ASSESSMENT OF THYROID PROFILE IN METABOLIC SYNDROME PATIENTS: AN OPD BASED OBSERVATIONAL CASE-CONTROL STUDY IN A TERTIARY HOSPITAL OF BHUBANESWAR, ODISHA

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ABSTRACT

Introduction: *Metabolic syndrome constitutes a cluster of risk factors characterized by abdominal obesity, hypertension, hyperglycemia, atherogenic dyslipidemia, prothrombotic and proinflammatory conditions. The prevalence of cardiovascular disease is 2–3 times higher in individuals with metabolic syndrome. Though this syndrome is highly prevalent in the developed countries, now it has a great tendency to encroach in developing countries like India. On the other hand, sub-clinical hyperthyroidism and overt hyperthyroidism are responsible for weight loss, fatigue, hyperglycemia, polyuria, polydipsia, atrial fibrillation, tachycardia, delirium, tremor, pretibial myxedema, etc. Similarly sub-clinical hypothyroidism and overt hypothyroidism are recognized risk factors for atherosclerotic cardiovascular disease, hyperlipidemia, low grade inflammation and hypercoagulability. Although metabolic syndrome and thyroid dysfunctions are established independent risk factors for cardiovascular disease, it is not clearly known whether there is any link between both entities. This study is an effort to investigate the association between metabolic syndrome & thyroid dysfunction.*

Aims and Objectives: *To estimate the thyroid hormones among the patients attending hospital with Metabolic Syndrome and to find out any relation from the result when was compared with the status of thyroid hormones of age-sex matched control group.*

Methodology: *In this cross-sectional, observational study, thyroid profiles were estimated in 150 metabolic syndrome patients of 30-60 age group as well as 150 age-sex matched normal individuals of same age group in the OPD of the Department of Medicine, Hi-Tech Medical College and Hospital, an urban area of Bhubaneswar, Odisha over a period of one and half year (September 2012 to February 2014).*

Result: *Though serum T_3 and T_4 levels are within the normal range but serum TSH level is remarkably increased of metabolic syndrome patients in comparison with that of the control group. And it is also observed that in the younger age group of metabolic syndrome patients, serum TSH levels are drastically increased in contrast to that of the same age group of controls.*

Conclusion: *From this study, we can draw a conclusion that the patients of metabolic syndrome have a tendency to produce a picture of sub-clinical hypothyroidism.*

Keywords: *Metabolic syndrome, Thyroid Profile, Central Obesity, Diabetic Profile, Lipid Profile, Hypertension, Subclinical hypothyroidism.*

INTRODUCTION

The metabolic syndrome is a constellation of metabolic derangements such as abdominal obesity, insulin resistance, hyperinsulinemia, impaired glucose tolerance, dyslipidemia, hypertension, and a proinflammatory and prothrombotic state.[1] It is a common cause of the development of atherosclerotic vascular disease and type 2 diabetes.[2]

It is estimated that around 20-25 percent of the world's adult population have the metabolic syndrome and they are twice as likely to die from and three times as likely to have a heart attack or stroke compared with people without the syndrome. In addition, people with metabolic syndrome have a fivefold greater risk of developing type 2 diabetes.[3] They would add to the existing 230 million people worldwide who already have diabetes[4], one of the most common chronic diseases worldwide and the fourth leading cause of morbidity and death in the developed world. The clustering of cardiovascular disease (CVD) risk factors that typifies the metabolic syndrome is now considered to be the driving force for a new CVD epidemic.

Each year, 3.2 million people around the world die from complications associated with diabetes. In countries with a high diabetic incidence, such as those in the Pacific and the Middle East, as many as one in four deaths in adults aged between 35 and 64 years is due to the disease. Type 2 diabetes, which accounts for 90 percent of all diabetes, has become one of the major causes of premature illness and death, mainly through the increased risk of CVD which is responsible for up to 80 percent of this deaths.[5, 6]

In most people with insulin resistance or type 2 diabetes, there is a multiple set of risk factors that commonly appear together, forming what is now known as the 'Metabolic Syndrome'. This 'clustering' of metabolic abnormalities that occur in the same individual appear to confer a substantial additional cardiovascular risk over and above the sum of the risk associated with each abnormality.[7, 8]

