RESEARCH PAPER

Assessment of procalcitonin level in obese patients with insulin resistance

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Abstract

Background: Obesity is a widespread health issue worldwide, marked by long-lasting, low-level inflammation and resistance to insulin. Procalcitonin (PCT) has been recognized as a probable indicator of inflammation linked to obesity, given that high levels of PCT in the blood are strongly associated with measures of fatness and insulin resistance. Nevertheless, the exact role of PCT in insulin resistance remains uncertain.

Objectives: The study aims to provide insights into the role of PCT in obesity-related inflammation and evaluate its potential as a diagnostic tool for insulin resistance.

Methods: The study included 120 subjects with obesity and insulin resistance, and 80 control group. The study also included anthropometric measurements (BMI, WC, and blood pressure) and laboratory tests (fasting serum insulin, fasting serum glucose, and plasma procalcitonin).

Results: In the study, 120 patients diagnosed with obesity were compared to 80 controls. The research found that the average level of procalcitonin (PCT) was significantly higher in obese patients ($P < 0.05$) when compared to the control group. Specifically, the mean PCT level in obese patients was 0.122±0.168 ng/ml, while in controls, it was 0.086±0.0047 ng/ml. The analysis also showed a significant correlation between PCT and insulin resistance, as measured by HOMA-IR, with a Pearson correlation coefficient of 0.187 and a (P-value 0.040).

Conclusion: The study found that the mean level of procalcitonin (PCT) was significantly higher in patients with obesity and insulin resistance compared to controls.

Keywords: Procalcitonin, Insulin Resistance, Obesity.

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Introduction

Obesity and insulin resistance (IR) are significant health concerns globally, with a strong correlation between the two. Obesity is a triggering factor for diabetes associated with insulin resistance.[1] In Basrah, Southern Iraq, the prevalence of overweight and obesity was reported to be 55.1% between 2003 and 2010. 2 A local study conducted in Basrah with over 5400 participants found that the prevalence of type 2 diabetes mellitus (T2DM), which is frequently linked to insulin resistance (IR), ranged from 8.5 percent to 13.9 percent.[3] Obesity is a complex disease associated with an increase in several inflammatory markers, leading to chronic low-grade inflammation. This inflammation is often linked with insulin resistance, a condition that contributes to the development of metabolic disorders such as type 2 diabetes.4 Although

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traditionally a biomarker for bacterial infections[5], procalcitonin (PCT) has recently emerged as a potential marker for chronic low-grade inflammation in obesity. However, the relationship between PCT levels and insulin resistance in obese patients is not yet fully understood. In response to cytokines, various types of cells, including adipose tissue, generate procalcitonin, an inflammatory marker. According to recent research, PCT levels are linked to central adiposity, indicating a potential involvement in inflammation associated with obesity.[6] The body's cells can become less responsive to insulin, a crucial hormone for regulating blood sugar levels. This condition is known as insulin resistance and can cause higher levels of insulin and glucose in the blood, leading to the development of type 2 diabetes and other metabolic disorders. [7] Conditions like obesity and hypertension are frequently linked to insulin resistance, which has been extensively studied to better understand its molecular mechanisms and potential treatments. [8] A variety of health issues such as cardiovascular disease, type 2 diabetes, and certain types of cancer are correlated with obesity. Additionally, insulin resistance is linked to obesity and can aid in the development of metabolic syndrome.[9,10] There is a rise in the number of women of reproductive age and children who are affected by obesity. This has sparked interest in comprehending the potential effects of maternal obesity on the health of the offspring over the long term. [9]

The aim of this study is to evaluate the level of procalcitonin in obese patients with insulin resistance, which may offer valuable insights into the role of PCT in obesity-related inflammation and its potential as a diagnostic tool for insulin resistance. [1,11]

