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Correlation between fasting insulin and blood pressure in obese and non-obese middle aged Indian diabetic adults

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Abstract
Objectives: To observe the relation between fasting insulin and blood pressure in obese and non-obese middle aged type two diabetes patients. **Material and Methods:** The present study was carried out at RL Jalappa Hospital attached to Sri Devaraj Urs Medical College, Tamaka, and Kolar. This study includes 276 diabetic patients with the age group of 40-50 years and WHO Body Mass Index Guidelines were used to classify the subjects into four groups. Anthropometric and biochemical measurements were evaluated by standard procedures. Statistical analysis was done by using SPSS version 16.0. Mean and standard deviation was done by ANOVA and Pearson's correlation Coefficient was used to find association between various risk factors. **Results:** BMI was positively correlated with SBP and DBP values. The fasting insulin levels were also increased with BMI variations. Weight gain is associated with an increase in insulin resistance and this in turn leads to development of complications for diabetes includes cardiovascular and renal diseases. Obesity is a positive risk factor in the development of dyslipidemia, insulin resistance and hypertension, which are linked more strongly to intra-abdominal obesity. **Conclusion:** As the BMI increases fasting blood sugars and glycolated hemoglobin levels were decreased but fasting insulin levels were increased. However fasting insulin was positively correlated with blood pressure in obese subjects and negatively correlated with non-obese subjects.

Keywords: Fasting insulin, Blood pressure, Obesity, Diabetes

1. Introduction

Hypertension is a frequent and almost ubiquitous health disorder, prevalence is more in developed and developing countries[1].A significant association has been demonstrated and confirmed between insulin resistance and essential hypertension, independent of glucose intolerance and obesity[2]. Fasting insulin is a clinical index reflecting the state of glucose metabolism. Hyperinsulinemia, as a compensation for impaired glucose tolerance, is known to be an early clinical manifestation of insulin resistance [3]. Insulin resistance and hyperinsulinemia are known to have profound relationship with various medical diseases, such as metabolic syndrome, cardiovascular disease, and obesity[4-7]. These diseases are significantly associated with hypertension, which suggest a clinical relation between hyperinsulinemia and hypertension. Studies conducted were reported that the cellular and molecular mechanism in which elevated insulin level could raise blood pressure [8-10].

However, clinical evidences are still insufficient to provide a definite etiologic association between hyperinsulinemia and development of hypertension in middle aged obese and non-obese adults. Furthermore, data is limited regarding whether risk of hypertension increases in specific age, ethnicity and to observe relation in obese and non-obese adults. Thus, this study is planned to investigate the relationship between fasting insulin level and blood pressure in middle aged obese and non-obese adults.

Objectives

1. To compare the fasting insulin levels in obese and non-obese subjects
2. To correlate fasting insulin levels with blood pressure in obese and non-obese subjects

Material and Methods

Study design and setting

Study was conducted in RL Jalappa Hospital and Research Centre. Patients attending to medicine department, with the age group of 35-50 years were included in the study.

A total of two hundreden sixty six individuals were included in the study using convenience sampling. Type 1 diabetes mellitus, peripheral vascular disease, acute or chronic infection, cancer, hepatic disease; myocardial infarctions were excluded from the study. Written informed consent was obtained from all the subjects.

Study questionnaire

Data was collected by means of questionnaire and it consisted of age, gender, weight, height, body mass index, waist circumference, hip circumference, waist-hip ratio and blood pressure and biochemical investigations, fasting blood glucose and serum lipid profile.

Anthropometry and clinical measurements

The equipment's used for measuring anthropometric and clinical parameters were calibrated and certified for their accuracy by central work shop and also inter rater reliability were obtained for each of the parameters. Weight was measured (to the nearest 0.5 kg) with the participant standing motionless. Weighing scale without shoes or any heavy outer garments, and weight equally distributed over each leg. Height was measured(to the nearest 0.1cm) using a standard non-elastic tape measure with the participant standing against a wall, without shoes, and the head looking straight. Waist circumference (WC) was measured using a standard non-elastic tape (to the nearest 0.1cm). The participant was asked to stand with the arms by the sides and to breathe out normally. Standing to the side of the participant, the inferior margin (lowest point) of the last rib and the crest of the ilium (top of the hip bone) was located and marked with a skin marker. The midpoint between the two was marked and measurement for waist circumference was taken at the level of this midpoint. The hip circumference (HC) was measured around the maximum circumference of the hips. Sitting blood pressure was measured using blood pressure (BP) apparatus. Two readings were taken at an interval of 10 min. If difference between the two readings were more than10 mm Hg, a third reading of BP was recorded. The mean of 2 (or 3) readings were taken as the final measurement.

