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Relationship between lipid profile and blood pressure in hypertensive patients

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Abstract

Arterial hypertension and dyslipidemia are two of the most prevalent cardiovascular risk factors in the general population and their relationship has become a central focus for cardiovascular disease prevention. The objectives of this study were to evaluate the differences of lipid profile, blood pressure (BP) profile and the influence of risk factors in a group of patients with essential arterial hypertension. Over two years, 140 patients with essential hypertension have been evaluated. We analyzed: the cardiovascular risk factor profile, with specific accent on the lipid parameters, left ventricular mass index (LVMI) and the values of systolic and diastolic BP (SBP, DBP) at hospital admission and discharge in non-acute setting. The results showed that admission BP was better correlated with hypercholesterolemia than BP at discharge, especially total cholesterol and HDL. All lipid markers were increased in patients with higher grades of arterial hypertension, total cholesterol having the best statistical significance (149.38 ± 40.04 – grade 1 vs. 197.29 ± 54.75 – grade 2 vs. 187.88 ± 44.29 mg/dl – grade 3, p=0.015). However, LVMI was not significantly different according to BP grade and did not correlate with lipid markers. LDL presented higher values in the hypertensive patients' group with newly diagnosed diabetes (121.36 ± 39.84 vs. 97.31 ± 37.51 mg/dl, p=0.023), while the other risk factors were not apparently associated with significantly different lipid values. Our results sustain the close relation between lipid profile, hypertension and the risk for diabetes development.

Keywords: arterial hypertension, blood pressure, dyslipidemia, cholesterol, type 2 diabetes mellitus

Introduction

Elevated blood pressure (BP) values represent the primary world-wide factors that contribute to premature death and increase in disability-adjusted life years [1]. Monitoring of office BP and out-of-office BP have been proven to be correlated with the incidence of important cardiovascular diseases (CVD) (hemorrhagic stroke, ischemic stroke, myocardial infarction, sudden death, heart failure, and peripheral artery disease), as well as end-stage renal disease [2]. Furthermore, there is increasingly more evidence that links hypertension with an increasing risk of developing atrial fibrillation [3], cognitive decline and dementia [4, 5]. Therefore,

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arterial hypertension has become the major preventable cause of cardiovascular disease and all-cause death around the world.

High BP is often accompanied by other cardiovascular risk factors in populations and among individuals. Out of these risk factors dyslipidemia occurs most often, probably due to multiple interactions between high lipid values, the development of atherosclerosis and endothelial dysfunction [6, 7]. Consequently, understanding more deeply the relationship between hypertension and dyslipidemia could direct the treatment approach of these two entities in order to prevent CVD and premature death.

The objectives of this study were to evaluate the differences of lipid profile, blood pressure (BP) profile and the influence of risk factors in a group of patients diagnosed with essential arterial hypertension.

Material and Methods

Study subjects

The current 2-year prospective study included patients previously diagnosed with arterial hypertension according to the European guidelines' definitions [2]. Patients were referred from general practitioners for general cardiac evaluation at the local Department of Cardiology. Exclusion criteria were acute onset of CVD, other acute medical problems or secondary hypertension. This study was carried out in accordance with the World Medical Association Declaration of Helsinki and was approved from an ethical standpoint by the local Ethics Committee.

Study design

The following cardiovascular risk factors were assessed: age, gender, smoking status, chronic alcohol consumption, personal history of stroke or type 2 diabetes mellitus (DM). Manual BP values evaluation with a standardized manual sphygmomanometer was done at admission and also at discharge according to ESC/ESH Guidelines [2]. However, we have graded the BP in the classical three categories [2] according to the BP personal history of each individual. Body mass index (BMI) was evaluated and obesity was defined as BMI ≥ 30 kg/m^2. A transthoracic echocardiogram was performed to all patients for the detection of left ventricular hypertrophy (LVH), marker of hypertension target organ damage, with a LV mass index (LVMI) threshold of 115 g/m^2 for men and 95 g/m^2 for women [2]. The following biochemical markers were analyzed: total cholesterol, high density lipoprotein (HDL) and low-density lipoprotein (LDL) cholesterol, triglycerides, creatinine and fasting plasma glucose. The dyslipidemia was evaluated and defined according to ESC/EHS Guidelines [2]. The estimated glomerular filtration rate (eGFR) was calculated using the Chronic Kidney Disease Epidemiology Collaboration (CKD-EPI) equation [8].

The database was created in Microsoft Excel and the statistical analysis was performed using SPSS v. 20. A p value < 0.05 was considered as having statistical significance.

Results

The study cohort included 140 hypertensive subjects, with 41 (58.6%) men. The mean age was 69.6 ± 10.5 (range 35–88) years. Patients' demographics and the main risk factors are presented in table 1.