However, even before levels of blood glucose are high enough for a person to be diagnosed with diabetes, hyperglycaemia and related changes in

blood lipids (increase in triglycerides and decrease in the HDL-C) increase a person's risk of CVD.[8] The more components of the metabolic syndrome that are evident, the higher is the cardiovascular mortality rate.[9]

Obesity is one of the most important health risks of our time. The prevalence of obesity has increased worldwide since the mid 1970s. According to the National Health and Nutrition Examination Survey, obesity affected 32.2% of adults in 2003–2004 and reached a peak in subjects in the fifth decade of life.[10] Obesity is associated with an increased risk of diabetes, dyslipidemia, kidney disease, cardiovascular disease- all cause mortality, and cancer.[10] Thus, severe obesity is an important cause of premature mortality among middle-aged adults.[11] Moreover, obesity, especially central obesity, is linked to many endocrine abnormalities,[12] including thyroid dysfunction.[13]

Thyroid hormone plays an important role on various aspects of metabolism, development and differentiation of cells.[14] The thyroid gland secretes the thyroid hormones, thyroxine (T_4) and the more biologically active form triiodothyronine (T_3).[15] Thyroid disease, namely hypothyroidism and hyperthyroidism, constitutes the most common endocrine abnormality in recent years, diagnosed either in subclinical or clinical form.[16]

Thyroid disease is associated with various metabolic abnormalities, due to the effects of thyroid hormones on nearly all major metabolic pathways. Thyroid hormones regulate the basal energy expenditure through their effect on protein, carbohydrate, and lipid metabolism. This might be a direct effect or an indirect effect by modification of other regulatory hormones such as insulin or catecholamines.[17] Dyslipidemia is a common metabolic abnormality in patients with thyroid disease, either in the overt or subclinical forms of the disease, and constitutes the end result of the effect of thyroid hormones in all aspects of lipid metabolism leading to various quantitative and/or qualitative changes of triglycerides, phospholipids, cholesterol, and other lipoproteins.[18]

Thyroid dysfunction is defined as the altered serum thyroid stimulating hormone (TSH) level with normal or altered thyroid hormones [triiodothyronine (T_3) and thyroxin (T_4)]. Decreased level of the circulating blood TSH with increased levels of the circulating T_3 and T_4 is called overt hyperthyroidism whereas decreased level of the circulating blood TSH with normal levels of the circulating T_3 and T_4 is called subclinical hyperthyroidism. Increased level of the circulating blood TSH with decreased level of the circulating T_3 and T_4 is called overt hypothyroidism whereas increased level of the circulating blood TSH with normal levels of the circulating T_3 and T_4 is called subclinical hypothyroidism.

About 300 million people in the world are affecting from thyroid dysfunction and over half are presumed to be unaware of their condition.[19] According to American Association of Clinical Endocrinologists, over 27 million of Americans have some form of the thyroid disease with hypothyroidism being most prevalent among all thyroid dysfunctions.[20] It has been estimated that about 42 million of people in India suffer from thyroid diseases.[19]

Thyroid hormones profoundly influence the basal metabolic rate (BMR) of the body. Complete lack of the thyroid secretion can decrease the BMR to fall 40 to 50 percent below normal, and extreme excesses of thyroid secretion can increase the BMR to 60 to 100 percent above normal. Thyroid hormones play a vital role in cell differentiation during fetal development and help in maintain thermogenic and metabolic homeostasis in adult, so normally functioning thyroid is essential for the healthy living of an individual.[21]

Thyroid diseases are common clinical problems because these are associated with aging.[22] More over majority of the cases has subclinical hypothyroidism and easily pass unrecognized.[6] The American Thyroid Association recommends that adults be screened for thyroid dysfunction by measurement of the serum TSH concentration, beginning at the age of 35 years and every 5 years thereafter.[20]

Hence the study is undertaken to establish the effect of central obesity leading to metabolic syndrome on the thyroid hormones.

AIMS & OBJECTIVES

1. To estimate the thyroid hormones among the patients attending hospital with Metabolic Syndrome.
2. To find out any relation from the result when was compared with the status of thyroid hormones of age-sex matched control group.

