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Evaluation of Plasma Galanin Hormone Levels in Iraqi Women Patients with Endocrine Thyroid Disorder

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Abstract

Background: Thyroid hormones play a vital role in regulatory processes, including metabolism, energy balance, and neuroendocrine function. Galanin, a neuropeptide expressed throughout many organs and tissues in the body, including the brain and peripheral tissues, is implicated in hormonal regulation and metabolic processes. Evidence suggests a potential relationship between galanin and thyroid function, particularly in hormonal disorders such as hypothyroidism or hyperthyroidism.

Aim of the study: Assess whether galanin acts as a biomarker or elucidates the pathogenesis of thyroid dysfunction by comparing galanin levels in women recently diagnosed with hypothyroidism, hyperthyroidism, and normal thyroid function.

Subjects and Method: We performed enzyme-linked immunosorbent assay (ELISA) to measure serum galanin concentrations in a case-control study comprising (n=60) diagnosed with thyroid dysfunction, including (n=30) with hypothyroidism and (n=30) with hyperthyroidism, compared with apparently healthy control subjects (n=30). Demographic information was obtained from all participants, including age and BMI. in addition, biochemical parameters were also estimated in all participants, including thyroid function test, lipid profiles and liver enzymes

Results: significantly serum concentration of galanin hormone was increased sharply in patient with hyperthyroid comparing with hypothyroid group (p-value<0.001) and with control subject (p-value<0.001). Furthermore, are slightly correlated with LDL-C.

Conclusion: These results suggest a possible regulating function of galanin in thyroid hormone imbalance and its potential involvement with the pathogenesis of thyroid dysfunction.

تقييم مستويات هرمون الجالانين في بلازما النساء العراقيات المصابات باضطرابات الغدة الدرقية الهرمونية

فرقد البيضاني

الخلاصة

المقدمة

تلعب هرمونات الغدة الدرقية دورًا حيويًا في العمليات التنظيمية، بما في ذلك التمثيل الغذائي، وتوازن الطاقة، ووظيفة الغدد الصماء العصبية. هرمون الجالانين، وهو ببتيد عصبي يُعبَّر عنه في العديد من أعضاء وأنسجة الجسم، بما في ذلك الدماغ والأنسجة الطرفية، له دور في التنظيم الهرموني والعمليات الأيضية. تشير الأدلة إلى وجود علاقة محتملة بين هرمون الجالانين ووظيفة الغدة الدرقية، وخاصةً في الاضطرابات الهرمونية مثل قصور أو فرط نشاط الغدة الدرقية.

هدف الدراسة

تقييم ما إذا كان هرمون الجالانين يعمل كمؤشر حيوي أو يُوضح مسببات خلل وظيفة الغدة الدرقية، وذلك بمقارنة مستويات الجالانين لدى النساء اللواتي شُخِّصْنَ مؤخرًا بقصور أو فرط نشاط الغدة الدرقية، ووظائف الغدة الدرقية الطبيعية.

الموضوع والطريقة

أجرينا اختبار الممتز المناعي المرتبط بالإنزيم لقياس تركيزات هرمون الجالانين في المصل في دراسة حالة وشاهد شملت (ن = 60) مريضًا تم تشخيص إصابتهم بخلل في الغدة الدرقية، منهم (ن = 30) مصابون بقصور الغدة الدرقية و(ن = 30) مصابون بفرط نشاط الغدة الدرقية، مقارنةً بأفراد سليمين ظاهريًا (ن = 30). تم الحصول على المعلومات الديموغرافية من جميع المشاركين، بما في ذلك العمر ومؤشر كتلة الجسم. بالإضافة إلى ذلك، تم تقدير المعايير الكيميائية الحيوية لجميع المشاركين، بما في ذلك اختبار وظائف الغدة الدرقية، ومستويات الدهون، وإنزيمات الكبد.

النتيجة

زاد تركيز هرمون الجالانين في المصل بشكل ملحوظ لدى المرضى الذين يعانون من فرط نشاط الغدة الدرقية مقارنةً بمجموعة قصور الغدة الدرقية (القيمة الاحتمالية <0.001) ومجموعة الضبط (القيمة الاحتمالية <0.001).

الخلاصة

تشير هذه النتائج إلى وظيفة تنظيمية محتملة لهرمون للجالانين في اختلال توازن هرمون الغدة الدرقية وتورطه المحتمل في التسبب في خلل نشاط الغدة الدرقية.

1. Introduction

In 1983, Viktor Mutt's lab and the Karolinska Institute of Science in Stockholm, Sweden, discovered a neuropeptide called galanin(Crawley, 1995). Galanin peptide, found from the porcine origin digestive system, has been proven to have the capacity to influence the contraction of smooth muscles and metabolism of glucose across species(Abot et al., 2018). Galanin neuropeptide consist of length sequence about 30 peptide amino acids residue with molecular weight 3400 Da in humans. In the structure of galanin the C terminal is Amidation; amid group is NH2 instead of hydroxyl group OH, which is very important in the biological activity of this neuropeptide (Zhu et al., 2022)