Participants & Methods

This study was conducted from the 1st of November, 2022 through the 31st of Jun of 2023. The study included 120 patients with MS, 59 males and 61 females, 25-78 years of age. They were diagnosed by a Consultant Endocrinologist at Faiha Specialized Diabetes, Endocrine, and Metabolism Center, Basrah, Iraq. The study also included 80 control subjects, 41 males and 39 females, 27-75 years of age. Obesity is typically defined using the Body Mass Index (BMI), which is calculated by dividing a person's weight in kilograms by the square of their height in meters. The National Center for Biotechnology Information (NCBI) also confirms that obesity is defined as a BMI greater than or equal to 30 kg/m^2.[12] Anthropometric measurements including weight, height, waist circumference (WC), body mass index (BMI), and blood pressure were taken. Blood pressure were measured by physicians at Faiha Specialized Diabetes, Endocrine, and Metabolism Center using sphygmomanometer. The COBAS INTEGRA 400 plus is used to measure various biochemical parameters. This system automatically schedules each sample's tests to minimize analyzer turnaround time and increase throughput. Measurements including fasting blood sugar (FBS), blood urea (B. Urea), serum creatinine, total cholesterol (TC), triglycerides (TG), high-density lipoprotein-cholesterol (HDL-C), low-density lipoprotein-cholesterol (LDL-C), very low-density lipoprotein-cholesterol (VLDL-C), and Hemoglobin A1C (HbA1c). While procalcitonin and insulin level were measured using the COBAS e-411 system. This system is a fully automatic analyzer applied to immune analysis, whose measurement basis is Electrochemiluminescence (ECL).

ECL technology uses streptavidin-coated magnetic micro-particles as a solid phase, antigen/antibody interactions, and interference suppression methods. In addition, the degree of insulin resistance was also determined using Homeostatic Model Assessment of Insulin Resistance (HOMA-IR) formula.

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$$\mathrm{HOMA-IR} = \frac{\text{fasting insulin } (\mu U/L) \times \text{fasting glucose } (mg/dL)}{405}$$

Blood specimens were extracted from two distinct groups, comprising patients with obesity and a control group, following a minimum 8-hour overnight fast. A disposable butterfly blood collection system was used to obtain five milliliters of venous blood while the patients were seated. The blood obtained was then apportioned as follows:

1. Two milliliters were placed into an anticoagulant tube containing a 1.5 mg/ml tri potassium ethylene diamine tetra acetic acid (K3EDTA tube) for the purpose of measuring HbA1c levels.
2. The remainder of the blood was transferred into tubes containing gel, which aids clot formation and allows for easier serum separation without anticoagulants, and was then set aside for a time at room temperature (20-25) ˚C for coagulation. Following this, the blood samples were centrifuged at 3000 rpm for 5 minutes. Once complete, the serum was utilized to estimate the routine biochemical test, including Plasma Procalcitonin, serum insulin, fasting blood glucose, HbA1c, lipid profile, and Renal function test.

Patients who were taking lipid-lowering drugs or displayed any signs of infection were excluded. Age and sex-matched healthy volunteers were brought in as controls (n=80).

Results

Table-1, displays the distribution of patients with obesity and control subjects based on socio-demographic variables. The age range of the subjects was between 27 to 78 years, and the majority of patients with obesity and controls were between the ages of 35 to 44, with frequencies of 35.0% and 38.75%, respectively. However, the age group (≥ 65) had the lowest proportion, with comparative frequencies of 8.33% and 7.50%, respectively. The overall mean age for patients with obesity and control subjects was 49.43±11.76 years and 48.45±11.20 years, respectively.

Table 1. Socio-demographic characteristics of patients with Obesity, and control subjects.

Characteristic		Subject	
		Control N=80	Obesity N=120
Age(years)		Mean ±SD	Mean ±SD
		48.45±11.20	49.43±11.76
		N0. (%)	N0. (%)
Gender	Male	41(51.2)	59(49.2)
	Female	39(48.8)	61(50.8)
Education	Primary	17(21.25)	22(18.33)
	Secondary	11(13.75)	18(15.00)
	Institute	52(65.00)	80(66.66)
Smoking	Smoking	28(35.0)	39(32.8)
	Ex-smoker	0(0.00)	6(5.0)
	Non-smoking	52(65.00)	74(62.2)
Residency	Urban	75(93.75)	109(90.83)
	Rural	5(6.25)	11(9.16)

Patients with obesity were found to have a higher Body Mass Index (BMI) than control subjects, with a significant difference (P < 0.01). Waist Circumference (WC) was also higher among patients with Obesity in both genders compared to control subjects (P < 0.01). Additionally, SBP and DBP were significantly higher in patients with Obesity compared to control subjects (P < 0.01) as shown in (Table-2).

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Table 2. Anthropometric measurement among study groups.

