To Study the Association of Free Insulin Levels, Obesity Markers & Lipid Profile Parameters in Newly Diagnosed Patients of Type 2 Diabetes Mellitus in Tertiary Care Centre of Kumaon Region

Authors
Seema Gupta¹, Basant Joshi², Taukeer Ahmad³, Sangeeta Singh⁴
¹Assistant Professor, ²Tutor, ³PG JR, ⁴Associate Professor
¹,²,³,⁴Department of Biochemistry, Govt. Medical College, Haldwani, India
Corresponding Author
Sangeeta Singh
Email: singh_4647@yahoo.co.in

Abstract
Diabetes Mellitus is the commonest metabolic abnormality in the world. Type 2 diabetes the commonest form of diabetes constitutes nearly 90% of diabetic population in any country. Type 2 diabetes mellitus is characterized by impaired insulin secretion, insulin resistance, excessive hepatic glucose production, and abnormal fat metabolism. Obesity, particularly visceral or central (as evidenced by the hip-waist ratio), is very common in type 2 diabetes mellitus. Obesity is always associated with increase in plasma triglycerides. Dyslipidemia includes hypertriglyceridemia, reduced HDL cholesterol, and increased numbers of small, dense LDL particles. The present was therefore planned to study the correlation between markers of obesity, lipid profile & insulin resistance in newly diagnosed patients of type 2 Diabetes mellitus.

Materials & Methods: 100 newly diagnosed patients of Type 2 DM were taken as cases. Healthy age & sex matched 100 subjects were included in control group.

Results: In this study 37 patients of DM were overweight and 19 were obese. All the female patients showed waist hip ratio (WHR) >0.85 and 33 males out of 43 had WHR >0.90. Mean waist circumference in diabetic cases were significantly raised when compared with healthy controls. The mean level of Triglyceride & VLDLc in diabetic cases was found to be significantly raised when compared with normal subjects. The mean level of ApoB was found to be significantly elevated in diabetics as compared with controls. in this study the levels of HbA1c & serum free insulin were also significantly raised in diabetic cases as compared to normal subjects.

Conclusion: This study showed that newly diagnosed diabetic patients have high incidence of obesity, insulin resistance and dyslipidemias, which predisposed them to metabolic syndrome. Significantly high levels of HbA1c in newly diagnosed DM suggests its utility as the predictor of future risk for metabolic syndrome.

Keywords: diabetes mellitus, dyslipidemias, obesity, insulin resistance.

Introduction
The global epidemic of diabetes will challenge our generation to develop novel strategies to prevent and treat this lifelong condition. Every 10 seconds, two people develop diabetes and one person dies from diabetes-related causes. In 2007, 246 million people worldwide had diabetes. That number is expected to climb to 380 million by 2030 (International Diabetes Federation, 2007).
In most developed countries, diabetes is the fourth or fifth leading cause of death and there is concern that it will become an epidemic in many developing and newly industrialized nations. The global prevalence of diabetes will double in the next 30 years due to population growth, urbanization, increasing prevalence of obesity, aging, and physical inactivity (Wild S et al., 2004). \(^{(3)}\)

Diabetes can be caused by a variety of hormonal and cellular defects, which result in elevated blood glucose levels. Insulin and other hormones are released in response to rising blood glucose levels. \(^{(4)}\)

The two broad categories of Diabetes Mellitus are Type 1 and Type 2. The unique feature of type 1 diabetes mellitus is its progressive autoimmunity resulting in complete destruction of the pancreatic beta cell. Viral triggers such as enteroviruses, coxsackie virus B, congenital rubella, cytomegalovirus, and mumps are suspected culprits (American Association of Diabetes Educators, 2006). \(^{(5)}\)

Type 2 diabetes is a heterogeneous group of disorders that in combination result in hyperglycemia. These disorders include beta cell death, insulin resistance, excessive hepatic glucose release, and other hormone deficiencies (American Association of Clinical Endocrinologists, 2007). \(^{(6)}\)

Type 2 diabetes mellitus is characterized by impaired insulin secretion, insulin resistance, excessive hepatic glucose production, and abnormal fat metabolism (Kaprio et al., 1992). \(^{(7)}\)

