ORIGINAL ARTICLE

Evaluation of Thyroid Profile and Complement 'C3' in Metabolic Syndrome

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Abstract

Diabetes mellitus (DM) is associated with thyroid dysfunction. The aim of this present study was to measure the level of thyroid hormones (FT_3, FT_4, TSH), FPG, PPG, HBA1C, Serum C3 in type II diabetic patients of either sex and to assess their clinical presentations and to compare and correlate the findings with males and females. In this **s**tudy, 177 type II diabetic subjects and 100 healthy control subjects were investigated for FT_3, FT_4, and TSH. FPG, PPG, HbA1C, and S. C3 complement were measured as supplementary parameters to predict the immune system. The level of TSH was significantly higher in type II diabetics as compared to control, but FT_3 and FT_4 did not show statistical significance. Significantly higher levels of FPG, PPG, HbA1C, and Serum C3 and were also noted but serum C3 showed a significant increase with some immune dysfunction compared to control subjects. Type II diabetes should undergo regular screening to detect asymptomatic thyroid dysfunction along with complement C3 and other biochemical parameters to improve the quality of life and reduce the complication rate.

Keywords: FPG, PPG, FT_3, FT_4, TSH, HbA1c, Serum complement C3.

Abbreviation: Free triiodothyronine (FT_3), Free tetraiodothyronine (FT_4), Thyroid stimulating hormone (TSH), Fasting plasma glucose (FPG), Postprandial plasma glucose (PPG), Glycated Haemoglobin (HbA1c), and Serum C3 complement (S. C3)

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Introduction

Diabetes mellitus (DM) is a metabolic disorder primarily characterized by increased glucose levels in the blood which is caused by impaired insulin secretion, insulin resistance and/or relative insulin deficiency resulting in abnormal metabolism. Every physician has always been challenging unabated complications related to the influence of other endocrine glands in the understanding and management of diabetes mellitus, despite great efforts been made the disease and its complications are well documented.[1-3] Abnormal thyroid hormone levels are always found in DM occasionally.[4] Diabetes and thyroid dysfunction are the most common metabolic-endocrine disorders with worldwide prevalence and serious complication in all groups of people with either sex. Cellular metabolism intimately involved in insulin and thyroid hormones, and thus deficit or excess of these hormones could result in the functional derangement of each other. Both insulin and iodothyronines influence their physiological and biochemical interrelationship on the metabolism of carbohydrates, proteins, and lipids are well established[5] which indicates that being diabetogenic, is a cause with high levels of iodothyronines which are insulin antagonists while the absence of iodothyronines inhibits the development of diabetes.[6] The major alterations in thyroid hormone in type II diabetes are a reduction in the TSH stimulation of the thyroid gland, probably caused by central hypothyroidism, and in the peripheral generation of T_3 from T_4. In addition, T_4 deiodination to T_3 in peripheral tissues is decreased.[7,8] Type II diabetes may induce a "low T_3 state" characterized by free T_3 levels and low serum total, but near normal serum T_4, increase in reverse T_3 (rT_3) and TSH concentrations.[9] The plasma T_3 levels studies determine or indicate the long term diabetic control.[10] Impaired TSH response to TRH or loss of normal nocturnal TSH peak may also result in suggesting poorly controlled diabetes. TSH responses and "low T_3 state" may normalize with improvement in glycemic status. Thyroid disease and DM are strongly associated, and this has important clinical implications for insulin sensitivity and treatment requirements. Both diabetes and thyroid dysfunction is also associated with a poor immune function, infection, inflammation process and activation of various responses in long term diabetes.