MATERIALS AND METHODS

In this study, we have taken the patients of metabolic syndrome according to the definition and data from the International Diabetes Federation (IDF).[4] According to the new IDF definition, for a person to be defined as having the metabolic syndrome they must have:

- **Central obesity:** Waist circumference was measured at the midpoint between the lower costal margin and the highest point of the iliac crest at the end of normal expiration. If BMI is >30kg/m², central obesity can be assumed and waist circumference does not need to be measured.

Plus any two of the following two factors;

- **Raised triglycerides:** ≥ 150 mg/dL (1.7 mmol/L) or specific treatment for this lipid abnormality.
- **Reduced HDL cholesterol:** < 40 mg/dL (1.03 mmol/L) in males, < 50 mg/dL (1.29 mmol/L) in females or specific treatment for this lipid abnormality.
- **Raised blood pressure:** Systolic BP ≥ 130 or diastolic BP ≥ 85 mm Hg or treatment of previously diagnosed hypertension.
- **Raised fasting plasma glucose (FPG):** FPG ≥ 100 mg/dL (5.6 mmol/L), or previously diagnosed type 2 diabetes. If above 5.6 mmol/L or 100 mg/dL, Oral glucose tolerance test (OGTT) is strongly recommended but is not necessary to define presence of the syndrome.

Study design: This was a hospital-based, observational, cross-sectional, case-control study. The study design included a prospective component as biochemical evaluations were carried out once, in a single hospital visit.
Study area: The study was conducted at Hi-Tech Medical College and hospital, Bhubaneswar, India by the Department of Biochemistry in collaboration with the Department of Medicine.
Study population: Patients attending outpatient department (OPD) of Department of Medicine with Metabolic Syndromes were taken as cases. After obtaining informed consent, patients attending OPD of Department of Medicine were screened for Metabolic Syndrome as per International Diabetic Federation definition. Then the cases and controls were screened for inclusion and exclusion criteria. Those found to have metabolic syndrome were recruited in the study as cases. Age & sex matched healthy controls were recruited from relatives and peers of the patients, and persons attending OPD for routine health checkups in Hi-Tech Medical College & Hospital.

Inclusion criteria for Case:
- Known metabolic syndrome patients on regular checkup.
- Known diabetic patients with central obesity and hypertension.

Exclusion criteria for Case:
- Suffering from thyroid dysfunction or taking any sorts of medicines to improve thyroid function test.
- Suffering from disorders of the hypothalamic-pituitary-thyroid axis.
- Suffering from any chronic debilitating disease like malignancy, acute infection, trauma.
- Patients with known consumption of oestrogen, corticosteroid, iodine containing drugs.
- Pregnant women.

Criteria for Control:
- Apparently healthy subjects or persons attending OPD for routine health checkup with age group of 30-60 years.

Sample size: 150 cases and 150 controls were included in this study.
Study period: September 2012 to February 2014.

Parameters Studied:
Demographic Parameters: Age, Sex.
Anthropometric Parameters: Waist circumference, Height, Weight, Body Mass Index (BMI).
Blood Pressure: Systolic Blood Pressure (SBP), Diastolic Blood Pressure (DBP).
Biochemical Parameters: Lipid Profile (serum high density lipoprotein [HDL], low density lipoprotein [LDL], very low density lipoprotein [VLDL] and triglycerol [TG] levels), Diabetic Profile (Fasting Plasma Glucose [FPG], Post-Prandial Plasma Glucose [PPPG], and Glycosylated Haemoglobin [HbA1c]) and thyroid profile (Serum Triiodothyronine [T_3], Thyroxin [T_4] and Thyroid Stimulating Hormone [TSH]).