Galanin has been demonstrated to be integral to various physiological process including cognition (Zhu et al., 2022)nutrition (Marcos and Coveñas, 2021)and a sensory perception (Fonseca-Rodrigues et al., 2022). Importantly, it involved in the regulation of various anterior pituitary hormones (Falkenstetter et al., 2020). The relationship of galanin to the thyroid gland is somewhat complicated, including indirect and direct effects on thyroid function via the central nervous system and hormonal homeostasis. According to several research, Galanin modulates the release of the thyroid hormones thyroxine and triiodothyronine by influencing the gland's interaction with nerve impulses and the surrounding hormone system, which controls the gland's function. For instance, it has an impact on energy balance, metabolism, and other gland processes (Can et al., 2024a). Galanin regulates thyroid gland function by acting on hormone-regulating centers in the brain because it contains three neuroreceptors GALR1, GALR2 and GALR3 with different signaling pathways (Šípková et al., 2017),which are found in regions of the brain that control hormonal balance and thyroid function (Šípková et al., 2017). In additional, this neuropeptide involved in the mechanism of managing the stress response, and as is known stress and tension have a significant impact on the gland's levels (Radhika and Rekha, 2024). Some investigations have confirmed that Galanin has an effect on appetite management and metabolic activity, which is related to the actions of these hormones in regulating metabolism. Galanin's function is summarized by its influence on nerve tissues that maintain hormonal homeostasis (Fang et al., 2015). The disturbance in the balance of these processes lead to changes in hormonal homeostasis in respond primary to the changes in work of central nerve system. For these reasons, this study is to investigate any possible correlation between thyroid function and serum galanin levels in women. The study aims to evaluate whether galanin reflects a biomarker or helps to explain the pathophysiology of thyroid malfunction by comparing galanin concentrations in women newly diagnosed with hypothyroidism, hyperthyroidism, and normal thyroid.

2. Subjects and Methods

2.1. Subject

The research design is a (case-control) study, conducted with (n=30) controls and (n=60) patients; comprising (n=30) hypothyroid and (n=30) hyperthyroid individuals. age ranged between (20-65) years female. The selection of the patients depends on several criteria's; for the patient should be newly diagnosed in hyperthyroidism or hypothyroidism. The practical side of the study was performed at Imam Hassan Al-Mujtaba Center for Diabetes and Endocrinology were randomly selected from the patients attending the Endocrinology Consultation Unit. Questionnaires have been designed to gather information from both the control and case groups, including patients diagnosed with thyroid dysfunction. The medical history of each female patient was recorded, including age and any prior disorders. Furthermore, those with chronic liver illness, malignancies, those aged 65 and older or under 20, as well as patients with cardiovascular disorders, peripheral vascular disease, stroke, infections, and emergency cases were excluded. Furthermore, women who are presently pregnant or intend to become pregnant in the near future have also been excluded from this study. The local ethics committee approved the study, and all participants provided written informed permission prior to their involvement.

2.2. Study Parameters

2.2.1.Clinical Assessment

This study involved measuring the height and body weight of all participants to compute the Body Mass Index (BMI) using the formula: weight (kg) divided by height (m^2) according to standardized equations; BMI = Weight (Kg) / Height (cm2) ("Quetelet's index (W/H2) as a measure of fatness. - Abstract - Europe PMC," n.d.) In this investigation, TSH, Free T3 and Free T4 was measured to diagnosed the thyroid disfunction, with lipid profile and Galanin concentration.

2.2.2.Blood Collection Data

Blood samples are taken from all subjects after a 10- to 12-hour fast. The sampled volume of blood is 5 milliliters, extracted with disposable syringes while seated. The collected blood was preserved in clean, sterile containers. The samples were collected between 8:00 and 12:30 a.m. Blood was permitted to coagulate at 37°C for 10-15 minutes prior to centrifugation at 2000xg for approximately 10-15 minutes. Subsequently, the serum is divided into two components and stored at -20°C. The serum taken from patients and controls was used to measure the following parameters: TSH, free (T4 and T3), lipid profile and liver enzymes (ALT, AST).

2.2.3.Estimation of Plasma Serum Galanin Concentration Levels

The concentration levels determined using a kit called Quick Step Human galanin, GAL ELISA Kit (enzyme-linked immunosorbent assay). However, according to the instruction's manual (SunlongBiotech,China). The assay range of detection 3 - 200 pg/mL and the sensitivity 0.6 pg/mL, with an intra-assay coefficient of variance (CV) less than < 10% and inter -assay coefficient of variance (CV) less than < 12%.

2.3. Statistical Analysis

Statistical Analysis for Social Science software (SPSS 24 IBM, Armonk, USA) is used to explain results as mean ± SD. To calculate the degree of variability and variations in mean values of variables between control, apparently healthy, and patient groups. The data was examined using the analysis of variance (one-way ANOVA) test. The differences between the control and patient groups were compared using the t-test. Also, calculate. Correlations between all of the researched variables were evaluated using Pearson's correlation coefficient (r), and linear regression analyses were utilized to evaluate data. The ROC analysis was additionally used to determine the sensitivities and specificity of this study biomarker.

3. Result

3.1. Comparison of Plasma Clinical Biomarkers and Demographic Data Among Control, Hypothyroid, and Hyperthyroid Groups

The clinical characteristics including 90; patients (n = 60), this comprises (n=30) patients with hypothyroid and 30 patients with hyperthyroid (females; mean ± SD age, 52.70 ± 11.567 years) and (n=30) control (n=30) (female; mean ± SD age, 50.12 ± 11.533years). According to the presented data, their testing parameters are seen in Table1, Table2, Table3 and Table4.