Obesity, particularly visceral or central (as evidenced by the hip-waist ratio), is very common in type 2 diabetes mellitus. In the early stages of the disorder, glucose tolerance remains near-normal, despite insulin resistance, because the pancreatic beta cells compensate by increasing insulin output. As insulin resistance and compensatory hyperinsulinemia progress, the pancreatic islets in certain individuals are unable to sustain the hyperinsulinemia state (Alvin C. Powers, 2008). \(^{(8)}\)

Insulin resistance, the decreased ability of insulin to act effectively on target tissues (especially muscle, liver, and fat), is a prominent feature of type 2 diabetes mellitus and results from a combination of genetic susceptibility and obesity (Defronzo RA, 1988, Kahn CR, 1994). \(^{(9,10)}\)

The obesity accompanying type 2 diabetes mellitus, particularly in a central or visceral location, is thought to be part of the pathogenic process. Obesity increases the risk for various comorbidities, and recent advances in the understanding of adipose tissue biology offer an insight into the complex pathophysiologic mechanisms.

Obesity is always associated with increase in plasma triglycerides. Dyslipidemia includes hypertriglyceridemia, reduced HDL cholesterol, and increased numbers of small, dense LDL particles (Marsh JB, 2003). \(^{(11)}\) Other features of the dyslipidemia of abdominal adiposity include elevated very low density lipoproteins (VLDL), and reduced HDL, which are the large buoyant antiatherogenic subspecies of total HDL. In some individuals, Apo B levels may be elevated, reflecting an increase in the number of small, dense lipoprotein particles (VLDL and LDL) (McNamara J et al., 1987). \(^{(12)}\)

Overproduction of apolipoprotein B can result in lipid-induced endoplasmic reticulum stress and insulin resistance in the liver (Su Q et al., 2009). \(^{(13)}\)

Considering these facts the present study plan to correlate between the parameters of obesity, dyslipidemias and insulin resistant in newly diagnosed patients of type 2 diabetes mellitus.

**Materials and Methods**

After permission from institutional ethical committee and a written informed consent, The present study was carried out in the Department of Biochemistry, in association with the Department of Medicine, Government Medical College, Haldwani, during the period of 2014 to 2015. 100 patients of newly diagnosed type 2 diabetes mellitus based on diagnostic criteria for diabetes According to American diabetes association
ADA) were included as cases those were in age group of 20-60 years. 100 age and sex matched healthy subjects were taken as controls. Patients with Gestational diabetes mellitus were excluded from the study.

All patients were subjected to detailed history and thorough clinical examination.

**Anthropometric measurements**

**Weight:** Body weight (in kg) was measured in light clothing and without shoes. The weight was recorded to the nearest kg.

**Height:** Height was measured without shoes with the subjects standing fully erect on a flat surface and taken to the nearest centimetre.

**Body mass index:** Body mass index was calculated by the formula- Weight in kg/ (Height in meter).²

**Waist circumference:** Waist circumference (in centimetre) was measured at midway between the costal margin & iliac crest. Waist circumference was measured at the end of normal expiration.

**Hip circumference:** Hip circumference (in centimetre) was taken as the largest circumference at the posterior extension of the buttocks (Transtrochantaric). Waist hip ratio is the waist circumference divided by the hip circumference.

Taking all aseptic precautions, about 5 ml of blood was drawn by vein puncture from a peripheral vein, with a disposable syringe. All samples were collected in the morning after an overnight fast. Sample for fasting blood glucose, lipid profile, Apo B, free insulin were collected in a plain vial. The blood thus collected in clean dry glass tubes was allowed to stand for 30 minutes at room temperature for the retraction of clot. This was then centrifuge at 3000 r.p.m. for 10 minutes to separate the serum. The serum was stored at 4°C in the refrigerator for analysis.

For the quantification of HbA1c, sample was collected in Ethylenediaminetetraacetic acid (EDTA) vial.

The parameters including blood sugar, lipid profile, HbA1c were analyzed in fully automated Roche/Hitachi Cobas c 501 analyzer. Serum ApoB level was analyzed in semiautomatic analyzer (MERCK Microlab 300) and estimation of serum free insulin was done in ELISA Micro plate reader (MIOS JUNIOR MERCK).

