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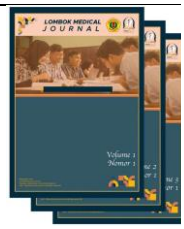

Hyperthyroid Status with Glycemic Control in Patients with type 2 Diabetes Mellitus at Peripheral Hospital

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Abstract: By 2030, it is estimated that the number of patients with type 2 diabetes mellitus (T2DM) in Indonesia will increase from 8.4 million to 21.3 million. Thyroid dysfunction (TD) impacts the glycemic control of patients with T2DM. In thyroid dysfunction, metabolism becomes disturbed, blood glucose levels increase, and causing insulin in the body to be eliminated more quickly. This case report explores a T2DM patient with hyperthyroidism and glycemic control, including pre-, intra-, and post-patient care. In this case, a 25-year-old woman presented with typical thyroid symptoms accompanied by an increase in blood glucose. The patient underwent strict glycemic control and therapy for T2DM and hyperthyroid disease. In our report, during pre-, intra-, and post-inpatient care for type 2 DM patients with hyperthyroid status, we observed that good glycemic control can be maintained when treatment for both diabetes mellitus and hyperthyroidism is routinely administered. The appropriate treatment for patients with T2DM and hyperthyroidism had a positive impact on the patient's clinical condition during these three time periods. Diabetes mellitus followed by thyroid dysfunction may lead to a higher risk of cardiovascular disease; thyroid dysfunction may worsen diabetes mellitus, and diabetes mellitus may worsen thyroid function. Therefore, it is important to screen thyroid function in high-risk patients as part of the comprehensive management of patients with type 2 diabetes mellitus

Keywords:. Thyroid Status, Thyroid Dysfunction, Type 2 Diabetes Mellitus, Glycemic Control, Hyperthyroid

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Introduction

Diabetes mellitus is classified based on the pathogenic process that causes hyperglycemia, or high levels of glucose in the blood, accompanied by metabolic disorders of carbohydrates, lipids, and proteins as a result of insulin insufficiency. This insufficiency can be caused by a deficiency in insulin production by pancreatic beta cells or by the inoperability of insulin receptors in the body (Banday et al., 2020). The World Health Organization (WHO) predicts an increase in T2DM patients in Indonesia from 8.4 million in 2000 to approximately 21.3 million by 2030. According to the Indonesian Central Bureau of Statistics in 2003, the Indonesian population over 20 years old was 133 million, with a diabetes mellitus (DM) prevalence of 14.7% in urban areas and 7.2% in rural areas. It is projected that by 2030, there will be 8.2 million DM patients in rural areas (Kemenkes, 2020).

Hyperthyroidism is a clinical condition in which there is an increased synthesis of thyroid hormones by

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the thyroid gland, increasing the concentration of these hormones in the tissues, characterized by the rise in T3 and T4 (Srikandi et al., 2020). The prevalence of hyperthyroidism in Europe is 0.8%, and in the United States, it is 1.3%. The prevalence of hyperthyroidism increases with age and is more common in women (De Leo et al., 2016). Various conditions can lead to cases of hyperthyroidism, such as Graves' disease, toxic adenoma, toxic multinodular goiter, and thyroiditis. Hyperthyroidism can worsen blood glucose control and increase insulin requirements (Wisnu et al., 2018). When hyperthyroidism occurs, thyroid hormone will affect glucose metabolism, resulting in increased hepatocyte plasma membrane concentrations of GLUT-2, which is the main transporter in the liver, leading to increased GLUT-2 levels and abnormal glucose metabolism (Ogbonna et al., 2019).

Thyroid hormone changes are common in patients with diabetes, especially with poor glycemic control. In thyroid dysfunction, metabolism is disturbed, blood glucose levels increase, and insulin in the body is eliminated more quickly (Akelba et al., 2023). A patient with diabetes mellitus will exhibit an impaired TSH response to TRH. Lower T3 levels result from decreased peripheral conversion of T4 to T3; T3 levels normalize when glycemic control is well managed. Other studies suggest that short-term excess T3 may cause insulin resistance, potentially leading to T2DM (Rong et al., 2021). Thyroid dysfunction can affect various metabolic processes in the body and contribute to insulin resistance, so it can be concluded that thyroid disorders have a significant impact on the glycemic control of individuals with diabetes mellitus (Kartika et al., 2020).