Table1: Clinical Characteristics of Demographic Information

Parameters	Control (n=30)	Hypo - TR (n= 30)	Hyper - TR (n=30)
Age (year)	48.89 ± 10.033	50.12 ± 11.533	52.7 ± 11.567
BMI (kg/m^2)	26.21± 4.26	29.76± 3.38 ^{c***}	27.87± 4.31 ^{b*}
b: significant vs. hypothyroidism group, **c**: significant vs. hyperthyroidism group, *p < 0.05, **p < 0.001			

Table2: Clinical Characteristics of Thyroid Function Test Information and Study Biomarker

Parameters	Control (n=30)	Hypo - TR (n= 30)	Hyper - TR (n=30)
TSH(μIU/ml)	2.08 ± 0.40	6.95 ± 1.83 $^{a**, c***}$	0.29 ± 0.20 ^{b***}
Free T3(Pg/dL)	3.00 ± 0.58	2.12 ± 0.55 $^{a***, c***}$	6.54 ± 1.05 ^{b***}
Free T4(ng/dL)	1.18 ± 0.29	0.57 ± 0.28 $^{a***, c***}$	3.43 ± 0.81^{b***}
Galanin (pg/ml)	176.85 ± 89.52	412.41 ± 261.41$^{a***, c*}$	280.15 ± 183.03 ^{b*}
a: significant vs. control group, **b**: significant vs. hypothyroidism group, **c**: significant vs. Hyperthyroidism group, *p < 0.05, **p < 0.01, **p < 0.001			

Table3: Clinical Characteristics of Lipid Profile Information

Parameters	Control (n=30)	Hypo - TR (n= 30)	Hyper - TR (n=30)
Cholesterol (mg/dl)	188.9± 27.28	235.3 ± 14.02 $^{a*, c*}$	189.91 ± 42.15^{b*}
TG (mg/dl)	148.84± 61.18	196.93 ± 17.62 ^{a*}	189.10± 92.35
VLDL (mg/dl)	29.76 ± 12.23	38.74 ± 17.9	37.82 ± 18.47
HDL-C (mg/dl)	42.31± 7.39	42.30 ± 8.59	40.706± 8.95
LDL-C (mg/dl)	111.52± 36.80	155.86 ± 13.21 ^{a*}	111.382± 32.66
a: Significant vs. control group, **b**: Significant vs. hypothyroidism group, **c**: Significant vs. hyperthyroidism group, *p < 0.05*			

Table4: Clinical Characteristics of Liver Function Test

Parameters	Control (n=30)	Hypo - TR (n= 30)	Hyper - TR (n=30)
ALT (IU/L)	22.19± 12.6	23.34± 11.04	26.99± 23.20
AST (IU/L)	22.59± 15.91	22.71± 11.08	31.19± 30.84
ALT: Alanine aminotransferase – a liver enzyme used to assess liver cell function and injury. **AST**: Aspartate aminotransferase – a liver-related enzyme also found in other tissues such as the heart and muscles; used in conjunction with ALT to evaluate liver health. Values are presented as mean ± standard deviation. No statistically significant differences were observed among the groups.			

With no statistically significant differences noted in the Table1, the mean age distribution within the three different groups i.e., control, hypothyroid (Hypo-TR), and hyperthyroid (Hyper-TR) was similar (control: 48.89 ± 10.03 years, hypothyroid (Hypo-TR: 50.12 ± 11.53 years, hyperthyroid (Hyper-TR: 52.70 ± 11.57 years). This suggests that, among the study groups, age was very equal; this is one indication of normal distribution of data variables. On the contrary, body mass index (BMI) varied significantly across groups. With a BMI of 29.76 ± 3.38 kg/m², the hypothyroid (Hypo-TR) group was far higher than both the control ($p < 0.001$) and hyperthyroid ($p < 0.05$). Though the difference was less clear ($P < 0.05$), the Hyper-TR group also displayed a greater BMI (27.87 ± 4.31 kg/m²) than the control group (26.21 ± 4.26