The complement system is a part of the innate immune system, made up of large diverse plasma proteins produced in the liver, gets activated when exposed to pathogenic infection. There is various relevant biological evidence suggest the functional role of the complement system in insulin resistance, beta cell dysfunction, beta cell deterioration, macrovascular and microvascular complications.[6] The innate immune system, including acute-phase reactants, contribute to the development of T2DM and the metabolic syndrome. It is hypothesized that the innate immune system modulates the effects of many factors, including genes, fetal programming, nutrition, and aging, upon the later development of metabolic problems associated with insulin resistance. Complement is the major plasma protein of the immune system complement pathway; high S. C3 levels are been reported in subjects with diabetes.[11] Lifestyle factors, such

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as stress, caloric restriction, and exercise, influence peripheral metabolism, the immune system of thyroid hormones apart from Hepatic and renal pathology induced subsequent injury resulting in consistent shifts in thyroid hormone profile. In this context, the levels of the thyroid may aggravate the complication of diabetes faster and silently. As the levels of thyroid hormones are not taken up on the routine practice. Therefore, finding a relation may help to know the disease process better and help in efficient treatment and assessment of the progression of complications. Therefore, this study aimed at measuring the level of thyroid hormones (FT_3, FT_4, TSH) in type II diabetic patients of either sex and to compare and correlate the findings with complement 'C3' system.

Materials and Methods

This is a case-control study carried out at Kannur Medical College (KMC), Kannur, Anjarakandy. The study was approved, and oral informed consent was obtained from the patients and normal subjects, before the study. Study included a group of 100 individuals consisting of 48 males and 52 females normal healthy subjects as controls matched with age, sex and ethnic background, who were the staff and relative/friends of patients attending the hospital and 177 diagnosed cases (100 males and 77 females) of type II DM irrespective of age taken from the OPD of Medicine Department (test group). After the oral informed consent was taken from the patient by communicating in either English or local language, 5 mL of venous blood drawn from the antecubital vein after an overnight fast with all antiseptic precautions, 2 mL is dispensed into fluoride container for estimation of blood glucose FPG, PBG by GOD-POD method,[12] and another 3 mL of blood was collected in heparinized vials for estimation serum Thyroid profile mainly free T_3,[13] free T_4,[14] TSH by chemiluminescence (CLIA).[15] Another 2 mL venous blood was for the estimation of complement C3 by turbidimetric immunoassay.[16] By kit from Agape diagnostic LTD, 4 mL in EDTA Vacuettes for HbA1C.[17] Blood samples will be centrifuged at 2000 rpm for 15 minutes. All the biochemical tests were done using the automated analyzer.

Statistical Analysis

The results obtained were statistically analyzed by using SPSS, version 20.0, continuous variables were presented as mean with standard deviations and then compared between different groups of the study by applying Independent't' test. The results were expressed as mean± SD and were taken as significant when the probability (p <0.05), (p <0.001) as a percentage of the observing values of 't' at a particular degree of freedom and Pearson's correlation analysis was performed.

Table 1: Demographic characteristics of type II diabetic subjects and control Group

Parameter	*Type II diabetic subjects N = 177*	*Control Group N = 100*
Age (Mean ± SD) years	68.58 ± 12.54	69.34 ± 14.11
Range (years)	31–90	31–90
(Males %)	56.50%	48.00%
(Females %)	43.50%	52.00%
Body mass index (Mean ± SD), kg/m^2	27.0 ± 2.9**	23.5 ± 1.7
Systolic blood pressure (mm of Hg)	126.74 ± 9.22*	112.43 ± 8.1
Diastolic blood pressure (mm of Hg)	94.18 ± 2.7*	82.12 ± 6.4

Values are given as Mean ± S.D from 177 subjects in test and 100 control group (**p<0.01- Highly Significant, *p <0.05 Significant)