Collection and Preparation of Blood Sample: Blood samples were drawn from all subjects, both cases as well as healthy controls, after 12 hours overnight fasting. 10 ml of blood was drawn from each of them by venipuncture of the antecubital vein under strict aseptic condition using dry disposable syringe & needle. From collected blood, 7 ml was immediately transferred into vacutainer (without anticoagulant), 1.5 ml was transferred into another vacutainer containing sodium fluorides (10mg/ml blood), and rest 1.5 ml of blood was poured in vacutainer containing EDTA. First two groups of vacutainers were then allowed to stand for 30 minutes at room temperature. After 30 minutes, they were centrifuged at 3000 rpm for 10 minutes for serum separation. The supernatant serum was pipetted out from one vacutainer and was used for various biochemical assays immediately on the same day. And the third group i.e. vacutainer containing blood with EDTA mixed thoroughly by gentle shaking for 2 min.

The serum from vacutainer without anticoagulant was used to estimate serum total cholesterol, serum triglyceride, serum high density lipoprotein cholesterol, serum low density lipoprotein cholesterol, serum very low density lipoprotein cholesterol, serum thyroxine, serum free thyroxine, serum triiodothyronine, and serum thyroid

stimulating hormone. The serum and blood from vacutainers containing sodium fluorides and EDTA were used to estimate fasting blood glucose level and glycosylated haemoglobin respectively.

After taking these blood samples, the case and control group were asked to take meal. Just after 2 hours of completion of meal, another 2 ml of blood was taken from the antecubital vein of other side under strict aseptic condition using dry disposable syringe & needle. This 2 ml of blood was transferred again into vacutainer containing sodium fluorides. It was then allowed to stand for 30 minutes at room temperature. After 30 minutes, it was centrifuged at 3000 rpm for 10 minutes for serum separation. The supernatant serum was pipetted out for the estimation of post-prandial blood glucose level.

Total lipid profile; FPG and PPPG were estimated by auto-analyzer ERBA EM-200. HbA1c was determined by Bio-Rad D-10 Dual Program automatic analyzer.[23-26] Serum T_3, T_4 and TSH levels were determined by electrochemiluminescence immunoassay using a Cobas auto-analyzer (Roche Diagnostics).[27-39]

Methods for collection of other data: A pre-designed, pre-tested, semi-structured questionnaire was used to collect various socio-demographic data like name, age, sex, address along with data about physical examination and clinical history.

Heights were measured in centimeter scale using a stadiometer; fraction values were approximated to the nearest centimeter. Weights were taken in kilograms using a calibrated weighing machine and fractions were approximated to its nearest kilogram. Body Mass Index (BMI) or the "Quetelet Index" was calculated as per the formula of Adolphe Quetelet.

Blood pressure (BP) was measured (in mm of Hg) using a mercury sphygmomanometer and a standard cuff in the arm. The average of three measurements was recorded as final recording.

According to the World Health Organization's data gathering protocol,[40] the waist circumferences were measured at the midpoint between the lower margin of the last palpable rib and the top of the iliac crest, using a stretch-resistant tape that provides a constant 100 g tension. Hip circumferences were measured around the widest portion of the buttocks.[40] In these measurements, the tape was parallel to the floor. For both measurements, the individual was stood with feet close together, arms at the side and body weight evenly distributed, and little clothing to be put on. The subjects were relaxed, and the measurements were taken at the end of a normal expiration. Each measurement was repeated twice; if the measurements were within 1 cm of one another, the average was calculated. If the difference between the two measurements exceeds 1 cm, the two measurements were repeated.[41] Waist-Hip Ratio (WHR) is used as a measurement of obesity, which in turn is a possible indicator of other more serious health conditions. WHO STEPS states that abdominal obesity is defined as a waist–hip ratio above 0.90 for males and above 0.85 for females, or a body mass index (BMI) above 30.0.[42]

STATISTICAL METHODS

The data collected was checked for error, cleaned and double entered into MS-Excel spread sheets and checked for any entry error. Then the whole data was imported into IBM SPSS Statistics (version 20.0) and further analysis was done. Data was first summarized and then analyzed for test of significance e.g. chi-square test, independent sample student t-test wherever applicable using the software package. P value less than 0.05 was taken as significant. The whole procedures involved were transcription, preliminary data inspection, content analysis and interpretation.

ETHICAL ISSUES

There was no associated risk or chance of harm to study subject other than the minimal risk associated with phlebotomy. However phlebotomy was done using disposable syringe & needle with complete aseptic measures and under direct supervision to minimize risks. Every subject was observed for an hour for any complication after phlebotomy.