Biochemical investigations

All the biochemical parameters were analyzed at central biochemistry laboratory at R L Jalappa Hospital and research Centre Fasting blood glucose was estimated by glucose/oxidase peroxidase. Fasting insulin by chemflaminiscence. Cholesterol was estimated by cholesterol oxidase, triglycerides by glycerol phosphate oxidase peroxidase, high-density lipoprotein (HDL) by the precipitation method using phosphotungstate/magnesium. LDL was calculated using Friedewald's formula.

Body mass index classification

WHO guidelines[11:] Normal- BMI 18.5-24.99; over weight-BMI ≥25-29.99; obesity-BMI≥30.

Central obesity

Adult Treatment Panel III guidelines (NCP-ATP III) [13]: waist circumference > 102 cm for men and > 88 cm for women.

As per WHO [14]: waist-Hip Ratio (WHR) > 0.9 for men or >0.85 for women.

Pre-hypertension and hypertension

According to Joint National Committee VII guidelines [15] - pre-hypertension:120-139/80-89 mmHg; hypertension: ≥140/≥90 mmHg.

Self-reported hypertension and diabetes

Impaired Fasting Glucose (IFG) and Type 2 diabetes mellitus (DM): As per American Diabetes Association [16] – IFG: ≥110-125 mg/dl and type 2 DM: ≥126mg/dl.

Dyslipidemia[13]

Hypercholesterolemia: Total serum cholesterol level ≥200 mg/dl, Hypertriglyceridemia: Fasting serum triglycerides levels ≥ 150 mg/dl, Decreased high-density lipoprotein cholesterol (HDL): Fasting serum HDL-cholesterol <40mg/dl for males and <50 mg/dl for females. Increased low-density lipoprotein (VLDL): Fasting serum VLDL cholesterol ≥30mg/dl.

Statistical Analysis

Data analysis was done using SPSS version 16. Mean and standard deviation were done by using ANOVA. Pearson correlation coefficient test was used to identify the positive or inversely tested. P value <0.05 considered as significant.

Results

Total 273 type 2 diabetic subjects were enrolled in the study and all the studied subjects were divided into four groups based on the WHO, BMI classification. The mean and standard deviation of anthropometric measures of the four groups were shown in table 1. The age of the diabetic subjects were ranged from 46.07±16.96 to 57.03 ±11.30. In all the three groups weight was highly significant (P=0.000). The group I showed less weight (48.92±11.63) and group IV showed more weight (80.40±11.80). The mean height of the studied patients were 164.19±10.69 for group II followed by group I (162.64±6.90) group III (161.83±9.03), group IV (157.68±5.99). Among the observations the mean lowest BMI was 16.47±1.82 and highest mean BMI was 33.82±3.09. The lowest (86.71±11.28) WC were found in group I and highest (105±11.23) WC were observed in group IV. The group IV showed more HC (102.24±16.15) and group I was having 89.35±10.31. The lowest HC were found in group I (89.35±10.31) and highest HC was found in (102.24±16.15) group IV. The Systolic blood pressure (SBP) was ranging from 126.86 to 132.80 mmHg/dl and diastolic blood pressure (DBP) were varied from 78.31 to 84.16 mmhg/dl.

The mean Fasting blood glucose (FBS) values were higher in group I (180.14±86.31) and lower FBS values(140.62±61.60) were observed in group IV but it was statistically not significant(P=0.413). Post prandial blood glucose (PPBS) values were found highest (282.50±115.97) in group I followed by group III (262.19±99.63) and group II (251.89±96.29) and the lowest PPBS (240.48±75.58) were observed in group IV. However these difference were statistically not significant (P=0.509). Group II was found highest values of fasting insulin 27.12±91.25 than other groups observed. The HbA1c values were highest in group I (10.65±3.92) and the lowest HbA1c values were found in group IV (8.69±2.20). Higher uric acid values were found in group III (5.60±4.06) and group II (5.04±1.13). Group III (1.65±5.64) and group IV (1.64±17.78) were found higher serum creatinine values than the normal. Total cholesterol was varied from 152.71±31.69 to 174.49±39.51. Group II was found more triglycerides (209.08±126.93) and group I was found with in normal (106.71±57.96) limits. HDL-c was observed more in group II (37.18±4.28) and highest LDL-c was found in (102.42±36.77) among the studied subjects (Table2).