Result and Observation

In the present study, 177 known diabetic patients with a family history of type II DM (100 males and 77 females) attending the diabetic OPD were compared with 100 normal controls (48 males, 52 females) were studied. Our results from Table 1 show the demographic characteristics and age and sex, BMI, BP (systolic and diastolic) distribution of type II diabetic subjects and control group. Both type II diabetic and control group included with a mean age of 68.58 ± 12.54 and 69.34 ± 14.11, respectively, with varying BMI 27.0 ± 2.9 in type II along with 23.5 ± 1.7. Table 2 shows the age distributions of the population under study, where the age is being represented according to the different age category of frequency distribution in both type II and control subjects as (31–50), (51–70) and (71–90). Table 3 shows the percentage distribution in Males and Females in the different age categories where 43.50% of males and females are in 51 to 70 years. category. Table 4 shows comparison of thyroid function test, BSL, HbA1C, S. C3 complement in T2DM and control groups along with various laboratory parameters where the serum levels of TSH were significantly elevated in type II diabetic subjects as compared to Control group but serum free T_3 and free T_4 did not show any statistical significance in diabetic subjects compared to the control group. Plasma glucose both FPG and PPG, HbA1c, S.C3 showed statistical significance when compared with the control group. Table 5 calculates the variation of Thyroid Function Test based on Gender in Type II Diabetic and Control groups where males and female fT3 and fT4, FPG, PPG, HbA1c, S. C3 values are not significant in when compared to control but except for TSH. Table 6 shows the distribution of thyroid disorder in T2DM and control group. Out of 177 type II diabetic subjects studied, 24 patients had subclinical hyperthyroidism followed by low T3 syndrome, subclinical hyperthyroidism, primary hypothyroidism, whereas no primary hyperthyroidism cases are noted.

Discussion

Hypothyroidism, hyperthyroidism and diabetes mellitus with the weak immune system are common endocrinopathies seen in the general diabetic population. There is inter-dependence between insulin and thyroid hormones for normal metabolism so that diabetes mellitus and thyroid diseases are associated and can mutually influence each other.[18] Patients with diabetes mellitus patients with thyroid dysfunction often land up in increased risk for complications.[19] An effort has been made in this study to evaluate the thyroid function in patients with type II diabetes mellitus, to look into their clinical presentation and compare and correlate with thyroid status and to see if gender has any impact in this study.

Table 2: Age wise distribution of population with its percentage

		Group category		
Age	*Range in Years*	*Control No of Persons*	*Type 2 DM Subjects (No of Persons)*	*Total*
	31–50	30 = 30%	42 = 23.72%	72 = 25.99%
	51–70	40 = 40%	77 = 43.50%	117 = 42.23%
	71–90	30 = 30%	58 = 32.76%	88 = 31.76%
Total		100 = 100%	177 = 100%	277 = 100%

Table 3: Distribution of males and females for sex matched study

		Group category					
		Age	*Control*	*Type-II DM Subjects*	*Total*	*Chi-square value*	*p value*
Age	Male	31-50	15	22	37		
		51-70	21	46	67		
		71-90	12	32	44		
	Total		48	100		2.073	0.656
Age	Female	31–50	15	20	35		
		51–70	19	31	50		
		71–90	18	26	44		
	Total		52	77			

Distribution of subjects and control according to gender wise, There is no significant difference in the gender ratio, between the two groups (Chi-square value is 2.073, $p = 0.656$) the study is sex matched

The prevalence of thyroid dysfunction greatly varies in different studies, Wazzan et al.[20] in their cross-sectional study reported 12.9% of abnormal thyroid dysfunction while Pasupathi et al.[4] reported 45% and Udiong et al.[21] reported 46.5%. In the current study, 53% of thyroid dysfunction is found among type II diabetes. This higher prevalence may be attributed to the mixed population, differences in socio-environmental and genetic factors, lifestyles factors and improper self-awareness could be some of the reasons for this variability.

There is a significant increase in the TSH values in type II diabetic subjects compared to the control as seen in Tables 4 and 5 and non-significant free T_3, free T_4 levels. This corresponds to a hypothyroid-like state. Moreover, this significant rise in TSH levels cannot be attributed to one specific mechanism as multiple factors influence thyroid status. The rise in TSH levels may be attributed to decrease TRH synthesis seen in diabetes which could be responsible for the occurrence of low thyroid hormone levels in diabetics[8,22] resulting in a significant increase in the TSH values in our study. Moreover, the relatively increased insulin levels present in type II diabetes mellitus patients due to the peripheral resistance which results in a hyperglycaemic state which results in a compensatory rise in the insulin secretion which is not so helpful in decreasing the hyperglycaemic state. This insulin excess may result in the overall decrease in thyroid hormone as it is known that insulin may increase the FT_4 level compared to the FT_3 level by inhibiting the hepatic conversion of T_4 to T_3 depressing the deiodinase enzyme activity thus causing the accumulation of FT_4 and decrease in FT_3 levels.[23] In response to this thyroid status by feedback mechanism, there is an increase in the TSH levels which is in relation to our study. This hypothyroid state accelerates the same process as both clinical and subclinical hypothyroidism have been known as insulin resistant states.[9,24,25] and which further aggravates the complications of diabetes and result in nephropathy, retinopathy, decreasing the immune system.[26-28] thus worsening the condition.