The protocol of the study was approved by the Institutional Ethics Committee (IEC) for Human Research, Hi-Tech Medical College & Hospital, Bhubaneswar. Voluntary informed consent was taken from all participants in a consent form that was reviewed & approved by the IEC. Consents were taken by principal researcher himself. All participants were clearly explained that they reserve the right to withdraw from the study at any time they choose. A copy of the consent form was given to each participant. The study was continuously being monitored by the IEC during the study period.

No internal/ external funding/ grant were received for the study. It was solely funded by principal investigator himself. No conflict of interest was there to be declared.

RESULTS & ANALYSIS

The study was conducted at Hi-Tech Medical College & Hospital, Bhubaneswar under the Department of Biochemistry in association with the Department of Medicine. 150 patients suffering from metabolic syndrome were enrolled in the study as cases, after obtaining informed consent. Another 150 age & sex matched healthy controls were also included for comparison purpose.

Table 1: Age distribution between Case & Control group

Group	Total No.	Maximum age (Yrs.)	Minimum age (Yrs.)	Mean age (Yrs.)	Standard deviation	Standard error of mean
Case	150	58	37	46.6	5.2	0.737
Control	150	59	37	48.6	5.2	0.737

Among the cases, 66% of them were females and remaining 34% were males. Female to male ratio was 1.94:1. The minimum age recorded among the cases was 37 and the maximum was 58. The mean (±SD) age of cases was 47.7 (±5.2). Among the controls, 68% of were females and 32% were males; female to male ratio was 2.1:1. Minimum age recorded among the control group was 37 and maximum was 59. The mean (±SD) age of control group was 49.5 (±5.2).

Table 2: Age & sex distribution between Case & Control group

Parameters		Case		Control		x^2 value & d. f.	P value	Inference
		No.	(%)	No.	(%)			
Sex	Female	99	(66%)	102	(68%)	x^2= 0.162; d. f. =1	0.687	Matched
	Male	51	(34%)	48	(32%)			
Age (Yrs.)	30 to 40	36	(24%)	30	(20%)	x^2= 0.045; d. f. =2	0.832	Matched
	40 to 50	72	(48%)	60	(40%)			
	50 to 60	42	(28%)	60	(40%)			

Table 2 is showing the distribution of age and sex between case and control groups. Chi-square test shows the difference in male and female distribution between both groups were statistically insignificant (P= 0.687); similarly the difference in age distribution between groups were also insignificant (P= 0.832).

Height, weight, waist circumference (WC), and hip circumference (HC) were recorded for each subject. Body mass index (BMI) and waist-hip ratio (WHR) were calculated from collected data. BMI was calculated by [weight in kilogram / (height in meter)^2]. Then the data was summarized by calculating the mean and SD for each parameter in both the group differently. Table 3 is showing the summarized data on anthropometric parameters and blood pressure for both groups.

Table 3: Summarized data on anthropometric parameters for Case and Control groups

Group	Parameters	Minimum	Maximum	Mean	SD
Case (n=150)	Height (cm)	147.3	186.7	165.9	8.8
	Weight (Kg)	63.4	103.0	82.2	9.5
	BMI (Kg/m^2)	27.8	31.7	29.8	1.1
	WC (cm)	81.7	104.2	91.2	7.2
	HC (cm)	86.4	117.3	101.2	7.1
	WHR	0.86	0.98	0.9	0.03
Control (n=150)	Height (cm)	149.9	185.4	166.1	9.6
	Weight (Kg)	51.4	93.1	66.2	11.2
	BMI (Kg/m^2)	21.6	27.8	23.8	1.4
	WC (cm)	74.6	87.9	79.6	4.4
	HC (cm)	91.3	109.1	99.6	5.1
	WHR	0.72	0.88	0.80	0.04

The means of the both case and control groups were compared and tested by independent sample t test for statistical significance. The mean height of the controls were slightly higher than cases, but it is not significant (P= 0.949). Slightly larger hip circumference was seen among cases, but this was also not significant (P= 0.192). However, significantly higher weight (P< 0.001), BMI (P< 0.001), waist circumference (P< 0.001), and waist-hip ratio (P< 0.001) were observed among cases in comparison to the control group. Table 4 describes the comparison of anthropometric parameters and blood pressure between both groups.