	Obesity	Control	P-value
	Mean ±SD	Mean ±SD	
BMI	32.62±5.3	24.94±1.53	0.000
SBP	142.01±12.33	121.56±7.17	0.000
DBP	85.53±9.45	76.86±6.25	0.000
WC(cm) in men	115.79±14.58	89.66±7.06	0.000
WC(cm) in women	109.77±8.86	82.95±4.74	0.000
Total	112.77±11.86	86.30±5.89	0.000

Table-3, Illustrates the prevalence of Hypertension and Diabetes Mellitus measurement alongside the percentages within subjects. Hypertension was present in 44.2% of total patients with Obesity (n =120), while it was absent in all control subjects (n = 80). Similarly, DM was present in 82.5% of total patients with Obesity (n =120), but absent in all control subjects (n = 80).

Table 3. The prevalence of Hypertension and Diabetes Mellitus measurement among study groups.

			Subject		Total
			Obesity	Control	
Hypertension	**Non-HTN**	No.	67	80	147
		(%)	55.8	100.0	73.5
	HTN	No.	53	0	53
		(%)	44.2	0.0	26.5
Total		No.	120	80	200
		(%)	100.0	100.0	100.0
DM	**Non-DM**	No.	21	80	101
		(%)	17.5	100.0	50.5
	DM	No.	99	0	99
		(%)	82.5	0.0	49.5
Total		No.	120	80	200
		(%)	100.0	100.0	100.0

Table-4 displays the parameters, mean, standard deviation, and p-value for various biomarkers in the obesity and the control groups. Fasting blood sugar (FBS), triglyceride, VLDL, HOMA-IR levels, HbA1c, and procalcitonin were found to have a significantly higher mean in the patients group (p-value =≤ 0.01) compare to the Controls group. Total cholesterol (T.cholesterol) also showed a significant difference between the two groups (p-value ≤0.05). The LDL-C values in the two groups did not significantly differ from one another (p-value ≥ 0.05). The patients group had significantly decreased HDL-C levels (p-value ≤ 0.01) in comparison to the Control group.

Table 4. Laboratory investigation among study groups

Parameters	Subject	No.	Mean ± SD Deviation	P-value
Procalcitonin (ng/ml)	Patients	120	0.122±0.168	0.000
	Control	80	0.086±0.047	
FBS (mg/dl)	Patients	120	218.82±127.90	0.000
	Control	80	89.68±5.51	
HbA1c	Patients	120	7.98±2.13	0.000
	Control	80	5.07±1.37	
T. Cholesterol (mg/dl)	Patients	120	181.96±51.78	0.017
	Control	80	166.32±32.52	
Triglyceride (mg/dl)	Patients	120	318.74±192.68	0.000
	Control	80	102.26±27.70	
LDL-C(mg/dl)	Patients	120	100.05±39.03	0.445
	Control	80	103.94±28.46	
VLDL (mg/dl)	Patients	120	60.54±32.22	0.000
	Control	80	19.76±5.25	
HDL-C(mg/dl)	Patients	120	34.07±7.66	0.000
	Control	80	44.73±10.57	
HOMA-IR	Patients	120	10.94±6.05	0.000
	Control	80	1.77±0.97	

In addition, PCT showed a significant correlation with BMI and waist circumference, as depicted in (Figure-2 and Figure-3), among all the obesity indices. The Pearson correlation coefficient demonstrates for Procalcitonin and various obesity measurements including BMI, waist circumference (WC), and for insulin resistance measured by HOMA-IR. The correlation coefficient for PCT and BMI was 0.682**, PCT and WC was 0.516**, and PCT and HOMA-IR was 0.187*. The P-value for the correlation between PCT and BMI was 0.000, the P-value for the correlation between PCT and WC was 0.000, and the P-value for the correlation between PCT and HOMA-IR was 0.040. The support for these findings has been constant throughout., (Figure-1). Furthermore, among the obesity indices, PCT was significantly correlated with BMI, waist circumference (Figure 2,3)