There is a significant elevation in S. C3 levels in type II subjects than controls (p <0.001) with poor glycemic control and susceptibility to infection (HbA1c >8.0%). There was a significant correlation of S. C3 with FPG, PPG, FT_3, FT_4, TSH, HbA1C, no significant difference in S. C3 between males and females in type II DM subjects ($p = 0.137$, $p = 0.142$). An independent association was obtained with estimated Insulin resistance with the levels of serum C3 with type II DM subjects in both men and women by Wlazlo et. al.[29] evaluated highly immune complement contribution

Table 4: Comparison of thyroid function test, BSL, HbA1c, S. C3 complement in control groups and type II diabetic subjects

Variables	*Group*	*No*	*Mean*	*SD*	*95% confidence interval for the Mean*		*"t" test p value*
					Lower	*Upper*	
Serum TSH (uIU/mL)	Control	100	3.15	1.09	2.85	3.05	<0.001
	Type-II DM subjects	177	8.79*	2.57	5.36	8.36	
Serum free T4 (ug/dL)	Control	100	5.80	0.79	3.48	6.02	0.79
	Type-II DM subjects	177	7.86 NS	0.23	4.86	8.02	
Serum Free T3 (ng/mL)	Control	100	1.14	0.55	1.0	1.28	<0.05
	Type-II DM subjects	177	0.76	0.15	0.62	0.82	
Fasting plasma glucose (FPG) (mg/dL)	Control	100	90.58	7.89	88.86	92.10	<0.001
	Type-II DM subjects	177	167.26**	39.82	128.36	163.28	
Postprandial glucose (PPG) (mg/dL)	Control	100	106.42	9.81	90.62	108.22	<0.001
	Type-II DM subjects	177	284.54**	43.16	188.41	279.56	
HbA1C (%)	Control	100	4.75	0.56	2.94	4.68	<0.001
	Type-II DM subjects	177	9.58**	1.23	7.86	9.48	
S. Insulin (uU/mL)	Control	100	7.23	1.67	5.38	7.80	<0.001
	Type-II DM subjects	177	27.41**	5.55	19.86	27.00	
S.C3 (mg/dL)	Control	100	108.74	9.92	83.57	106.89	<0.05
	Type-II DM subjects	177	199.87*	39.84	168.98	204.35	

Statically test were carried out by using independent sample t-Test, Values are given as mean ± S.D in each group. (*p <0.05-Significant, (**p <0.001-Significant, NS-Not significant)

Table 5: Variation of thyroid function test based on gender in type II diabetic and control groups