Table 4: Comparison of anthropometric parameters between Case and Control groups

Parameters	Mean		T statistics	P value	95% C.I. of difference	
	Case	Control			Lower	Upper
Height (cm)	165.9	166.1	-0.064	0.949	-3.77	3.53
Weight (Kg)	82.2	66.2	7.725	<0.001*	11.95	20.20
BMI (Kg/m^2)	29.8	23.8	24.02	<0.001*	5.49	6.48
WC (cm)	91.2	79.6	9.71	<0.001*	9.20	13.95
HC (cm)	101.2	99.6	1.31	0.192	-0.83	4.07
WHR	0.9	0.8	12.92	<0.001*	0.084	0.114

* Difference between groups is significant.

SBP and DBP were recorded for each subjects of both case and control groups. Table 5 is showing the summarized data on anthropometric parameters and blood pressure for both groups.

Table 5: Summarized data on blood pressures between Case and Control groups

Group	Parameters	Maximum	Minimum	Mean	SD
Case (n=150)	SBP (mm of Hg)	120	150	135.4	6.9
	DBP (mm of Hg)	72	96	85.1	5.0
Control (n=150)	SBP (mm of Hg)	112	138	128.4	6.3
	DBP (mm of Hg)	70	90	81.8	5.6

Among the cases, 123 (82%) were on anti-hypertensive therapy, but 27 (18%) and total control group did not take any antihypertensive drugs. The means of SBP and DBP the both case and control groups were compared and tested by independent sample t test for statistical significance. Significantly higher SBP (P<0.001) and DBP (P= 0.003) were observed among cases in comparison to the control group. Table 6 describes the comparison of blood pressures between both groups.

Table 6: Comparison of blood pressures between Case and Control groups

Parameters	Mean		T statistics	P value	95% C.I. of difference	
	Case	Control			Lower	Upper
SBP (mm of Hg)	135.4	128.4	5.321	<0.001*	4.42	9.67
DBP (mm of Hg)	85.1	81.8	3.086	0.003*	1.17	5.39

* Difference between groups is significant.

The serum lipid profile was estimated for both cases and controls. The mean (±SD) of serum total cholesterol was 211.9 (±42.6) mg/dl among cases in contrast to 174.2 (±5.9) mg/dl among controls. The mean (±SD) of serum HDL-C was 39.5 (±5.6) mg/dl in the case group whereas 56.8 (±4.3) mg/dl in the control group. The mean (±SD) of serum triglyceride among the cases and controls were 229.3 (±120.3) mg/dl and 127.3 (±10.7) mg/dl respectively. Table 7 is showing the summarized data of lipid profile of case and control groups.

Table 7: Summarized data of parameters of lipid profile of Case and Control groups

Group	Parameters	Minimum	Maximum	Mean	SD
Case (n=150)	Total Cholesterol (mg/dl)	162	299	211.9	42.6
	HDL-C (mg/dl)	28	48	39.5	5.6
	LDL-C (mg/dl)	98	178	126.8	23.2
	VLDL-C (mg/dl)	22	97	45.8	24.0
	TG (mg/dl)	112	487	229.3	120.3
Control (n= 150)	Total Cholesterol (mg/dl)	164	185	174.2	5.9
	HDL-C (mg/dl)	51	65	56.8	4.3
	LDL-C (mg/dl)	84	98	92.0	3.9
	VLDL-C (mg/dl)	21	29	25.5	2.1
	TG (mg/dl)	103	148	127.3	10.7

The mean (±SD) of serum LDL-C among the cases and controls were 126.8 (±23.2) mg/dl and 92.0 (±3.9) mg/dl respectively. And the mean (±SD) of serum VLDL-C was 45.8 (±24.0) mg/dl among the cases in contrast to 25.5 (±2.1) mg/dl respectively.

Among the cases, 102 (68%) were on the medication to improve the lipid profile, and rest 48 (32%) of cases and the total control group did not take any such medication.

