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Carotid intima-media thickness and serum leptin in psoriasis

Psoriasis is considered a systemic inflammatory condition analogous to other inflammatory immune disorders. Although the influence of environmental factors on psoriasis is not precisely defined, body mass index (BMI) has been reported to be one of the important associated factors [1].

Leptin, a protein secreted by the adipose tissue, plays important roles in metabolism and immunity. It regulates body weight and exerts other biologic functions that modulate hematopoiesis, angiogenesis and immune responses [2]. Additionally, leptin mediates proliferative and anti-apoptotic activities in different cell types, including T cells [3] and eosinophils [4]. Leptin receptor is expressed primarily in the hypothalamus, but it is also expressed by peripheral blood mononuclear cells, vascular endothelial cells and smooth muscle cells. Since psoriasis is an immune-mediated inflammatory disease, characterized by hyperproliferation of keratinocytes and infiltration of mostly T lymphocytes, leptin may provide a link between T cell function and inflammation in psoriasis [5].

Leptin signaling has shown to exert direct effects on the vascular endothelium and on vascular smooth muscle cells [6] and has been hypothesized to be proatherogenic. A recent cross-sectional analysis found a significant independent association between leptin and coronary artery calcification (CAC) among patients with type 2 diabetes mellitus [7]. However, prospective studies of leptin and cardiovascular risk are inconsistent [8, 9].

Patients with psoriasis may carry an excess risk of heart disease, which would represent an important and previously unrecognized cause of morbidity and mortality [10]. Prevention requires early identification of individuals at risk of developing cardiovascular disease but still clinically asymptomatic, such that intensive preventive measures may be instituted to arrest the progression of disease. Carotid intima-media thickness (IMT) measurement is a promising tool for detecting atherosclerosis in its pre-occlusive/subclinical phase [11].

The development of high resolution ultrasonography (US) for vascular imaging in recent years has enabled the study of onset, rate of progression and regression of carotid arterial plaques [12]. However, Doppler US is still user-dependant and as such susceptible to error [13].

Our aim is to evaluate carotid IMT and serum leptin levels in psoriatic patients as an indicator of subclinical atherosclerosis.

Materials and methods

Our study included 50 psoriatic patients recruited from the physical medicine, rheumatology and rehabilitation clinic as well as from the dermatology outpatient clinic at Ain Shams University Hospitals, Cairo, Egypt. In addition, 10 healthy age- and sex-matched controls with no prior history of cardiovascular disease (CVD) were enrolled in the study. Psoriasis was clinically diagnosed according to the Moll and Wright criteria for PSA [14].

Exclusion criteria included: subjects with a history of diabetes mellitus, hypertension, hypothyroidism, renal failure (serum creatinine >1.3 mg/dl), alcoholics, smokers, pregnant women and women on oral contraceptives, as well as patients with other joint diseases.

Hypertension was defined as systolic blood pressure >140 mm Hg or diastolic blood pressure >90 mm Hg, or self-reported use of antihypertensive medications. Diabetes mellitus was defined as a fasting blood glucose >126 mg/dl^{-1}, nonfasting blood glucose >200 mg/dl^{-1} or pharmacological treatment for diabetes [11].

Patients with a family history of atherosclerosis, overt cardiovascular diseases (including pre-existing coronary heart disease with a history of angina pectoris or myocardial infarction, or a history of cerebrovascular accident, transient ischemic attack or peripheral vascular disease) were also excluded from the study.

Patients on medication such as lipid-lowering therapy, antihypertensive or anti-aggregant drugs, nitrates or long-term systemic steroids, β-blockers, thiazides, systemic corticosteroids, cyclosporine and systemic regimens for psoriasis within the preceding 6 months were excluded. No subjects in the psoriasis or control group were following a special dietary regimen. Consent was obtained from all participants.

Presented at
Parts of this study were presented at the Angioplasty Summit TCTAP 2011 held in Soeul, Korea, April 27–29, 2011.

