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Alterations of the preptin–myostatin axis and their association with glycemic control and atherogenic risk in type 2 diabetes mellitus

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Abstract

Background: Type 2 diabetes mellitus (T2DM) is a complex metabolic disorder characterised by chronic hyperglycemia, insulin resistance, and progressive β-cell dysfunction. Emerging evidence suggests that novel peptide hormones, including preptin and myostatin, may contribute to metabolic dysregulation and cardiovascular risk. **Aim:** The purpose of the study was to examine the changes in the preptin-myostatin axis and determine their relationship with glycemic control, insulin resistance, inflammation, and atherogenic risk in patients with T2DM who had and did not have early cardiovascular disease (CVD).

Methods: The case-control study involved 110 participants (3 groups) who included healthy controls (n=30), T2DM without complications (n=40), and T2DM with early CVD (n=40). We connected astudy at Baghdad Medical City Hospital between April and July 2025. Measurements taken were serum preptin, myostatin, and hs-CRP. There was a measure of glycemic indices (HbA1c, fasting blood sugar (FBS), HOMA-IR) and parameters of lipid profile. Calculation of non-HDL cholesterol and Atherogenic Index (log TG/HDL) was done. SAS (2018) and SPSS (2019) were used as the statistical tools.

Results: In the patients with T2DM, serum preptin, myostatin and hs-CRP levels were remarkably higher, especially in those patients who had early CVD (P≤0.01). These modifications were accompanied by deteriorating glycemic regulation and lipid disorders. The non-HDL-C and Atherogenic Index were also much elevated in diabetic groups. The correlation of myostatin with glycemic markers was rather low but significantly positively correlated with hs-CRP in uncomplicated T2DM. **Conclusion:** The preptin-myostatin axis is highly changed in T2DM and is linked with the failure to manage glucose levels and atherogenic risk. These peptides can be potential biomarkers that connect the metabolic dysfunction and cardiovascular complications.

Keywords: Preptin; Myostatin; Type 2 Diabetes Mellitus; Atherogenic Index; Cardiovascular Disease; Insulin Resistance

1. Introduction

Diabetes mellitus (DM) is one of the greatest public health issues in the world today in the 21 st century. It is a long-lasting metabolic illness whereby hyperglycemia is sustained due to impairments in insulin secretion, insulin action or both. According to the International Diabetes Federation the number of people in the world who are already living with diabetes is estimated to be hundreds of millions, and this figure is expected to grow significantly in the next decades. Diabetes is not only hyperglycemia but also includes microvascular complications (nephropathy, neuropathy and retinopathy) and macrovascular complications (coronary artery disease, stroke and peripheral arterial disease)(1) .

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Diabetes mellitus is widely categorized into Type 1 diabetes mellitus (T1DM) and Type 2 diabetes mellitus (T2DM), which differ in their pathophysiological processes, yet both of them end in chronic hyperglycemia and its related complications (2).

Type 1 diabetes mellitus is mainly an autoimmune disease, which involves the destruction of pancreatic (β)-cells. The result of this destruction is unconditioned insulin deficiency. Environmental triggers like viral infections in conjunction with genetic susceptibility especially HLA class II genes lead to the development of the disease. T1DM normally shows up during childhood or adolescence, but cases of the disease in adulthood are becoming more common. The patients normally manifest themselves as polyuria, polydipsia, weight loss and may even develop diabetic ketoacidosis when not treated. Survival requires lifelong exogenous insulin therapy (3).

Pathogenesis of T2DM is multifactorial, and it includes genetic predisposition, obesity especially visceral adiposity), sedentary lifestyle and environmental factors. Insulin resistance first occurs in peripheral tissues, in particular skeletal muscle, liver and adipose tissue, resulting in loss of glucose uptake and excess production of glucose in hepatic tissues. Pancreatic 8-cells in response raise insulin secretion in order to keep the glucose level within normal limits. In the long term, there is dysfunction of β-cells, which lead to inadequate secretion of insulin in comparison with the metabolic requirement (4) .

Despite the differences in etiology between T1DM and T2DM, there exists an overlapping of metabolic pathways between the two that includes inflammation, oxidative stress, and endothelial dysfunction. The chronic hyperglycemia results in the activation of several pathogenic pathways, such as polyol, advanced glycation end-products (AGEs), protein kinase C, and the hexosamine pathway flux. All these mechanisms lead to vascular damage and atherosclerosis (5).