The differences in various parameters of lipid profile were checked for statistical significance by independent sample t test. Table 8 shows the comparison of lipid profile parameters between both the groups.

Table 8: Comparison of lipid profile parameters of Case and Control groups

Parameters	Mean		T statistics	P value	95% C.I. of difference	
	Case	Control			Lower	Upper
Total Cholesterol (mg/dl)	211.9	174.2	6.2	<0.001*	25.4	49.9
HDL-C (mg/dl)	39.5	56.8	-17.3	<0.001*	-19.2	-15.3
LDL-C (mg/dl)	126.8	92.0	10.4	<0.001*	28.0	41.4
VLDL-C (mg/dl)	45.8	25.5	6.0	<0.001*	13.4	27.1
TG (mg/dl)	229.3	127.3	6.0	<0.001*	67.7	136.3

* Difference between groups is significant.

The mean of serum total cholesterol, HDL-C, LDL-C, VLDL-C, and TG – all the parameters of lipid profile are more in cases than controls and are statistically strongly significant (all p value <0.001) between cases and controls.

The glycemic profile was estimated in both case and control groups. Here the glycemic profile is consists of FBS, PPBS, and HbA_{1c}. In serum FBS, the mean (±SD) were 126.0 (±11.4) mg/dl in cases and 117.0 (±7.6) mg/dl in controls. In case of serum PPBS, the mean (±SD) were 156.9 (±31.3) mg/dl and 138.4 (±7.1) mg/dl in the cases and control group respectively. The summarized data of glycemic profile of case and control groups is shown in table 9.

Table 9: Summarized data of parameters of glycemic profile of Case and Control groups

Group	Parameters	Minimum	Maximum	Mean	SD
Case (n=150)	FBS (mg/dl)	108	151	126.0	11.4
	PPBS (mg/dl)	122	287	156.9	31.3
	HbA_{1c}	6.5	8.3	7.2	0.48
Control (n= 150)	FBS (mg/dl)	101	128	117.0	7.6
	PPBS (mg/dl)	123	149	138.4	7.1
	HbA_{1c}	6.0	6.4	6.2	0.14

The anti-diabetic drugs were taken by 117 (78%) of the cases, whereas the remaining 33 (22%) and total control group did not take any sort of anti-diabetic drugs.
Again the differences in parameters of glycemic profile were checked for statistical significance by independent sample t test. Table 10 shows the comparison of glycemic profile parameters between both the groups.

Table 10: Comparison of parameters of glycemic profile of Case and Control groups

Parameters	Mean		T statistic	P value	95% C.I. of difference	
	Case	Control			Lower	Upper
FBS (mg/dl)	126.0	117.0	4.6	<0.001*	5.1	12.8
PPBS (mg/dl)	156.9	138.4	4.1	<0.001*	9.4	27.6
HbA_{1c}	7.2	6.2	14.1	<0.001*	0.8	1.1

* Difference between groups is significant.

Here, the mean of serum FBS & PPBS and HbA_{1c} – all the parameters of glycemic profile are more in the cases than controls and are statistically strongly significant (all p value <0.001) between cases and controls.
Now, serum T_3, T_4 and TSH levels were estimated in case and control groups. The data are summarized in table 11.

Table 11: Summarized data of parameters of thyroid profile of Case and Control groups

Group	Parameter	Minimum	Maximum	Mean	SD
Case (n=150)	T_3 (µg/dl)	0.53	1.80	1.17	0.35
	T_4 (µg/dl)	4.8	8.4	6.4	0.98
	TSH (mIU/l)	9.1	15.2	11.7	1.51
Control (n= 150)	T_3 (µg/dl)	0.54	1.80	1.17	0.34
	T_4 (µg/dl)	4.8	8.1	6.4	0.91
	TSH (mIU/l)	2.2	5.6	4.3	0.86

In case group, the mean (±SD) of serum T_3, T_4 and TSH levels were 1.17 (±0.35) µg/dl, 6.4 (±0.98) µg/dl and 11.7 (±1.51) mIU/l respectively. And in control group, the mean (±SD) of serum T_3, T_4 and TSH were 1.17 (±0.34) µg/dl, 6.4 (±0.91) µg/dl and 4.3 (±0.86) mIU/l respectively. Now, the differences in parameters of thyroid profile were checked for statistical significance by independent sample t test.
Here both the cases and control groups were not any medication which improves the thyroid profile status. Table 12 shows the comparison of thyroid profile parameters between both the groups.