**Statistical Analysis**

The data were compiled and entered in MS Excel sheet and the analysis was carried out using the Statistical Package for the Social Sciences (SPSS 19.0.2) program for windows. Unpaired “t” test was used to analyze all the data for statistical significance. Correlation and regression coefficient were also calculated among relevant parameters.

**Results**

Table 1 shows the age and sex distribution among the studied patients. All the patients studied were of the age group 25-60 years.

Table 2 shows the distribution of diabetic subjects according to their BMI. Of the 100 cases 41 subjects (17 males & 24 females) had normal BMI, 37 (16 males & 21 females) were overweight and 19 (9 males & 10 females) were obese. Only healthy subjects with normal BMI were taken as controls.
Table 2: Distribution of diabetic subjects according to their Body Mass Index (According to WHO criteria)

| BMI (kg/m²)     | Male | Female | Total |
|-----------------|------|--------|-------|
| Normal (18-24)  | 17   | 24     | 41    |
| Over weight (25-29) | 16   | 21     | 37    |
| Obese (>30)     | 9    | 10     | 19    |
| Total           | 43   | 57     | 100   |

Table 3 shows the distribution of WHR in the studied subjects. The normal WHR ratio in male is <0.90 and female is <0.85. Among the studied subjects 33 males had increased WHR, whereas all the females had WHR > 0.85.

Table 3: Distribution of diabetic patients according to Waist Hip Ratio (WHR)
(The values of WHR in control males and females were <0.90 and < 0.85 respectively)

| WHR | Male (n=43) | Female(n=57) | Total No |
|-----|-------------|--------------|----------|
|     | <0.90 | >0.90 | <0.85 | >0.85 |
| NO  | 10    | 33    | 0      | 57    |

Table 4 shows mean waist circumference in healthy subjects vs diabetic patients. The mean levels of waist circumference in diabetic males were significantly raised (p= 0.0001) when compared with healthy male controls. The mean levels of waist circumference in diabetic females were also significantly raised (p= 0.0001) when compared with healthy female controls.

Table 4: Waist Circumference in studied subjects (mean±SD).

| Variables            | Male with DM | Healthy Male | P value | Female with DM | Healthy Female | P value | Normal Range (cm) |
|----------------------|--------------|--------------|---------|----------------|----------------|---------|-------------------|
| Waist circumference  | 96.26±1.01   | 85.65±0.57   | 0.0001  | 90.34±0.68     | 75.63±0.25     | 0.0001  | Male < 90 Female <80 |

Table 5 shows biochemical parameters in healthy controls vs diabetic patients. The mean level of total cholesterol in diabetic cases was mildly elevated when compared with healthy controls (230.8±32.6 vs 154±37.80; p=0.0126). The mean level of TG (256.52±24.92 vs 132±36.8; p=0.0001) and VLDLc (40.45±2.34 vs 24.10±2.15; p=0.0001) in diabetic cases was raised and highly significant when compared with healthy controls. The mean level of LDLc was raised in diabetics but statistically insignificant. The mean level of HDLc was reduced in diabetics (40.03±1.12) when compared with healthy controls (42.51±1.51) the p value was 0.015. The mean level of ApoB was elevated in diabetics (76.89±3.92) when compared with controls (70.28±3.66) the p value was 0.032.

The newly diagnosed diabetic patients in this study showed higher levels of HbA1c (7.30±0.25%) as compared to healthy controls (4.4±0.88) with p value of 0.001. The mean level of serum free insulin in diabetic and healthy controls were 7.83±1.66 and 2.76±0.74 respectively p value also found to be significant (0.001)

Table 5: Biochemical parameters studied in healthy control vs diabetic patients

| Parameters               | Healthy controls | Diabetic cases | P value |
|--------------------------|------------------|----------------|---------|
| Lipid profile (mg/dl)    |                  |                |         |
| Total cholesterol        | 154±37.80        | 230.8±32.6     | 0.0126  |
| Triglycerides            | 132±36.8         | 256.52±24.92   | 0.0001  |
| Low density lipoprotein cholesterol | 83.9±27.5        | 108.60±35.01   | 0.605   |
| Very low density lipoprotein cholesterol | 24.10±2.15       | 40.45±2.34     | 0.0001  |
| High density lipoprotein cholesterol | 42.51±1.51       | 40.03±1.12     | 0.015   |
| ApoB                     | 70.28±3.66       | 76.89±3.92     | 0.032   |