One of the characteristic features of T2DM is the fact that this condition is closely related to cardiovascular disease (CVD), and it is the primary cause of morbidity and mortality in diabetic patients. Dyslipidemia in T2DM is characterised by high triglycerides, a high volume of small dense LDL, low levels of HDL cholesterol and high levels of non-HDL cholesterol. Such lipid disorders favour atherogenesis. Also, long-term low-grade inflammation, which is frequently characterised by high levels of high-sensitivity C-reactive protein (hs-CRP), is at the heart of plaque development and instability(6).

Over the past few years, the role of novel peptide hormones and myokines in metabolism has received growing interest. Preptin and myostatin have been among them that have become potential mediators between glucose metabolism, insulin resistance, muscle mass regulation, and cardiovascular risk.

Preptin is a 34-amino acid peptide hormone that is co-secreted with insulin and amylin by the 34 pancreatic 3 -cells. It is formed out of the E-peptide part of pro-insulin-like growth factor II (pro-IGF-II). According to experimental studies, preptin increases glucose-mediated insulin secretion in a dose-dependent fashion, and it is an amplifier of the β-cell activity. High levels of circulating preptin have been reported in patients with poor glucose tolerance, obesity, and T2DM. The hypothesis is that higher levels of preptin can be a compensatory response to insulin resistance, though chronic elevation can lead to 8 -cell stress and metabolic dysregulation(7).

Transforming growth factor-B (TGF-B) superfamily Myostatin, or growth differentiation factor-8 (GDF-8) is a protein belonging to the superfamily. It is mostly synthesised in skeletal muscles and acts as a negative muscle growth regulator. In addition to its involvement in muscle mass regulation, myostatin has been found to be involved in metabolic homeostasis. High levels of myostatin have been linked to insulin resistance, obesity, sarcopenia, and cardiovascular disease. Mechanistically, myostatin can block insulin signalling pathways and facilitate adipogenesis, thus causing metabolic syndrome and the advancement of T2DM (8).

Although interest is increasing, there is little information on a combination of assessment of preptin and myostatin in patients with T2DM, especially in comparison with cardiovascular risk factors, including non-HDL cholesterol and Atherogenic Index (log TG/HDL). The knowledge of these associations can shed light on new biomarkers and possible therapeutic targets that can lead to a decrease in the number of metabolic and cardiovascular complications.

Thus, the current research was aimed at exploring the changes of the preptin-myostatin axis in patients with T2DM having and without early cardiovascular disease and assessing their relationship with the quality of glycemic control, insulin resistance, inflammatory condition, and atherogenic risk(9) .

2. Materials and methods

2.1. Study Design and Population

This cross-sectional research will be carried out at the Department of Chemistry and Biochemistry, College of Medicine, Al-Iraqia University, Baghdad, Iraq, during the six months between January and June 2025.

One hundred and ten respondents were recruited and divided into three groups

- Control group (n = 30): It seems that the participants are healthy without diabetes mellitus or any clinical signs of cardiovascular disease.
- T2DM without complications (n = 40): The group of patients with type 2 diabetes mellitus without vascular complications reported.
- T2DM and early cardiovascular disease (CVD) (n = 40): Type 2 diabetes mellitus patients who had early cardiovascular involvement, which was clinically established.

The diagnosis of type 2 diabetes mellitus was made based on the American Diabetes Association (ADA) criteria. The participants were in the age range of 40 to 70 years. The duration of the disease of diabetic patients was five years or more.

The exclusion criteria were type 1 diabetes mellitus, chronic liver disease, chronic kidney disease, thyroid disorders, malignancy, acute or chronic inflammatory diseases, pregnancy, lactation, and long-term corticosteroid/antioxidant treatment.

All participants were informed by writing their consent before being enrolled. The Ethics Committee of the College of Medicine, Al-Iraqia University, approved the ethical approval and the study was carried out in line with the institutional ethical standards.

2.2. Sample Collection and Processing

The educational laboratories in Baghdad Medical City were the source of blood samples. Aseptic venous blood (only about 5 mL) was collected in each of the participants following a 1012-hours fast.