All subjects (patients and controls) underwent thorough clinical assessment. Blood pressure was measured in the supine position on three different occasions after adequate physical and mental rest, and the average of the three readings was taken. All anthropometric measurements were done by the same physician on the day blood specimens were taken. Height and weight of the subjects were obtained in light clothing without shoes. Height was measured as the distance from the top of the head to the bottom of the feet (no shoes) using a fixed stadiometer. BMI was calculated as the weight in kilograms divided by the square of the height in metres.

The clinical severity of skin affection in psoriatic and psoriatic arthritis patients was estimated using the psoriatic area and severity index (PASI) [15]. PASI score is a complex composite index indicating the severity of three main signs of psoriatic plaques (such as, erythema, scaling and thickness) and is further weighted by the amount of coverage of these plaques in the four main body areas (head, trunk, upper extremities and lower extremities). PASI scores ranges from 0 to 72, with the higher scores indicating greater disease severity [16]. The body is divided into four sections: head (H) (10% of a person's skin); arms (A) (20%); trunk (T) (30%); legs (L) (40%). Each of these areas is scored individually and the four scores are then combined into the final PASI. For each section, the percent of area of skin involved is estimated and then transformed into a grade from 0 to 6:

- Grade 0: 0% of involved area
- Grade 1: <10% of involved area
- Grade 2: 10%–29% of involved area
- Grade 3: 30%–49% of involved area
- Grade 4: 50%–69% of involved area
- Grade 5: 70%–89% of involved area
- Grade 6: 90%–100% of involved area

Within each area, the severity is estimated by three clinical signs: erythema (redness), induration (thickness) and desquamation (scaling). Severity parameters are measured on a scale of 0–4, from none to maximum.

The sum of all three severity parameters is than calculated for each section of skin, multiplied by the area score for that area and multiplied by the weight of the respective section (0.1 for head, 0.2 for arms, 0.3 for body and 0.4 for legs).

$$\begin{aligned} PASI = {} & 0.1 * (E_H + I_H + D_H) A_H \\ & + 0.2 * (E_A + I_A + D_A) A_A \\ & + 0.3 * (E_T + I_T + D_T) A_T \\ & + 0.4 * (E_L + I_L + D_L) * A_L \end{aligned}$$

The following tests were performed: serum leptin level (ng/ml), lipid profile (including serum triglycerides (TG), serum low density lipoproteins (LDL) and serum high density lipoproteins (HDL). Venous blood samples were drawn from subjects after a period of 12 h fasting. Samples were collected in serum separator tubes, allowed to clot for 30 min and centrifuged for 15 min at 2000x g at room temperature; serum was collected and stored at –70°C until analyzed. Serum leptin level was determined by ELISA assay method using a commercial kit (Diagnostic System Lab, USA).

Carotid duplex ultrasonography

Patients and controls were examined while in supine position with the neck extended and turned slightly to the contra-lateral side. Carotid IMT was measured using a high-resolution B-mode ultrasound machine (GE vivid 5, vingmed ultrasound, REF=FB000880, SER=2970VM, manufactured in Horten, Norway).

Patients lay in a supine position during the examination and carotid arteries were scanned cross-sectionally and longitudinally. Minimal gain was adjusted to visualize the lumen-intimal and medial-adventitial interfaces defining IMT in the far wall. IMT was measured offline in the distal common carotid artery (the arterial segment 1 cm proximal to the carotid bulb), bulb and proximal internal carotid artery (the arterial segment 1 cm distal to the carotid bifurcation). Plaques were not present and, if present, the maximum thickness was then measured and included in the mean IMT. This was done by means of a three-stage process:

1 Scanning technique

The examination started with a transverse scan of the carotid artery from as low in the neck as possible, to as high in the neck as possible behind the angle of the mandible.