Blood glucose levels (mg/dl)

| Fasting       | 86.7±9.3        | 137.6±42.2     | 0.0001  |
| Post prandial | 106±12.3        | 229.8±25.1     | 0.0001  |

Other parameters

| HbA1c (%)   | 4.4±0.88        | 7.30±0.25      | 0.001   |
| Serum Free insulin (µIU/ml) | 2.76±0.74 | 7.83±1.66 | 0.001 |
Fig 1 shows significant positive correlation between waist circumference and triglyceride levels.

\[ r = 0.095, \ p < 0.01, \quad y = 10.80 - 744.0x \]

**Fig 1** Correlation between waist circumference and triglyceride levels in patients of diabetes mellitus

Fig 2 shows positive correlation between waist circumference and ApoB levels.

\[ r = 0.024, \ p \text{ NS}, \quad y = 0.863 \cdot 5.80x \]

**Fig 2** Correlation between waist circumference and serum Apo B levels in patients with Diabetes Mellitus
Discussion

In this study out of 100 newly diagnosed diabetic patients, 57 were females and 43 were males. Similar observation were also shown in the study of Alshkri and Elmehdawi.\(^{(15)}\)

Abdominal obesity characterized by high waist circumference is a stronger predictor than generalized obesity defined by elevated Body Mass Index (BMI) of subsequent development of major coronary event, vascular mortality, diabetes and metabolic syndrome. Overweight is defined as a BMI of 25-29 and obese as a BMI >30 (WHO, 2000).\(^{(16)}\)

MA Shekhar et al., 2005 in their study in Mysore on urban patients found the BMI to be 23.9 in males and 25.3 in females.\(^{(17)}\) In the study of Alshkri and Elmehdawi, 2008 out of 99 patients, 61 were females and 38 were males of all patients, 74.4% were obese and obesity was significantly more frequent among females (p<0.001). Mean BMI was 33.6 kg/m\(^2\).\(^{(18)}\)In our study according to BMI, obesity was predominant in females as compared to males, which is comparable with the above studies.

Waist–hip ratio (i.e. the waist circumference divided by the hip circumference) was suggested as an additional measure of body fat distribution. In our study WHR was increased in all the females studied (>0.85) while 33% of males had increased WHR (> 0.90). Various studies have shown that WHR is an important cardiovascular risk factor and greater levels are associated with multiple risk factors. Gupta R et al., 2003 reported that WHR >0.9 in men and >0.8 in women is associated with a significant increase in multiple risk factors.

Dyslipidemia, characterised as an increased free fatty acid, triglyceride, small dense LDLc and low HDLc levels is widely accepted risk factor for coronary heart disease. In our study serum TG and VLDL levels were significantly elevated in patients of diabetes mellitus as compared to healthy subjects. Whereas no significant difference was found in levels of total cholesterol , LDLc and HDLc.

Study by VS Prasad et al., 2015, observed high levels of serum triglyceride in diabetes Mellitus.\(^{(19)}\) Huges et al., 2011, showed that relative risk of Myocardial infarction correlates directly with increased triglyceride and inversely with HDL-c levels in both Caucasians and Asians Indians.\(^{(20)}\) The combination of abdominal obesity and low HDL was also reported as the most common combination among Chinese type-2 diabetics(Lee YJ, Tsai JC, 2002).\(^{(21)}\)
Apo B is one of the component found in chylomicron, VLDL, intermediate density lipoprotein and LDL. The association of Apo B with diabetes has potential role as a subclinical inflammatory agent (Faraj M et al., 2006). Apo B is a good surrogate measure of increased LDL particle numbers in people with insulin resistance (Williams K et al., 2003), and small LDL particle number was best correlated with Apo B and triglycerides and HDL-cholesterol) in the Framingham Heart study (Kathiresan S et al., 2006).