The samples were divided into ethylenediaminetetraacetic acid (EDTA) tubes to measure the glycated haemoglobin (HbA1c) and plain tubes to prepare serum. The blood samples were centrifuged at a rate of 3000 rpm and at room temperature in 10minutes. Serum was thoroughly separated, aliquoted into sterile microtubes and frozen at -20 o C until biochemical examination.

All the pre-analytical treatment steps were carried out in line with standardised laboratory procedures to maintain sample integrity and reliability of the analysis.

2.3. Materials and Laboratory Instrumentation

Biochemical analyses were performed using modern automated laboratory systems and commercially available assay kits. The following materials and instruments were used:

- Human Preptin ELISA Kit (CUSABIO, USA)
- Human Myostatin ELISA Kit (CUSABIO, USA)
- COBAS C111 automated chemistry analyzer (Roche Diagnostics, Germany)
- COBAS E411 immunoassay analyzer (Roche Diagnostics, Germany)

Routine biochemical parameters were analyzed using fully automated systems. Calibration and internal quality control procedures were conducted prior to analysis in accordance with the manufacturers' recommendations.

3. Biochemical Measurements

3.1. Glycemic Parameters

Fasting blood sugar (FBS) was measured using the glucose oxidase–peroxidase enzymatic method on the COBAS C111 analyzer. Glycated hemoglobin (HbA1c) was determined using standardized methods.

Serum insulin levels were measured using an ELISA method. Insulin resistance was assessed using the Homeostasis Model Assessment of Insulin Resistance (HOMA-IR), calculated as:

$$HOMA - IR = Fasting\ Insulin\ (\mu IU/mL) \times Fasting\ Glucose\ (mg/dL)\ /\ 405$$

3.2. Lipid Profile and Atherogenic Indices

Total cholesterol (TC), triglycerides (TG), and high-density lipoprotein cholesterol (HDL-C) were determined using enzymatic colorimetric methods on the COBAS C111 analyzer. Low-density lipoprotein cholesterol (LDL-C) was calculated using the Friedewald equation when triglyceride levels were < 400 mg/dL.

Non-HDL cholesterol was calculated as:

$$Non - HDL = TC - HDL - C$$

The Atherogenic Index of Plasma (AIP) was calculated using the formula:

$$AIP = log(HDL - CTG)$$

3.3. Inflammatory and Novel Biomarkers

Serum preptin and myostatin concentrations were measured using commercially available ELISA kits (CUSABIO, USA) according to the manufacturer's instructions.

High-sensitivity C-reactive protein (hs-CRP) was measured using an immunoassay method on the COBAS E411 analyzer.

All assays were performed in duplicate to ensure analytical precision. Intra- and inter-assay coefficients of variation were maintained below 10%.

3.4. Statistical Analysis

The analysis of data was conducted with the help of SPSS version 2019 (Statistical Package for the Social Sciences). Analysis of variance (ANOVA) was used to compare differences between groups and pairwise comparisons of means between them were made using the Least Significant Difference (LSD) test. The Chi-square (kh2) test was used to test the relationships between categorical variables. Correlation coefficients have been estimated to evaluate the correlation between continuous variables.

3.5. Statistical significance was defined as:

- **P ≤ 0.05: Significant**
- **P ≤ 0.01: Highly significant**

4. Results

4.1. Demographic Characteristics

The demographic characteristics of the study population are presented in Table 1. No significant differences were observed among the groups regarding gender distribution (P=0.1772).

Table 1 Distribution of sample study according to Gender in difference groups

Gender	Control No. (%)	T2D without CVD No. (%)	T2D with early CVD No. (%)	P-value
Male	19 (63.33%)	24 (60.00%)	21 (52.50%)	0.1772 NS
Female	11 (36.67%)	16 (40.00%)	19 (47.50%)	
Total	30	40	40	--

NS: Non-Significant.

4.2. Age and BMI

Age did not differ significantly between the study groups (P=0.2461). However, BMI was significantly increased in T2DM patients, particularly in those with early CVD (P≤0.01), as shown in Table 2.

Table 2 Comparison between difference groups in Age and BMI

Group	Mean ±SE	
	Age (year)	BMI (kg/m^2)
Control	52.13 ±0.2	25.67 ±0.11 c
T2D without complications	51.67 ±0.69	30.10 ±0.12 b
T2D with early CVD	53.25 ±0.70	32.06 ±0.14 a
L.S.D.	1.998 NS	0.367 **
P-value	0.2461	0.0001

Means having with the different letters in same column differed significantly. ** (P≤0.01).