Comparing the means of significance between the groups was shown in table 3. Group I Vs Group II was found significance for all anthropometric measurements, whereas group I Vs III showed Significance for weight, BMI and WC only. Group I Vs IV was found significance for weight, height, WC and HC. DBP was highly significance in group I Vs II (P< 0.001), whereas group II Vs IV showed significant (P<0.05). Table 4 shows the Pearson's correlation coefficient to rank the variables weather positively or inversely related with fasting insulin in association with anthropometric and other biochemical indices. Among these parameters age (p=0.044, r=.124), weight (p=0.039, r=0.127), WC (p=0.028, r=0.135) and uric acid (p=0.004, r=0.175) were significant positively correlated with insulin. Table 5 shows BMI classification based on WHO criteria, according to this criteria Fasting insulin was negatively correlated with Group III (25-25.99 Kgm^2) (p=0.940, r=-0.008) and Group IV(> 30 kg/m^2) (p=0.157, r= - 0.244) and also no significant difference was observed.

Discussion

Patients with type 2 diabetes (T2DM) are considered on high priority as they are potential targets for rapid evaluation to prevent the progression of complications[11, 12, and 13]. The highly significant anthropometric indices were observed between the four groups. The more height were found in group II (164.19 ± 10.69cm) and lowest height (157.68±5.99cm) were found in subjects with BMI >30kg/m^2. Weight of the patients was ranged from 48.92±11.63 to 80.40±11.80cm. However the weight and height were showed statistically significant (P<0.001) between the BMN variation. The mean values for WC was significant between the groups. Studies observed by wannamethee et al [14] showed WC and BMI are equal predictors of diabetes. Obesity is a positive risk factor in the development of type 2 diabetes, dyslipidemia, insulin resistance and hypertension [15] Obesity is often expressed in terms of body mass index[16] The distribution of adipose tissues in different autonomic depots also has substantial implications for mortality. The risk of diabetes increases progressively with increasing body mass index and WHR. Weight gain is associated with an increase in insulin resistance and deterioration in glucose tolerance[17]. In the present study the observations were clearly showing that as the BMI increases the SBP and DBP were also increased (Table 1).This shows the development of cardiovascular risk is higher in obese subjects. These results are similar to the observations by Reddy et al[18] and Reddy et al [19]

Among the studied subjects the poor glycemic control was observed. In all four classified groups the FBS and PPBS was more than the normal values and the less FBS was found in group IV with BMI values >30kg/m2. In the present study as the BMI values increases the FBS values were decreased. This may be due to the regular exercise, and antidiabetic treatment and also strict diet control[20]. But it was not statistically significant (p=0.413). Similar observation was also found with PPBS values (Table2). HbA1c of diabetic subjects showed 10.65±3.92 % in group I whereas group IV showed 8.69±2.20 %. This is clearly showing that as the BMI values increases the HbA1c values were decreased. The renal profile of T2DM subjects were found that the uric acid values were just above the normal values but the serum creatinine values were observed more than the normal values in group III and IV and as the BMI increases the serum creatinine values were also increased. Dyslipidemia was observed in group II and group III whereas in group I and II were having normal lipid values. This may be due to the anti-cholesterol lowering agents.

Conclusion

In the present study it is clearly showing that as the BMI increases the FBS and PPBS were decreased. Similar findings were observed with HbA1c values. But the renal functions were increased with increase in BMI values. BMI was positively correlated with SBP and DBP values. The fasting insulin levels were also increased with BMI variations. Weight gain is associated with an increase in insulin resistance and this intern to development of risk for complication for diabetes and cardiovascular and renal diseases. Obesity is a positive risk factor in the development of dyslipidemia, insulin resistance and hypertension, which are linked more strongly to intra-abdominal obesity.

Table 1: The mean and standard deviation of anthropometric measures of four groups

PARAMETERS	GROUP I Mean ± SD	GROUP II Mean ± SD	GROUP III Mean ± SD	GROUP IV Mean ± SD	ANOVA-F-value with significance
AGE (years)	46.07±16.96	54.01±10.84	57.03 ± 11.30	52.36±10.14	4.62 P=0.004*
Weight (kg)	48.92±11.63	61.89±8.60	69.11±8.83	80.40±11.80	49.07 P=0.000**
Height (cm)	162.64±6.90	164.19±10.69	161.83±9.03	157.68±5.99	3.62 P=0.014
BMI (Kg/m^2)	16.47±1.82	22.30±1.64	26.84±1.41	33.82±3.09	457.98 P=0.000**
WC(cm)	86.71±11.28	93.17±8.86	96.49±9.51	105±11.23	15.99 P=0.000**
HC(cm)	89.35±10.31	92.42±9.27	95.03±8.70	102.24±16.15	8.19 P=0.000**
WHR	1.00±.15	1.02±.12	1.03±.13	1.06±.133	0.725 P=0.538
SBP (mmHg)	126.86±13.98	128.23±14.36	129.74±15.62	132.80±10.89	0.87 P=0.455
DBP (mmHg)	79.28±8.43	78.31±9.66	79.84±9.96	84.16±10.72	2.56 P=0.055