Diabetes and thyroid dysfunction have been shown to influence each other; diabetes affects thyroid function test results, while thyroid hormones contribute to the regulation of carbohydrate metabolism and pancreatic function (Kartika et al., 2020). Thyroid hormones impact glucose metabolism through several mechanisms; when hyperthyroidism occurs, the half-life of insulin is reduced due to an increased rate of degradation and greater release of biologically inactive insulin precursors. Another mechanism explaining hyperthyroidism and hyperglycemia is increased intestinal glucose absorption mediated by elevated thyroid hormones (Kalra et al., 2019).

From previous studies on thyroid status and glycemic control, there is an association between thyroid hormone disorders and carbohydrate and lipid metabolism. However, since the mechanism is still unclear, it is questionable whether the results of these studies are coincidental. Further research is needed to determine the relationship between thyroid status and glycemic control in patients with type 2 diabetes. Therefore, this case report was created as a source of information for future research.

Case Presentation

A 25-year-old female was admitted to Betun Public Health Center with signs and symptoms of rapid fatigue, palpitations, frequent sweating, and neck lumps. The patient did not experience difficulty swallowing, and there was no change in her voice (hoarseness). The patient's family complained that her eyes looked more bulging than before. The patient reported frequent sweating, even when she was not engaged in strenuous activity or during hot weather; she feels that her hands are always moist as if sweating, feeling more comfortable in cooler room temperatures. In the last three months, the patient has lost about 9 kg, with weight dropping from 61 kg to 52 kg. The patient has experienced weight loss but increased appetite, accompanied by a heightened frequency of urination. During the physical examination, it was found that her blood pressure was 103/74 mmHg, pulse rate was 100 beats per minute, respiration rate was 20 breaths per minute, and temperature was 36.5 °C. Laboratory examination at the public health center during pre-inpatient care revealed blood glucose levels of 205 mg/dL. The patient has been presenting with typical hyperthyroid symptoms for three months, but these symptoms do not interfere with her activities, so she has not consulted a healthcare provider and has not received any treatment for her hyperthyroid symptoms.

The patient had been diagnosed with diabetes mellitus six months ago before experiencing typical hyperthyroid symptoms that worsened over the past week. There was no family history of thyroid disease, but the patient's father also had a history of type 2 diabetes mellitus. The patient had been treated with metformin 1500 mg three times a day for diabetes mellitus for six months; however, she rarely visited the health facility and did not take her medication regularly. Because the patient exhibited symptoms of hyperthyroidism and was untreated, she was referred.

The patient was admitted to Penyangga Perbatasan Betun Regional Hospital with signs and symptoms of frequent urination, palpitation, and vomiting. On physical examination, it was found that the general condition appeared to be moderately ill; blood pressure was 123/84 mmHg, pulse rate was 110 beats per minute, respiration was 22 breaths per minute, and temperature was 36.5°C. An examination of the neck showed an enlarged thyroid gland. Laboratory examination results revealed blood glucose levels of 590 mg/dl, HbA1c 12.2%, TSH 0.0003 mIU/l, and fT4 34.47 pmol/l. Ultrasonography (USG) of the neck indicated that the size of the thyroid gland was enlarged. The