Table 12: Comparison of parameters of thyroid profile of Case and Control groups

Parameters	Mean		T statistic	P value	95% C.I. of difference	
	Case	Control			Lower	Upper
T_3 (µg/dl)	1.17	1.17	0.08	0.94	-0.13	0.14
T_4 (µg/dl)	6.4	6.4	0.27	0.78	-0.32	0.43
TSH (mIU/l)	11.7	4.3	30.09	<0.001*	6.92	7.91

* Difference between groups is significant.

From this comparison, the mean of serum T_3 and T_4 of cases and controls are not statistically significant, but the mean of serum TSH are more in cases than controls and is statistically strongly significant (p <0.001) between cases and controls.
When this thyroid profile was compared with the lower age group of cases i.e. 30-40 years and that age group of control, the summarized data are given in table 13.

Table 13: Summarized data of parameters of thyroid profile of Case and Control groups in 30-40 years age group

Group	Parameter	Minimum	Maximum	Mean	SD
Case (n=36)	T_3 (µg/dl)	0.48	1.36	1.04	0.32
	T_4 (µg/dl)	4.6	8.7	6.7	0.93
	TSH (mIU/l)	7.9	10.4	9.1	1.32
Control (n= 30)	T_3 (µg/dl)	0.52	1.51	1.11	0.31
	T_4 (µg/dl)	4.5	8.2	6.2	0.82
	TSH (mIU/l)	2.4	5.9	4.7	0.81

In case group, the mean (±SD) of serum T_3, T_4 and TSH were 1.04 (±0.32) µg/dl, 6.7 (±0.93) µg/dl and 9.1 (±1.32) mIU/l respectively. And in control group, the mean (±SD) of serum T_3, T_4 and TSH were 1.11 (±0.31) µg/dl, 6.2 (±0.82) µg/dl and 4.7 (±0.81) mIU/l respectively. Now, the differences in parameters of thyroid profile were checked for statistical significance by independent sample t test. Table 14 shows the comparison of thyroid profile parameters between both the groups.

Table 14: Comparison of parameters of thyroid profile of Case and Control groups in 30-40 years age group

Parameters	Mean		T statistic	P value	95% C.I. of difference	
	Case	Control			Lower	Upper
T_3 (µg/dl)	1.04	1.11	0.07	0.82	-0.11	0.17
T_4 (µg/dl)	6.2	6.7	0.29	0.62	-0.35	0.41
TSH (mIU/l)	9.1	4.7	31.12	0.004*	7.12	7.96

* Difference between groups is significant.

Now, from this comparison in the above table, the mean of serum T_3 and T_4 of cases and controls in the 30-40 years age group are not statistically significant also, but the mean of serum TSH are more in cases than controls and is statistically significant (p= 0.004) between cases and controls.

DISCUSSION AND CONCLUSION

From this study, it is observed that serum T_3 and T_4 levels in metabolic syndrome patients are almost in the same levels in comparison to that of the normal individuals, but in case of serum TSH levels are in higher side in the metabolic syndrome patients in contrast to controls and it is statistically proven. So it is clear from this study that the metabolic syndrome has a great tendency to bring on sub-clinical hypothyroidism. Another important finding of this study is there is a trend of presence of metabolic syndrome in the lower age group i.e. even in 30-40 years age group. And in this age group, the serum TSH concentration is increased in contrast with the control group.

In comparison purpose, it is evident that serum TSH level is marked increased in lower age group those who are prone to metabolic syndrome. So, we must keep in mind that when we come across the patients having metabolic syndrome in OPD or in IPD, we have to estimate the thyroid profile routinely, whether it may be younger or older age group; and we should start the treatment of thyroid dysfunction precisely treatment of subclinical hypothyroidism simultaneously with the treatment of metabolic syndrome.

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