Serum Adiponectin and Leptin as Predictors of the Presence and Degree of Coronary Atherosclerosis

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ABSTRACT

Background: *Recently, the adipocyte derived proteins; adiponectin and leptin, have been found to be associated with obesity, type 2 diabetes, insulin resistance, hyperinsulinemia, dyslipidemia and the presence of coronary artery disease. However, the association of these proteins with the degree of coronary atherosclerosis has not been not been well elucidated.* ***Objectives:*** *To determine the relationship between serum adiponectin and leptin levels and the presence and degree of coronary atherosclerosis.* ***Methods:*** *Seventy patients performing diagnostic coronary angiography in our catheterization laboratory for the investigation of coronary artery disease (CAD) were recruited. The control group included (20 subjects) who were non-diabetics, non-hypertensives, with no history of previous acute coronary syndrome, having normal ECG, of matched age, sex, body mass index (BMI), and waist/hip ratio, performing coronary angiography for stable angina with inadequate exercise test results, and proved to have a completely normal coronary angiography. All cases and control were subjected to complete history and clinical examination including 12 lead ECG, measurement of BMI, and hip/waist ratio. Fasting blood glucose, full lipogram, serum adiponectin, and serum leptin were measured. Angiographic evaluation of coronary atherosclerosis was performed by assessing three atherosclerotic indices; severity (transverse disease), extent (longitudinal disease), and pattern (lesion complexity).* ***Results:*** *The independent predictors of the atherosclerosis lesion severity were larger waist/hip ratio (beta, 0.34), followed by higher LDL-cholesterol (beta, 0.32), low serum adiponectin level (beta, -0.23), older age (beta, 0.19), higher leptin level (beta, 0.17), current unstable angina (beta, 0.17), and finally previous myocardial infarction (MI) (beta, 0.14). This model is a good one as indicated from the model adjusted r^2 (50%). For the extent of atherosclerosis index lower serum adiponectin level was by far the most important independent predictor (beta, -0.45), followed by higher LDL-cholesterol (beta, 0.23), older age and previous MI (beta, 0.21 for both), while higher serum leptin level was only a univariate predictor. The model adjusted r^2 was 65%. For the atherosclerosis pattern index, the independent predictors were previous MI (beta, 0.31), lower serum adiponectin level (beta, -0.29), larger waist/hip ratio (beta, 0.26), higher serum leptin level (beta, 0.24), older age (beta, 0.22), and higher fasting blood glucose level (beta, 20). The model adjusted r^2 was 62%.* ***Conclusion:*** *Both serum adiponectin and leptin*

might play an important pathogenic role not only in the occurrence but also in the severity, extent and lesion complexity in CAD patients.
Key Words: *adiponectin; leptin; severity; extent; pattern; coronary atherosclerosis.*

INTRODUCTION

Atherosclerotic cardiovascular complications are major causes of morbidity and mortality. The precise mechanism underlying the development of atherosclerotic vascular disease has not been fully elucidated.[1]

Adiponectin is a protein hormone secreted exclusively by adipocytes. It is a member of the adiposecreted proteins termed 'adipocytokines' or 'adipokines'[2]. Adiponectin binds to two different seven-transmembrane domain receptors called 'AdipoR1' and 'AdipoR2'. AdipoR1 and AdipoR2 are clearly involved in energy metabolism but have opposite effects. Adipo R1 is predominantly expressed in skeletal muscle, whereas Adipo R2 is predominantly expressed in liver and throughout the brain[3]. Many other cells have adiponectin receptors (macrophages, osteoblasts, adipocytes, endothelial and muscular cells of the vascular wall, pancreatic cells and central nervous system cells)[4].

Adiponectin has been proposed to exhibit a protective effect against atherosclerosis. It is involved in glucose and lipid metabolism [5]. It has been found that hypoadiponectinemia is associated with obesity, type 2 diabetes, insulin resistence, hyperinsulinemia [6] and dyslipidemia[7]. Furthermore, patients with hypoadiponectinemia are found to be at increased risk of myocardial infarction (MI)[8].