echogenicity was homogeneous, there were no nodules or cysts, and no calcifications; Color Doppler Ultrasound (CDUS) showed no increase in parenchymal vascularity. There was no enlargement of the lymph nodes of the right and left sides of the neck, with an impression of diffuse struma. The purpose of the ultrasound examination in this patient was to assess the structure of the thyroid gland and whether there were nodules or enlargement, as the presence of nodules could lead to malignancy. The patient was given initial management for hyperglycemia, diabetes mellitus, and hyperthyroidism. Based on the above results, the patient was diagnosed with type 2 diabetes mellitus (T2DM) and aggravated Graves' hyperthyroidism. During inpatient care, the patient was treated with an Intra Venous Fluid Drip (IVFD) of NaCl 0.9%, loading 1000 cc; injection of insulin Novorapid 10 IU three times daily; injection of insulin Levemir 12 IU daily; injection of omeprazole 80 mg twice daily; propylthiouracil 100 mg three times daily; propranolol 10 mg daily; and atorvastatin 20 mg daily, followed by neck ultrasound, monitoring of blood glucose levels, and hospitalization for four days during inpatient care.

After four days of inpatient care and treatment for hyperthyroidism and diabetes mellitus, the patient had improved, with reduced chest palpitations, no weakness, and no frequent urination. Laboratory results indicated blood sugar levels of 194 mg/dl.

On the fourth day of treatment, the patient was discharged, and treatment continued on an outpatient basis. The patient received an injection of Novorapid insulin 14 IU three times daily, an injection of Lantus insulin 20 IU daily, atorvastatin 20 mg daily, and propylthiouracil 100 mg three times daily.

Post-inpatient care, the patient visited the hospital for a check-up, and the laboratory examination showed a history of decreased and increased blood glucose at several control times. Laboratory tests showed a blood glucose level of 229 mg/dL at the patient's first visit. Within one month, the patient returned for a second visit, and laboratory tests indicated blood glucose levels of 341 mg/dL. The patient's third visit revealed laboratory results: blood glucose 46 mg/dL. During the eighth visit, the patient was tested for blood glucose and HbA1c, with blood glucose at 341 mg/dL and HbA1c at 10%. After seven months of therapy for diabetes mellitus and hyperthyroidism, the patient was reassessed for thyroid function tests and HbA1c. The laboratory tests showed the following results: blood glucose levels of 170 mg/dL, HbA1c 9.7%, TSH 0.0001 mIU/L, fT4 19.23 pmol/L.

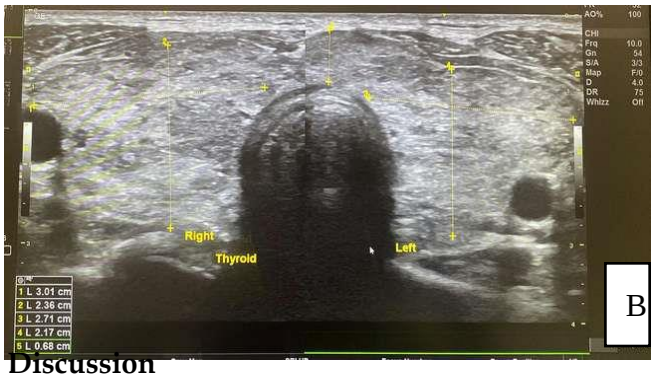
After seven months of therapy for diabetes mellitus and hyperthyroidism, blood glucose and thyroid function were gradually controlled, although there were fluctuations in blood glucose levels during control periods. This variability could be attributed to an excess of circulating thyroid hormone in hyperthyroidism, which is associated with poor glycemic control, including hyperglycemia. It can be concluded that thyroid status plays a role in glycemic control in these patients. In addition to the impact of hyperthyroidism on glycemic control, patient noncompliance with disease management and medication adherence may contribute to impaired glycemic regulation.

Therefore, patients diagnosed with a degenerative disease should be encouraged to monitor their condition, take their medication regularly, and adopt healthy lifestyle changes.

