Haematological Profile and Body Composition In Hypothyroid Patients

Sudhir Modala[1], Usha Dhar[2], K V Thimmaraju[3], Manisha Baghel[4], Bandi Hari Krishna[5]

ABSTRACT

Introduction: Hypothyroidism is characterized by a broad clinical spectrum ranging from an overt state of myxedema, end-organ effects and multisystem failure to an asymptomatic or subclinical condition with normal levels of thyroxine and triiodothyronine and mildly elevated levels of serum thyrotropin. Thyroid hormone is involved in hemoglobin synthesis in adults and maturation of hemoglobin in fetus and by affecting hematopoietic process, hypothyroidism results in anemia through slowing the oxygen process. Therefore in this study, we planed to assess the haematological profile in hypothyroid patients and haematological changes.

Material and Methods: This is a cross sectional with four groups. Group 1 (n=37): Newly diagnosed hypothyroid subjects, Group 2 (n=37): Hypothyroid subjects with < 5 years, Group 3 (n=37): Hypothyroid subjects with > 5 years, Group 4 (n=37): Controls.

Results: There was significant difference in Vit B12, Folic acid, Hb%, HCT, WBC count, Platelet count, RDW%, MCH, MCHC. But there was no significant difference in RBC count, MPV, MCV. However, there was significant difference in Vit B12), Folic acid, HB%, WBC count, MPV, Platelet count, RDW%, MCH, MCHC of newly diagnosed hypothyroids when compared to controls. In hypothyroids with less than five years of history and in medical treatment, there was significant difference in Folic acid, HB%, HCT, MPV, Platelets, RDW% when compared to controls. Further, the Folic acid, HCT, MPV, Platelets, RDW% in hypothyroids with history of more than five years without regular treatment between group when compared to controls. Correlation analysis showed significant association of visceral fat with vitamin B12 in newly diagnosed hypothyroid subjects (r = - 0.23), and total leukocyte count (r = -0.42) in newly diagnosed hypothyroid subjects.

Conclusions: The body fat distribution and hematological parameters was altered in hypothyroidism and there was significant association between visceral fat and Vitamin B12 in newly diagnosed hypothyroidism. Further, there was no restoration in individuals with irregular treatment.

Keywords: Hypothyroidism, Anaemia, Body Composition, Visceral Fat

INTRODUCTION

Thyroid disorders are amongst the most prevalent of medical conditions. Their manifestations vary considerably from area to area and are determined principally by the availability of iodine in the diet. Epidemiological studies of thyroid dysfunction have limitations, for example the definition of overt hypothyroidism and subclinical hypothyroidism, the selection criteria of the sample used, the influence of age, sex, genetic and environmental factors and the different techniques used for the measurement of thyroid hormones and the relative paucity of incidence data.

Hypothyroidism is characterized by a broad clinical spectrum ranging from an overt state of myxedema, end-organ effects and multisystem failure to an asymptomatic or subclinical condition with normal levels of thyroxine and triiodothyronine and mildly elevated levels of serum thyrotropin. The prevalence of hypothyroidism in the developed world is about 4-5%.[1,2] In India, hypothyroidism was usually categorized under the cluster of iodine deficient disorders (IDDs), which were represented in terms of total goiter rates and urinary iodine concentrations, typically assessed in school-aged children.[3-5] Ever since India adopted the universal salt iodization program in 1983[6], there has been a decline in goiter prevalence in several parts of the country, which were previously endemic.[7-9] The prevalence of hypothyroidism was high, affecting approximately one in 10 adults in the study population.[10] Female gender and older age were found to have significant association with hypothyroidism. Metabolic abnormalities associated with hypothyroidism include anemia.[11] The prevalence of anemia and haematological abnormalities in patients with hypothyroidism has been shown to be 20-60%.[12] Thyroid dysfunction is usually associated with body weight and subclinical hypothyroidism is more frequently associated with weight gain.[13]

Anemia is a decrease in number of red blood cells (RBC's) or less than the normal quantity of hemoglobin in the blood. Anemia can have several reasons, such as, abnormality of the formation and reduction on the half life time of the red cells. The size is reflected in mean corpuscular volume (MCV). The prevalence of anemia in patients with hypothyroidism has been shown to be 20-60%. Thyroid hormone is involved in hemoglobin synthesis in adults and maturation of hemoglobin in fetus and by affecting hematopoietic process, hypothyroidism results in anemia through slowing the oxygen process.