Leptin, the product of the obese gene, is mainly produced by adipocytes[9]. Leptin is a satiety factor that regulates body weight by inducing a decrease in food intake and an increase in energy consumption[10]. Plasma leptin concentrations reflect the amount of adipose tissue and they positively correlate with the insulin resistance[11].

Furthermore, leptin is involved in a number of diverse physiological processes, such as regulation of endocrine functions, inflammation, immune response, reproduction, and angiogenesis[12].

Leptin receptors have been also identified in various peripheral tissues, including in the cardiovascular system and in human coronary arteries. It seems to have both vasodilatory and vasoconstrictory actions on vascular endothelium[13]. The exact role of leptin in cardiac and vascular homeostasis is still not fully understood[14].

OBJECTIVES

To determine the relationship between serum adiponectin and leptin levels and the presence and degree of coronary atherosclerosis.

MATERIALS & METHODS

Subjects:

Seventy consecutive patients performing diagnostic cardiac catheterization in Assiut University Hospital Catheterization Laboratory for the investigation of coronary

artery disease (CAD) were recruited. Patients were excluded if they had peroxisome proliferator-activated receptor (PPAR)-alpha or PPAR-gamma agonists, concurrent inflammatory or neoplastic disease, hemodynamically significant valvular heart disease, or prior revascularization procedure. The control group included (20 subjects) who were non-diabetics, non-hypertensives, with no history of a previous acute coronary syndrome, having normal ECG, of matched age, sex, BMI, and waist/hip ratio, performing coronary angiography for stable angina with inadequate exercise test results and proved to have a completely normal coronary angiography. The study was approved by Assiut faculty of medicine ethical committee. All patients and controls gave an informed consent to the study protocol. All cases and control were subjected to complete history and clinical examination including 12 lead ECG, measurement of body mass index (BMI), and waist/hip ratio (WHR).

Laboratory measurements:

Fasting blood samples were obtained before angiography. Serum was separated immediately by centrifugation and kept at -20˚C until analysis. Serum adiponectin concentration was assayed with an adiponectin ELISA kit (Biovendor Laboratory Medicine, Inc., Czech Republic). Serum Leptin was assayed with human leptin ELISA kit (DRG international, Inc., Germany). Total cholesterol, triglyceride, high density lipoprotein (HDL)-cholesterol and glucose levels were measured by enzymatic colorimetric method using reagents from (Human Gesellschaft fur Biochemica Diagnostica mbH, Germany). Low density lipoprotein LDL-cholesterol was calculated by Friedewald's formula [(15)].

Evaluation of coronary atherosclerosis by angiogram:

Angiographic evaluation of coronary atherosclerosis was performed by assessing three atherosclerotic indices; severity and extent using the criteria of Bogaty et al.[(16)] and pattern of the lesion was assessed according to Scanlon et al. [(17)].

Severity pertains exclusively to the degree of narrowing (transverse disease), and was evaluated by counting the number of major epicardial vessels with ≥70% narrowing of the lumen diameter. The maximum number of vessels was three. Left main stenosis ≥50% was counted as two vessels.

Extent considers the proportion of each coronary segment that appears abnormal (longitudinal disease). The coronary arteries were classified into 15 segments; one is the left main, 5 in the left anterior descending (proximal, mid, distal and 2 diagonals), 4 in the non-dominant left circumflex (proximal, distal and 2 obtuse marginals), and 5 in the dominant right coronary (proximal, mid and distal, posterior descending and posterior left ventricular arteries). For each of these segment a score ranged from 0-3 was given as according to the length of the abnormal segment (narrowed and/or irregular) as follows; 0 if angiographically normal, 1 if ≤10% abnormal, 2 if >10% to 50% abnormal, and 3 if >50% abnormal. Then, the extent index was

calculated by dividing the extent score calculated from the segments seen by antegrade flow divided by their number; thus it could range from 0 (score of 0) to a maximum of 3 (score of 45 divided by 15).