2 Identification of the internal and external carotid arteries

The external carotid artery has branches just above the bifurcation: the superior thyroid, the ascending pharyngeal and the lingual arteries. These may all arise from the external carotid artery below, around or at the level of the angle of the mandible. As the distal vascular bed is highly resistive, the spectral waveform obtained from the ECA is typically highly resistive, that is, a rapid and brief forward flow during systole followed by little or no flow during diastole.

3 Assessment of carotid atherosclerosis

(a) *Direct visualization and measurement*
IMT was measured as mentioned above. A deposition of more than 1.5 mm constituted an atherothrombotic plaque.
(b) *Velocity criteria*
ICA was diagnosed as normal when ICA PSV was less than 125 cm/s and no plaque or intimal thickening was visible; less than 50% stenosis when ICA PSV was less than 125 cm/s and plaque or intimal thickening was visible; 50%–69% stenosis when ICA PSV was125–230 cm/s and plaque was visible; ≥70% stenosis to near occlusion when ICA PSV was more than 230 cm/s and visible plaque and lumen narrowing were seen; near occlusion when there was a markedly narrowed lumen on color Doppler US; and total occlusion when there was no detectable patent lumen on grey scale US and no flow on spectral, power and color Doppler.

We considered the positive IMT value (IMT >1.00 mm) as a cut-off point in the current study [17, 18]. Furthermore, to have a single intimal thickness value for easier statistical correlations, we used the mean of the IMT of the four examined vessels (MIMT).

Statistical analysis

Descriptive statistics was performed for all variables of the study. For categorical variables, absolute counts as well as percentages were generated. For quantitative variables, the range, mean, standard devi-

ation and standard error of the mean were calculated. Comparison of categorical data was done using the χ^2 test. Quantitative data was tested using either the pooled *t*-test (for parametric data) or using the Mann-Whitney U test for non-parametric significance. A correlation study for relationships of different variables was done using the Pearson correlation coefficient (*r*). *P* is considered significant if less than 0.05. The ANOVA test was used to study the effect of independent (predictor) variables on one dependant variable. Data was graphically represented using the HGW program.

Results

Altogether, 50 psoriatic patients took part in our study, comprising 15 female patients (30%) and 35 male patients (70%). A group of 10 healthy matched individuals (eight males and two females) participated in our study as controls. Descriptive data of the patients and controls are shown in **Tab. 1**.

The laboratory results for our psoriatic patients and control group (lipid profile and serum leptin) are shown in **Tab. 2**.

The results of carotid IMT for patients and controls measured by duplex US are shown in **Tab. 3**.

Since the positive IMT value (IMT >1.00 mm) is considered as a cut-off point in the current study, the patient group was divided into groups A and B. We considered group A: patients with a positive IMT value in one or more of carotid vessels examined, and group B: patients with an intimal thickness ≤1 mm in all carotid vessels examined. Accordingly, 31 of our patients (62%) formed group A, while the rest (19 patients=38%) formed group B. Only two of our controls (20%) had positive IMT values. A comparison between group A and B in terms of mean values of demographic, clinical and laboratory findings is shown in **Tab. 4**.

There was a significant positive correlation between the triglyceride level with the PASI score (r=+0.37, P<0.05) (**Fig. 1**) and a highly significant positive correlation between serum leptin with the PASI score (r=+0.59, P<0.001) (**Fig. 2**) in the patients studied.

Abstract · Zusammenfassung

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Carotid intima-media thickness and serum leptin in psoriasis

Abstract

Background. Psoriasis, a chronic inflammatory immune disorder, has been linked to increased cardiovascular mortality and morbidity. Leptin, an obesity-related peptide, has been shown to exert direct effects on the vascular endothelium and on vascular smooth muscle cells. Carotid intima-media thickness (IMT) measurement is a promising tool for detecting atherosclerosis in its pre-occlusive/subclinical phase.