kg/m²). These findings reflect the identified metabolic consequences of thyroid malfunction, especially the link between hypothyroidism and weight increase, as well as the somewhat low BMI values usually connected with hyperthyroidism. Table2 explains the clinical characteristics of thyroid function tests for women patients and the study biomarker galanin between three groups: control apparently healthy, hypothyroid group (Hypo-TR), and hyperthyroid group (Hyper-TR). The levels of TSH were markedly elevated in the Hypo-TR group (6.95 ± 1.83 μIU/ml) in comparison to both the control group (2.08 ± 0.40 μIU/ml, $p < 0.001$) and the Hyper-TR group (0.29 ± 0.20 μIU/ml, $p < 0.001$). Free T3 levels were markedly reduced in the hypothyroid group (2.12 ± 0.55 pg/dL) versus control group (3.00 ± 0.58 pg/dL, $P < 0.001$), while levels were significantly elevated in the hyperthyroid group (6.54 ± 1.05 pg/dL) when compared with both the control and hypothyroid groups ($P < 0.001$ for both group comparisons). Relative to both the control and hypothyroid groups, free T4 levels showed the same pattern: they were significantly raised in the hyperthyroidism group (3.43 ± 0.81 ng/dL) and greatly reduced in the hypothyroid group (0.57 ± 0.28 ng/dL). It is noteworthy that compared to the control group as seen in Table2, both groups with thyroid malfunction had increased serum galanin levels. The hypothyroid group (412.41 ± 261.41pg/mL) had the highest mean galanin level, followed by the hyperthyroid group (280.15 ± 183.03 pg/mL); the control group recorded the lowest mean galanin level (176.85 ± 89.52 pg/mL). Although every group showed significant variation, the data suggest to a trend towards higher galanin concentrations associated with thyroid malfunction, particularly hypothyroidism as seen in Fig.1. The results of the investigation revealed variations in lipid parameters in comparison with the control group as seen in the Table 3. With statistically significant differences ($P < 0.05$), total cholesterol levels increased somewhat in the hypo-TR group (235.3 ± 14.02 mg/dL) and in the hyper-TR group (189.91 ± 42.15 mg/dL) relative to the control group (188.9 ± 27.28 mg/dL). With statistically significant differences in the hypo-TR group ($P < 0.05$), triglyceride (TG) levels similarly raised considerably in the hyper-TR group (189.10 ± 92.35 mg/dL) and the hypo-TR group (196.93 ± 17.62 mg /dL) ($P < 0.05$), compared to the control group (148.84 ± 61.18 mg/dL). Analogously, very low-density lipoprotein (VLDL) values were greater in both groups with thyroid dysfunction, especially in the hypothyroid group (38.74 ± 17.9 mg/dL) relative to the control group (29.76 ± 12.23 mg/dL). With a little, non-statistically significant increase in the hypo-TR group (42.92 ± 8.59 mg/dL) and a modest decline in the hyper-TR group (40.71 ± 8.95 mg/dL), compared to the control group (42.31 ± 7.39 mg/dL), high-density lipoprotein (HDL-C) levels were very stable across all groups. While LDL-C in the hyper-TR group remained similar (111.38 ± 32.66 mg/dL), LDL-C levels revealed a marked slightly higher in the hypo-TR group (155.86 ± 13.21mg/dL) compared to the control group (111.52± 36.80 mg/dL).

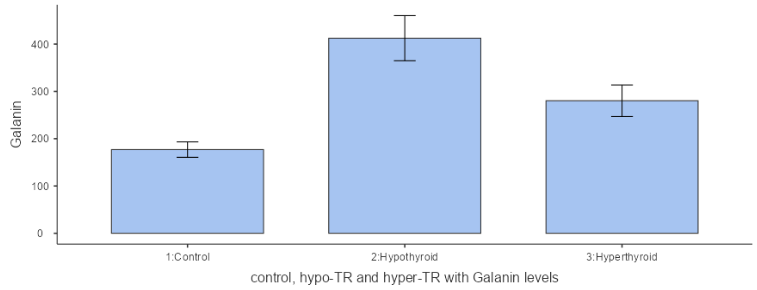

Figure1: Plasma Galanin Levels in Control, Hypothyroid, and Hyperthyroid Groups
The bar chart illustrates the mean plasma galanin concentrations (pg/ml) among the three study groups: **Control** group: lowest galanin level, **Hypothyroid** group: significantly elevated galanin levels, **Hyperthyroid** group: intermediate levels between control and hypothyroid. Error bars represent the standard deviation. These findings suggest that **galanin levels are notably increased in hypothyroid patients**, indicating a potential role in thyroid hormone regulation or compensatory neuroendocrine mechanisms.

3.2. The Correlation Analysis Between Galanin Hormone and Biochemical Parameters

In liver function tests as shown in Table 4, alanine aminotransferase (ALT) levels were slightly elevated in the Hyper-TR group (26.99 ± 23.20 IU/L) relative to the Hypo-TR group (23.34 ± 11.04 IU/L) and the control group (22.19 ± 12.6 IU/L), though these variations did not reach statistical significance. AST levels were elevated in the Hyper-TR group (31.19 ± 30.84 IU/L) relative to the Hypo-TR group (22.71 ± 11.08 IU/L) and the control group (22.59 ± 15.91 IU/L); however, these differences were not statistically significant. Fig.2 and detailed in Tables5 and Table6 show the correlation analysis between serum Galanin levels and diverse clinical and biochemical indicators in the hyperthyroid (hyper-TR) and hypothyroid (hypo-TR) patient groups, respectively. The magnitude and direction of relationships were evaluated using Pearson's correlation coefficient (r), and statistical significance was determined by the Pearson correlation test. This investigation aimed to investigate potential correlations between Galanin and variables including lipid profile, thyroid hormones, liver enzymes, and anthropometric measurements as shown in Fig.3. The correlation patterns between galanin hormone levels and the examined biomarkers seem different in the hypothyroid group. However, they did not show a significant association. This indicates that the association between galanin and various metabolic indicators may be affected by the degree of hypothyroidism development as seen in the Table6.

Table5: Correlation Between Galanin and Parameters Between Hyper-TR Patients Group

Parameters	Galanin (pg/ml)	
	P value	**Pearson's correlation coefficient (r)**
Age (years)	0.804	0.047
BMI (Kg/m²)	0.208	-0.237
TSH(μIU/ml)	0.664	0.083
Free T3(Pg/dL)	0.932	0.016
Free T4(ng/dL)	0.273	0.207
Cholesterol(mg/dl)	0.506	-0.126
HDL (mg/dl)	0.221	0.140
LDL (mg/dl)	0.037	-0.383
VLDL (mg/dl)	0.0857	0.021
TG (mg/dl)	0.657	-0.085
ALT (mg/dl)	0.432	0.254
AST (mg/dl)	0.543	0.351

Values shown are for the **hyperthyroid group**. Significant correlation ($p < 0.05$) was observed only between **galanin and LDL levels**, with a moderate negative correlation (**r = -0.383**).