Investigations	*Gender*	*Type II diabetes mellitus*	*Control*	*t value*	*p value*
Serum TSH (uIU/mL)	Males Females	6.89 ± 2.77 7.46 ± 2.40	3.15±1.09	1.63	<0.05
Serum free T4 (ng/dl)	Males Females	7.23 ± 0.29^{NS} 7.29 ± 1.50^{NS}	5.80±0.79	–0.843 –0.824	0.403 0.416
Serum free T3 (pg/mL)	Males Females	0.36 ± 0.65NS 0.56 ± 0.82^{NS}	1.14±0.55	–9.444 –9.53	0.350 0.346
Fasting plasma glucose (FPG) (mg/dL)	Males Females	224.33 ± 54.26^{NS} 197.81 ± 94.71^{NS}	90.08 ± 6.89	–1.969 –2.010	0.055 0.051
Postprandial glucose (PPG) (mg/dL)	Males Females	254.04 ± 83.98^{NS} 301.46 ±101.89^{NS}	107.12 ± 8.81	–1.787 –1.801	0.080 0.078
HbA1C (%)	Males Females	8.4 ± 03.98^{NS} 9.06 ± 01.89 NS	4.75 ± 0.56	2.73	<0.001
S.Insulin (uU/mL)	Males Females	1.09 ± 0.60** 0.73 ± 0.30*	0.82 ± 0.17	2.861 2.775	0.006 0.010
S.C3 (mg/dL)	Males Females	29.38 ± 8.03^{NS} 26.31 ± 6.28 NS	23.06 ± 4.86	1.511 1.496	0.137 0.142

Values are given as Mean ± S.D in each group. (*p <0.05-Significant, (**p <0.001-Significant, ***p <0.01-Highly Significant, NS-Not significant)

to vascular diseases in type-II subjects. Immunoglobulins and S. C3 increase significantly in type II DM subjects than controls were hypothesized by Akinlade et al.,[30] Our results hypothesize that in type II DM impaired immune and inflammatory complement component S. C3 may affect insulin resistance and beta cell function, the inflammatory response also contributes to the pathogenesis of type-II DM. Moreover, our study also shows significant positive correlation values between FPG and PPG, F and HbA1c, FPG and S. C3, similar such correlation was also seen with PPG, FT_3 with FT_4, FT3 with TSH has a negative correlation, similar such correlation was also seen with FT_4, but the correlation fails to show any statistical significance. This may be attributed to the early duration of diabetes without adequate impairment of immune function to cause complications. It could also be due to altered dietary habits and age-related increase in serum C3 level.[31]

As diabetic cases of more than 5 years duration (from the 1st clinical diagnosis) is selected, both fasting and postprandial blood glucose concentration is significant in our study compared to the control (Tables 4 and 5). Though glycated hemoglobin was estimated in our study, along with the levels of high fasting and postprandial blood glucose concentration we can assume that the glycemic status of our patients was poor. Also considering the duration of diabetes we may conclude that both glycemic status and the duration of diabetes may play a role in the development of thyroid dysfunction.[32]

As shown in Table 6, both the males and females TSH, FT_3 and FT_4 values are not significant in when compared to control. Thus, Gender is not having an impact on our study. This may be attributed to the age group prevalence which predominantly had subjects in their 4th, 5th and 6th decade and also due to the prolonged duration of the illness.

In our study as seen from Table 5, out of the 177 type II diabetic subjects we have found 10% subclinical hyperthyroidism that consist of equal sex distribution followed by 46%, subclinical hypothyroidism, 36%, Primary hypothyroidism, 8% low T_3 syndrome. This finding is consistent with reports of Suzuki et al.[8] and Smithson et al.[33] But our study did not find any case of primary hyperthyroidism although subclinical hyperthyroidism was plenty, this may be attributed to the decreased sensitivity of the thyroid gland to TSH secretion seen in type II diabetes mellitus patients.[7,21]

Low T_3 syndrome can also be an important indicator of metabolic stress and indicates an impairment of extra-thyroidal peripheral metabolism on the body resulting in low T_3 levels.[34] We can also assume that sub-clinical hyperthyroidism and hypothyroidism as a result of early metabolic changes which may lead on to full-blown conditions of the same. It is seen that subclinical conditions are more dangerous than the full-blown disease as may be left unnoticed and cause early complications. Moreover, in our study clinical features of the primary hypothyroidism cases which was observed were atypical and non-specific with the predominant symptom presented was unexplained giddiness, weight loss and intolerance to heat with 43.8% and this may indicate that the thyroid dysfunction had occurred only for a very short duration for their symptoms to manifest or even the thyroid disease is being masked by the effects of diabetes mellitus silently. This is an even more grave situation which warrants the regular screening of diabetic individuals for thyroid diseases. The symptoms occurring of thyroid dysfunction in diabetic patients will help in a better understanding of the course of the disease and alert us about the early warning signs.