4.3. Glycemic Indices

Glycemic indices were significantly elevated in diabetic groups compared with controls. HbA1c, fasting blood glucose, and HOMA-IR progressively increased from control to T2DM without complications and reached the highest values in T2DM with early CVD (P≤0.01) (Table 3).

Table 3 Comparison between difference groups in HbA1c, F.B.S. and HOMA-IR

Group	Mean ±SE		
	HbA1c (%)	F.B.S. (mg/dl)	HOMAP-IR
Control	5.48 ±0.01 c	95.68 ±0.45 c	2.031 ±0.04 c
T2D without complications	7.24 ±0.03 b	153.42 ±1.04 b	6.69 ±0.14 b
T2D with early CVD	7.98 ±.04 a	173.65 ±0.91 a	8.84 ±0.19 a
L.S.D.	0.0862 **	2.539 **	0.4147 **
P-value	0.0001	0.0001	0.0001

Means having with the different letters in same column differed significantly. ** (P≤0.01).

4.4. Lipid Profile

Lipid parameters showed significant dyslipidemia in diabetic patients. Total cholesterol, triglycerides, and LDL were significantly higher, whereas HDL was significantly lower in T2DM groups, especially in those with early CVD (P≤0.01) (Table 4).

Table 4 Comparison between difference groups in Cholesterol, Triglycerid , HDL and LDL

Group	Mean ±SE			
	Cholesterol (mg/dl)	Triglyceride (mg/dl)	HDL (mg/dl)	LDL (mg/dl)
Control	186.35 ±1.15 c	111.47 ±2.61 c	55.16 ±0.48 a	116.95 ±0.83 c
T2D without complications	199.17 ±1.42 b	198.40 ±2.32 b	42.01 ±0.30 b	135.23 ±0.98 b
T2D with early CVD	228.56 ±1.27 a	267.28 ±4.76 a	37.89 ±0.27 c	160.08 ±1.06 a
L.S.D.	3.729 **	10.071 **	0.968 **	2.812 **
P-value	0.0001	0.0001	0.0001	0.0001

Means having with the different letters in same column differed significantly. ** (P≤0.01).

4.5. Preptin, Myostatin, and hs-CRP

Serum preptin, myostatin, and hs-CRP levels were significantly elevated in T2DM patients compared with controls (P≤0.01). Preptin levels showed a progressive increase from control to T2DM and reached the highest concentrations in T2DM patients with early CVD (Table 5). This progressive elevation is illustrated in Figure 1.

Table 5 Comparison between difference groups in Preptin, Myostatin and hs-CRP

Group	Mean ±SE		
	Preptin (ng/ml)	Myostatin (ng/ml)	hs-CRP (mg/L)
Control	310.45 ±5.47 c	2.72 ±0.06 c	1.428 ±0.08 c
T2D without complications	452.57 ±6.14 b	5.15 ±0.09 b	3.940 ±0.12 b
T2D with early CVD	549.98 ±6.31 a	6.65 ±0.08 a	6.424 ±0.20 a
L.S.D.	17.327 **	0.2386 **	0.4296 **
P-value	0.0001	0.0001	0.0001

Means having with the different letters in same column differed significantly. ** (P≤0.01).