Table6: Correlation Between Galanin and Parameters Between Hypo-TR Patients Group

Parameters	Galanin (pg/ml)	
	P value	**Pearson's correlation coefficient (r)**
Age (years)	0.893	0.26
BMI (Kg/m²)	0.446	-0.144
TSH(μIU/ml)	0.766	0.057
Free T3(Pg/dL)	0.632	-0.091
Free T4(ng/dL)	0.631	0.082
Cholesterol(mg/dl)	0.557	- 0.112
HDL (mg/dl)	0.411	0.156
LDL (mg/dl)	0.607	- 0.098
VLDL (mg/dl)	0.769	0.34
TG (mg/dl)	0.623	-0.093
ALT (mg/dl)	0.313	0.118
AST (mg/dl)	0.221	0.140

Galanin (pg/ml): A neuropeptide involved in metabolic and endocrine regulation. **BMI:** Body Mass Index (kg/m²). **TSH:** Thyroid Stimulating Hormone (μIU/ml). **Free T3 / Free T4:** Unbound triiodothyronine and thyroxine hormones (pg/dL and ng/dL, respectively). **Cholesterol, HDL, LDL, VLDL, TG:** Lipid profile parameters measured in mg/dL. **ALT / AST:** Liver enzymes (Alanine and Aspartate aminotransferase, respectively) measured in mg/dL. **r:** Pearson's correlation coefficient, indicating the strength and direction of association. **p-value:** Statistical significance ($p < 0.05$ is considered significant).

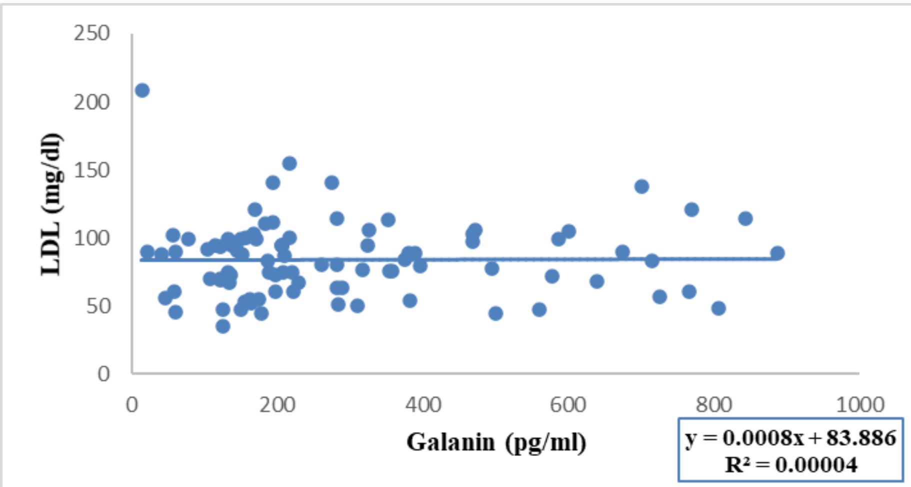

Figure2: Correlation Between Plasma Galanin Levels and LDL Concentration
The scatter plot shows the relationship between plasma galanin levels (pg/ml) and LDL cholesterol levels (mg/dl). The linear regression line indicates a **very weak positive correlation** ($R^2 = 0.00004$), with the regression equation: **$y = 0.0008x + 83.886$**. This suggests **no meaningful association** between galanin and LDL levels in the study population.