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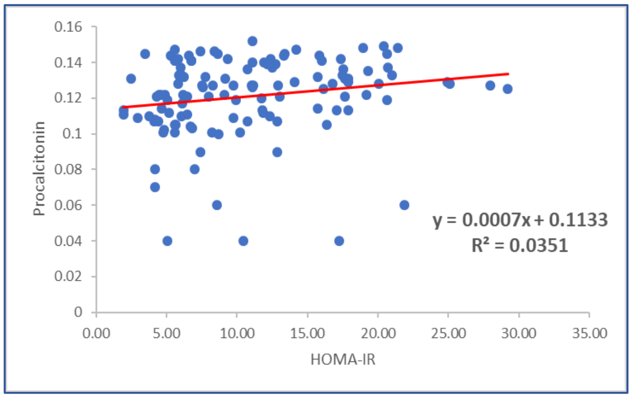

Fig 1. Correlation between procalcitonin and HOMA-IR

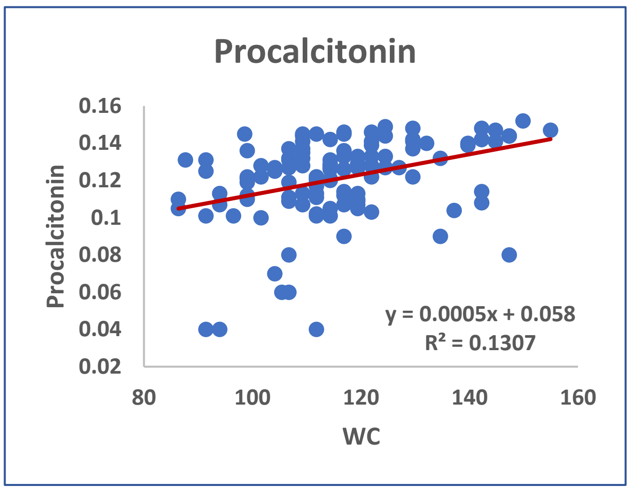

Fig 2. Correlation between procalcitonin and waist circumference

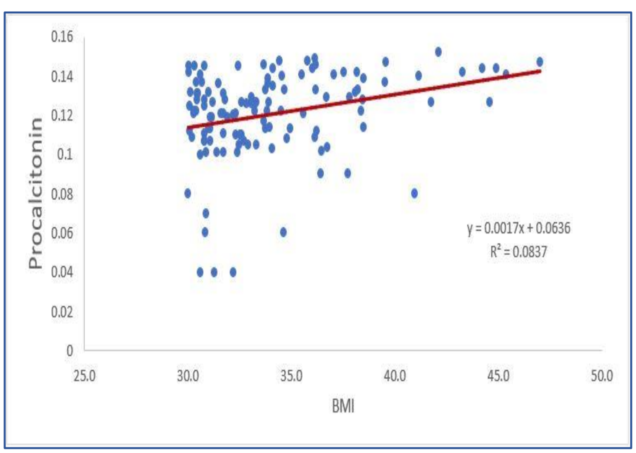

Fig 3. Correlation between Procalcitonin and BMI

Discussion

Procalcitonin, a potential biomarker of obesity-related inflammation, has been found to be associated with body mass index (BMI), waist circumference (WC), and insulin resistance (HOMA-IR) in obese patients compared to healthy control subjects. A study conducted in Egypt, found a significant positive correlation between procalcitonin and BMI, insulin, and HOMA-IR in obese groups. [11] The data provided indicates a noteworthy contrast in BMI, occurrence of hypertension and diabetes mellitus, and waist circumference between individuals with obesity and those in the control group. Furthermore, the research revealed that patients with obesity had increased levels of insulin resistance (HOMA-IR) and plasma procalcitonin (PCT) compared to the control group. It was also observed that the PCT level was considerably linked with the level of insulin resistance as measured by HOMA-IR. Another study also found that plasma procalcitonin was significantly correlated with insulin resistance (HOMA IR), and waist circumference.[13] A study in 2022 highlighted the connection between obesity and insulin resistance, suggesting that systemic metabolic abnormalities might drive inflammation in some patients.[14] This aligns with our study's findings of higher HOMA-IR values in obese patients, indicating a higher level of insulin resistance. A review in 2020 discussed the role of obesity in triggering diabetes associated with insulin resistance.[15] This is consistent with our study's findings of a higher prevalence of DM in obese patients. A study in 2006 discussed the mechanisms linking obesity to insulin resistance and type 2 diabetes.[16] The study suggested that in obese individuals, adipose tissue releases increased amounts of non-esterified fatty acids, glycerol, hormones, pro-inflammatory cytokines, and other factors that are involved in the

