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Original Research Article

Evaluation of thyroid function and lipid profile of hypertensive subjects

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Abstract

Hypertension and dyslipidemia are major risk factors for cardiovascular disease, accounting for the highest morbidity and mortality among the Nigerian population. Thyroid dysfunction on the other hand is the second most common endocrinal disorder in Nigeria and the prevalence rate of thyroid dysfunction is much higher among the hypertensive population. The objective of this study was to evaluate serum thyroid hormones and lipid profiles of hypertensive subjects. This was a hospital-based cross-sectional study carried out among 232 participants including 172 hypertensive subjects and 60 normotensive controls in Medical Out-Patient Clinic, Central Hospital, Benin City Nigeria. Data were collected on blood pressure, Thyroid Stimulating Hormones (TSH, T_3 & T_4), and lipid profile. The mean (± standard deviation) systolic and diastolic blood pressures of the test and control subjects were 157.00±23.40 and 114.42±11.00 (systolic), 98.57 ± 10.36, and 78.50 ± 7.25 (Diastolic) which were higher in the hypertensive patients (*P*=0.001 and 0.005 respectively). The serum levels of TG, and LDL were higher while HDL levels were lower in hypertensive subjects compared to the normotensives (*P*=0.045, 0.002, & 0.000, respectively). There was no statistical significant difference observed in the mean levels of TC between the groups (*p*=0.603). The serum levels of T3 and T4 were significantly higher in hypertensive subjects when compared with that of normotensive subjects(P<0.05). There was no statistical significant difference observed in the mean levels of TSH between the groups. The present study concludes that the prevalence of hyperthyroidism was greater among hypertensive subjectes than the normotensive subjects. Based on the obtained results, the serum lipid profile and thyroid hormones may be useful in identification of patients at risk of hypertension since they are useful tests that carry important prognostic information.

Keywords: Hypertension, thyroid hormones, lipid profiles

INTRODUCTION

Hypertension is one of the non-communicable diseases that give a cause for global concern. Globally, the burden of hypertension (HTN) is rapidly increasing and is found to be affecting mostly the African continents (WHO, 2013). The prevalence of HTN in Nigeria may form a greater part of the total burden in Africa because of her large population which is currently estimated to be over 170 million (Adeloye et al., 2015). In recent years, rapid urbanization, increased life expectancy, unhealthy diet, and lifestyle changes have led to an increased rate of cardiovascular disease (CVD) in Nigerians and research has shown that with an increasing adult population and change of life style commonly seen among Nigerian population, the burden of hypertension may keep increasing as time goes on (Kayima et al., 2013). Hypertension is defined as a systolic blood pressure of ≥140 mmHg or a diastolic blood pressure of ≥90 mmHg. So a person is considered hypertensive when either the systolic or the diastolic blood pressure value is ≥140⁄90 mmHg upon repeated sphygmomanometric measurements (Chobanian et al., 2003). In addition, a separate classification was established for isolated systolic hypertension, which is defined as the concomitant presence of a systolic blood pressure of ≥140 mmHg and a diastolic blood pressure of <90 mmHg (Chobanian et al., 2003).

Lipid profile consists of a group of biochemical tests (TC, TG, HDL, and LDL) often used in predicting, diagnosing and treating lipid related disorders including atherosclerosis (Brites et al., 1998). Hypertension and dyslipidemia are major risk factors for cardiovascular disease (CVD) and account for more than 80% of deaths and disability in low- and middle-income countries (Reddy, 2004). It is widely accepted that CVD is associated with hypertension and increased blood levels of low-density lipoprotein (LDL), total cholesterol (TC), and triglycerides (TG). In contrast, a low level of high density lipoprotein (HDL) is a risk factor for mortality from CVD (Mora et al., 2013). Epidemiological studies have established a strong association between hypertension and coronary artery disease (Liu et al., 2013).

Thyroid hormones have profound metabolic effects, the most striking action being an increase in energy expenditure (Riis et al., 2005; Brennan et al., 2006) Thyroid hormones play an important role in regulating lipid metabolism; and thyroid dysfunctions can result in lipid abnormalities which increase the risk of endothelial dysfunction, hypertension and cardiovascular disease (Liberopoulos et al., 2002). Thyroid dysfunction is a common endocrinal disorder in the general populations (Kadiyala et al., 2010) Decreased thyroid function often accompanied with the elevation of total cholesterol (TC) and 4-14% of hypercholesterolemia was reported as a hypothyroid state (Rizos et al., 2011; Pearce, 2012). Moreover, cardiovascular disorders are usually associated with thyroid dysfunction (Garduño-Garcia et al., 2010; Ichiki, 2015). Dyslipidemia and atherosclerosis related cardiovascular disorders were proved to be associated with hypothyroidism (van Tienhoven-Wind and Dullaart, 2015b). Sinus tachycardia, atrial flutter and atrial fibrillation are commonly found in patients suffering from overt or subclinical hyperthyroidism (Giandalia et al., 2014). Thus, knowing the association of thyroid hormone parameters with dyslipidemia among hypertensive subjects in the study area is profoundly important to enhance the knowledge gap of the interrelation between hypertension, thyroid hormone and dyslipidemia. Therefore, the aim of the present study was to evaluate blood lipid profile and thyroid hormones in hypertensive subjects.