Objective. The objective of the study was to evaluate carotid IMT and serum leptin levels in psoriatic patients as an indicator of subclinical atherosclerosis.

Materials and methods. The study was conducted in 50 psoriatic patients and 10 healthy controls. The clinical severity of skin affection in psoriatic patients was estimated using the psoriatic area and severity index (PASI). Serum leptin levels (ng/ml) and lipid profiles [including serum triglyceride (TG), serum low density lipoproteins (LDL) and serum high density lipoproteins (HDL)] were measured from blood samples. Carotid IMT was measured using carotid duplex ultrasonography.

Results. Psoriatic patients showed significantly higher leptin levels and higher IMT than controls. The mean of the intima-media thickness of the four vessels examined (MIMT) showed a positive correlation with patients' mean ages, disease duration, body mass index, PASI scores, systolic blood pressure, diastolic blood pressure, leptin levels, LDL levels and triglyceride levels and no correlation with the mean HDL level.

Conclusion. Psoriasis is an independent risk factor for subclinical atherosclerosis. This cardiovascular impairment is influenced mainly by disease severity, serum TG levels and serum leptin levels.

Keywords

Psoriasis · Carotid intima-media thickness · Serum leptin · Serum triglyceride · Atherosclerosis

Karotis-Intima-Media-Dicke und Serumleptin bei Psoriasis

Zusammenfassung

Hintergrund. Psoriasis, eine chronisch-entzündliche Autoimmunkrankheit, wird mit erhöhter kardiovaskulärer Mortalität und Morbidität in Verbindung gebracht. Bei Leptin, einem adipositasbezogenen Peptid, wurde nachgewiesen, dass es eine direkte Wirkung auf Endothel und glatte Muskelzellen der Gefäße hat. Die Messung der Karotis-Intima-Media-Dicke („intima-media thickness", IMT) ist ein vielversprechendes Instrument zur Erkennung der Arteriosklerose und ihrer präokklusiven/subklinischen Phase.

Ziel. Ziel der Studie war die Bestimmung der Karotis-IMT und des Serumleptinspiegels bei Psoriasispatienten als Indikator einer subklinischen Arteriosklerose.

Material und Methoden. Die Studie wurde mit 50 Psoriasispatienten und 10 gesunden Kontrollen durchgeführt. Bei den Patienten wurde der klinische Schweregrad der Hautaffektion anhand des PASI („psoriatic area and severity index") erhoben. Anhand von Blutproben wurden Serumleptinspiegel (ng/ml) und Lipidprofile [einschließlich Triglyzeride (TG), LDL („low-density lipoprotein") und HDL („high-density lipoprotein") im Serum] gemessen. Die Karotis-IMT wurde mit der Karotisduplexsonographie ermittelt.

Ergebnisse. Bei den Psoriasispatienten waren signifikant höhere Leptinspiegel und eine höhere IMT als bei den Kontrollen nachzuweisen. Das Mittel der IMT für die vier untersuchten Gefäße zeigte eine positive Korrelation mit den Durchschnittswerten für Patientenalter, Krankheitsdauer, Body-Mass-Index, PASI, systolischem und diastolischem Blutdruck, Leptin, LDL und TG, aber keine Korrelation mit dem durchschnittlichen HDL-Wert.

Fazit. Psoriasis ist ein unabhängiger Risikofaktor für subklinische Arteriosklerose. Diese kardiovaskuläre Erkrankung wird hauptsächlich durch die Krankheitsschwere sowie die TG- und Leptinwerte im Serum beeinflusst.