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development of insulin resistance.[16] Another study from 2018 found that Plasma Procalcitonin (PCT), which is produced by adipose tissue, can serve as a biomarker for the insulin-resistant state present in metabolic syndrome. The study found that PCT significantly correlated with the level of Insulin Resistance, Waist Circumference, S. Triglycerides, S. VLDL, fasting blood glucose, and inversely with S.HDL.[17] This is consistent with the presented study's findings of a significant correlation between PCT and HOMA-IR, BMI, and WC. Elevated plasma procalcitonin levels within the normal range have been found to correlate with measures of obesity and insulin resistance in both men and women.

In conclusion, the findings of this study support previous research indicating a strong link between obesity, insulin resistance, and procalcitonin. Plasma procalcitonin was positively associated with body mass index and waist circumference. This suggests that plasma procalcitonin could serve as a potential marker for adipocyte dysfunction and chronic low-grade inflammation, both of which are common in obesity and insulin resistance

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تقييم مستوى البروكالسيتونين لدى المرضى الذين يعانون من السمنة المفرطة والذين يعانون من مقاومة الأنسولين

الخلفية: تعتبر السمنة مشكلة صحية منتشرة على نطاق واسع في جميع أنحاء العالم، وتتميز بالتهاب طويل الأمد ومنخفض المستوى ومقاومة الأنسولين. تم التعرف على البروكالسيتونين (PCT) كمؤشر محتمل للالتهاب المرتبط بالسمنة، بالنظر إلى أن المستويات المرتفعة من PCT في الدم ترتبط بقوة بمقاييس السمنة ومقاومة الأنسولين. ومع ذلك، فإن الدور الدقيق البروكالسيتونين بشأن البراءات في مقاومة الأنسولين لا يزال غير مؤكد.

الأهداف: تهدف الدراسة إلى تقديم نظرة ثاقبة لدور معاهدة التعاون بشأن البراءات في الالتهابات المرتبطة بالسمنة وتقييم إمكاناتها كأداة تشخيصية لمقاومة الأنسولين.

طرق العمل: شملت الدراسة ١٢٠ شخصًا يعانون من السمنة ومقاومة الأنسولين، و٨٠ مجموعة مراقبة. وتضمنت الدراسة أيضًا قياسات الجسم البشري (مؤشر كتلة الجسم، ووزن الجسم، وضغط الدم) والاختبارات المعملية (الأنسولين في الدم الصائم، الجلوكوز في الدم الصائم، والبروكالسيتونين في البلازما).

النتائج: تمت مقارنة ١٢٠ مريضاً مصابين بالسمنة مع ٨٠ مريضاً من مجموعة المراقبة. ووجد البحث أن متوسط مستوى البروكالسيتونين (PCT) كان أعلى بكثير في المرضى الذين يعانون من السمنة المفرطة (P <0.05) بالمقارنة مع المجموعة الضابطة. على وجه التحديد، كان متوسط مستوى معاهدة التعاون بشأن البراءات في المرضى الذين يعانون من السمنة المفرطة ٠,١٢٢ ± ٠,١٦٨ نانوغرام / مل، بينما في الضوابط، كان ٠,٠٨٦ ± ٠,٠٠٤٧ نانوغرام / مل. وأظهر التحليل أيضًا وجود علاقة كبيرة بين معاهدة التعاون بشأن البراءات ومقاومة الأنسولين، كما تم قياسها بواسطةHOMA-IR ، مع معامل ارتباط بيرسون قدره ٠,١٨٧ وقيمة> P 0.05. علاوة على ذلك، أظهرت مستويات معاهدة التعاون بشأن البراءات لدى المرضى الذين يعانون من السمنة المفرطة تغيرات ملحوظة (P <0.05) فيما يتعلق بقياسات السمنة، بما في ذلك مؤشر كتلة الجسم ومحيط الخصر.

الاستنتاج: وجدت الدراسة أن متوسط مستوى البروكالسيتونين ((PCTكان أعلى بكثير في المرضى الذين يعانون من السمنة ومقاومة الأنسولين مقارنة مع مجموعة التحكم.

الكلمات المفتاحية: البروكالسيتونين، مقاومة الأنسولين، السمنة.

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