Concerning cardiovascular risk factors, about 2/3 of patients were smokers with no significant differences regarding the level of hypertension before admission. However, in our study, smoking was correlated with a high body mass index (p=0.03). Obesity was present in approximately one third of the patients, with no correlation regarding BP or cholesterol levels. Personal history of stroke was met in less than 15% of patients, being related with a high BP value at admission (p = 0.018). The renal function was fairly similar in the study group according to the degree of arterial hypertension with non-significant differences between groups for creatinine (p = 0.330), urea serum levels (p=0.127) or eGFR (p = 0.159).

In our study cohort increased lipid values were correlated with the degree of arterial hypertension, assessed at the last check-up. Out of all lipid markers, total cholesterol presented the best statistical significance (149.38 ± 40.04 – grade 1 hypertension vs. 197.29 ± 54.75 – grade 2 hypertension vs. 187.88

Table 1. Study population characteristics

Parameter	Value
Age (years)	69.61 ± 10.57
BMI (kg/m^2)	29.45 ± 4.83
eGFR (ml/min/1,73m^2)	69.53 ± 20.51
FPG (mg%)	131.76 ± 68.42
Total cholesterol (mg%)	183.43 ± 49.43
LDL cholesterol (mg%)	112.96 ± 40.42
HDL cholesterol (mg%)	45.61 ± 15.6
Non-HDL cholesterol (mg%)	138.83 ± 45.53
Triglycerides (mg%)	123.51 ± 66.20
LVMI (g/m^2)	121.51 ± 55.13
SBP admission (mmHg)	142.34 ± 23.99
DBP admission (mmHg)	81.01 ± 11.29
SBP discharge (mmHg)	128.74 ± 17.28
DBP discharge (mmHg)	76.00 ± 11.62
HR (bpm)	82.80 ± 25.78

± 44.29 mg/dl – grade 3 hypertension, p=0.015) (figure 1).

The variations of BP values during the hospital admission were also related with high levels of lipids. Admission BP has better correlated with hypercholesterolemia than BP at discharge: systolic blood pressure (SBP)-total cholesterol (r = 0.16, p = 0.186), diastolic blood pressure (DBP)-total cholesterol (r = 0.29, p = 0.014). The distribution of cholesterol levels is illustrated in figure 2. Moreover, this correlation extended also to HDL: SBP-HDL (r = -0.31, p = 0.011), DBP-HDL (r = -0.40, p = 0.001).

On the other hand, LDL presented higher values in the hypertensive patients' group with newly diagnosed type 2 diabetes mellitus (NDT2DM) (121.36 ± 39.84 vs. 97.31 ± 37.51 mg/dl, p=0.023), while the other risk factors were not apparently associated with significantly different lipid values.

Regarding the cardiac impact of risk factors on BP and dyslipidemia, there were no other statistically relevant results. Left ventricular ejection fraction (LVEF) and LVMI were not significantly different according to BP grade and did not correlate with any lipid markers.

Discussion

This study provides evidence that baseline levels of lipids, particularly total cholesterol and HDL, are associated with increased levels of arterial hypertension, expressed by higher values of BP or the grade of arterial hypertension.

Though there is a lot of research over this topic, the precise biological mechanism by which lipids may give rise to elevations in BP still present some evidence gaps. Genetic and cross-sectional studies suggested a connection between dyslipidemia and hypertension. Hypertensive individuals have a higher prevalence of dyslipidemia and 12% of subjects with early-onset hypertension have an increased frequency of lipid disorders [9]. At first, smooth muscle cell hypertrophy and collagen deposition come as a consequence to high cholesterol levels leading to arterial stiffness translated to elevated systolic BP.

In addition, dyslipidemia leads to endothelial dysfunction and improper vasoregulation, as nitric oxide production release and subsequent activity being reduced among those with high total cholesterol and low HDL-C levels. Furthermore,