Table 2. Patient control History

Visit date	Heart Rate (x/minute)	Blood Glucose (mg/dL)	Hba1C (%)	TSH (mIU/ml)	FT4 (pmol/L)
Pre-Hospital					
24/07/2023	100	205	-	-	-
Inpatient care					
27/07/2023	110	590	12,2	0,0003	34,47
28/07/2023	86	456	-	-	-
29/07/2023	63	154	-	-	-
30/07/2023	80	194	-	-	-
Post-inpatient care					
28/11/2023	100	229	-	-	-
12/12/2023	100	341	-	-	-
19/12/2023	81	46	-	-	-
28/12/2023	82	88	-	-	-
09/01/2024	92	243	-	-	-
16/01/2024	77	120	-	-	-
23/01/2024	82	117	-	-	-
30/01/2024	107	480	10,8	-	-
06/02/2024	71	178	-	-	-
04/06/2024	98	170	9,7	-	19,23

Figure 1 A. Ultrasonography of the right and left thyroid and isthmus with CDUS does not show increased vascularization in the parenchyma. B. The right and left thyroid appear enlarged; the echo-parenchyma appears homogeneous, with no apparent nodules or cysts, no calcification, and a diffuse struma impression.



Discussion

Hyperthyroidism is a condition characterized by increased synthesis and secretion of thyroid hormones by the thyroid gland, marked by an elevation in T3 and T4 due to the immune system attacking the thyroid (Anidha et al., 2023). Changes in thyroid hormones are common in diabetic patients, particularly with poor glycemic control. Thyroid dysfunction results in impaired metabolism; in hyperthyroid disorders, blood glucose levels will rise, causing insulin in the body to be eliminated more rapidly (Kalra et al., 2019). In diabetic patients, TSH response to TRH is impaired, the decrease in T3 levels results from reduced peripheral conversion of T4 to T3, and T3 levels will normalize when glycemic control is achieved. Unrecognized thyroid dysfunction in type 2 diabetes mellitus (T2DM) can worsen glycemic control and elevate cardiovascular risk in T2DM (Kalra et al., 2019).

Diabetes mellitus is a group of metabolic disorders characterized by hyperglycemia due to abnormalities in insulin secretion, insulin action, or both. The two major categories of diabetes mellitus are classified as type 1 and type 2. Both types of diabetes begin with a condition of abnormal glucose homeostasis as the pathogenic process progresses (Sudoyo, 2014). When the glucose level in circulation increases, glucose is transported from the beta cells by the GLUT-2 transporter, where GLUT-2 is a solute carrier protein that acts as a glucose sensor for the beta cells. Once glucose is taken up, glucose catabolism is activated, and the intracellular ATP/ADP ratio increases. This causes membrane depolarization and enhances insulin secretion (Galacia, 2020). Glucose production is increased in hyperthyroidism because thyroid hormones raise the plasma membrane concentration of the hepatocyte glucose transporter type 2 gene (GLUT-2), the major glucose transporter in the liver, leading to augmented GLUT-2 levels. Elevated GLUT-2 levels contribute to increased hepatic glucose elimination and abnormal glucose metabolism (Hage, 2011).

In this case, the patient came to the Betun Public Health Center with signs and symptoms of rapid fatigue, palpitations, frequent sweating, eyes that appeared more bulging than before, an increased comfort level in cooler room temperatures, weight loss but increased appetite, a heart rate of 100 beats per minute, and neck lumps. The most common symptoms of hyperthyroidism are palpitations, weakness, difficulty sleeping, heat intolerance, sweating, and polydipsia. Physical examination usually reveals tachycardia, tremors in the extremities, and weight loss. In the present case, the patient had complaints of palpitations (+2), fatigue (+2), excessive sweating (+3), a preference for cold temperatures (+5), a palpable thyroid (+3), increased appetite (-3), weight loss (+3), moist hands (+1), exophthalmos (+2), a pulse greater than 90 beats per minute (+3), and the Wayne index in this case was recorded as 21. Wayne's Index is a clinical diagnostic tool for enhancing accuracy in the assessment of hyperthyroidism. The score is divided into three parts: a person with a score above 19 is considered to have toxic hyperthyroidism; a score between 11 and 19 is equivocal; and a score less than 11 indicates euthyroidism. The patient has been presenting with typical hyperthyroid symptoms for three months, but the symptoms do not interfere with the patient's activities, so the patient has not consulted a healthcare provider and has not received any treatment for hyperthyroid symptoms. The patient had no family history of thyroid disease, but the patient's father also has a history of type 2 diabetes mellitus. Laboratory examination at the public health center during pre-inpatient care found blood glucose levels at 205 mg/dl. The patient had been treated with metformin 1500 mg three times daily for diabetes mellitus for six months; however, she rarely visited the health facility and did not take her medication regularly. Because the patient exhibited symptoms of hyperthyroidism and was untreated, she was referred.