Pattern describes the complexity of the atherosclerotic lesion. A pattern score was obtained from each of the 15 segments above ranging from 0 to 3 according to the lesion complexity described in the American College of Cardiology/American Heart Association classification [17] as follows; 0 if normal, 1 if type A lesion, 2 if type B lesion, and 3 if type C lesion. Then, the pattern index was calculated the same way as the extent index by dividing the pattern score calculated from the segments seen by antegrade flow divided by their number.

Statistical analysis:

All data were analyzed using SPSS (Statistical Program for Social Sciences version 14 for windows, 2006, SPSS Inc., Chicago, IL, USA). Continuous variables were expressed as mean ± standard deviation (SD) and discrete variables were presented as frequencies and percentages. Continuous variables were compared between the two groups using the unpaired Student's t test for normally distributed data and the Mann–Whitney U test for non-normally distributed data. Discrete variables were compared using Chi-Square test. For each of the atherosclerosis indices, the univariate predictors were determined by Pearson correlation for the continuous variables and Spearman correlation for discrete variables. For each of the indices the significant univariate predictors were entered in a stepwise multivariate regression model to determine the independent predictors. Statistical significance was defined as a P value <0.05.

RESULTS

The clinical and laboratory characteristics of the study groups are shown in table 1. The patients group included 22 diabetics (31%), 42 hypertensive patients (60%), 36 patients (51%) with previous unstable angina, and 34 patients (49%) with a previous myocardial infarction (MI). Compared to the control group; the patient group had significantly lower adiponectin, and HDL-cholesterol levels and higher leptin, fasting blood glucose, total cholesterol, and LDL-cholesterol levels.

The predictors of the severity, extent and pattern indexes of coronary atherosclerosis are shown in tables 2, 3, 4 respectively. The independent predictor of the atherosclerosis lesion severity was larger waist/hip ratio (beta (0.34), followed by higher LDL-cholesterol (beta, 0.32), low serum adiponectin level (beta, -0.23), older age (beta, 0.19), higher leptin level (beta, 0.17), current unstable angina (beta, 0.17), and finally previous MI. This model is a good one as indicated from the model adjusted r^2 (50%).

For the extent of atherosclerosis index lower serum adiponectin level was by far the most important independent predictor (beta, -0.45), followed by higher LDL-cholesterol (beta, 0.23), older age and previous MI (beta, 0.21 for both), while higher serum leptin level was only a

univariate predictor. The model adjusted r^2 was 65%.

For the atherosclerosis pattern index, which represents the lesion complexity, the independent predictors were previous MI (beta, 0.31), lower serum adiponectin level (beta, -0.29), larger waist/hip ratio (beta, 0.26), higher serum leptin level (beta, 0.24), older age (beta, 0.22), and higher fasting blood glucose level (beta, 20). The model adjusted r^2 was 62%.

Table 1: Clinical and laboratory characteristics of the patients versus the control group

	Patients (70)	**Control (20)**	**P value**
Age	55.7±12	51.8±11	NS
Male gender	60(86%)	16(80%)	
Body mass index	29.3±3.7	28.6±4.5	NS
Waist/hip ratio	0.99±0.12	0.95±0.09	NS
Current Smoker	36 (51%)	7 (35%)	NS
Previous smoker	14 (20%)	6 (30%)	NS
Systolic blood pressure	125±34	118±9	NS
Diastolic blood pressure	82±14	79±8	NS
Adiponectin level (µg/dL)	8.7±4.9	12.7±4.4	0.001
Leptin (ng/mL)	29.7±12.7	13.9±6.0	<0.0001
Fasting blood glucose (mmol/L)	8.0±4.1	5.2±0.7	0.004
Triglycerides (mg/dL)	299±75	226±107	NS
Cholesterol (mg/dL)	222±45	195±18	0.01
LDL-cholesterol (mg/dL)	144±41	102±45	<0.0001
HDL- cholesterol (mg/dL)	31±10	41±4	<0.0001

