid profile. Abnormal blood lipids are risk factors for CVD.

Obesity is associated with cardiovascular disease, obese or overweight increases the risk of stroke, type 2 diabetes, coronary heart disease, hypertension (high blood pressure), dyslipidemia (high level of triglycerides, LDL cholesterol & low HDL cholesterol) with the potential health problems associated with obesity. The body mass index (BMI) can be an important tool in assessing health risks. The risk factor for type 2
Diabetes is a major worldwide epidemic affecting more than 300 million people. It is an important risk factor for diabetes mellitus (Leibson et al., 2002).

Hypertension (defined as a blood pressure = 140/90 mmHg) is an extremely common co-morbid condition in diabetes, affecting 20-60% of patients with diabetes, depending on obesity and age. With diabetes and high blood pressure together are the risks for the development of atherosclerosis. High blood pressure is a major cause of cerebro-vascular disease (strokes) and is a very significant factor in heart and renal disease, hypertension is a silent killer (Green et al., 1967). In many patients the condition causes no symptoms until the occurrence of major cardio-vascular complications. Therefore, there is a need for early detection of hypertension (WHO, 1959 & 1978). The prevalence of CAD was significantly higher among hypertensive compared to normotensive subjects. The risk for CAD was even higher among subjects who had both diabetes and hypertension (Arvind et al., 2002).

Elevated hs-CRP is related to increased risk for heart attack, coronary arteries after angioplasty, stroke and peripheral vascular disease (PVD). HS-CRP provides additional information about inflammation in the arteries-something not determined by lipid testing alone (Ridker et al., 1998). Recent research shows that having CRP in the high normal range may also be associated with other diseases such as complications of diabetes and obesity. The detection of hs-CRP is a more reliable and sensitive indicator of the inflammatory process than the erythrocyte sedimentation rate (ESR). hs-CRP concentration rise more rapidly than the ESR (Hind et al., 1984). C-reactive protein (CRP) has recently gained lot of interest (Pradhan et al., 2002) and Hassner, et al., 2003) studies have shown CRP to be associated with both diabetes and CAD (Blake et al., 2002; Abrams et al., 2003).

**Table 1. The morphological variables of the study groups.**

<table>
<thead>
<tr>
<th>Variables</th>
<th>Non Diabetes n = 150</th>
<th>Diabetes n = 150</th>
<th>t-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, y</td>
<td>48.00±14.68</td>
<td>52.22±14.18</td>
<td>2.53</td>
<td>0.0118*</td>
</tr>
<tr>
<td>Sex, male, n (%)</td>
<td>50.0</td>
<td>50.0</td>
<td>0.001</td>
<td>0.0000**</td>
</tr>
<tr>
<td>Sex, female, n (%)</td>
<td>50.0</td>
<td>50.0</td>
<td>0.001</td>
<td>0.0000**</td>
</tr>
<tr>
<td>Vegetarian,%</td>
<td>43.3</td>
<td>34.0</td>
<td>1.300</td>
<td>0.1946</td>
</tr>
<tr>
<td>Non-vegetarian,%</td>
<td>56.7</td>
<td>66.0</td>
<td>1.030</td>
<td>0.3038</td>
</tr>
<tr>
<td>Smoking,%</td>
<td>26.0</td>
<td>34.0</td>
<td>1.270</td>
<td>0.2055</td>
</tr>
<tr>
<td>Non smoking,%</td>
<td>74.0</td>
<td>66.0</td>
<td>0.830</td>
<td>0.4079</td>
</tr>
<tr>
<td>Alcoholic,%</td>
<td>26.0</td>
<td>31.3</td>
<td>0.860</td>
<td>0.3914</td>
</tr>
<tr>
<td>Non-alcoholic,%</td>
<td>74.0</td>
<td>68.7</td>
<td>0.540</td>
<td>0.5873</td>
</tr>
<tr>
<td>Family history positive,%</td>
<td>18.0</td>
<td>31.3</td>
<td>2.360</td>
<td>0.0194*</td>
</tr>
<tr>
<td>Family history negative,%</td>
<td>82.0</td>
<td>68.7</td>
<td>1.330</td>
<td>0.1840</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>163.09±6.17</td>
<td>160.78±7.74</td>
<td>2.850</td>
<td>0.0046*</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>66.15±6.14</td>
<td>69.19±5.24</td>
<td>4.613</td>
<td>0.0000**</td>
</tr>
<tr>
<td>Body mass index (kg/m²)</td>
<td>24.97±3.04</td>
<td>26.93±3.10</td>
<td>5.520</td>
<td>0.0000**</td>
</tr>
<tr>
<td>Systolic blood pressure (mmHg)</td>
<td>125.00±11.28</td>
<td>134.53±17.36</td>
<td>5.630</td>
<td>0.0000**</td>
</tr>
<tr>
<td>Diastolic blood pressure (mmHg)</td>
<td>83.13±9.35</td>
<td>89.87±12.64</td>
<td>5.250</td>
<td>0.0000**</td>
</tr>
</tbody>
</table>

Values are mean ± SD (Standard deviation) * P<0.05, ** P<0.001.