Based on the above results, the patient was diagnosed with type 2 diabetes mellitus and hyperthyroidism. During inpatient care, the patient was treated, and further investigations were conducted to confirm the diagnosis. In identifying cases of hyperthyroidism, serum TSH should be measured first, as it has high sensitivity and specificity in diagnosing thyroid disease. If the result is low, serum free T4 (fT4) or T3 concentrations should be checked. In overt hyperthyroidism, there is a decrease in serum TSH to <0.01 mIU/L and an increase in serum fT4 and T3. In subclinical hyperthyroidism, fT4 and T3 levels may be normal. In this case, the patient underwent laboratory investigations and was found to have low TSH levels with elevated serum fT4, resulting in a TSH of 0.0003 mIU/mL and fT4 of 34.47 pmol/L. HbA1c has become the standard for assessing glycaemic control in patients with diabetes since the American Diabetes Association

(ADA) recommended its use in 1988. HbA1c ≥48 mmol/mol (≥6.5%) in a laboratory using a validated method is diagnostic of diabetes (Wang, 2021). In this case, it is appropriate that the results of the laboratory test of HbA1c 12.2%, accompanied by an increase in glucose level of 590 mg/dL, indicate that the patient has type 2 diabetes mellitus.

During inpatient care, the patient will be examined via ultrasound to assess the structure of the thyroid gland and to determine whether there are any nodules or enlargements that may indicate malignancy. In the ultrasonography examination of the neck, it was found that the size of the thyroid gland was enlarged, the echo-parenchyma appeared homogeneous, there was an absence of nodules/cysts, and no calcifications. With color Doppler ultrasound (CDUS), there was no increase in vascularization in the parenchyma, and no enlarged lymph nodes were noted on the right and left sides of the neck; the impression was of diffuse struma, leading to the conclusion that there was no indication of malignancy. Valerievich et al. (2024) report a typical ultrasonography pattern in Graves' disease, characterized by symptoms of thyroid gland enlargement, homogeneous echo patterns, and increased intensity of intrathyroidal vascularization, commonly referred to as the term "thyroid inferno" (Ushakov, 2024). The purpose of performing an ultrasound examination in this patient is to evaluate the structure of the thyroid gland and to check for nodules or enlargement, as the presence of nodules may indicate malignancy. A study by Philip et al. found that examination with color flow Doppler sonography can diagnose significant disease with the presence of a thyroid inferno pattern. However, the thyroid inferno pattern is found not only in hyperthyroid patients but also in hypothyroid patients, according to a recent study by Valerievich et al. (2024). In other words, laboratory tests are still needed to diagnose hyperthyroidism by evaluating serum TSH.

Thyroid hormone changes are common in people with diabetes, especially if glycemic control is poor, because metabolism is also disturbed when the thyroid gland is hyperactive, causing blood sugar levels to rise and insulin to be used up more quickly in the body. The decrease in T3 levels is caused by a reduction in peripheral conversion of T4 to T3; T3 levels return to normal when glycemic control is achieved. The coexistence of thyroid dysfunction in diabetes mellitus will worsen macrovascular and microvascular complications, morbidity, mortality, and quality of life (Hage, 2011).