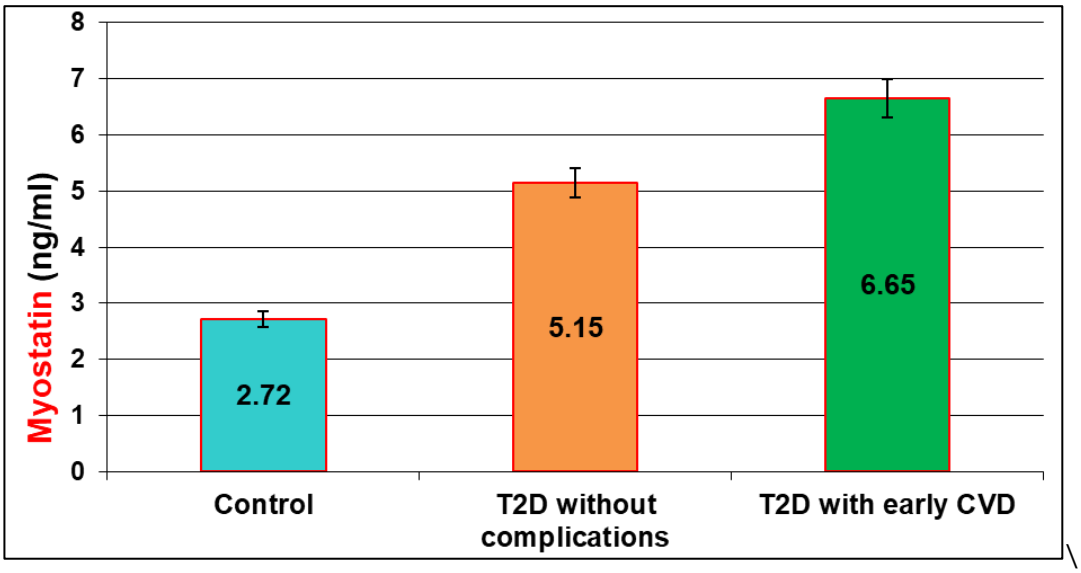

Figure 1 Comparison between difference groups in Myostatin

Myostatin concentrations were significantly higher in diabetic groups, particularly in those with early CVD (P≤0.01). The distribution pattern is shown in Figure 2.

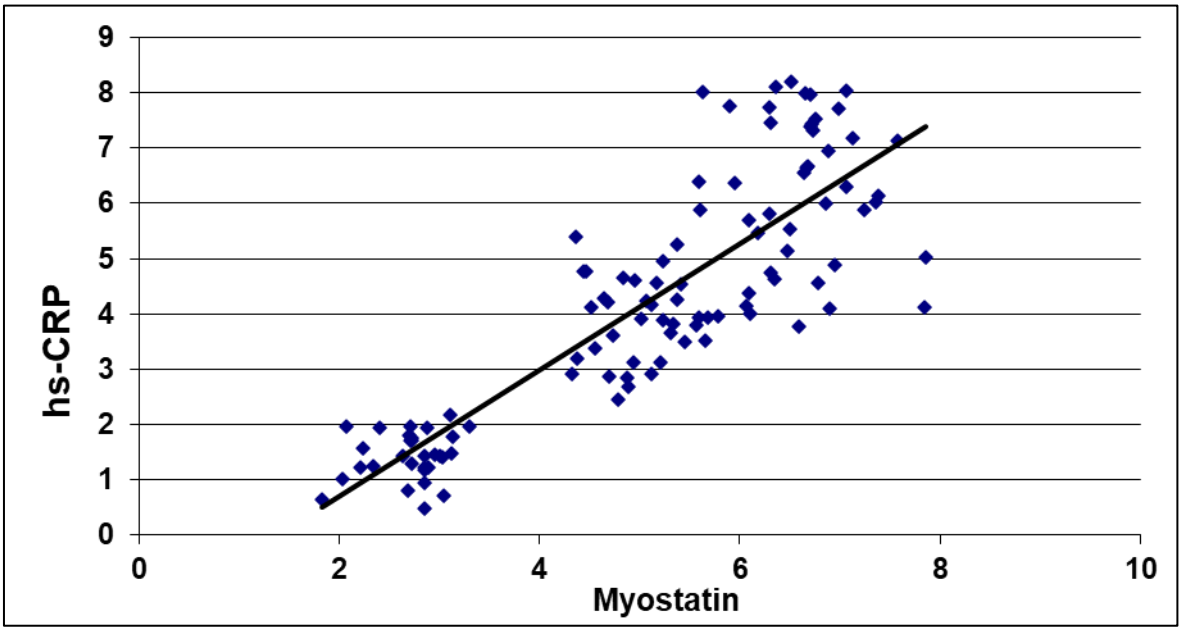

Figure 2 Relationship between Myostatin and hs-CRP

4.6. Atherogenic Risk Parameters

Non-HDL cholesterol and the Atherogenic Index (log TG/HDL) were markedly elevated in diabetic groups, particularly in patients with early CVD (P≤0.01), indicating increased atherogenic risk (Table 6).

Table 6 Comparison between difference groups in Non-HDL-C and Atherogenic Index_logTG_HDL

Group	**Mean ±SE**	
	Non HDL-C (mg/dl)	**Atherogenic Index_logTG_HDL**
Control	131.19 ±1.20 c	0.302 ±0.011 c
T2D without complications	157.71 ±1.48 b	0.676 ±0.005 b
T2D with early CVD	190.66 ±1.27 a	0.846 ±0.008 a
L.S.D.	3.833 **	0.023 **
P-value	0.0001	0.0001

Means having with the different letters in same column differed significantly. ** (P≤0.01).