NS; not significant

Table 2: Predictors of the severity of coronary atherosclerosis

	Univariate Predictors		**Multivariate Predictors**		
	r	**p value**	**B (95%CI)**	**Beta**	**p value**
Age	0.37	<0.0001	0.02(0.01–0.03)	0.19	0.004
Male gender	0.03	NS			
Body mass index	0.003	NS			
Waist/hip ratio	0.52	<0.0001	3.3(2.0–4.7)	0.34	<0.0001
Current Smoker	0.04	NS			
Previous or current smoker	0.06	NS			
Systolic blood pressure	0.21	0.05			
Diastolic blood pressure	0.09	NS			
Diabetes	0.43	<0.0001			
Previous myocardial infarction	0.24	0.02	0.32(0.02–0.62)	0.14	0.04
Current unstable angina	0.32	0.002	0.37 (0.09-0.66)	0.17	0.01
Adiponectin level (µg/dL)	-0.63	<0.0001	-0.05(-0.08– -0.02)	-0.23	0.003
Leptin (ng/mL)	0.43	<0.0001	0.01(0.003–0.026)	0.17	0.01
Fasting blood glucose (mµmol/L)	0.21	0.04			
Triglycerides (mg/dL)	0.20	NS			
Cholesterol (mg/dL)	0.44	<0.0001			
LDL-cholesterol (mg/dL)	0.60	<0.0001	0.008(0.005–0.012)	0.32	<0.0001
HDL- cholesterol (mg/dL)	-0.40	<0.0001			

NS; not significant

Table 3: Predictors of the extent index of atherosclerosis

	Univariate Predictors		**Multivariate Predictors**		
	r	**P value**	**B (95%CI)**	**Beta**	**P value**
Age	0.35	0.001	0.005(0.001–0.009)	0.21	0.008
Male gender	0.11	NS			
Body mass index	0.02	NS			
Waist/hip ratio	0.29	0.006			
Current Smoker	0.004	NS			
Previous smoker	0.14	NS			
Systolic blood pressure	0.16	NS			
Diastolic blood pressure	0.13	NS			
Diabetes	0.30	0.005			
Previous myocardial infarction	0.26	0.01	0.13(0.03-0.22)	0.21	0.008
Current unstable angina	0.28	0.008			
Adiponectin level (μg/dL)	-0.62	<0.0001	-0.03(-0.4– -0.02)	-0.46	<0.0001
Leptin (ng/mL)	0.40	<0.0001			
Fasting blood glucose (mmol/L)	0.25	0.02			
Triglycerides (mg/dL)	0.04	NS			
Cholesterol (mg/dL)	0.36	<0.0001			
LDL-cholesterol (mg/dL)	0.48	<0.0001	0.002(0.001–0.003)	0.23	0.007
HDL- cholesterol (mg/dL)	-0.43	<0.0001			

NS; not significant

Table 4: Predictors of the pattern index of atherosclerosis

	Univariate Predictors		**Multivariate Predictors**		
	r	**P value**	**B (95%CI)**	**Beta**	**P value**
Age	0.35	0.001	0.004(0.001–0.006)	0.22	0.003
Male gender	0.01	NS			
Body mass index	0.05	NS			
Waist/hip ratio	0.35	0.001	0.44(0.18–0.71)	0.26	0.001
Current Smoker	0.08	NS			
Previous smoker	0.09	NS			
Systolic blood pressure	0.08	NS			
Diastolic blood pressure	0.04	NS			
Diabetes	0.38	<0.0001			
Previous myocardial infarction	0.41	<0.001	0.12(0.07-0.18)	0.31	<0.0001
Current unstable angina	0.14	NS			
Adiponectin level (μg/dL)	-0.61	<0.0001	-0.01(-0.02– -0.005)	-0.29	0.001
Leptin (ng/mL)	0.45	<0.0001	0.003(0.001–0.006)	0.24	0.002
Fasting blood glucose (mmol/L)	0.36	0.001	0.01(0.003-0.017)	0.20	0.02
Triglycerides (mg/dL)	0.2	NS			
Cholesterol (mg/dL)	0.25	0.02			
LDL-cholesterol (mg/dL)	0.42	<0.0001			
HDL- cholesterol (mg/dL)	-0.41	<0.0001			