Thyroid hormones can increase fasting glucose production and decrease hepatic sensitivity to insulin. In addition to increased glucose production, there is also increased expression of the glucose transporter (GLUT2) on the plasma membrane of hepatocytes, along with increased IL-6 and TNF-α activity through the NF-κB pathway in autoimmune hyperthyroid diseases such as Graves' disease (Gierach, 2014). This case report indicates that although there is poor glycaemic control, appropriate and prompt diagnosis, along with addressing the hyperthyroid state, can lead to improved glycaemic control once the patient reaches clinical euthyroid/subclinical hyperthyroid status. Detecting thyroid dysfunction in T2DM patients will enable clinicians to provide optimal treatment for metabolic conditions, as thyroid conditions like hyperthyroidism will complicate the achievement of glycaemic targets and other comorbidities.

Diabetes and thyroid disease have been shown to influence one another; diabetes affects thyroid function test results, while thyroid hormones contribute to the regulation of carbohydrate metabolism and pancreatic function. Thyroid hormones impact glucose metabolism through several mechanisms: in hyperthyroidism, the half-life of insulin is reduced due to an increased rate of degradation and an elevated release of biologically inactive insulin precursors. Another mechanism explaining the link between hyperthyroidism and hyperglycemia is the increased intestinal glucose absorption mediated by elevated thyroid hormones.

The association between insulin and thyroid hormone is influenced by autoimmune pathology, forms part of metabolic syndrome, and impacts cellular metabolism. The pathophysiological link between type 2 diabetes mellitus and thyroid dysfunction is believed to arise from an interplay of various biochemical, genetic, and hormonal malfunctions. Increased expression of GLUT2 is observed in hyperthyroidism (Kalra et al., 2019). Thyroid dysfunction and diabetes mellitus are marked by a complex interdependent interaction. Insulin resistance may heighten thyroid gland nodularity, and coexisting diabetes may elevate the risk of visual loss in patients with Graves' disease.

Based on the history and physical examination described above, the patient was diagnosed with diabetes mellitus and hyperthyroidism. In this case report, the patient experienced both decreases and increases in blood glucose at several control times. This may be due to the association between thyroid disease and diabetes mellitus. It may also be attributed to late disease control and patient compliance. Therefore, patients diagnosed with degenerative diseases should be encouraged to maintain timely control, take their medications regularly, and transform their lifestyle habits from unhealthy to healthy, such as engaging in physical activities and adopting a nutritious diet as the primary therapeutic approach.

Because thyroid dysfunction is more common in patients with diabetes than in the general population, it is recommended that thyroid function screening be conducted in high-risk patients as part of the comprehensive management of individuals with type 2 diabetes mellitus. Identifying thyroid dysfunction in patients with diabetes mellitus will help clinicians provide optimal therapy for metabolic syndrome conditions associated with thyroid dysfunction, as such dysfunction complicates achieving glycemic targets and managing other comorbidities. In these patients, various medications are prescribed to address the conditions of type 2 diabetes mellitus and hyperthyroidism.

In the treatment prior to the patient's referral to the hospital, the patient was given metformin to control blood sugar levels. Metformin works by reducing glucose production in the liver, slowing intestinal absorption of sugar, and increasing peripheral glucose uptake. In addition to lowering blood sugar, metformin has been shown to have other beneficial effects for people with type 2 diabetes. These include lowering blood pressure, reducing the risk of cardiovascular disease, and improving lipid profiles by lowering triglycerides and cholesterol. Metformin therapy has a low risk of hypoglycemia when used as monotherapy (Indarto et al., 2023). Diabetic patients have a 2 to 4 times increased risk of stroke and cardiovascular disease compared with nondiabetics. The American Diabetes Association (ADA) recommends that the target LDL level for high-risk diabetic patients with cardiovascular risk factors be less than 70 mg/dl. One of the therapies used to lower LDL is atorvastatin. The patient was also given pharmacological interventions such as atorvastatin to reduce the complications of diabetes mellitus. In this case, the patient was prescribed atorvastatin 20 mg daily (Wulan P et al., 2021).