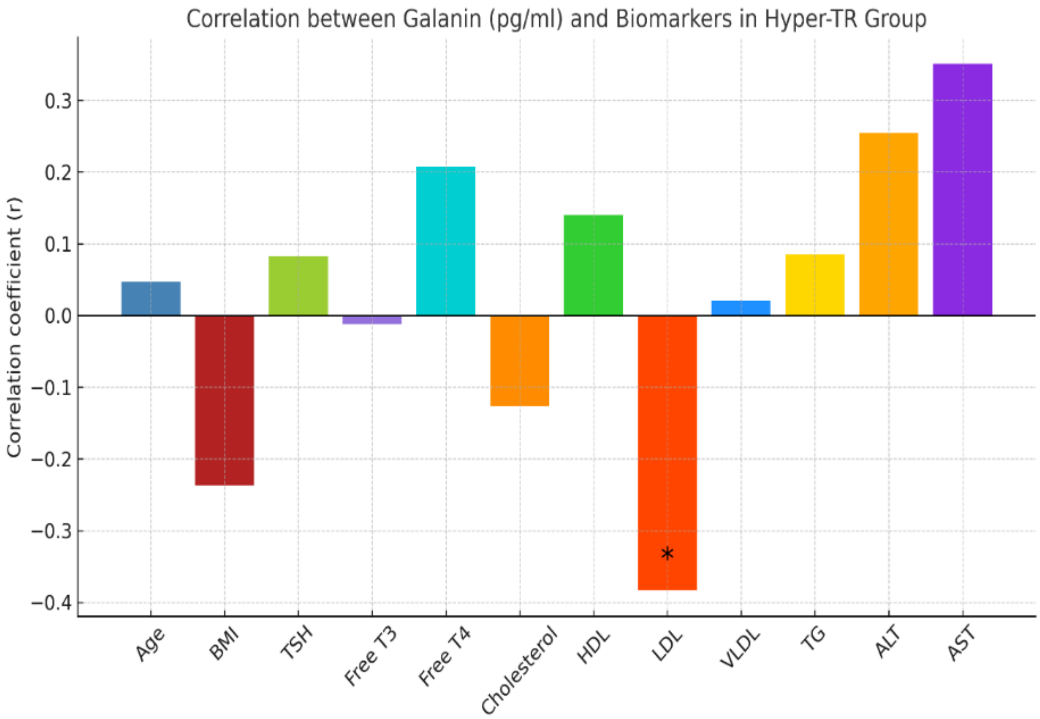

Figure3: Correlation Between Serum Galanin Levels and Various Biomarkers in the Hyperthyroid Group

The bar chart displays the correlation coefficients (r) between galanin (pg/ml) and several clinical biomarkers in patients with hyperthyroidism.

Notably, LDL shows a significant negative correlation with galanin ($p < 0.05$), indicated by the asterisk (*). Other variables such as AST, ALT, and HDL exhibit positive correlations, while BMI and LDL show inverse relationships. This suggests a possible regulatory link between galanin and lipid/liver parameters in hyperthyroid individuals.

Fig.4 and Fig.5 show the correlation coefficients (r) between serum levels of the galanin hormone and various biomarkers in the hypothyroid and hyperthyroid groups. Comparing the correlation patterns between these groups, several differences were revealed: In the hyperthyroid patient group, Galanin levels exhibited a statistically significant negative correlation with LDL cholesterol levels ($r = -0.383$, $p = 0.037$), indicating an inverse relationship between Galanin and LDL in this group as seen in the Figure 2. No further indicators exhibited significant relationships with Galanin in the hyperthyroid cohort. BMI had a negative connection ($r = -0.237$), although the association lacked statistical significance ($p = 0.208$). Conversely, among hypothyroid patients, none of the assessed measures exhibited a statistically significant connection with Galanin. The relationship between Galanin and LDL cholesterol was weak and non-significant ($r = -0.098$, $p = 0.667$), contrasting with the strong link found in the hyperthyroid cohort. BMI had a weak and non-significant association with Galanin in the hypothyroid cohort ($r = -0.144$, $p = 0.446$). The data indicate that the association between Galanin and lipid metabolism, specifically LDL cholesterol, may be modified in hyperthyroidism but remains unaffected in hypothyriodism

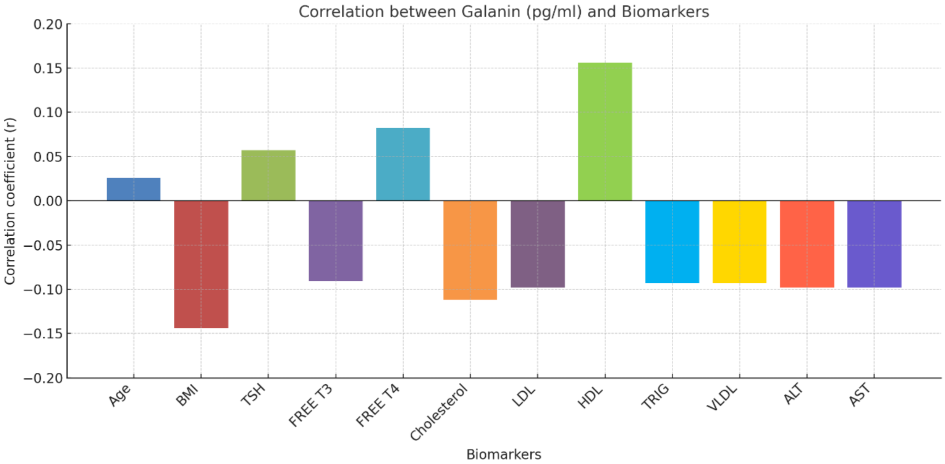

Figure4: Correlation Between Serum Galanin Levels and Various Biomarkers in the Overall Study Population

This bar chart displays the **Pearson correlation coefficients (r)** between **serum galanin levels (pg/ml)** and a range of clinical biomarkers across the full study population. **Positive correlations** were observed with HDL, Free T4, TSH, and Age. **Negative correlations** were found with BMI, Free T3, Cholesterol, LDL, VLDL, Triglycerides (TRIG), ALT, and AST. The strongest positive association was with **HDL**, while the most notable negative correlation appeared with **BMI**. No statistically significant correlations were indicated in this chart. Error bars are not shown.