Our study fails to find correlations of thyroid profile parameters with fasting and postprandial blood sugar as seen in Table 6. This may suggest the absence or the minimal role of blood sugar concentration in thyroid dysfunction. This finding is in comparable to the study by Swamy et al.[6] Glycated hemoglobin with thyroid parameters was taken up to find the role of glycemic status in causing thyroid dysfunction, even its correlation did not suggest us any significant changes, moreover a correlation of the symptoms in diabetics with the thyroid levels will give us an insight into the progression of the disease in diabetic patients. This is the major reason for screening all type II diabetes patients for thyroid diseases. We can also get an idea about the modes of intervention for treating and prevention. Unknown morbidity for the diabetic patient can be effectively counteracted with proper insights in this association and will help them to live with the disease with less complication.

Table 6: Correlations coefficient (r) with Thyroid Profile, Fasting and Postprandial Glucose, HbA1C, and Serum C3

	FPG		*PPG*		*FT3*		*FT4*		*TSH*		*HbA1C*		*S.C3*	
Variables	*Pearsons correlation coefficient (r)*	*p value*	*Pearsons correlation coefficient (r)*	*p value*	*Pearsons correlation coefficient (r)*	*p value*	*Pearsons correlation coefficient (r)*	*p value*	*Pearsons correlation coefficient (r)*	*p value*	*Pearsons correlation coefficient (r)*	*p value*	*Pearsons correlation coefficient (r)*	*p value*
FPG	1	–	0.974**	<0.001	-0.294	–	0.071	-	–0.078	–	0.429**	<0.001	0.853**	<0.001
PPG	0.974**	<0.001	1	–	-0.292	–	0.320	-	0.044	–	0.438**	<0.001	0.839**	<0.001
FT3	–0.294	–	–-0.292	–	1	–	0.654**	<0.001	–0.539**	<0.001	0.041	–	0.049	–
FT4	0.071	–	0.320	–	0.654**	<0.001	1	–	–0.564**	<0.001	0.073	–	0.015	–
TSH	–0.078	–	0.044	–	-0.539**	<0.001	–0.564**	<0.001	1	–	0.017	–	–0.029	–
HbA1C	0.429**	<0.001	0.438**	<0.001	0.041	–	0.073	-	0.017	–	1	–	0.785**	<0.001
S.C3	0.853**	<0.001	0.839**	<0.001	0.049	–	0.015	-	–0.029	–	0.785**	<0.001	1	–

Pearson correlation analysis was done to determine the association of FPG, PPG, TSH, FT3, FT4, HbA1c, S. C3 levels
** Correlation is significant at the 0.001 level (2 tailed)
* Correlation is significant at the 0.05 level (2 tailed)

Hypothyroidism has an altered metabolism leading to DM. Hypothyroidism is characterized by impaired glucose absorption from the gastrointestinal tract and delayed peripheral glucose assimilation and gluconeogenesis, decreased or normal hepatic glucose output and decreased peripheral tissue glucose disposal.[9] Thyroid dysfunction might be either cause or consequence of complication in DM.[27]

Conclusion

Thyroid function tests in individuals with metabolic syndrome were done to explore the possibility of thyroid receptor resistance. TSH levels were measured as indicators of thyroid functions. There was an increase in TSH levels with normal T_3 and T_4 in group I indicating that increased TSH probably due to thyroid receptor resistance may be a part of a metabolic syndrome rather than a state of hypothyroidism. T_3 and T_4 levels were comparable in patients and controls. There was a significant increase in TSH levels in patients as compared to the controls. Our study shows a high incidence of abnormal thyroid hormone level among type II diabetic subjects. Thus, thyroid dysfunction (hypothyroidism) is significant in diabetes population compared to the normal population. Moreover, diabetes should be regularly screened for thyroid and immune profile as this study shows altered thyroid profile in diabetic subjects having no symptoms suggesting of thyroid dysfunction.