**Table 2. The biochemical variables of the study groups.**

<table>
<thead>
<tr>
<th>Variables</th>
<th>Non Diabetes n = 150</th>
<th>Diabetes n = 150</th>
<th>t-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fasting blood sugar (mg%)</td>
<td>81.48±14.37</td>
<td>158.95±23.27</td>
<td>34.69</td>
<td>0.0000*</td>
</tr>
<tr>
<td>Post prandial blood sugar (mg%)</td>
<td>133.29±16.78</td>
<td>261.93±37.98</td>
<td>37.94</td>
<td>0.0000*</td>
</tr>
<tr>
<td>HbATC (%)</td>
<td>4.85±0.55</td>
<td>8.48±1.15</td>
<td>34.87</td>
<td>0.0000**</td>
</tr>
<tr>
<td>Total serum cholesterol (mg%)</td>
<td>197.36±26.33</td>
<td>209.57±26.56</td>
<td>3.99</td>
<td>0.0001*</td>
</tr>
<tr>
<td>Serum triglycerides (mg%)</td>
<td>164.62±40.33</td>
<td>184.78±49.10</td>
<td>3.88</td>
<td>0.0001*</td>
</tr>
<tr>
<td>HDL cholesterol (mg%)</td>
<td>46.11±5.16</td>
<td>42.30±7.12</td>
<td>5.30</td>
<td>0.0000*</td>
</tr>
<tr>
<td>LDL cholesterol (mg%)</td>
<td>149.25±27.22</td>
<td>165.27±29.43</td>
<td>4.89</td>
<td>0.0000*</td>
</tr>
<tr>
<td>VLDL cholesterol (mg%)</td>
<td>32.92±8.07</td>
<td>36.96±9.82</td>
<td>3.89</td>
<td>0.0011*</td>
</tr>
<tr>
<td>TC/HDL ratio</td>
<td>4.34±0.77</td>
<td>5.13±1.27</td>
<td>6.51</td>
<td>0.0000*</td>
</tr>
<tr>
<td>hs-CRP</td>
<td>1.03±0.99</td>
<td>4.33±2.57</td>
<td>14.6</td>
<td>0.0000*</td>
</tr>
</tbody>
</table>

Values are mean ± SD (Standard deviation), * P<0.001.
**Objectives of the present study**

- The present study is designed to find out the prevalence and incidence of lipid profile, high sensitive C - reactive protein (hs-CRP), biochemical and hematological changes among the type 2 diabetic patients in north Chennai area in Tamil Nadu, as this area is mostly occupied by economically backward, illiterate, alcoholic and smoking habits peoples who suffer from Diabetes.

- Preliminary study revealed that these people were taking treatment irregularly and there is a significant alteration of serum lipid profile, hs-CRP, biochemical parameters etc.

- Therefore to prevent the early incidence of heart diseases and other drastic consequences an elaborate study of the above mentioned parameters is needed, which will help these illiterate people, especially youngster to know their health condition, monitor and control the incidence of early coronary heart disease. Hence the present study is undertaken for the benefit of the north Chennai peoples.

**Materials and methods**

Nearly 300 blood sample were collected from patients in JPM diagnostic centre, north Chennai, Tamil Nadu and grouped them into diabetic (n=150) and non diabetic (n=150). Behavioral characters were calculated by using the data from the questionnaire like age, sex, height, weight, food habits, obesity, blood pressure (BP), family history, alcohol and smoking habits and correlated for interpretation.

**Anthropometric measurements**

The physical examination of body weight was calculated by taking weight in kg (Verma et al., 1982) and height was measured in centimeters (Frisancho et al., 1984). The body mass index was calculated from the formula; BMI = weight in kgs/(height in meters)². Patients were taken as obese if their body mass index was 29.9 (Olefsky et al., 1992).