Laboratory examination in-patient care obtained HbA1c results of 12.2%. When HbA1c >9%, the pharmacological therapy administered is insulin. Type 2 diabetes mellitus is treated by lowering blood sugar levels with insulin therapy when hypercatabolism (weight loss) is accompanied by symptoms of hyperglycemia, HbA1c levels >9%, or blood glucose levels ≥ 250 mg/dL. Insulin is the most effective anti-hyperglycemic agent, with a glucose-lowering effect of HbA1c reduction by 1.5% to 3.5% (Kim et al., 2012). In this case, the reported patient was treated with insulin injections of Novorapid 10 IU three times daily and Levemir 12 IU daily.

Treatment of hyperthyroidism involves reducing the synthesis of thyroid hormones through antithyroid drug therapy. A commonly used antithyroid drug from the thionamide group is propylthiouracil (PTU). The main mechanism of antithyroid drugs is the blockade of thyroid hormone synthesis by the thyroid gland. PTU inhibits the peripheral conversion of T4 to T3. In this case, thionamide antithyroid drugs were administered, with PTU at 100 mg three times a day (Juwita et al., 2018).

In the meantime, the use of propranolol aims to reduce the symptoms of hyperthyroidism caused by increased beta-adrenergic action, including palpitations and tremors. Propranolol can also decrease the conversion of T4 to T3 in peripheral tissues to reduce the amount of hormones that are in active form (Senn et al., 2023).

After hospitalization, the patient was discharged on the fourth day of treatment and continued on an outpatient basis, having made progress with reduced palpitations and less frequent urination. Although not treated in the intensive care unit (ICU) due to limited facilities, the patient improved by day 4 with normal and controlled blood glucose results.

The most important aspect of managing diabetes mellitus, particularly type 2 diabetes mellitus, is making lifestyle changes, including a balanced diet and regular exercise. Physical activity and exercise should be recommended and prescribed for all individuals with diabetes as part of managing glycemic control and overall health (Cholberg et al., 2016). Diabetes can be effectively controlled by modifying dietary habits, engaging in physical exercise, maintaining a reasonable body weight, monitoring lipid profiles, and taking the appropriate medication when necessary (Alam et al., 2021). Diabetes mellitus associated with thyroid dysfunction may lead to a higher risk of cardiovascular disease; likewise, thyroid dysfunction may exacerbate diabetes mellitus, and diabetes mellitus may worsen thyroid function (Kalra et al., 2019).

There is increasing evidence to support a link between type 2 diabetes mellitus and thyroid diseases. Islam M. R. reported in his journal that thyroid dysfunction was found to be more prevalent in T2DM (15.0%) compared to nondiabetic controls (5.0%), and this difference was statistically significant (p=0.018) (Islam et al., 2024). It is important to screen for thyroid dysfunction in T2DM patients, as each of these endocrinopathies and their complex interdependent interactions increase cardiovascular risks.

From this case report, it is found that thyroid status can lead to various mechanisms until glucose metabolism disorders occur in patients with type 2 diabetes mellitus. The findings in this case report are consistent with those of Kartika et al., who stated that there is a significant relationship between T4 and glycemic control in type 2 DM patients (p=0.041) (Kartika et al., 2024).

Conclusion

Thyroid dysfunction can affect various metabolic processes in the body and impact the glycemic control of patients with type 2 diabetes mellitus. Thyroid dysfunction can exacerbate type 2 diabetes mellitus, and diabetes can worsen thyroid dysfunction. In the report we studied, we found that during pre-, intra-, and post-patient care, we observed that good glycemic control can be maintained if patients are routinely monitored for both diabetes mellitus and hyperthyroidism. Routine blood glucose monitoring and appropriate therapy thus have a positive impact on the patient's clinical condition. Therefore, it is important to regularly monitor blood glucose levels in diabetic patients with thyroid dysfunction, considering the high cardiovascular risk in patients with T2DM and TD. In addition, further case reports with a more comprehensive population, criteria, and examinations are needed to investigate the factors that influence thyroid status on glycemic control in patients with T2DM.

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