Further failure to detect the presence of abnormal thyroid hormone level in type II diabetes may be a cause of poor management or development of complication in type II diabetes. Increased serum complement C3 has been related to body fat mass, metabolic syndrome, and chronic diseases. The purpose of this study was to evaluate the levels of C3 in the subjects of normal weight obese as well as their possible relationships with metabolic syndrome and inflammation. Association of serum complements C3 with metabolic syndrome components in normal weight obese women. Increased serum complement C3 has been related to CVD, body fat mass, metabolic syndrome, and chronic inflammatory disorder.

Regular exercise and adequate diet restrictions improve the glycaemic status and insulin resistance state may have a role in thyroid dysfunction. Screening should also be made mandatory to detect asymptomatic thyroid dysfunction and other biochemical variables to improve the quality of life and increase life expectancy. Although a more elaborate study carried out on more number of subjects and various biochemical parameters would have been more enterprising in establishing the actual role and relationship between the two but the paucity of time, the limited resource may be taken as a limitation of our study as this was cross-sectional prospective cohort study. It is hoped that this study will encourage new studies related to the above topic in large scale.

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References

1. Bando U, Ushiogi Y, Toya D, et al. Diabetic nephropathy accompanied by iodine induced nonautoimmuneprimary hypothyroidism: two cases report. Endocrinol J 1999;46 (6):803-810.