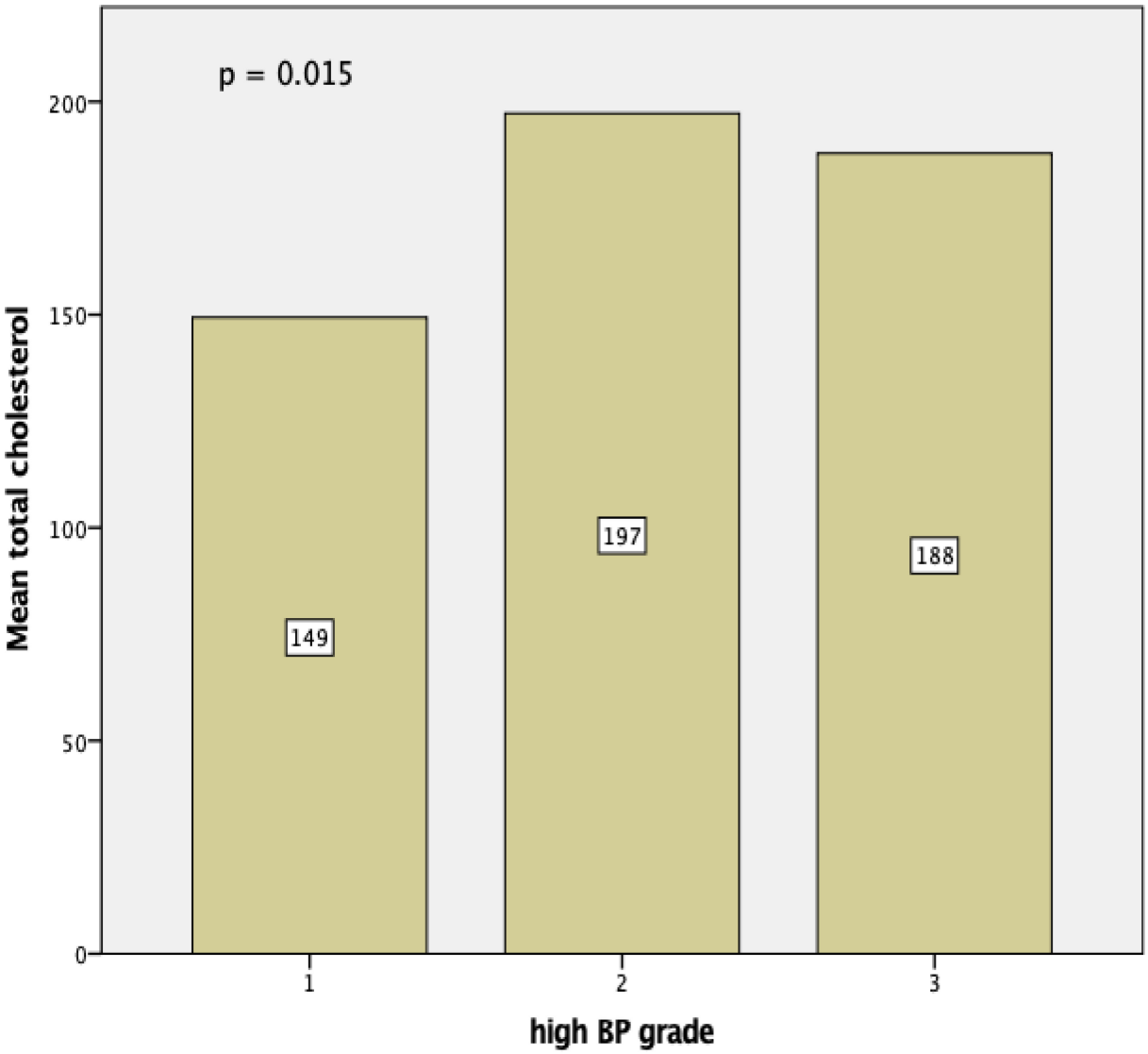

Figure 1. Total cholesterol values according to high BP grade

dyslipidemia has been associated with increased circulating levels of endothelin-1 [10] which in turn has been linked with hypertension [9]. In addition, dyslipidemia may cause damage to the renal microvasculature with the downstream effect of hypertension [11].

Limited, smaller prospective studies have provided evidence of an association between plasma lipid levels and the risk of hypertension. In one study, 1482 adult men and women were followed up for 7 years, with 40 cases of hypertension being developed. Increases of 1 standard deviation in triglycerides (110 mg/dL [1.24 mmol/L]) and HDL-C levels (11 mg/dL [0.28 mmol/L]) had age-adjusted RRs of 1.42 (95% CI, 1.06-1.89) and 0.82 (95% CI, 0.59-1.15), respectively [12]. In 2 separate studies from the San Antonio Heart Study, subjects with higher baseline triglyceride and lower HDL-C levels had a significantly greater risk of developing hypertension, whereas higher TC and LDL-C levels were associated with nonsignificant increased risk [13]. These results are consistent to the findings of our study, which reported a more significant correlation between HDL levels and the BP values. However, the severity of the disease expressed by the hypertension grade correlated only with the total cholesterol levels, as high cholesterol levels were more frequent in patients with grade 2 and 3 arterial hypertension. Taking into account the fact that we used in our study the level of hypertension