NS; not significant

DISCUSSION

Adipose tissue is not only an organ of energy storage but also a secretory organ producing a variety of bioactive substances, including adiponectin, leptin, tumour necrosis factor-α (TNF- α), and plasminogen activator inhibitor type 1 (PAI-1) that may contribute directly to the development of vascular disease[18].

This study confirms the previous reports that plasma adiponectin levels are lower in patients with coronary atherosclerosis [19-22] and that it is, on multivariate analysis, an independent predictor of the 3 aspects of the degree of coronary artery disease (extent, severity and complexity)[21,23,24]. However, Lim et al.[20] found no significant relation between serum adiponectin and the extent or severity of coronary atherosclerosis.

One of the initial steps in atherogenesis is adherence of monocytes to endothelial cells and their migration into the subendothelial space, where they take up oxidized lipoproteins and transform into foam cells[25]. Plasma adiponectin rapidly accumulates in the subendothelial space of the injured human artery[26]. In physiologic concentration, adiponectin has a dose-dependent inhibitory effect of TNF- α mediated expression of vascular cell adhesion molecules-1, endothelial-leucocyte adhesion molecule and intracellular adhesion molecule-1 thus it inhibits monocyte adhesion to endothelial cells and foam cell formation[18, 27]. Additionally, TNF-α has stimulatory effects on PAI-1 release from adipocytes,[28, 29]. PAI-1 has an important regulatory role in fibrinolytic processes and thrombus formation. Adiponectin also binds to platelet-derived growth factor-BB and subendothelial collagens and suppresses proliferation and migration of vascular smooth muscle cell, therefore limiting the progression of atherosclerosis and re-stenosis [27, 30].

Moreover, adiponectin exerts its vascular actions by direct stimulation of nitric oxide production in endothelial cells and taking part in vasodilatator actions and increasing blood flow. [31]

Studies in experimental animals have shown that adiponectin has the potential to inhibit neointimal formation [30,32]. Kubota et al. [32] reported that adiponectin-deficient mice have severe neointimal thickening and increased proliferation of vascular smooth muscle cells in mechanically injured arteries. In these mice, neointimal proliferation is attenuated by adenovirus-mediated adiponectin administration [25].

In this study, the patients group showed increased levels of fasting blood glucose, total cholesterol, and LDL-cholesterol but HDL-cholesterol decreased with decrease in adiponectin concentration. These findings may suggest that adiponectin may lead to vasculoprotection through improvement of lipid metabolism. Adiponectin suppresses lipid accumulation in macrophages, resulting in markedly decreased uptake of oxidized LDL and inhibition of foam cell formation [33]. Adiponectin induces AMP activated protein kinase, resulting in stimulation of glucose uptake in muscle, fatty acid oxidation in muscle and liver and

decrease of hepatic glucose production, cholesterol and triglyceride synthesis and lipogenesis [34]. Therefore, increased blood lipid concentrations in this study may be explained by our results which showed decreased concentrations of adiponectin in the patients group.

In the present study, WHR was an independent predictor of severity and pattern of coronary atherosclerosis. Increased WHR may be a sign of higher waist circumference (reflecting increased visceral fat, a cardiovascular disease (CVD) risk factor), reduced hip circumference (reflecting low gluteal muscle mass and/or low peripheral fat mass), or a combination of these. High gluteal muscle mass and high peripheral fat may protect against CVD [35, 36].