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Blood pressure measurements

The systolic and diastolic blood pressure was measured by using standard mercury sphygmomanometer. Hypertension was diagnosed as per the criteria provided by the WHO (1959 & 1978).

Biochemical parameters

A detailed clinical history was taken and physical examination performed. In the present study after overnight fasting (12 h) venous blood sample will be collected from 300 patients, serum and anticoagulant blood is separated, the serum will be used for the analysis of lipid profile, hs-CRP, other biochemical investigation and anticoagulant blood is used for blood sugar, HbA1c and haematological investigations.

Serum triglycerides (mg%) 162.44
Total serum cholesterol (mg%) 191.81
HbA1c (%) 4.84
Post prandial blood sugar (mg%) 133.23
Fasting blood sugar (mg%) 80.17
Diastolic blood pressure (mmHg) 79.19
Systolic blood pressure (mmHg) 118.08

Body mass index (kg/m²)
Male, % 47.5 54.9 47.1
Female, % 52.5 45.1 52.9

Statistical analysis

Statistical analysis was done by descriptive statistics, independent group t-test between means, two sample t-test between percent, chi-square test, compare means by ANOVA, Pearson’s correlation analysis was done to determine the relation of hs-CRP with other risk variables. Linear regression was used to determine the association of hs-CRP with diabetes and obese. All analysis were done using the windows based Statpac statistical package version 3.0.

Results

The study was conducted on 150 diabetic and 150 non diabetic patients (age & sex matched). The mean ± SD age of patients with diabetic was 52.22±14.18 (range 25-75 years) while the mean ± SD age of control was 48.00±14.68 (range 25-75 years). Out of 150 patients, 150 (50%) were males and 150 (50%) were females. Among control subjects 75 (50%) were males and 75 (50%) were females. Table 1 gives the detailed anthropometric parameters viz., weight in kgs, height in cms, body mass index of patients and control subjects. The body mass index increased in obese diabetics mean ± SD 26.9-3.7 (P<0.001) and overweight diabetic mean ± SD 26.4 when compared to obese control subjects mean ± SD 24.0-2.0 showed statistically significant. Table 1 gives the detailed
behavioural characters of food habits, family history, alcohol and smoking habits. Statistically increase in the behavioural character when compared to non diabetic and diabetic subjects, non-vegetarian 34.0%, smoking 34.0%, alcoholic 31.3%, family history+ 31.3% (P<0.05). And statistically diabetic patients had higher systolic blood pressure mean ± SD 134.53±17.36 (P<0.001), diastolic blood pressure mean ± SD 89.87±12.64 (P<0.001).

Table 2 showed the biochemical characteristics of the diabetics groups when compared to non diabetic groups statistically significant. The increased in the level of serum total cholesterol mean ± SD 209.57±26.56 (P<0.001), serum TGL mean ± SD 184.78±49.10 (P<0.001), serum LDL-cholesterol mean ± SD 165.27±29.43 (P<0.001), serum VLDL - cholesterol mean ± SD 36.96±9.82 (P<0.001) in decrease serum HDL-cholesterol levels mean ± SD 42.30±7.12, (P<0.001), and total cholesterol/HDL ratio mean ± SD 5.13±1.27 (P<0.001), found to increase in diabetic patients (Fig. 1). Fasting blood sugar mean ± SD 158.95±23.27 (P<0.001), post prandial blood sugar mean ± SD 261.93±37.98 (P<0.001), HbA1c mean ± SD 8.48±1.15 (P<0.001), hs-CRP mean ± SD 4.33±2.57 (P<0.001).

Table 3 showed the biochemical characteristics of the hs-CRP levels were statistically significant differences were found between obese diabetic compared with non obese non diabetic (Fig 2) and obese non diabetic subjects. Obese seems to be strongly associated with diabetes (HbA1c) mean ± SD 8.54±1.07 (P<0.001), the association of obese with diabetes was influenced by BMI mean ± SD 31.19±1.56 (P<0.001), the increase in the level of serum total cholesterol mean ± SD 228.38±19.16 (P<0.001), serum TGL mean ± SD 216.96±25.77 (P< 0.001), serum LDL-cholesterol mean ± SD 185.92±20.15 (P<0.001), serum VLDL - cholesterol mean ± SD 43.39±5.15 and decrease serum HDL-cholesterol levels mean ± SD 38.45±6.04, (P<0.001), and total cholesterol/HDL ratio mean± SD 5.13±1.27 (P<0.001), hs-CRP strong association with obese and diabetes (Fig. 3), hs-CRP mean± SD 6.71±2.78 (P<0.001).

