

The relationship between serum LDL-cholesterol, HDL-cholesterol and systolic blood pressure in patients with type 2 diabetes

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Abstract

Background: The prevalence of hypertension and lipid disorders is increased in patients with diabetes. The relationship between cholesterol and blood pressure values has not yet been well established in this group of patients.

Aim: To assess the correlation between lipid levels and blood pressure values in patients with type 2 diabetes.

Methods: The study group consisted of 122 patients (82 females, 40 males, mean age 63±10 years) with type 2 diabetes. The mean duration of diabetes was 7.4±5.8 years, and hypertension 3.2±4.6 years. In all patients glycosylated haemoglobin (HbA1c) and lipid serum concentrations were assessed.

Results: The mean serum LDL-cholesterol was 112±37 mg/dl (median: 112 mg/dl) and HDL-cholesterol – 47±18 mg/dl (median: 44 mg/dl). A significant inverse correlation between HDL-cholesterol and systolic blood pressure ($r=-0.177$, $p=0.05$) as well as a positive correlation between LDL-cholesterol and systolic blood pressure values ($r=0.196$, $p=0.031$) were found.

Conclusion: In patients with type 2 diabetes there is a significant relationship between lipid levels and blood pressure values, which suggests an increased susceptibility to vascular disease associated with LDL-cholesterol in these patients.

Key words: hypertension, cholesterol, diabetes

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Introduction

Over the last decade, there has been increasing interest in the clinical association between hypertension and diabetes [1, 2]. The prevalence of hypertension is two times higher in diabetics than in non-diabetics. In type 1 diabetes mellitus (DM), the incidence of hypertension is similar to the incidence of nephropathy [3]. In type 2 diabetes, hypertension is often present as a part of the metabolic syndrome with insulin resistance, also including central obesity and dyslipidaemia, while in type 1 diabetes hypertension may reflect the onset of diabetic nephropathy [4].

Hypertension substantially increases the risk of both macrovascular and microvascular complications,

including stroke, coronary artery disease, peripheral vascular disease, retinopathy, nephropathy and possibly neuropathy [4, 5]. Observational and clinical trial data have demonstrated that elevated systolic blood pressure (BP) confers significantly higher risk of total and coronary heart disease mortality than elevated diastolic BP or combined systolic/diastolic hypertension, especially in those with DM [6, 7].

It has also been shown that atherogenic dyslipidaemias are associated with the subsequent development of hypertension among healthy women [8]. Even young, slender, normotensive subjects with a positive history of hypertension may show various alterations in lipid metabolism, suggesting a positive

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correlation between lipid metabolism and hypertension [9]. In essential hypertension, the disturbances of glucose and lipid metabolism may be related to both insulin resistance and compensatory hyperinsulinaemia. Insulin-resistant patients with essential hypertension may have more risk factors for arteriosclerotic complications than other patients with essential hypertension [10].

Indeed, non-insulin dependent DM and hypertension commonly co-exist and may be a part of the insulin resistance or metabolic syndrome [11]. This syndrome consists of clinical and biochemical alterations which are strongly associated with accelerated atherosclerosis. These features include abdominal obesity, mixed dyslipidaemia (high triglyceride and low HDL-cholesterol levels), hyperinsulinaemia and hypertension. The underlying association between hypertension and diabetes in this syndrome remains unknown, but it is possible that endothelial dysfunction, resulting from both hypertension and diabetes, could be an important factor responsible for a high incidence of vascular disease in individuals with both conditions [12].

In this study we aimed to elucidate the relationship between lipid levels and BP values in patients with type 2 diabetes.

Methods

Patients

This cross-sectional study was conducted in patients with type 2 DM who were treated with either oral hypoglycaemic agent or insulin, and were admitted to hospital to control the diabetes. Those who had hypertension also received antihypertensive therapy consisting of amlodipine or diltiazem, beta blockers and/or thiazide diuretics, administered at various doses. Exclusion criteria included the presence of any chronic or acute infections and the use of lipid-lowering medications.

The study was carried out from July to August 2005 in the Hajar Medical Educational and Therapeutic Center of Shahrekord University of Iran. All patients signed consent forms for participation in this study. The duration of DM and hypertension as well as the type of medication were assessed during medical history taking. All patients underwent physical examination, including BP measurement and body mass index (BMI) calculation as well as laboratory measurements.

Blood pressure measurement

A trained physician measured all baseline BP using a standard sphygmomanometer. Two BP and heart rate measurements were averaged to create the baseline BP and heart rate variables. Follow-up BP were calculated from two measurements taken on a single day after at

least 30 minutes of rest. Hypertension was diagnosed according to the WHO guidelines [13] and the seventh report of the joint national committee on prevention, detection, evaluation and treatment of high BP [14].