Therefore in this study, we planed to assess the haematological profile in hypothyroid patients and haematological changes.

MATERIAL AND METHODS

This was a cross sectional study with four groups.
Group 1 (n=37): Newly diagnosed hypothyroid subjects,
Group 2 (n=37): Hypothyroid subjects with < 5 years,
Group 3 (n=37): Hypothyroid subjects with > 5 years,
Group 4 (n=37): Controls.

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Sample size was calculated based with expected correlation between visceral fat and haematological changes will be 0.56. In order to show that this is significantly different from 0 (no correlation) at alpha error 5% (0.05) and power 90%, with 2 sided test, we need to study 37 subjects in each group.

Inclusion criteria: Age: 18 – 40 years, Gender: Both male and female, Hypothyroid subjects.

Exclusion criteria: Hyperthyroid subjects, Morbid obese, chronic alcoholism, Chronic Smoking, pregnant, lactating women, kyphosis, scoliosis.

The study was approved by Institute ethics committee. After getting clearance from institute ethics committee, written informed consent was obtained from all the participants. All experiments were performed at research laboratory in the Dept of Physiology, Rohilkhand Medical College, Bareilly.

Recording of anthropometric and basal parameters: Participants were instructed to empty their bladder prior to anthropomorphic measurements. Height was measured by using a stadiometer in the upright position and weight was measured on a weighing machine. BMI was calculated by weight (Kg) divided by the square of height in meters. The Waist Circumference was measured as the minimum Circumference between the costal margin and iliac crest, measured in horizontal plane, with the subject standing. Hip circumference was measured as the maximum circumference in the horizontal plane, measured over the buttocks. The ratio of the former to the latter (Waist-Hip ratio) provides an index of proportion of intra-abdominal fat. After a 15-minutes of acclimitazation period, BP was measured 3 times to the nearest of 2 mm Hg in the sitting position, using a mercurial sphygmomanometer and appropriately sized cuffs. The average of 3 measurements was used to calculate systolic and diastolic BPs; mean BP will be calculated as the diastolic value plus one third of the pulse pressure value. Resting heart rate would be recorded by using 12 lead ECG. The rate pressure product was calculated by multiplying HR by SBP and dividing by 100 (RPP = (HR XSBP)/100).

Measurement of Body composition: Body fat distribution was measured by using body fat analyzer Omron HBF 375, working under the principle of bioelectrical impedance analysis (BIA).

5ml of blood was collected and processed for haematological profile and thyroid profile.

STATISTICAL ANALYSIS

Statistical analysis was performed using the Statistical Package R for windows. The data expressed as mean ± SD. Normality was tested with Kolmogorov–Smirnov test. To study the between group differences, ANOVA with post hoc test was used. To study the association of visceral fat with pulmonary function and haematological changes, pearson's correlation was used. The null hypothesis was rejected at P≤0.05.

RESULTS

The baseline and anthropometric parameters of controls, newly diagnosed hypothyroids, known hypothyroids with regular standard medical treatment of less than five years and more than five years without regular treatment were given in Table 1.