Schlüsselwörter

Psoriasis · Karotis-Intima-Media-Dicke · Serumleptin · Serumtriglyzeride · Arteriosklerose

Tab. 1 Descriptive data of patients and the control group

	Patients (*n* 50)		Controls (*n* 10)		*t*	*P*	S
	Range	Mean±SD	Range	Mean±SD			
Age (years)	31–63	44.34±8.60	28–48	39.7±7.17	1.598	>0.05	NS
DD (years)	2.4–16	6.50±2.95	–	–	–	–	–
BMI (kg/m^2)	21–42	29.39±6.45	20–41	28.40±5.15	*0.46*	>0.05	NS
PASI	6.8–65	20.99±16.67	–	–	–	–	–
SBP (mm Hg)	110–140	131.10±12.8	110–130	123.5±6.26	3.0	<0.05	S
DBP (mm Hg)	75–90	88.20±7.74	70–85	80±4.08	4.8	<0.001	HS

Sex is matched between both groups [χ^2=0.41, P >0.05 (NS)]. DD disease duration, BMI body mass index, SBP systolic blood pressure, DBP diastolic blood pressure, NS nonsignificant, HS highly significant, S significant.

Tab. 2 Comparison between patients and controls in terms of laboratory data

Laboratory findings	Patients (*n* 50)		Controls (*n* 10)		*t*	*P*	S
	Range	Mean±SD	Range	Mean±SD			
LDL (mg/dl)	70–170	116.8±29.9	67–165	112.4±22.3	0.44	>0.05	NS
HDL (mg/dl)	33–80	57.1±14.7	34–89	61.2±12.8	0.82	>0.05	NS
TG (mg/dl)	109–240	161.6±35.3	49–137	92.3±29.2	5.816	<0.001	HS
Leptin (ng/ml)	5–48	17.09±11.07	2.5–12	6.9±2.8	2.876	<0.05	S

LDL low density lipoprotein, HDL high density lipoprotein, TG triglyceride, NS nonsignificant, HS highly significant, S significant.

Tab. 3 Comparison between patients and controls in terms of mean values of carotid IMT

Vessels examined	Patients		Controls		*t*	*P*	S
	Range (mm)	Mean±SD	Range (mm)	Mean±SD			
LT CCA	0.6–1.53	0.97±0.26	0.48–0.9	0.75±0.14	2.65	<0.05	S
LT ICA	0.45–1.43	0.89±0.26	0.56–1.1	0.77±0.16	1.40	<0.05	NS
RT CCA	0.55–1.5	0.96±0.26	0.55–1.0	0.76±0.149	2.38	<0.05	S
RT ICA	0.5–1.6	1.02±0.29	0.5–1.0	0.77±0.17	2.56	<0.05	S

CCA common carotid artery, ICA internal carotid artery, NS nonsignificant, S significant.

Tab. 4 Comparison between groups A and B in terms of mean values of demographic, clinical and laboratory findings

	Group A (*n* 31)	Group B (*n* 19)	*t*	*P*	S
	Mean±SD	Mean±SD			
Age (years)	47.32±8.06	39.50±7.27	3.45	<**0.001**	HS
DD (years)	7.08±2.09	5.55±3.86	1.82	>0.05	NS
BMI (kg/m^2)	31.48±6.21	25.98±5.39	3.19	<0.05	S
Leptin (ng/ml)	21.69±11.46	9.58±3.86	4.44	<**0.001**	HS
PASI	27.80±18.00	9.88±2.46	4.30	<**0.001**	HS
LDL (mg/dl)	119.55±28.53	112.37±32.46	0.82	>0.05	NS
HDL (mg/dl)	59.03±13.91	54±15.75	1.18	>0.05	NS
TG (mg/dl)	169.52±32.58	148.68±36.53	2.10	<0.05	S
SBP (mm Hg)	134.52±13.00	125.53±10.66	2.66	<0.05	S
DBP (mm Hg)	89.35±8.44	86.32±6.20	1.36	>0.05	NS

DD disease duration, BMI body mass index, SBP systolic blood pressure, DBP diastolic blood pressure, LDL low density lipoprotein, HDL high density lipoprotein, TG triglyceride, NS nonsignificant, HS highly significant, S significant.