4.7. Correlation Analysis

Correlation analysis revealed limited associations between myostatin and metabolic parameters. However, a significant positive correlation was observed between myostatin and hs-CRP in T2DM patients without complications (P≤0.05), as presented in Table 7 and illustrated in Figure 3.

Table 7 Estimate of Correlation coefficient between Myostatin and others parameters in difference groups

Parameters	Control		T2D without complications		T2D with early CVD	
	Correlation-r	P-value	Correlation-r	P-value	Correlation-r	P-value
BMI	0.03 NS	0.8940	0.09 NS	0.5400	0.13 NS	0.4300
HbA1c	0.11 NS	0.5711	0.02 NS	0.9307	-0.06 NS	0.7138
F.B.S.	0.10 NS	0.5746	0.03 NS	0.8841	0.03 NS	0.8387
HOMA-IR	-0.32 *	0.0493	-0.04 NS	0.8153	-0.06 NS	0.6889
Cholesterol	-0.13 NS	0.4878	-0.16 NS	0.3109	0.20 NS	0.2171
Triglyceride	0.07 NS	0.7095	0.08 NS	0.6184	0.06 NS	0.7114
HDL	0.16 NS	0.3890	-0.07 NS	0.6280	-0.17 NS	0.3063
LDL	0.27 NS	0.1476	0.01 NS	0.943	0.03 NS	0.8700
Preptin	-0.35 *	0.0455	-0.15 NS	0.3607	-0.03 NS	0.8570
hs-CRP	0.20 NS	0.2944	0.28 *	0.0497	-0.14 NS	0.3898
Non HDL-C	-0.19 NS	0.3104	-0.14 NS	0.3828	0.23 NS	0.1454
Atherogenic Index_logTG_HDL	-0.04 NS	0.9831	0.12 NS	0.4631	0.14 NS	0.4003

* (P≤0.05), NS: Non-Significant.