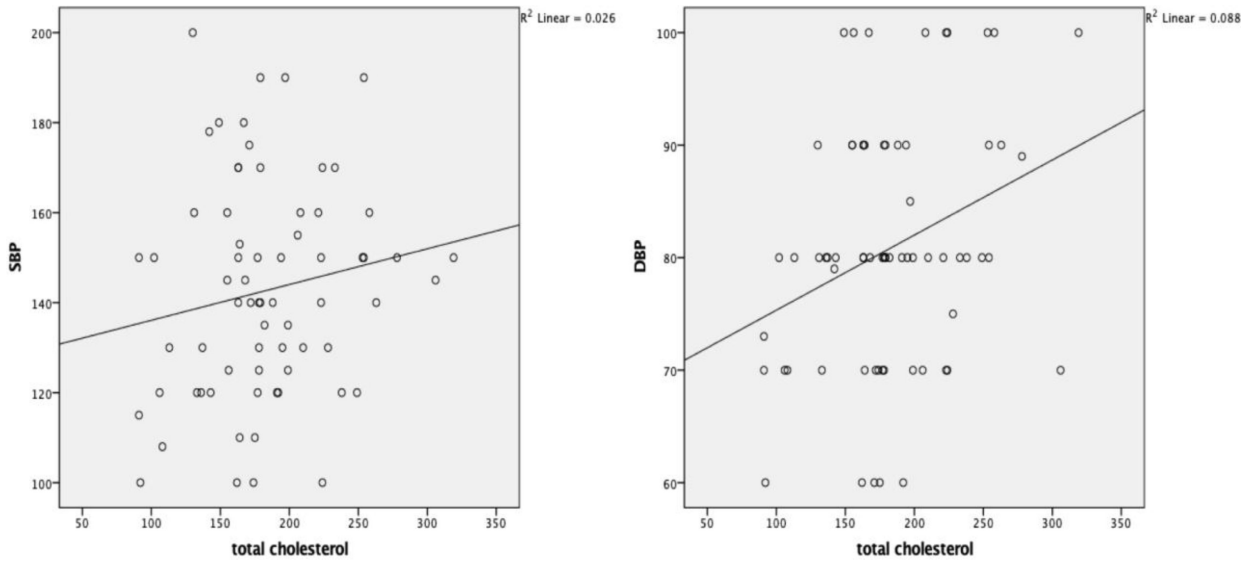

Figure 2. Relationship between total cholesterol and SBP, respectively DBP

at previous check-ups, we may consider that a part of the patients might have transitioned into a more severe group in time. Therefore, a more in-depth analysis might reveal a more precise stratification of the correlation between lipid markers and hypertension levels.

Secondly, dyslipidemia and hypertension are both parts of the metabolic syndrome. Some suggest that hypertension represents a late-stage manifestation of a metabolic syndrome [14-16]. Therefore, lipid profile proved to be also a constant marker in patients with newly diagnosed type 2 diabetes mellitus. Out of all cholesterol fractions, LDL showed the most significantly statistical values (p=0.023). These results confirm data presented in other studies which associated obesity, high cholesterol level with newly diagnosed type 2 diabetes. Both in our study and in the literature data, triglycerides levels showed no significant correlations with NDT2DM [17]. However, Boizel et al. demonstrated that a triglyceride/HDL ratio could be useful in assessing the processes involved in LDL size pathophysiology and relevant to the risk of clinical vascular disease in such group of patients [18]. Furthermore, a recent study showed that high levels of oxidized LDL are strongly correlated with increases in decanoyl carnitine and lysoPC (C14:0) which are relevant metabolites for predicting the risk of developing diabetes [19]. Although we comprehensively controlled for many common risk factors, our study did not consider confounders such as insulin resistance, endothelial disfunction, previous statin treatment or other relevant biological pathways that may affect lipid and BP levels.

In our study group, echocardiographic assessment of the left ventricle, through 2D measurements, did not show sufficient correlation with the degree of hypertension and the presence of high lipid values. However, our results are not sustained by the previous studies, which identify the linear relationship between high blood pressure values and the hypertrophic reorganization of the cardiac muscle [20, 21]. Our data may be influenced by the relatively small number of patients, the static measurements or, possibly, by the patients' drugs that have not been clearly assessed in our study. Furthermore, a recent study, based on the PAMELA population, revealed an increased prevalence of left ventricular hypertrophy (LVH) in patients with high normal blood pressure (6.7%) than in patients with normal blood pressure (2.1%) [22].

Conclusions

Our study revealed that high blood pressure values as well as higher grades of arterial hypertension are associated with increased levels of dyslipidemia, especially with total cholesterol and HDL-c values. Moreover, hypertensive patients with high LDL-c

values present an increased risk for type 2 diabetes mellitus development. Further studies are necessary to sustain these relationships and to evaluate the best management of each category of patients in order to prevent CVD and premature death.

Conflict of interest

The authors confirm that there are no conflicts of interest.

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