The present study shows Serum Apo B levels was significantly elevated in patients of diabetes Mellitus. Similarly Lim et al., 2011, found serum Apo B to be higher in diabetic patients. Ryoo et al., 2013, conducted a cohort study which followed up 25,193 healthy Korean males of diabetes mellitus without metabolic syndrome for 5 years, and reported that Apo B was a predictive factor for metabolic syndrome. Insulin resistance has been defined as a defect in insulin action that results in hyperinsulinemia, necessary to maintain euglycaemia. Many people with insulin resistance have high levels of blood glucose and high levels of insulin circulating in their blood at the same time.

In our study serum free insulin level was significantly elevated (p<0.005) in patients of diabetes mellitus as compared to those normal controls. Our study is supported by David E et al., 2002, that over 95 percent of men who had the hyperglycemia had hyperinsulinemia. HbA1c is the most commonly measured parameter for long term monitoring of diabetes mellitus. The level of HbA1c has been widely accepted as an indicator of mean daily blood glucose concentration over the preceding 8-12 weeks. In our study HbA1c levels were significantly elevated (p <0.01) in patients of diabetes mellitus as compared to normal controls.

These results suggest that HbA1c may be a surrogate marker not only of future diabetes, but also of CVD. Although there are many studies which report the utility of HbA1c in predicting CVD and diabetes. Jasmin S et al., 2008, observed that metabolic syndrome group showed significantly higher glucose, HbA1c levels and waist circumference.

**Conclusion**

This study concludes that in patients with diabetes mellitus there is high incidence of obesity and increased waist hip ratio. The serum parameters in present study also showed that there is significant elevation of atherogenic lipids, HbA1c and insulin resistance in diabetics. There is significant positive correlation between parameters of obesity and dyslipidemia. These data provide evidence that newly diagnosed patients of DM are at future risk of metabolic syndrome. Thus physician treating type 2 diabetics should consider metabolic syndrome with greater emphasis. Life style modification like weight loss, exercise of ≥30 min per day in take of high dietary fibers can decrease the incidence of morbidity &mortality associated with complication diabetes.

**References**

1. IC Health. National Cardiovascular Disease Database. Available from: http://www.whoindia.org/LinkFiles/NMH_Resources_National_CVD_database-Final_Report.pdf, accessed on February 10, 2008.
2. International Diabetes Federation (IDF). (2007). Diabetes alas. Belgium: International Diabetes Federation.
3. Wild, S., Roglic, G., Green, A., et al. (2004). Global prevalence of diabetes estimates for the year 2000 and projections for 2030. Diabetes Care, 27, 1047-1053.
4. World Health Organization. (2006). Definition and diagnosis of diabetes mellitus and intermediate hyperglycemia: Report of a World Health Organization and International Diabetes Federation. Geneva, Switzerland.
5. American Association of Diabetes Educators. (2006). Art and science of diabetes self-
management education: A desk reference for health care professionals. Chicago, Illinois.

6. American Association of Clinical Endocrinologists. (2007). Medical guidelines for clinical practice for the management of diabetes mellitus. Endocrine Practice, 13.

7. Kaprio J, Tuominen J, Koskenvuo M, Romanov K, Reunanen A, Eriksson J, Stengård J, Kesäniemi YA (1992); Concordance for Type 1 (insulin dependent) and Type 2 (non-insulin-dependent) diabetes mellitus in population based cohort of twins in Finland. Diabetologia, 35:1060-1067.

8. Alvin C. Powers, Harrison’s Principles of Internal Medicine, 2008, volume II, 17th edition, Page no. 2280-2281.

9. David E. Laaksonen, Hanna-Maria Lakka et al, Insulin resistance in metabolic syndrome Am J Epidemiol 2002; 156: 1070-1077.

10. Kahn R, Buse J, Ferrannini E, Stern MI. The metabolic syndrome: time for a critical appraisal: joint statement from the American Diabetes Association and the European Association for the Study of Diabetes. Diabetes Care. 2005;28:2289–2304.

11. Marsh JB. Lipoprotein metabolism in obesity and diabetes: insights from stable isotope kinetic studies in humans. Nutr Rev. 2003; 61:363–375.

12. McNamara J, Campos H, Ordovas J, Peterson J, Wilson P, Schaefer E. Effect of gender, age, and lipid status on low density lipoprotein subfraction distribution. Results of the Framingham Offspring Study. Arteriosclerosis. 1987; 7:483–490.