There was a highly significant positive correlation between BMI and serum leptin levels in the psoriatic patients (r=+0.532, P<0.001) (**Fig. 3**).

MIMT showed a positive correlation with patients' mean age, disease duration, BMI, PASI score, systolic blood pressure, diastolic blood pressure, leptin levels, LDL levels and triglyceride levels (**Tab. 5**).

MIMT showed no correlation with mean HDL levels. Multivariate analysis to show the cumulative effect of age, BMI and serum leptin (as predictors) on mean value of the four carotid artery records of the studied patients (as dependent variable) showed a highly significant effect (F=9.357, P<0.001=HS). The effect of age was significant (t=3.34, P<0.05), while effects of BMI and serum leptin were not significant (t=0.44, P>0.05 and t=1.52, P>0.05), respectively.

Discussion

Psoriasis and other disorders that are inflammatory in nature are linked to increased cardiovascular mortality and morbidity [19]. The chronic systemic inflammatory state per se has been linked to an acceleration of the atherosclerotic process. Proinflammatory cytokines, such as TNF-α and interferon are important participants in plaque formation as well as endothelial dysfunction [20]. Recently, psoriasis was also shown to be associated with myocardial infarction (MI), even after control of the known risk factors [21].

BMI is a complex variable that seems to affect immunity. It has been documented that circulatory levels of tumor necrosis factor-α (TNF-α) is significantly increased in obese as compared with non-obese subjects [22, 23]. In 2005, Naldi and colleagues even reported BMI to be one of the risk factors associated with psoriasis in their case-controlled study [1].

Leptin hormone, which helps control food intake, body weight and fat stores, also plays a role in immune and inflammatory processes. Although association does not necessarily signify causation, it is possible that the proinflammatory mediators in psoriasis may stimulate leptin expression, which may in turn eventually lead to metabolic dysregulation in these patients [24].

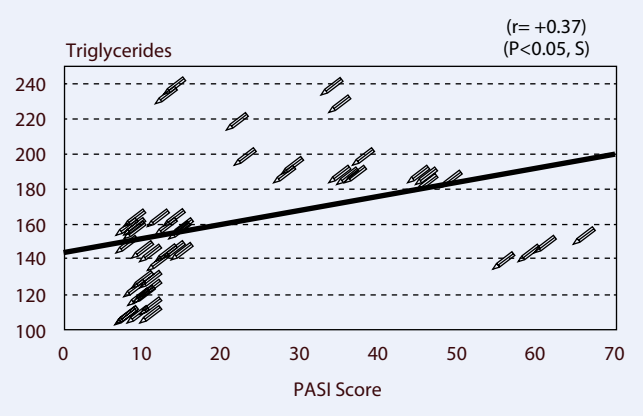

Fig. 1 ◀ Correlation between PASI score and serum triglycerides in the patients studied

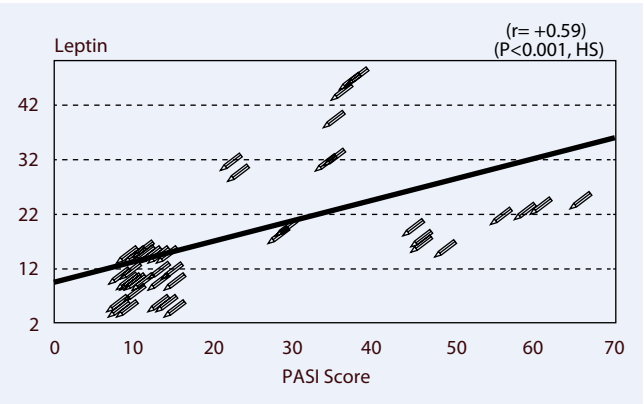

Fig. 2 ◀ Correlation between leptin levels and PASI score in the patients studied