There are several mechanisms through which visceral fat may promote CVD. 1) Visceral fat leads to an increase in adipokines including leptin which may promote atherosclerosis[37]. 2) Proteins that are potentially protective against the development of CVD (adiponectin, and peroxisome proliferator activated receptor-gamma) have lower levels of expression in visceral fat compared to the subcutaneous fat[38]. 3) Visceral fat has more beta-adrenergic receptors and a decreased function of antilipolytic receptors, which leads to higher rates of catecholamine-stimulated lipolysis and free fatty acids [39]. 4) Visceral fat produces more PAI-1, an inhibitor of fibrinolysis compared with subcutaneous fat [40], while expression of angiotensinogen, a potential regulator of blood pressure, is also higher in visceral fat [41].

In the current study, BMI wasn't a predictor of the degree of coronary atherosclerosis. The lack of agreement between WHR and BMI may reflect that these measures identify different distributions of fat (central obesity in case of WHR vs. subcutaneous/total fat in case of BMI). Notably, BMI assesses the entire body mass without differentiating between its components, namely muscle, visceral fat, subcutaneous fat, bone and fluid [42].

The functional integrity of the vascular endothelium exerts anti-atherosclerotic and anti-thrombotic effects[43]. Conversely, impaired endothelium-dependent coronary vasomotor function describes a pro-atherosclerotic state [44].

In the present study, serum leptin levels were higher in patients with coronary atherosclerosis than controls. Serum leptin was correlated positively with the severity, extent and pattern of coronary atherosclerosis. However, on multivariate analysis, the high level of serum leptin was independent factors affecting the severity and pattern only, but not the extent of coronary atherosclerosis. Leptin was previously reported to be an independent predictor of CAD [45,46]. However, other investigators emphasized a potential protective role of leptin in CAD [47, 48, 49].

Functional leptin receptors are present on endothelial cells. However, the actions of leptin to modulate endothelial function remain controversial [50]. Leptin can elicit changes that may be detrimental to cardiovascular health. Its

administration may stimulate increases in oxidative stress in in vitro cultured human endothelial cells [(51)]. The increase in oxidative stress may interact with nitric oxide to form peroxynitrite and, thereby, decrease the bioavailability of nitric oxide, which is associated with an impairment of endothelium-dependent vasodilation[(52)]. Leptin also promotes neointimal growth in mice[(53)] and stimulates migration and proliferation of vascular smooth muscle cells [(54)].

Leptin stimulates synthesis and secretion of endothelin-1, a potent vasoconstrictor and mitogen[(55)]. Leptin also correlates positively with plasma concentration of PAI-1, fibrinogen, and von Willebrand factor [(56,57,58)] and promotes ADP-induced platelet aggregation [(59)]. It potentiates production of inflammatory cytokines, e.g., TNF-α, and interleukins 2 and 6 in cells [(60)]. Leptin stimulates lipoprotein lipase secretion in macrophages [(61)] and increases accumulation of cholesterol esters in foam cells, especially at high glucose concentrations [(62)]. Leptin promotes hepatic HDL and decreases plasma HDL level in mice [(63)]. Moreover, it causes sympathetic activation, pressor responses [(64)].

In contrast, there is evidence supporting several potentially beneficial effects of leptin. Momin et al.[(65)] reported that leptin is an endothelium-independent vasodilator in saphenous vein and internal mammary artery vascular rings isolated from patients with CAD. These vascular effects in an isolated preparation are independent of any neurally mediated actions of leptin. They are consistent with several previous reports demonstrating leptin-induced coronary artery vasodilation in humans and activation of endothelial nitric oxide production in human aortic endothelial cells [(66)].