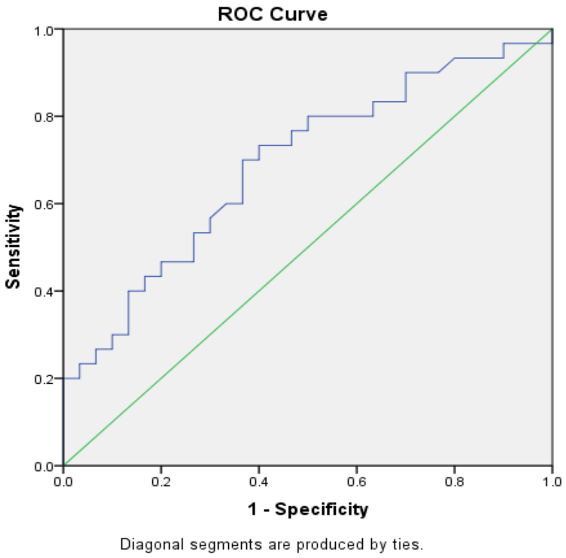

Figure5: ROC Curve Analysis of Serum Galanin Levels for Differentiating Hyperthyroid Patients from Controls

This Receiver Operating Characteristic (ROC) curve evaluates the diagnostic performance of **serum galanin levels** in distinguishing **hyperthyroid patients** from **healthy controls**. The curve plots **sensitivity** versus **1 − specificity** at various cutoff values. The **area under the curve (AUC)**, although not displayed here, reflects the test's overall accuracy. The curve deviates above the diagonal reference line, indicating **diagnostic value** above random chance.

3.3. Receiver Operating Characteristics (ROC) Curve Diagnostic Performance of Serum Levels of Galanin

Table7 illustrates the findings of the ROC (Receiver Operating Characteristic) curve analysis assessing the diagnostic efficacy of serum galanin levels in women diagnosed with hyperthyroidism. The area under the curve (AUC) was 0.703, signifying a moderate discriminating capacity. The ideal cut-off value, found via Youden's index, was 0.333 pg/ml, resulting in a sensitivity of 73.3% and a specificity of 60.0%. The 95% confidence interval for the AUC range from 0.556 to 0.824, indicating a moderate diagnostic accuracy of Galanin in differentiating hyperthyroid state in female patients

Table7: AUC, Optimal Threshold, Sensitivity, and Specificity of Serum Galanin Among Hyperthyroid and Healthy Control

Test Result Variable(s)	Area under the Curve (AUC)	Cut off value Youden's index	Specificity	Sensitivity	95% Confidence Interval	
					Lower Bound	Upper Bound
Galanin (pg/ml) In hyperthyroid patient's women	0.703	0.333	0.600	0.733	0.556	0.824
AUC (Area Under the Curve): Reflects the diagnostic accuracy of galanin; AUC = 0.703 indicates fair diagnostic performance. Cut-off Value: The optimal threshold of galanin for distinguishing hyperthyroid patients from controls. Youden's Index: Summarizes the performance of the test (Youden's Index = Sensitivity + Specificity – 1) Specificity: The proportion of true negatives correctly identified. Sensitivity: The proportion of true positives correctly identified. 95% Confidence Interval: Range in which the true AUC value lies with 95% certainty.						

Table8 illustrates the findings of the ROC (Receiver Operating Characteristic) curve analysis assessing the diagnostic efficacy of serum galanin levels in women diagnosed with hypothyroidism. The area under the curve (AUC) was 0.763, signifying a moderate discriminating capacity. The ideal cut-off value, found via Youden's index, was 123.15pg/ml, resulting in a sensitivity of 83.3% and a specificity of 23.3 %. The 95% confidence interval for the AUC range from 0.636 to 0.889, indicating a moderate diagnostic accuracy of Galanin in differentiating hypothyroid state in female patients

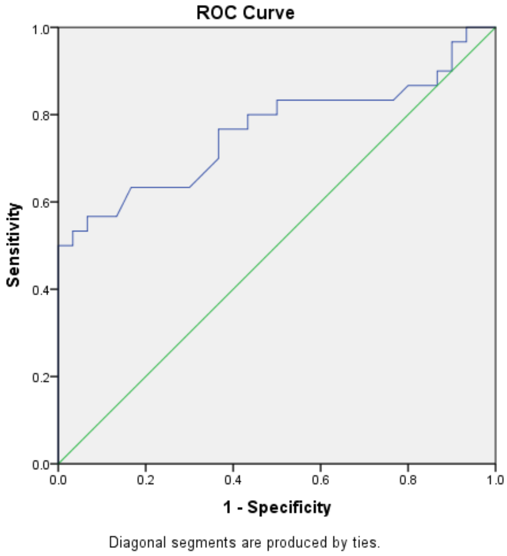

Figure6: ROC Curve of Serum Galanin Levels in Hypothyroid Female Patients Compared to Control Group

This ROC curve evaluates the diagnostic performance of **serum galanin levels** in distinguishing **hypothyroid patients** from **healthy controls**. The curve plots **sensitivity** versus **1 − specificity** at various cut-off values. The position of the curve above the diagonal reference line suggests **good diagnostic discrimination**.

This analysis helps determine the **optimal threshold** for galanin to **predict**

Table8: AUC, Optimal Threshold, Sensitivity, And Specificity of Serum Galanin Among Hypothyroid and Healthy Control

Test Result Variable(s)	**Area under the Curve (AUC)**	**Cut off value Youden's index**	**Specificity**	**Sensitivity**	**95% Confidence Interval**	
					Lower Bound	**Upper Bound**
Galanin (pg/ml) In hypothyroid patient's women	0.763	123.15	0.233	0.833	0.636	0.889

AUC (Area Under the Curve): AUC = 0.763 indicates **good diagnostic ability** of galanin for identifying hypothyroidism. **Cut-off Value:** 123.15 pg/ml is the optimal galanin level for diagnosis. **Youden's Index:** Measures overall test performance (Sensitivity + Specificity − 1). **Specificity:** Proportion of true negatives (healthy controls) correctly identified. **Sensitivity:** Proportion of true positives (hypothyroid patients) correctly identified. **95% Confidence Interval:** Range of uncertainty around the AUC estimate.