Laboratory methods

Blood samples were collected after a 12-hour overnight fast and centrifuged within 15 min of venopuncture. Glycosylated haemoglobin (HbA1c) was measured by chromatography method using Hb-Gold (UK) (normal value in our laboratory is $\leq 6.1\%$). The levels of serum creatinine, blood urea nitrogen and total protein were measured using standard methods. Also, triglyceride, total cholesterol and HDL-cholesterol levels were assessed using standard methods. Serum LDL-cholesterol level was calculated using Friedewald's formula [15]. Body mass index was calculated using the standard formula (weight in kilograms/height in square metres (kg/m^2)). Creatinine clearance (CrCl) was evaluated from serum creatinine, age and body weight [16].

Statistical analysis

Results are expressed as mean \pm SD and median values. Statistical correlations were assessed using a partial correlation test. Comparison between female and male genders' data was assessed using Student's t-test.

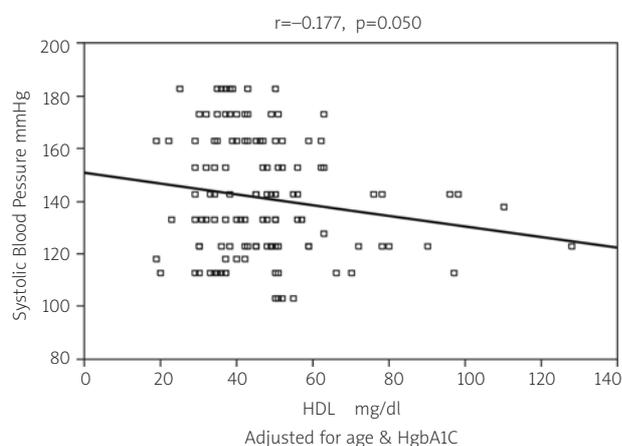
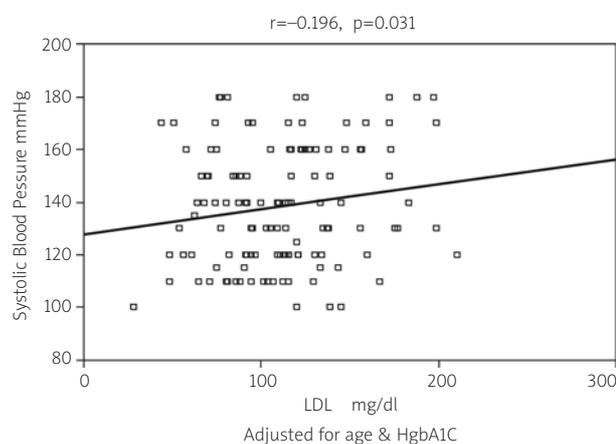
All analyses were performed with the SPSS statistical package (version 11.00 for Windows; SPSS, Chicago). A p value < 0.05 was considered statistically significant.

Results

The present study included 122 patients (82 females, 40 males). Baseline characteristics of patients are described in Table I. The mean age was 63 ± 10 years and the mean length of the time they were diabetic was 7.4 ± 5.8 years (median 6 years). The duration of hypertension was 3.2 ± 4.6 years (median 96 months). The mean systolic and diastolic BP values were 138 ± 23 mmHg and 83 ± 12 mmHg, respectively. The mean total cholesterol level – 198 ± 52 mg/dl (median 192 mg/dl), LDL-cholesterol – 112 ± 37 mg/dl (median 112 mg/dl), and HDL-cholesterol – 47 ± 18 mg/dl (median 44 mg/dl). A significant inverse correlation between HDL-cholesterol and mean systolic BP ($r = -0.177$, $p = 0.050$) (Figure 1) as well as a significant positive correlation between LDL-cholesterol and mean systolic BP ($r = 0.196$, $p = 0.031$) (Figure 2) were found (data adjusted for age and HgbA1c). No significant correlation between serum triglyceride or total cholesterol levels and the duration of hypertension or mean systolic BP was found (NS). In addition, no significant relationship between serum lipids and mean diastolic BP was documented (NS).