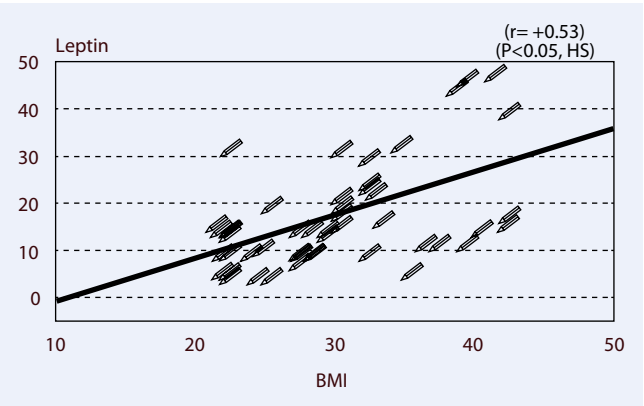

Fig. 3 ◀ Correlation between BMI and serum leptin in the patients studied

In the present study, we tried as far as possible to match BMI in patients and controls to help exclude the relationship between leptin levels and obesity. Although the mean values of BMI in our patients were slightly higher than the controls, there was no statistically significant difference between the two groups.

Serum leptin mean values were still significantly higher in the patient group than the control group and showed a positive correlation with BMI as expected. Leptin mean values also showed a positive correlation with PASI scores of our patients, thus proving its clear association with psoriasis.

These finding concur with those of Cerman et al. [25], who suggested in their study that leptin might serve as a marker of severity in psoriasis and may also be a pathogenetic cofactor contributing to the chronicity of the disease. Consequently, its role in obesity and cardiovascular disease in patients with psoriasis warrants further investigation. This group also suggested that drugs targeting the proinflammatory effects of leptin may be a new adjuvant therapeutic approach in psoriasis.

In contrast, the study done Aktan and colleagues [5] did not support any possible relation between serum leptin levels and psoriasis. Considering the relatively small number of subjects (20 only) and relatively low mean PASI (6.2) scores in their patient group, they themselves finally suggested further studies investigating severe inflammatory forms of psoriasis.

Serum lipids are strong predictors of cardiovascular risk. Numerous studies have mentioned that increased clinical cardiovascular morbidity in patients with psoriasis in general and psoriatic arthritis in particular was explained in part by the presence of a pathogenic lipid profile and increased lipoprotein A in psoriatic patients [26].

In our study, although HDL was higher in the control group while serum TG and LDL were higher in the patient group, this failed to reach a statistically significant difference except for TG. There was also a significant positive correlation between serum TG mean levels and PASI scores in our psoriatic patients, thus highlighting the effect of dyslipidemia and severity of the disease.

Cardiovascular disease is the end result of the atherosclerotic process. The various diagnostic modalities currently used (exercise electrocardiography, stress echocardiography, thallium scanning, coronary angiography) can detect atherosclerotic disease only when it becomes significantly advanced and occlusive. Similarly, various risk-factor assessment scores can predict the risk of future cardiovascular events, but fail to identify the ongoing atherosclerotic process [11].

Carotid IMT also serves as a risk factor for myocardial infarction (MI) and stroke in asymptomatic adults, independent of traditional cardiovascular risk factors. Thus, determining carotid IMT provides useful and early information about atherosclerosis at a subclinical, pre-occlusive phase of the disease in individuals at risk [27].

In the present study, carotid MIMT values were higher in patients than controls in all four vessels examined, yet did not reach statistical significance in the left ICA.