Table 4 showed the comparative studies on biochemical characteristics of the hypertensive diabetic with non diabetic patients there was a significant higher concentrations of serum total cholesterol mean ± SD 211.61±26.21 (P < 0.001), serum TGL mean ± SD 187.36±44.09 (P < 0.001), serum LDL-cholesterol mean ± SD 168.20±28.76 (P <0.001), serum VLDL-cholesterol mean ± SD 37.47±8.82 (P<0.001) and decrease serum HDL-cholesterol levels mean ± SD 41.41±5.96, (P <0.001) and total cholesterol/HDL ratio mean± SD 5.26±1.25 (P < 0.001)(Fig. 4), fasting blood sugar mean ± SD 159.56±23.33 (P <0.001), post prandial blood sugar mean ± SD 262.76±41.71 (P <0.001), HbA1c mean ± SD 8.51±1.20 (P <0.001), hs-CRP mean ± SD 4.67±2.90 (P<0.001) in the diabetics.

Discussion

Hyperlipidaemia as a metabolic abnormality frequently associated with diabetes mellitus (Mohan et al., 2001). The present study has clearly showed that all lipid fractions are abnormally elevated in diabetic groups when compared with non diabetic groups. The risk factors such as obesity, smoking and hypertension were found to promote the development of diabetes mellitus (Kulkarni et al., 1999) and also increased hyperlipidaemias leads to atherosclerosis (Dunn et al., 1988). Our study reveals that all risk factors such as obesity, smoking, alcohol consumption, hypertension, and family history positively increased in diabetic groups. Previous studies have strongly suggested an inverse correlation of HDL-cholesterol level with the development of ischaemic heart disease (Castelli et al., 1977, Miller et al., 1977; Goldbourt, et al., 1979). Most of the studies have revealed the inverse relationship of HDL-cholesterol with atherosclerosis. Smoking has observed to adversely affect HDL-cholesterol (Hulley et al., 1979).

Cohen et al., 1979 showed a significantly increase in the level of serum cholesterol and LDL cholesterol in obese diabetics when compared with obese controls. Sharma (1970) and Jain (1980) observed increase in the levels of serum total cholesterol, serum triglycerides in diabetic subjects as compared to normal controls. The studies of Santen et al. (1972) and Peret et al. (1974) observed mean serum triglyceride levels higher in obese diabetics in comparison to obese control subject. Bijlani et al. (1984) found HDL-cholesterol to be significantly lower in obese diabetics as compared to normal weight diabetics. The present study has clearly shown that all lipoprotein particles-total cholesterol, TGL, LDL, VLDL-was significantly higher and HDL cholesterol decreased in diabetic obese group compared to non diabetic non obese and non diabetic obese group.

The present study revealed that more than one-third of the hypertensive patients suffered from diabetes (Banerjea, 1966). Hypertension was detected in 45.3% cases of diabetes mellitus (Patel, 1975). The present study also revealed that hypertension was detected in 138 (46%) among diabetes 87 (57%), non diabetes 51(34%) and hypertensives had increased cholesterol (Shroff et al., 1973). Cardio vascular diseases (CVD) have emerged has global health problem. Hypertension is one of the major risk factor for CVD. Several prospective studies have identified the major risk factors for hypertension like obesity, smoking and alcohol consumption. Serum creatinine and urea are commonly elevated in renal hypertension (De Bano et al., 1991;
Golwalla et al., 1997; Camm et al., 1998). Hyperlipidaemia is an important risk factor for cardiovascular disease, while hypertension can leads to renal complications also.

Conclusion
This present investigation has clearly shown that all lipid fractions, total cholesterol, TGL, LDL, VLDL are abnormally elevated but a decrease level of HDL in diabetics was observed and compared with non diabetics. Lipid concentration elevated in hypertensive with diabetes. This study has clearly shown that hs-CRP, body mass index was increased in obese diabetes when compared with non diabetics obese and non diabetics non obese. hs-CRP strongly associated in obese with diabetes. Lipid profile (total serum cholesterol, TGL, LDL & VLDL) was significantly higher and HDL cholesterol decreased in diabetic obese women as compared to diabetic obese male. The risk factors such as obesity, smoking, alcohol consumption and hypertension was found to promote the development of type 2 diabetes.

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We are grateful to the Director, Mrs. D. Joyce Marlin, JPM diagnostic centre, Chennai for the opportunity and the help rendered to carry out the investigation in her medical laboratory.

References