Table 2: The mean and standard deviation of physiological measures of four groups

PARAMETERS	GROUP I Mean ± SD	GROUP II Mean ± SD	GROUP III Mean ± SD	GROUP IV Mean ± SD	ANOVA-F-value with significance
FBS (mg/dl)	180.14±86.31	162.86±76.83	157.51±78.16	140.62±61.60	0.958 P=0.413
PPBS(mg/dl)	282.50±115.97	251.89±96.29	262.19±99.63	240.48±75.58	0.776 P=0.509
FI	12.80±16.02	21.92±91.25	23.29±47.61	27.80±22.98	0.211 P=0.889
HbA1c (%)	10.65±3.92	9.32±3.23	9.48±4.19	8.69±2.20	0.934 P=0.425
URIC ACID (mg/dl)	4.47±.96	5.04±1.13	5.60±4.06	4.88±.79	1.44 P=0.230
Serum creatinine(mg/dl)	0.95±.26	1.05±.56	1.65±5.64	1.66±17.78	2.29 P=0.078
TC (mg/dl)	152.71±31.69	172.93±44.71	174.49±39.51	158.60±31.96	2.00 P=0.114
TG (mg/dl)	106.71±57.96	209.08±126.93	199.37±205.49	167.44±115.89	2.08 P=0.10
HDL (mg/dl)	38.42±5.12	37.18±4.28	36.22±6.12	36.24±5.79	1.20 P=0.307
LDL (mg/dl)	92.64±35.90	95.91±43.08	102.42±36.77	90.24±31.98	0.935 P=0.424
VLDL (mg/dl)	22.07±12.29	42.69±27.46	44.57±66.77	35.46±22.63	1.17 P=0.319

Table 3: Post HOC (BONFERRONI TEST) comparing the significant means of anthropometric and DBP in four groups.

	Age	DBP	HT	WT	BMI	WC	HC
Group I Vs Group II		p<0.001	p<0.001	p<0.001	p<0.001	P>0.05	p<0.001
Group I Vs Group III	p<0.05	P>0.05	P>0.05	p<0.001	p<0.001	p<0.05	P>0.05
Group I Vs Group IV	P>0.05	P>0.05	P>0.05	p<0.001	p<0.001	p<0.001	p<0.001
Group II Vs Group III	P>0.05	P>0.05	P>0.05	p<0.001	p<0.001	p<0.05	P>0.05
Group II Vs Group IV	P>0.05	p<0.05	p<0.05	p<0.001	p<0.001	p<0.001	p<0.001
Group III Vs Group IV	P>0.05	P>0.05	P>0.05	p<0.001	p<0.001	p<0.001	p<0.001

DBP was found highly significant with anthropometric measurements in between the classified groups.

Table 4: Correlation of Fasting insulin with Anthropometric and Biochemical Indices

		AGE	SBP	DBP	HT	**WT**	BMI	**WC**	HC	WHR	FBS	PPBS	SCr	**UA**	TC	TG	HDL	LDL	VLDL	HbA1c
FI	Pearson Correlation (r)	**.124***	.001	-.044	.057	**.127***	.078	**.135***	.108	.012	.093	.062	.055	**.175****	-.050	-.045	-.035	-.019	-.041	-.020
	Sig. (2-tailed)	**.044**	.992	.470	.352	**.039**	.205	**.028**	.078	.851	.132	.314	.373	**.004**	.420	.467	.568	.770	.502	.742
	N	**266**	266	266	266	**266**	266	**266**	266	266	266	266	266	**266**	266	266	266	249	266	266

* Correlation is significant at the 0.05 level (2-tailed). ** Correlation is significant at the 0.01 level (2-tailed).

Table 5: Correlation of Fasting insulin with BMI variations

	18.5-24.99 Kg/m2	25-29.99 Kg/m2	>30 kg/m2
FI Pearson correlation	.014	-.008	-.244
Sig. (2-tailed)	.869	.940	.157
N	133	88	35

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