As shown in Table 1, there was no significant difference between age (p< 0.576) and height (p<0.063) of the study participants. Significantly difference in weight (p<0.000), BMI (p<0.000), Heart rate (p<0.000), blood pressure (SBP p<0.000, DBP p<0.022) and rate pressure product (p<0.000) were seen. Further, there was significant difference in weight (p<0.05), BMI (p<0.05), SBP (p<0.05), PP (p<0.05), RPP (p<0.05), MAP (p<0.05) and HR (p<0.05) in newly diagnosed hypothyroids and hypothyroids with history of more than five years without regular treatment when compared to controls.

Table 2 shows the between groups and within group differences of fT3 (p<0.000), fT4 (p<0.000), TSH (p<0.000), total body fat (p<0.000) and visceral fat (p<0.001). But there was no significant difference in subcutaneous fat (p<0.07). The levels of fT3 (p<0.05), fT4 (p<0.05) and TSH (p<0.05). Further, there was significant difference in total body fat (p<0.05), and visceral fat (p<0.05), in newly diagnosed hypothyroids and hypothyroids with history of more than five years without regular treatment between group when compared to controls.

As shown in Table 3, there was significant difference in Vit B12 (p<0.000), Folic acid (p<0.000), Hb% (p<0.000), HCT (p<0.000), WBC count (p<0.000), Platelet count (p<0.000), RDW% (p<0.000), MCH (p<0.000), MCHC (p<0.000). But there was no significant difference in RBC count (p<0.130), MPV (p<0.708), MCV (0.549). However, there was significant difference in Vit B12 (p<0.05), Folic acid (p<0.05), HB%

parameter	Control group (n=37)	Newly diagnosed (n=37)	Less than 5yrs (n=37)	More than 5 Yrs (n=37)	P value (ANOVA)
	30.30±3.61	29.43±4.42	30.54±3.61	29.49±5.02	0.576
Height (cm)	158.43±5.47	159.76±5.63	159.59±5.28	160.08±4.04	0.063
Weight(kg)	57.59±3.48	68.03±6.54*	58.05±4.74	62.54±6.91#	0.000
BMI	22.98±1.58	26.71±2.80*	22.86±2.27	23.90±3.33	0.000
SBP(mmHg)	124.86±4.56	114.30±6.14*	122.35±6.80	115.62±6.99#	0.000
DBP(mmHg)	80.76±2.87	79.46±3.0	81.57±3.78	79.73±3.26	0.022
PP(mmHg)	44.11±4.05	34.84±5.96*	40.78±6.84	35.89±8.16#	0.000
MAP(mmHg)	95.46±2.96	91.07±3.27*	95.16±3.81	91.69±2.93#	0.000
RPP	9885.46±486.87	8251.32±701.17*	9758.59±617.98	8434.92±699.26#	0.000
HR (bpm)	79.16±2.40	72.22±5.14*	79.76±2.36	73.03±5.29#	0.000

Data expressed as Mean ± SD. BMI: Body Mass Index, SBP: Systolic Blood Pressure, DBP: Diastolic Blood Pressure, PP: Pulse Pressure, RPP: Rate Pressure Product, HR: Heart Rate; *Controls Vs. Newly diagnosed hypothyroid subjects; p<0.05; @ Controls Vs. Hypothyroids with < 5 years duration; p< 0.05; # Controls Vs. Hypothyroids with > 5years duration; p< 0.05.

Table-1: Baseline characteristics of controls, newly diagnosed hypothyroid subjects, less than 5 years and more than 5 years hypothyroid subjects.

(p<0.05), WBC count (p<0.05), MPV (p<0.05), Platelet count (p<0.05), RDW% (p<0.05), MCH (p<0.05), MCHC (p<0.05) of newly diagnosed hypothyroids when compared to controls. In hypothyroids with less than five years of history and in medical treatment, there was significant difference in Folic acid (p<0.05), HB% (p<0.05), HCT (p<0.05), MPV (p<0.05), Platelets (p<0.05), RDW% (p<0.05) when compared to controls. Further, the Folic acid (p<0.05), HCT (p<0.05), MPV (p<0.05), Platelets (p<0.05), RDW% (p<0.05) in hypothyroids with history of more than five years without regular treatment between group when compared to controls.