MATERIAL AND METHODS

The study population comprised 172 hypertensive subjects and 60 normotensive control subjects from Medical Out-Patient Clinic, Central Hospital, Benin City, Nigeria. Initially, a physician at Central Hospital, Benin City examined all participants; their medical history was taken to collect information about general condition, physical activity and current medications if any. Study participants were excluded from the study if they had a history of thyroid disease, kidney, chronic liver and cardiovascular disorders, psychiatric disorder, administration of drugs affecting levels of thyroid hormone, pregnancy and lactation, subjects on antidepressant and/or antipsychotic therapy, HIV/AIDS patients, malignancy and type I diabetes mellitus. Blood pressure was taken on the left arm after 5 minutes' relaxation, in a sitting position, using a standard mercury sphygmomanometer with appropriate cuff size; systolic (SBP) and diastolic (DBP) blood pressures corresponded to Korotkoff sounds 1 and V, respectively. Height and body weight were measured with participants standing without shoes and heavy outer garments. Body mass index (BMI) was calculated as weight, divided by height squared (Kg/m2). Fasting serum total cholesterol (TC), high density lipoprotein cholesterol (HDL-C), low density lipoprotein cholesterol (LDL) and triglycerides (TG) were determined enzymatically. Serum thyroid Stimulating Hormone (TSH), Triiodothyronine (T3) and Tetraiodothyronine (T4) were measured by enzyme-linked immunoassay sandwich method.

Statistical Analysis

Data was analyzed using the Statistical Package for Social Sciences (SPSS) version 20 software (SPSS Inc., Chicago, IL, USA). Continuous variables were presented as mean ± standard deviation and were compared using the student *t*-tests. A "*P*" value of <0.05 was considered statistically significant.

RESULTS

Table 1 showed the Mean ± SD of body mass index (BMI) and blood pressure of both hypertensive (test) and non hypertensive (control) subjects. The mean systolic blood pressure levels of both groups were 157.00± 23.40 & 114.42 ± 11.00 respectively, showing that the mean levels of systolic blood pressure was significantly higher in hypertensive when compared with non hypertensive subjects (p = 0.001). The mean levels of diastolic blood

Table 1. (BMI) and blood pressure of hypertensive subjects and controls

Parameters	Hypertensive Subject n=172	Control Subjects n=60	P-Value
Systolic blood pressure (mmHg)	157.00 ±23.40	114.42±11.00	0.001*
Diastolic blood pressure (mmHg)	98.57 ± 10.36	78.50 ± 7.25	0.005*
BMI (Kg/m^2)	32.00± 8.20	29.32± 5.06	0.450

BMI= body mass index, *=significant

Table 2. Lipid profile of hypertensive (test) and normotensive (control) subjects

Parameters	Test Subjects n= 172	Control Subjects n=60	P-value
TG (mmol/L)	0.96± 0.46	0.74± 0.34	0.045*
HDL-C (mmol/L)	1.14± 0.24	1.57± 0.32	0.000*
LDL-C (mmol/L)	3.07± 0.63	2.29± 0.67	0.002*
TC(mmol/L)	4.65±1.24	4.30± 1.17	0.603

TG= triglyceride, HDL-C= high-density lipoprotein cholesterol, LDL-C= low- density lipoprotein cholesterol, TC= total cholesterol. *=significant

Table 3. Serum TSH, T3 and T4 values of hypertensive subjects and control

Parameters	Test Subjects n=172	Control Subjects n=60	P=value
TSH(µU/mL)	1.59±1.16	1.39±0.87	0.694
T4 (µg/dL)	9.59±1.93	6.37±1.58	0.003*
T3 (ng/ml)	1.38±0.41	1.02±0.34	0.024*

TSH= Triiodothyronine, T4= Tetraiodothyronine T3= Triiodothyronine, *=significant

pressure was also significantly higher in hypertensive when compared with non hypertensive subjects 98.57±10.36 and 78.50±7.25, respectively (p = 0.005). There was no statistical significant difference in the mean levels of body mass index (BMI) between the groups (p = 0.450).

Regarding the lipid profile of the hypertensive subjects and the normotensive subjects, Table 2 shows that hypertensive subjects had a significant higher serum TG and LDL-C than normotensive subjects (P<0.05). However, hypertensive subjects had a significant lower serum HDL-C than normotensive (P=0.000). There was no statistical significant difference observed in the mean levels of TC between the test and control subjects (P=0.603).

The serum TSH, T3 and T4 data of the whole study participants are shown in Table 3. A significant higher T3 and T4 were observed among the hypertensive subjects when compared with the normotensive subjects (P<0.05). There was no statistical significant difference observed in the mean levels of TSH between the test and control subjects (P=0.694).

DISCUSSION

In this study, we evaluated blood lipids profile and thyroid hormones in hypertensive subjects. The increased systolic and diastolic blood pressure among the hypertensive subjects affirm that they were actually diagnosed of hypertension.