Table I. Demographic and laboratory characteristics of studied patients

Parameter	Minimum	Maximum	Mean±SD	Median
Age (years)	25	84	63±11	64
Duration of diabetes (years)	0.1	25	7.4±6.8	6
Duration of hypertension (years)	0.00	25	3.2±4.5	0.80
BMI (kg/m ²)	19.9	53	25.5±4.5	25.3
Creatinine (mg/dl)	0.6	10	1.32±1.34	1
Creatinine Clearance (ml/min)	10	110	64±24	64
HgbA1C (%)	3.9	13.3	7.6±1.9	7.6
Total cholesterol (mg/dl)	90	388	198±52	192
Triglyceride (mg/dl)	37	580	183±102	155
LDL-cholesterol (mg/dl)	44	210	112±37	112
HDL-cholesterol (mg/dl)	19	128	47±18	44

**Figure 1.** Correlation between HDL-cholesterol and mean systolic blood pressure**Figure 2.** Correlation between LDL-cholesterol and mean systolic blood pressure

Discussion

The present study documented a significant positive correlation between LDL-cholesterol and the mean systolic BP as well as a significant inverse correlation between HDL-cholesterol and the mean systolic BP. Patients with type 2 diabetes can have many lipid abnormalities, including hyperchylomicronaemia, elevated levels of very low-density lipoprotein cholesterol (VLDL-cholesterol), LDL-cholesterol or triglyceride and decreased levels of HDL-cholesterol. These patients are prone to have abnormalities in the size and composition of LDL particles (smaller, denser particles), which increase atherogenicity even if the absolute concentration of LDL-cholesterol is not significantly increased [17]. Both DM and hypertension alter lipid and lipoprotein metabolism and increase the risk of coronary artery disease [18]. It has

been well documented that an impairment of endothelial function is characteristic for many diseases, including essential or secondary hypertension, hypercholesterolaemia and atherosclerosis [19].

Elevated LDL-cholesterol levels may increase sensitivity to angiotensin II. It has been shown that in healthy, young subjects with isolated hypercholesterolaemia an increased sensitivity to angiotensin II can be partly normalised by LDL-cholesterol lowering therapy. These findings indicate that LDL-cholesterol levels directly influence angiotensin II sensitivity [20]. In young male subjects vascular responsiveness to angiotensin II is strongly determined by the LDL-cholesterol serum level, which is a potential contributing factor to the increased cardiovascular risk, even when LDL-cholesterol level remains within the so-called normal range [21].

Our results may be of practical significance by indirectly indicating an increased susceptibility to vascular disease associated with LDL-cholesterol in diabetic patients. LDL-cholesterol, either elevated or even within the normal range, could be an independent risk factor for developing or aggravating hypertension. This study also addressed the hypothesis that new therapeutic methods such as statin treatment may be useful in the reduction of LDL-cholesterol in patients with an early stage of type 2 diabetes.

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Związek pomiędzy stężeniem LDL- i HDL-cholesterolu a skurczowym ciśnieniem tętniczym u chorych z cukrzycą typu 2

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Streszczenie

Wstęp: Częstość występowania nadciśnienia tętniczego i zaburzeń lipidowych wśród pacjentów z cukrzycą jest zwiększona. Związek pomiędzy stężeniem cholesterolu i wartościami ciśnienia tętniczego w tej grupie chorych nie został jeszcze dokładnie zbadany.

Cel: Ustalenie korelacji pomiędzy stężeniem lipidów w surowicy krwi oraz wartościami ciśnienia tętniczego u chorych z cukrzycą typu 2.

Metodyka: Grupa badana składała się ze 122 chorych (82 kobiet, 40 mężczyzn, średni wiek 63±10 lat) z cukrzycą typu 2. Średni czas trwania cukrzycy wynosił 7,4±5,8 lat, a nadciśnienia 3,2±4,6 lat. U wszystkich chorych oznaczono poziom hemoglobiny glikozylowej (HbA1c) i stężenie lipidów w surowicy krwi.

Wyniki: Średnie stężenie LDL-cholesterolu wynosiło 112±37 mg/dl (mediana: 112 mg/dl), a HDL-cholesterolu – 47±18 mg/dl (mediana: 44 mg/dl). Wykazano istotną statystycznie ujemną korelację pomiędzy stężeniem HDL-cholesterolu a skurczowym ciśnieniem tętniczym ($r=-0,177$; $p=0,05$) oraz pozytywną korelację pomiędzy stężeniem LDL-cholesterolu i wartościami skurczowego ciśnienia tętniczego ($r=0,196$; $p=0,031$). Nie wykazano istotnych korelacji pomiędzy wartościami ciśnienia skurczowego a stężeniem całkowitego cholesterolu lub poziomem trójglicerydów. Również wartości ciśnienia rozkurczowego lub średniego ciśnienia tętniczego nie korelowały z żadną z frakcji lipidowych osocza.

Wnioski: U chorych z cukrzycą typu 2 wykazano istotną korelację pomiędzy stężeniami niektórych frakcji lipidowych a wartościami ciśnienia skurczowego, co może sugerować zwiększone ryzyko chorób naczyniowych u osób z podwyższonym poziomem frakcji LDL-cholesterolu w tej grupie pacjentów.

Słowa kluczowe: nadciśnienie tętnicze, cholesterol, cukrzyca

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