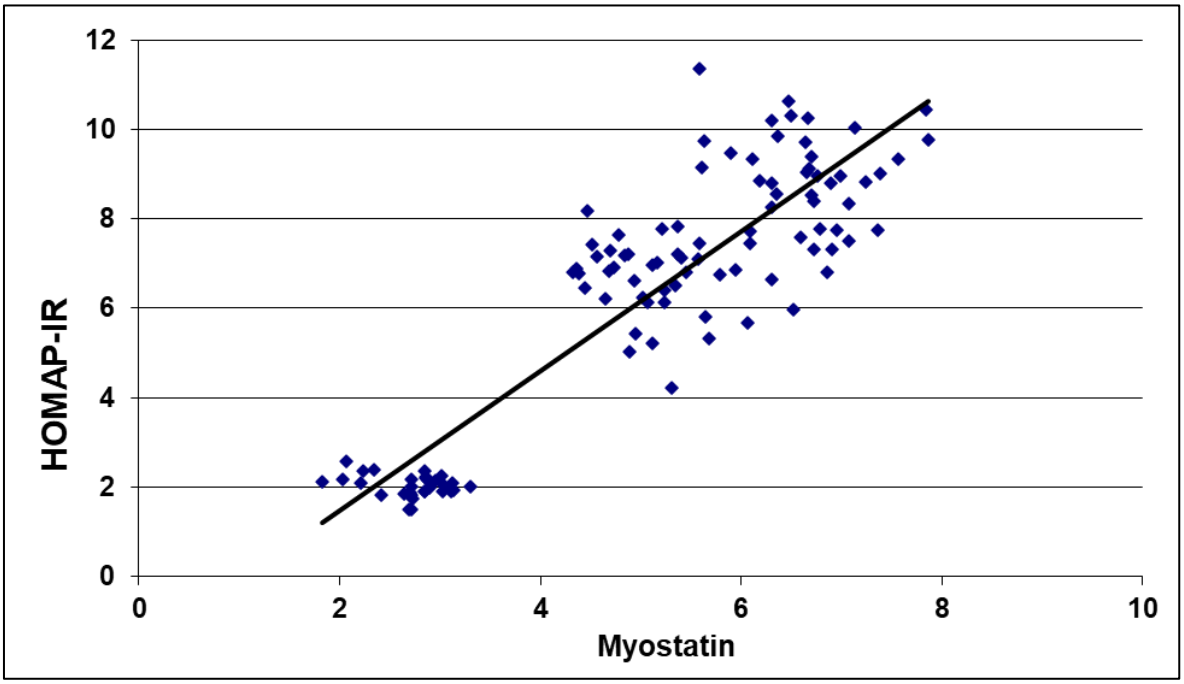

Figure 3 Relationship between Myostatin and HOMAP-IR

- BMI, glycemic indices, lipid parameters, preptin, myostatin, and hs-CRP were significantly increased in T2DM groups, especially those with early CVD (P≤0.01).
- Non-HDL-C and Atherogenic Index were markedly elevated in diabetic groups.

- Myostatin showed limited correlation with metabolic parameters but was positively correlated with hs-CRP in uncomplicated T2DM.
- Preptin levels progressively increased from control → T2DM → T2DM with CVD.

5. Discussion

This research paper examined the changes in the preptin-myostatin axis and their connexion to glycemic control, inflammatory condition, and atherogenic risk in type 2 diabetes mellitus (T2DM) patients with and without early cardiovascular disease (CVD)(10). The results indicate that this axis is evidently dysregulated in diabetic patients whereby there are progressive rises in circulating preptin, myostatin, and inflammatory markers, especially in patients with the onset of cardiovascular involvement. These findings confirm the hypothesis that pancreatic peptide hormone-skeletal muscle derived factors interactions can lead to metabolic worsening and cardiovascular risks in T2DM (11).

Among the main findings of the current research is the high level of glycemic indices such as HbA1c, fasting blood glucose, and HOMA-IR in diabetic populations as compared to healthy controls. In addition, such parameters were the greatest in patients with T2DM and early CVD. The trend is indicative of the gradual worsening of glucose homeostasis and insulin sensitivity in advanced diabetes (12). The rise in HOMA-IR indicates a significant level of insulin resistance, which is a primary pathological process in T2DM and a key driver of cardiovascular complications development. Some of the metabolic processes triggered by chronic hyperglycemia include oxidative stress, activation of protein kinase C, and formation of advanced glycation end-products all of which are involved in endothelial dysfunction and vascular damage(13).

The anthropometrical findings also support the metabolic pattern of the study population. In spite of the fact that there was no significant difference between age between groups, the BMI was significantly more in diabetic patients, especially in patients with early CVD. Obesity is broadly acknowledged to be one of the major factors of insulin resistance and systemic inflammation (14). As well as being an energy storage site, adipose tissue is an endocrine organ, releasing adipokines and inflammatory mediators, which increase metabolic imbalances (15). This increased BMI in diabetic individuals with cardiovascular involvement could thus be a cause of increased metabolic and inflammatory abnormalities found in them(16).

Along with glycemic control disorder, the research has shown that diabetic patients have significant dyslipidemia, such as increased total cholesterol, triglycerides, and LDL cholesterol and decreased HDL cholesterol. This pattern of dyslipidemia is common to the T2DM and is commonly known as the diabetic dyslipidemia (17). These changes stimulate the creation of small dense LDL particles and the atherosclerosis progression. This gradual rise of lipid abnormalities in each of the study groups suggests that deterioration of metabolic control could be accompanied by deterioration of cIn line with this finding, the computed non-HDL cholesterol and atherogenic index of plasma (AIP) was significantly greater in diabetic samples particularly in those who had early CVD (18).

These indices are becoming more and more accepted as valid measures of atherogenic risk since they combine a number of lipid elements that are linked to cardiovascular disease. The non-HDL cholesterol gives the overall load of atherogenic lipoproteins, and the AIP gives the information on the size of lipoprotein particles and metabolic disorders (19). The strong increase of these indices in the current study proves the idea that diabetic patients, especially with cardiovascular complications, have a much higher atherogenic burden (20).

One of the main conclusions of this study is that the concentration of circulating preptin rises progressively in healthy controls, patients with uncomplicated T2DM and finally CVD in T2DM with early (21).