Correlation analysis showed significant association of visceral fat with vitamin B12 in newly diagnosed hypothyroid subjects (r = - 0.23) and total leukocyte count (r = -0.42) (Figure 1) in newly diagnosed hypothyroid subjects.

Discussion

Baseline and anthropometric parameters: The baseline parameters like height, weight, body mass index (BMI), blood pressure (SBP, DBP), heart rate (HR) pulse pressure, mean arterial pressure (MAP), rate pressure product (RPP) were taken in this study. These results were depicted in Table 1.

As shown in Table 1, there was no significant difference between age (p< 0.576) and height (p<0.063) of the study participants. Significantly difference in weight (p<0.000), BMI (p<0.000), Heart rate (p<0.000), blood pressure (SBP p<0.000, DBP p<0.022) and rate pressure product (p<0.000) were seen. Further, there was significant difference in weight (p<0.05), BMI (p<0.05), SBP (p<0.05), PP (p<0.05), RPP (p<0.05), MAP (p<0.05) and HR (p<0.05) in newly diagnosed hypothyroids and hypothyroids with history of more than five years without regular treatment when compared to controls.

Hypothyroidism is defined as a deficiency of thyroid activity, which results from reduced secretion of both T3 and T4 irrespective of the cause. Iodine deficiency is the most common cause of hypothyroidism worldwide but it can be caused by other causes such as several conditions of the thyroid gland or, less commonly, the pituitary gland or hypothalamus. Low thyroid hormone levels cause the body's functions to slow down, leading to general symptoms like dry skin, fatigue, loss of energy, memory problems higher cholesterol levels etc.

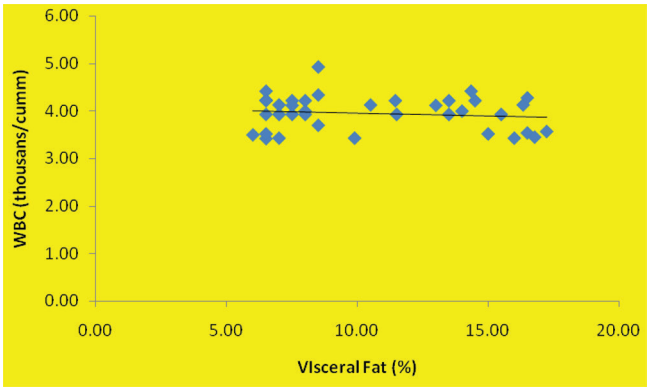

Figure-1: Association of visceral fat with total leukocyte count in newly diagnosed hypothyroid subjects (r = -0.42).

parameter	Control group(n=37)	Newly (n=37)	Less than 5yrs(n=37)	More than 5 yrs (n=37)	P value (ANOVA)
	2.95±0.55	0.93±0.38*	0.83±0.38@	0.95±0.39#	0.000
fT4	1.36±0.30	0.43±0.15*	0.46±0.14@	0.50±0.11#	0.000
TSH	3.56±0.82	8.04±1.10*	7.69±0.89@	7.62±1.09#	0.000
Total body fat	25.64±2.92	28.04±3.99*	25.09±2.62	26.33±2.91#	0.001
Visceral fat	6.85±1.63	10.65±3.89*	6.93±2.15	10.09±4.11#	0.000
Subcutaneous fat	18.33±3.37	20.53±5.41	19.05±2.78	19.81±2.79	0.070

Data expressed as Mean ± SD; *Controls Vs. Newly diagnosed hypothyroid subjects; p<0.05; @ Controls Vs. Hypothyroids with < 5 years duration; p< 0.05; # Controls Vs. Hypothyroids with > 5years duration; p< 0.05.