2. Bergesio F, Bandini S, Cresci B, et al. Hyperthyroidism: Is it really the major factor affecting glucose tolerance in ureamia. Electrolyte Metab 1996;22(1-3):187-191.
3. Sperling MA, Jenson BK. Diabetes In: Nelson textbook of paediatrics 16th edition, USA:WB Saunders Company 2000; pp.1348-1349.
4. Pasupathi P, Bakthavathsalam G, Saravanan G, et al. Screening for thyroid dysfunction in the diabetic/non-diabetic population. Thyroid Science 2008; 3(8):1-6.
5. Dias CM, Nogueira P, Rosa AN, et al. Total cholesterol and high-density cholesterol in patients with insulin dependent diabetes mellitus. Acta Medica 1995;8:619-628.
6. Swamy RM, Kumar N, Srinivasa K, et al. Evaluation of hypothyroidism as a complication in Type II Diabetes Mellitus. Biomedical Research 2012;23(2):170-172.
7. Calvo R, Escobar MG, Rey EFet al. Maternal nonthyroidal illness and fetal thyroid hormone status, as studied in the streptozotocin-induced diabetes mellitus rat model. Endocrinol. 1997;138:1159-1169.
8. Suzuki J, Nanno M, Gemma R, et al. The mechanism of thyroid hormone abnormalities inpatients with diabetes mellitus. Nippon Niabunpi. Gakki. Zasshi 1994; 7(4): 465-470.
9. Donckier JE. Endocrine diseases and diabetes. In: Text book of Diabetes mellitus. Pickup JC, Williams G (eds), Blackwell Publishing Company, Chichester 2003:27.1-27.25.
10. Schlienger JL, Anceau A, Chabrier G, et al. Effect of diabetic control on the level of circulating thyroid hormones. Diabetologia. 1982;22;486-488.
11. Hertle E, Van Greevenbroek, MM, Stehouwer CD. Complement C3: An emerging risk factor in cardicometabolic disease . Diabetologia 2012,Apr;55(4):881-884.
12. Trinder P. Determination of glucose in serum, plasma and CSF, GOD/POD method. Ann Clin Biochem 1996; 6:24-27.
13. Nobre EL, Jorge Z, Prata S, et al. Profile of the thyroid function in a population with type-2 diabetes mellitus 2002:298-300.
14. Ramasamy V, Kadiyala R, Fayyaz F, et al. Value of a baseline serum thyrotropin as a predictor of hypothyroidism in patients with diabetes. Endocrine Practice 2010;14:1-25.
15. Beck-Pacozz P, Persani L. Variable biological activity of thyroid stimulating hormone. Europian journal of Endocrinol 1994;31: 331-340.
16. Serum complement C3 , Estimation. Agappe diagnostic LTD. Feb 2015.
17. Engbeak F, Christensens SE, Jespersen B. Enzyme immunoassay of hemoglobin A1C; Analytical characteristics & Clinical performance for patients with diabetes mellitus , with and without Uremia. Clin Chem 1989;35:93-97.
18. Sathish R, Mohan V. Diabetes and thyroid diseases - a review. Int J Diab Dev Countries 2003;23:120-123.
19. Hage M, Zantout MS, Azar ST. Thyroid disorders and diabetes mellitus. Journal of thyroid research 2011;2011:1-7.
20. Hessa T, Al Wazzan, Daban A, et al. Prevalence and associated factors for thyroid dysfunction among type 2 diabetic patients,kuwait. Alexandria bulletin 2010;46(2):141-148.
21. Udiong CE, Udoh AE, Etukudoh ME. Evaluation of thyroid function in Diabetes Mellitus in calabar, nigeria. Indian Journal of Clinical Biochemistry 2007;22(2):74-78.
22. De-Greef WJ, Rondeel JM, Van-Haasteren GA, et al. Regulation of TRH production and release in rats. Acta Medica Austriaca 1992;19(1):77-79.
23. Mannheim B. Extrathyroidal factor affecting thyroidhormone concentration. Rational approach to thyroiddiagnosis, GmbH, Boehringer Mannheim. 1984;2-4.
24. Cettour-Rose P, Theander-Carrillo C, Asensio C, et al., Hypothyroidism in rats decreases peripheral glucose utilisa-tion, a defect partially corrected by central leptin infusion. Diabetologia 2005; 48(4): 624-633.
25. Maratou E, Hadjidakis DJ, Kollias A, et al. Studies of insulin resistance in patients with clinical and subclinical hypothyroidism, European Journal of Endocrinology 2009;160(5):785-790.
26. Chen HS, Wu TEJ, Jap TS, et al. Subclinical hypothy-roidism is a risk factor for nephropathy and cardiovascular diseases in Type 2 diabetic patients. Diabetic Medicine 2007;24(12):1336-1344.
27. Den Hollander JG, Wulkan RW, et al. Correlation between severity of thyroid dysfunction and renal function. Clinical Endocrinology 2005;62(4):423-427.
28. Yang GR, Yang JK, Zhang L, et al. Association between subclinical hypothyroidism and proliferative diabetic retinopathy in type 2 diabetic patients: a case-control study. Tohoku Journal of Experimental Medicine 2010;222(4):303-310.
29. Wlazlo N, Marleen M.J. van Greevenbroek, Isabel Ferreira, Edith J.M. Feskens, et. al. Complement Factor 3 Is Associated With Insulin Resistance and With Incident Type 2 Diabetes Mellitus Over a 7-Year Follow-up Period: The CODAM Study. Diabetes Care 2014;4: 132804.
30. Akinlade KS, Arinola OG, Salimonu LS, et al. Circulating immune complexes, immunoglobulin classes (IgG, IgA and IgM) and complement components (C3, C4 and Factor B) in diabetic Nigerians. West Afr J Med 2004.
31. Musch W, Verfaillie L, Decaux G. Age-Related Increase in Plasma Urea Level and Decrease in Fractional Urea Excretion: Clinical Application in the Syndrome of Inappropriate Secretion of Antidiuretic Hormone. Clin J Am Soc Nephrol 2006;1:909-914
32. Islam S, Yesmine S, Khan SA, et al. A comparative study of thyroid hormone levels In diabetic and non-diabetic patients. Southeast Asian J Trop Med Public Health 2008;39(5):913-916.
33. Smithson, MJ. Screening for thyroid dysfunction in a community population of diabetic patients. Diabet Med 1998;15:148-150.
34. Roos A, Bakker SJ, Links TP, et al. Thyroid function is associated with components of the metabolic syndrome in euthyroid subjects. Journal of Clinical Endocrinology and Metabolism 2007;92:491-496.