4. Discussion

Since age showed no appreciable variation across the three study groups (control, hypothyroid, and hyperthyroid), the present study implies that age was not a major factor determining the reported metabolic or hormonal parameters. This age-matching raises group comparison dependability.

Body mass index (BMI), especially in the hypothyroid group whose levels above those of the control group and the hyperthyroid patients, varied significantly, nevertheless. This result is in line with the well-documented link between hypothyroidism and higher body weight, largely resulting from lower basal metabolic rate, fluid retention, and reduced thermogenesis connected with low thyroid hormone levels(Qiu et al., 2023). Interestingly, in this study those with hyperthyroidism had a somewhat higher BMI than the control group; although, given their greater metabolism, one would usually expect their BMI to be lower. This could represent personal variation, disease length, or other compensating elements (like a higher hunger). Previous research indicates that not all hyperthyroidism sufferers are underweight, particularly in the early or subclinical phases when the catabolic effects could not be clearly evident(Lee and Pearce, 2023). These results highlight the effect of thyroid dysfunction on body weight control, therefore generally supporting the importance of considering BMI as a clinical indicator and a possible outcome of changed thyroid hormone activity. This study investigated alterations in thyroid hormones, their impacts, and their association with the neuropeptide hormone galanin. We compared individuals with hypothyroidism (Hypo-TR), hyperthyroidism (Hyper-TR), and healthy controls. The results showed clear and significant differences in all thyroid measurements between the groups, which matched the known characteristics of thyroid problems. The data clearly reveal that TSH hormone levels were strongly raised in hypothyroid patients and conversely in the hyperthyroid group. These findings determine negative feedback systems in response to thyroid hormone levels. While they were raised in hyperthyroid patients compared to the control group, free T3 and T4 hormones levels were noticeably lowered in hypothyroid patients, therefore verifying the usual biochemical composition of each thyroid disease. Significantly, the study showed a gradual increase in galanin levels across all thyroid disorders; hypothyroid individuals had the greatest values. Such an increase could be either a compensatory neuroendocrine reaction linked with hypothyroidism or a possible function of galanin in thyroid hormone control. Though they were less evident than in the hyperthyroid group, the raised galanin levels in hypothyroid patients suggest their role in thyroid-related neuroendocrine signaling(Can et al., 2024b). Previous research has detected the function of galanin in regulating the hypothalamic-pituitary-thyroid axis, namely in controlling the secretion of TRH and TSH. The findings indicated that circulating galanin levels fluctuate markedly with thyroid functional state (Abed, n.d.). This indicates that the heightened galanin levels in hyperthyroid people may signify higher sympathetic and metabolic activity, whereas the elevated levels in hypothyroidism may reflect modified neural feedback due to hormone shortage. These results taken together indicate galanin as a prospective biomarker associated with thyroid dysfunction. Current studies keep clarifying its particular function and relation to thyroid dysfunction. Future research could look into galanin's therapeutic target or diagnostic marker possibilities for thyroid disorders. This study investigates the lipid profile of patients with thyroid dysfunction as a significant indicator associated with thyroid hormones and body mass index. Participants with thyroid hormone insufficiency showed elevated levels of total cholesterol and triglycerides(Arce-Sánchez et al., 2021; Mutalazimah et al., 2022). This corresponds to previous studies connecting hypothyroidism to dyslipidemia. These alterations are likely attributable to diminished activation of low-density lipoprotein

(LDL) receptors and reduced lipid clearance, both of which are significant characteristics of hypothyroidism. Indeed, the elevation of VLDL in the hypothyroidism group significantly supports the existence of elevated LDL lipid profiles in these individuals. Triglycerides and VLDL were higher in the hyperthyroid group than in the control group, although these differences were not statistically significant. Total cholesterol increased slightly but significantly. Thyroid hormones' complicated metabolic activities alter lipid production and blood filtration, causing this rise. Additionally, in this study, the combination of low thyroid hormones causes a decrease in fat metabolism, which affects total cholesterol, causing it to rise, as well as LDL and triglycerides, and a slight decrease in HDL levels. The levels of lipid profile are affected by the severity of hypothyroidism(Arce-Sánchez et al., 2021), meaning that higher TSH levels are associated with a greater increase in fat. The liver enzyme levels in the hyperthyroid group were elevated compared to the hypothyroid group and the healthy control group; however, these differences did not achieve statistical significance. This is due to increased thyroid hormones inducing toxic effects on the liver, resulting in oxidative stress and subsequently impacting liver enzyme activity(Piantanida et al., 2020). These results confirm that thyroid dysfunction affects the metabolic system. Additional research using larger sample sizes and longitudinal methods is necessary to validate these findings and clarify the underlying mechanisms.

5. Conclusion

The results indicate that elevated galanin levels in women with thyroid disorders are a potential biomarker associated with impaired thyroid function. Current studies continue to elucidate its specific function and its relationship to thyroid dysfunction. Future research may investigate galanin's therapeutic target or its potential as a diagnostic marker for thyroid disorders.

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