Table-2: Body fat distribution and Thyroid function tests of controls, newly diagnosed hypothyroid subjects, less than 5 years and more than 5 years hypothyroid subjects.

parameter	Control group (n=37)	Newly diagnosed (n=37)	Less than 5 yrs (n=37)	More than 5 Yrs (n=37)	P value (ANOVA)
	519.24±74.04	250.53±82.09*	511.57±85.55	495±117.85	0.000
Folic Acid	14.57±2.22	2.67±1.50*	12.03±5.29@	10.45±5.67#	0.000
HB%	11.78±1.04	9.79±0.95*	10.72±1.55@	11.16±1.60	0.000
HCT%	39.68±2.32	38.65±1.67	38.14±1.58@	38.35±1.60#	0.002
RBC	3.51±0.58	3.27±0.47	3.40±0.51	3.27±0.50	0.130
WBC	4.54±0.64	3.95±0.36*	4.28±0.64	4.41±0.69	0.000
MPV	9.57±1.34	11.79±2.16*	11.19±2.24@	11.74±2.40#	0.708
Platelets	2.94±0.32	2.36±0.56*	2.23±0.49@	2.24±0.54#	0.000
RDW%	12.51±0.70	15.26±2.25*	15.51±2.61@	15.15±2.18#	0.000
MCV	116.06±20.98	120.87±20.67	115.19±20.76	120.35±21.61	0.549
MCH	34.57±7.10	30.44±4.67*	32.39±7.10	35.03±7.64	0.014
MCHC	29.81±3.23	25.41±3.05*	28.17±4.20	29.17±4.43	0.000

Data expressed as Mean ± SD; *Controls Vs. Newly diagnosed Hypothyroid subjects; p<0.05; @ Controls Vs. Hypothyroids with < 5 years duration; p< 0.05; # Controls Vs. Hypothyroids with > 5years duration; p< 0.05.

Table-3: Hematological parameters of controls, newly diagnosed hypothyroid subjects, less than 5 years and more than 5 years hypothyroid subjects.

The relationship between thyroid function and body weight in euthyroid individuals has been given a great medical concern. Various researchers have studied the effect of the thyroid hormones on body mass index (BMI), and it has been demonstrated that overt thyroid dysfunction affects body weight. Clinical hypothyroidism causes an increase in body weight, while hyperthyroidism reduces it[14]

Body mass index (BMI) is a measure of weight adjusted for height, calculated as weight in kilograms divided by the square of height in meters (kg/m^2). Although BMI is often considered an indicator of body fatness, it is a surrogate measure of body fat because it measures excess weight rather than excess fat. BMI is a simple, inexpensive, and noninvasive surrogate measure of body fat. In contrast to other methods, BMI relies solely on height and weight and with access to the proper equipment, individuals can have their BMI routinely measured and calculated with reasonable accuracy.

Furthermore, studies have shown that BMI levels correlate with body fat and with future health risks. High BMI predicts future morbidity and death. Therefore, BMI is an appropriate measure for screening for obesity and its health risks. In this study, there was significantly high BMI in newly diagnosed hypothyroid subjects, which indicates the risks of development of various diseases. Further, it is shown that, in participants with less than 5 years fo history and if they are taking regular medication, the BMI levels are almost similar to controls. It indicates the treatment will be helpful to come back to normal BMI.

Hyperthyroidism is usually associated with peripheral vasodilatation and reduction of the diastolic blood pressure (BP) and sometimes with systolic hypertension, while hypothyroidism may be accompanied by diastolic hypertension, as many clinicians are aware. Elevation of the diastolic BP was found to be common in patients with hypothyroidism[15] But in this study, there was no significant difference in DBP of hypothyroid subjects.