Results of this study revealed that the mean values of serum TG, and LDL were significantly higher among the hypertensive subjects compared with normotensive subjects. Conversely, the mean HDL level was lower in hypertensive subjects compared to normotensive subjects (P=0.001). Hypertension is recognized globally as a major risk factor for cardiovascular disease (CVD), stroke, diabetes, and renal diseases (Saha et al., 2006). Research has also shown that there is interplay between hypertension and dyslipidemia (Dalal et al., 2012). The higher serum level of LDL-C and TG among the hypertensive subjects when compared with the normotensive subjects might be from low activity of lipoprotein lipase enzyme or the limited lipoproteins clearance, which then lead to increased LDL-C and TG levels in blood (Chubb et al., 2005; Lo et al., 2006). Atherogenic dyslipidemia was observed among the hypertensive subjects. Atherogenic dyslipidemia is characterized by three lipid abnormalities: elevated serum TG, elevated small low-density lipoprotein (LDL) particles, and reduced serum HDL cholesterol (Janine et al., 2011).

Furthermore, thyroid hormones in this present study revealed that the serum levels of T3 and T4 were significantly higher in hypertensive subjects when compared with that of normotensive subjects. Thyroid diseases are one of the commonly occurring endocrine disorders worldwide. Thyroid hormones significantly affect lipoprotein metabolism as well as some cardiovascular disease (CVD) risk factors, thus influencing the overall CVD risk (Duntas, 2002; van Tienhoven-Wind and Dullaart, 2015a). Thyroid hormones induce 3-hydroxy-3-methylglutarylcoenzyme A (HMGCoA) reductase, which is the first step in cholesterol biosynthesis (Chen et al., 2016). Triiodothyronine (T3) causes an up regulation of LDL receptors, controls the sterol regulatory element-binding protein-2 (SREBP-2), which in turn regulates LDL receptor's gene expression and protects LDL from oxidation. This protection increases the level of LDL in the blood (Rizos et al., 2011) as seen among the test subjects. Thyroid hormones also influence HDL metabolism by increasing cholesteryl ester transfer protein (CETP) activity, which exchanges cholesteryl esters from HDL2 to the very low density lipoproteins (VLDL) and TGs to the opposite direction (Duntas and Brent, 2012; Triolo et al., 2013). Therefore, the increase in cholesteryl ester transfer protein (CETP) activity could have also increased TG serum level as seen among the hypertensive subjects. Aside activation of CETP, thyroid hormone also stimulates lipoprotein lipase (LPL), which catabolizes the TG-rich lipoproteins, and the hepatic lipase (HL), which hydrolyzes HDL2 to HDL3 and contributes to the conversion of intermediate- density lipoproteins (IDL) to LDL and in turn LDL to sdLDL (Chen et al., 2016). Therefore, the elevated levels of TG, LDL-C, and reduced HDL-C seen among the hypertensive subjects could also be as a result of the effects of increased T3 and T4 on the lipid metabolism.

More so, thyroid hormones have potential hemodynamic effects on the cardiovascular system (Neves et al., 2008; Ichiki, 2015). Increased triiodothyronine levels exert positive inotropic and chronotropic effects, leading to enhanced heart rate and systolic contractility and, consequently, increased cardiac output. It also stimulates sarcoplasmic reticulum Ca-ATPase, leading to systolic and diastolic dysfunction (Neves et al., 2008). More so, triiodothyronine reduces peripheral vascular resistance, causing a decrease in diastolic blood pressure and cardiac after load, which further raises cardiac output (Ichiki (2015). Decreased vascular resistance accounts for activation of renin-angiotensin-aldosterone system, which increases blood volume and cardiac preload, augmenting cardiac output even more (Peppa et al., 2011).

This present study revealed that the hypertensive subjects had increased T3 and T4 levels, with increased serum TG and LDL-C. This result is not in agreement with some studies where total cholesterol(TC), triglyceride (TG), and low-density lipoprotein cholesterol (LDL-C) were significantly higher in hypothyroid state (increased TSH and decreased or normal T3 and T4) (Cappola and Ladenson, 2003; Asranna et al., 2012). The hyperthyroid subjects in the present study did not manifest any symptom of clinical hyperthyroidism. However, Biondi and Cooper, 2008 found that even patients with subclinical hyperthyroidism had significantly higher average heart rate, enhanced systolic function, impaired diastolic function with prolonged isovolumic relaxation time, and increased left ventricular mass compared with euthyroid subjects.

The result of this study is in agreement with the report of Prisant *et al*. (2006) who demonstrated that hyperthyroidism increases systolic blood pressure by decreasing systemic vascular resistance, increasing heart rate, and raising cardiac output. This result shows that the increased SBP and DBP may have been enhanced by the subclinical hyperthyroidism observed among this hypertensive subjects.

CONCLUSION

The present study concludes that the prevalence of hyperthyroidism was greater among hypertensive subjectes than the normotensive subjects. Based on the obtained results, the serum lipid profile and thyroid hormones may be useful in identification of patients at risk of hypertension since they are useful test that carries important prognostic information.

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