Preptin is a peptide hormone that is derived out of pro-insulin-like growth factor II and is co-secreted with insulin by the pancreatic cells (22). Preptin, according to the experimental evidence, potentiates the glucose-mediated insulin secretion and could be an amplifier of β-cell activity (23).High preptin concentrations in diabetic individuals can thus be an indication of a compensatory mechanism to insulin resistance (24). Nevertheless, long-term hypersecretion can also be the sign of β-cell strain and the development of metabolic dysregulation (25). The recorded gradual rise in the levels of preptin among study groups is an indication that this peptide could be a biomarker of metabolic severity in T2DM and cardiovascular risk (26).

Equally, myostatin levels were highly increased in diabetic groups and the highest level was found in patients with a history of early cardiovascular disease (27). Myostatin belongs to the transforming growth factor-2 (TGF-2) superfamily

and it is a negative regulator of skeletal muscle growth. Along with its implication in muscle biology, myostatin has been implicated more frequently in metabolic control (28;29). High myostatin content has been linked to the decrease in muscle glucose uptake, adiposity, and insulin signalling (30). Because skeletal muscle plays the major role in postprandial glucose disposal, excessive myostatin activity can be the cause of systemic insulin resistance and aggravated glycemic control (31).

The results are also corroborated by the graphical representation, which is included in the study. The bar chart used to present the myostatin levels in the study groups demonstrates that there is a definite step-by-step increase of the levels in the control group, diabetic persons with cardiovascular complications (32). This tendency shows the possible use of myostatin as an indicator of metabolic worsening. In addition to this, myostatin and hs-CRP have a positive relationship as indicated by the scatter plot of myostatin and hs-CRP. Given that hs-CRP is a well-known indicator of systemic inflammation, this correlation indicates that myostatin can be connected to the action of inflammatory cascades in the development of metabolic diseases (33;34).

Interestingly enough, the correlation analysis showed that myostatin was strongly related with hs-CRP in patients with uncomplicated T2DM, but the correlation with glycemic parameters was rather weak (35). This observation may imply that the role that myostatin plays in metabolic disease may have a closer connection with inflammatory processes than with direct glucose metabolism. Low grade chronic inflammation is already known to be a characteristic feature of T2DM and of importance in insulin resistance and atherosclerosis. The positive correlation between myostatin and hs-CRP in the current study may be due to the interaction of skeletal muscle signalling pathways and systemic inflammation activities (36).

Together, the observations can be employed in favor of a functional interaction of the pancreatic 8-cells activity and skeletal muscle metabolism that can be called preptin-myostatin axis. Such a dysregulation of the axis may be a mechanistic interrelation among insulin resistance, inflammation, and cardiovascular risk. High preptin may reflect compensatory hyperactivity of 3 -cells as a result of metabolic stress but high myostatin may prevent muscle glucose metabolism and exacerbate insulin resistance. These changes can work in a synergistic effect causing progressive dysfunction of the metabolism and vascular damage in T2DM (37;38).

These results are intriguing with reference to their clinical implications. Provided that it is substantiated by bigger studies, circulating levels of preptin and myostatin could become a set of potential biomarkers in stratifying cardiometabolic risk early in the case of diabetic patients. The capability of recognising those who are at risk of cardiovascular complications may enhance preventive measures and direct therapeutic interventions. In addition, it has been proposed that the activation of myostatin signalling pathways are an effective treatment option in improving insulin sensitivity and metabolic fitness (39).

Although these are good findings, a number of limitations are to be noted (40). The study exercise was conducted on a comparatively limited sample size and cross-sectional design which limits the fact that one can draw causal links (41). Further, other factors such as medication, lifestyle habits and physical activity were not adequately evaluated and could be a contributing factor to the levels of circulating biomarkers. Further studies using a larger cohort with longitudinal designs will be needed to establish the clinical utility of the preptinmyostatin axis as a biomarker of cardiometabolic risk (42).

Limitations

The single-center design and very small sample size are two of the study's drawbacks that could limit how far the results can be applied. Furthermore, the study's cross-sectional design makes it more difficult to determine causal correlations. To confirm these results and elucidate the molecular involvement of preptin and myostatin in metabolic diseases, more multicenter and longitudinal research is advised.

6. Conclusion

In conclusion, people with type 2 diabetes have considerably higher levels of both preptin and myostatin, especially those who have cardiovascular issues. These biomarkers could be complimentary markers of peripheral metabolic impairment and pancreatic function. Their combined evaluation could offer insightful information on the course of the illness and possible targets for treatment.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

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