Body composition: Thyroid hormones regulate metabolism of the whole human body - triiodothyronine (T3) is necessary to maintain the energy requirements of various cells and tissues, to balance their anabolism and catabolism, and regulate body weight.[16,21] An abnormal amount of T3 disturbs a number of metabolic processes. shortage of T3 in hypothyroidism reduces basic metabolic rate and thermogenesis, inhibits catabolism and gains total body weight[17]; excess of T3 in hyperthyroidism reverses these processes.[6] Specific therapy of hypo[18,19] and hyperthyroidism[20-22] restores a proper body mass. Only few studies evaluated changes in body composition.

In this study, Table 2 shows the between groups and within group differences of fT3 ($p<0.000$), fT4 ($p<0.000$), TSH ($p<0.000$), total body fat ($p<0.000$) and visceral fat ($p<0.001$). But there was no significant difference in subcutaneous fat ($p<0.07$). The levels of fT3 ($p<0.05$), fT4 ($p<0.05$) and TSH ($p<0.05$). Further, there was significant difference in total body fat ($p<0.05$), and visceral fat ($p<0.05$), in newly diagnosed hypothyroids and hypothyroids with history of more than five years without regular treatment between group when compared to controls.

Haematological changes: Thyroid hormones play an important physiological role in humans. It may regulate human hematopoiesis in the bone marrow.[23] The association of thyroid disorders and abnormalities in hematological parameters is well known. 1979,Fein showed that Graves' disease is associated with anemia.[24] Horton observed a decreased number of red blood cells (RBCs) in the peripheral blood (PB) of patients after thyroidectomy.[25] Hypothyroidism can cause certain forms of anemia on the one hand or hyperproliferation of immature erythroid progenitors on the other hand. The anemia is usually macrocytic hypochromic anemia of moderate severity.[25] In contrast, anemia is not frequently observed in patients with hyperthyroidism, whereas erythrocytosis is fairly common.[26] It has been found that all hematological parameters return to normal when a euthyroid state is achieved.[26] As far as white blood cells and thrombocytes are concerned, a slightly depressed total leucocyte count, neutropaenia, and thrombocytopenia have been observed in hypothyroid patients.[27] Furthermore, elevated, normal, or slightly depressed total leucocyte counts have been found in hyperthyroid patients, with only a relative decrease in the number of neutrophils and a relative increase in the number of eosinophils and mononuclear cells (MNCs). Nevertheless, hyperplasia of all myeloid cell lines in hyperthyroidism and their hypoplasia in hypothyroidism were reported by Axelrod.[28]

In this study, as shown in Table 3, there was significant difference in Vit B12 ($p<0.000$), Folic acid ($p<0.000$), Hb% ($p<0.000$), HCT ($p<0.000$), WBC count ($p<0.000$), Platelet count ($p<0.000$), RDW% ($p<0.000$), MCH ($p<0.000$), MCHC ($p<0.000$). But there was no significant difference in RBC count ($p<0.130$), MPV ($p<0.708$), MCV (0.549). However, there was significant difference in Vit B12 ($p<0.05$), Folic acid ($p<0.05$), HB% ($p<0.05$), WBC count ($p<0.05$), MPV ($p<0.05$), Platelet count ($p<0.05$), RDW% ($p<0.05$), MCH ($p<0.05$), MCHC ($p<0.05$) of newly diagnosed hypothyroids when compared to controls. In hypothyroids with less than five years of history and in medical treatment, there was significant difference in Folic acid ($p<0.05$), HB% ($p<0.05$), HCT ($p<0.05$), MPV ($p<0.05$), Platelets ($p<0.05$), RDW% ($p<0.05$) when compared to controls. Further, the Folic acid ($p<0.05$), HCT ($p<0.05$), MPV ($p<0.05$), Platelets ($p<0.05$), RDW% ($p<0.05$) in hypothyroids with history of more than five years without regular treatment between group when compared to controls.

CONCLUSION

From this study, it is concluded that the body fat distribution and hematological parameters was altered in hypothyroidism and there was significant association between visceral fat and Vitamin B12 in newly diagnosed hypothyroidism. Further, there was no restoration in individuals with irregular treatment.

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