Leptin may also activate adult human endothelial progenitor cells and promote angiogenesis [(67)].Under normoglycemic conditions leptin may protect macrophages from cholesterol overload[(68)]. This apparent discrepancy between the potentially protective actions of leptin, and its association with impaired cardiovascular outcome in epidemiological studies, may be reconciled by several explanations, including: first, the broad spectrum of cardiovascular actions of leptin; second, dose dependent effects of leptin; and third, the concept of selective leptin resistance [(14)].

Conclusion:

Both serum adiponectin and leptin might play an important pathogenic role not only in the occurrence but also in the severity, extent and lesion complexity in CAD patients. Waist/hip ratio, probably reflecting visceral obesity, is an important predictor of the degree of coronary atherosclerosis.

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الاديبونكتن والليبتين في المصل كمؤشرات للتنبؤ بوجود و درجة تصلب الشرايين التاجية

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خلفية : وجد حديثا أن البروتينات المشتقة من الخلايا الدهنية "الاديبونكتن والليبتين" لها علاقة مع البدانة ، والسكري من النوع الثانى ، ومقاومة الانسولين و وجود مرض الشريان التاجي. ومع ذلك ، فإن ارتباط هذه البروتينات مع درجة تصلب الشرايين التاجية لم يتم توضيحه جيدا.
الهدف: تحديد علاقة الاديبونكتين و الليبتين بحدوث تصلب شرايين القلب و درجتها.
الطرق :تم دراسة ٧٠ مريضا بتصلب الشرايين التاجية قاموا باجراء قسطرة قلب وشملت الدراسة أيضا ٢٠ شخصا كمجموعة ضابطه من غير المصابين بداء السكري وارتفاع ضغط الدم وليس لهم تاريخ مرضى سابق فيما يخص متلازمة الشريان التاجي الحادة ، بعد تخطيط القلب العادي ، و كانت هذه المجموعة متناسقة من حيث العمر والجنس ومؤشر كتلة الجسم و نسبة الخصر / الأرداف ، حيث تم عمل قسطرة قلب لهم بسبب الاشتباة في ذبحة صدرية مستقرة ولكن كان رسم قلب بالمجهود غير كافي ، وثبت أن شراينهم التاجية طبيعية. وجميع الحالات التي شملتها الدراسة خضعت لاخذالتاريخ المرضى والفحص السريري و تخطيط القلب الكهربائى، وقياس مؤشر كتلة الجسم و نسبة الخصر / الأرداف. وقياس نسبة السكر في الدم ، و منحنى دهون كامل و مستوى الاديبونكتين و الليبتين بالمصل. و تم تقييم تصلب الشرايين التاجيةعن طريق ثلاثةمؤشرات ؛ شدةالانسداد، وطوله ونمطه (التعقيد).
النتائج: المؤشرات المستقلة للتنبؤ بشدة تصلب الشرايين كانت نسبة الخصر / الأرداف، يليه ارتفاع الدهون الخفيفة وانخفاض مستوى الاديبونكتين بالمصل و السن الأكبر وارتفاع مستوى البيتين والذبحة غير المستقرة الحالية و إحتشاء عضلة القلب. المؤشرات المستقلة للتنبؤ بطول الشرايين المتصلبة هى إنخفاض مستوى الاديبونكتين بالمصل (أهم المؤشرات المستقلة)، يليه ارتفاع نسبة الدهون الخفيفة و السن الكبير و إحتشاء عضلة القلب
و بالنسبة لنمط المرض كانت المؤشرات المستقلة للتنبؤ هى إحتشاء عضلةالقلب ، وانخفاض مستوى الاديبونكتين بالمصل، نسبة الخصر / الأرداف، و إرتفاع الليبتين بالمصل و السن الكبير وارتفاع مستوى السكر في الدم.
الاستنتاج : يمكن أن يلعب كل من الاديبونكتن والليبتين دورا هاما ليس فقط في حدوث تصلب الشرايين التاجية ولكن أيضا في شدتها ، ومداها و تعقيد نمطها.