13. Su Q, Tsai J, Xu E, Qiu W, Berezki E, Santha M, Adeli K (2009). "Apolipoprotein B100 acts as a molecular link between lipid-induced endoplasmic reticulum stress and hepatic insulin resistance". Hepatology 50(1): 77–84. doi:10. 1002/hep. 22960. PMID 19434737.

14. American Diabetes Association. (2008). Clinical practice recommenda-tion: Standards of medical care. Diabetes Care, 31. (Suppl. 1), S14.

15. Alshkri MM, Elmehdawi RR. Metabolic Syndrome among Type-2 Diabetic Patients in Benghazi-Libya: A pilot study. Libyan J Med 2008; AOP: 080715: [Online], available from: www. ljm. org. ly. (accessed on 12 June 2008).

16. World Health Organization Western Pacific Region International Obesity Task Force. The Asia-Pacific perspective: redefining obesity and its treatment. Sydney: Heath Communications Australia Pty Limited; 2000.

17. MA Shekhar, HM Somashekar, BS Vishwanath. Study of incidence of obesity in newly diagnosed type 2 diabetics using anthropometric measurements Int J Diab Dev Countries 2005;25: 102-04

18. Gupta R, Rastogi S, Panwar RB, Soangra MR, Gupta VP, Gupta KD. Major coronary risk factors and coronary heart disease epidemic in India. South Asian J PrevCardiol2003;7:11-40.

19. Valluri Satya Prasad, et al, “The Prevalence of Metabolic Syndrome in Newly Diagnosed Type 2 Diabetes Mellitus”. Journal of Evidence based Medicine and Healthcare; Volume 2, 2015; Page:2500-2507.

20. Huges et al, Premature coronary artery disease in North India: An Angiography study of 1971 patientes. Indian Heart. 2011;57;311-318.

21. Lee YJ, Tsai JC. ACE gene insertion/deletion polymorphism associated with 1998 World Health Organization definition of metabolic syndrome in a Chinese type 2 diabetic patients. Diabetes Care 2002;25:1002–8.

22. Faraj M, Messier L, Bastard JP, et al. Apolipoprotein B: a predictor of inflammatory status in postmenopausal overweight and obese women. Diabetologia 2006;49:1637-46.

23. Williams K, Sniderman AD, Sattar N, D’Agostino R Jr, Wagenknecht LE, Haffner
SM. Comparisons of the associations of apolipoprotein B and low-density lipoprotein cholesterol with other cardiovascular risk factors in the Insulin Resistance Atherosclerosis Study (IRAS). Circulation 2003;108:2312-16.

24. Kathiresan S, Otvos JD, Sullivan LM, et al. Increased small low-density lipoprotein particle number: a prominent feature of the metabolic syndrome in the Framingham Heart Study. Circulation 2006;113:20-29.

25. Lim JS, Lee DH, Park JY, Jin SH, Jacobs DR (2011). "Reliability of low-density lipoprotein cholesterol, non-high-density lipoprotein cholesterol, and apolipoprotein B measurement". Journal of Clinical Lipidology 5 (4): 264–272. doi:10.1016/j.jacl.2011.05.004. PMID 17478563.

26. Ryoo JH, Park SK. Association of apolipoprotein B and incidence of metabolic syndrome in Korean men: a 5-years’ follow-up study. Atherosclerosis 2013;226:496-501.

27. Yokota C, Ikeyuchi M, Suzuki M, Norioka M, Ikeda K, Shinozaki K, Harano Y. Insulin resistance rather than hyperinsulinemia more closely associated with essential hypertension. ClinExpHypertens1995;17:523-36.

28. David E. Laaksonen, Hanna-Maaria Lakka et al, Insulin resistance in metabolic syndrome Am J Epidemiol 2002; 156: 1070-1077.

29. Osei K, Rhinesmith S, Gaillard T, Schuster D. Is glycosylated hemoglobin A1c a surrogate for metabolic syndrome in nondiabetic, first-degree relatives of African-American patients with type 2 diabetes? J ClinEndocrinolMetab2003; 88: 4596–4601.

30. Jasmin S, Venesa Abdie-Nekie et al, Study of HbA1c As A Reliable Indicator For Metabolic Syndrome In Non Diabetic Patients 2008.