Like Mazlan et al. [18], we considered an IMT value of more than 1 mm as a pos-

Tab. 5 Correlations between MIMT and different variables in the patients studied

	MIMT of patients		
	r	*P*	S
Age (years)	0.57(**)	<0.001	HS
DD (years)	0.33(*)	<0.05	S
BMI (kg/m^2)	0.43(**)	<0.05	S
PASI	0.78(**)	<0.001	HS
SBP (mm Hg)	0.54(**)	<0.001	HS
DBP (mm Hg)	0.47(**)	<0.05	S
Leptin (ng/dl)	0.41(**)	<0.05	S
LDL (mg/dl)	0.29(*)	<0.05	S
HDL (mg/dl)	0.02	>0.05	NS
TG (mg/dl)	0.28(*)	<0.05	S

S significant, HS highly significant, NS non-significant, IMT intima media thickness, DD disease duration, BMI body mass index, SBP systolic blood pressure, DBP diastolic blood pressure, LDL low density lipoprotein, HDL high density lipoprotein, TG triglyceride.

itive result, thus dividing our patients into group A (a positive result in any of the vessels examined) and group B (none of the examined vessels show positive results). Indeed, 62% of our patients showed positive results, thus proving an increased cardiovascular risk manifested as increased carotid intima-media thickness in psoriatic patients.

Mean values of patients' age, BMI, SBP, PASI score, serum TG and serum leptin were significantly higher in group A than B. MIMT showed a positive correlation with patients' age, disease duration, BMI blood pressure, PASI scores, serum leptin, serum TG and serum LDL.

Our findings agree with those of Iribarren et al. [28], who reported that plasma leptin concentrations in their study were shown to be associated with carotid IMT, suggesting that leptin may have an unfavorable influence on the development of atherosclerosis.

Another study demonstrated an effect of leptin on arterial distensibility measured by high-resolution brachial artery US [29]. The mechanisms responsible for the possible effects of leptin on the vascular wall were far from clear. It has been proposed that leptin is able to enhance ADP-induced platelet aggregation and angiogenesis [30, 31]. Recently, the presence of leptin receptor has been demonstrated in human atherosclerotic human arteries [32].

In their study, El Mongi et al. [33] also proved that patients with psoriasis had increased carotid artery IMT compared with controls. Carotid IMT positively correlated with patients' age, duration of disease and severity of psoriasis. Mazlan et al. [18] concluded in their work that IMT correlated with age, waist circumference and blood pressure. On the other hand, Youssef et al. [21] partially agreed with us. They mentioned in their study that psoriasis and psoriatic arthritis were associated with subclinical atherosclerosis by exhibiting increased carotid IMT compared with healthy controls. However, in actual fact, they found no correlation between disease duration and PASI score and IMT in their study. This was perhaps due to the relatively young age group of their patients compared to ours, or may be related to the fluctuating course of psoriasis.

An interesting finding in our study is that carotid artery IMT showed a direct correlation with TG levels in the psoriasis patients. Our results are consistent with those of Tam et al. [34] and Eder et al. [35], who reported an association between increased IMT and TG levels in psoriasis patients. Hypertriglyceridemia has been shown to predict coronary artery disease [36].

By using multivariate analysis we found a highly significant cumulative effect of age, BMI and serum leptin (as predictors) on mean value of the four carotid artery records of the patients studied (as dependent variables) (F=9.357, P<0.001=HS). However, the effect of age alone was significant (t=3.34, P<0.05), while the effects of BMI and serum leptin were not significant (t=0.44, P>0.05 and t=1.52, P>0.05), respectively. This partly supports our hypothesis on the cumulative effect of our independent variables; however, the data collected from the small number of patients studied may not have been sufficient to study the effect of age, BMI and leptin independently on mean IMT.

Conclusion and recommendations

We conclude that psoriasis patients had impaired endothelial function and thicker IMT of the CCA compared with healthy control subjects. This cardiovascular impairment is influenced mainly by the severity of the disease, serum TG levels and serum leptin levels. It is our recommendation that psoriatic patients be advised to routinely assess intima-media thickness level and serum leptin levels in order to reduce cardiovascular morbidity and mortality. They should also be evaluated for hyperlipidemia. Administrating lipid-lowering medication to patients, particularly those with severe disease, may improve the prognosis in this patient group.

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Conflict of interest. The corresponding author states that there are no conflicts of interest.

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