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THE THYROID-GLUCOSE NEXUS: INVESTIGATING THE RELATIONSHIP BETWEEN THYROID HORMONAL IMBALANCE AND IMPAIRED GLUCOSE TOLERANCE

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Abstract

Background: Thyroid disease and diabetes mellitus are common endocrine disorders that impact each other's diagnosis and treatment. **Objective:** To investigate the relationship between thyroid dysfunction and impaired glucose tolerance. **Methods:** This cross-sectional observational study involved 72 patients with thyroid dysfunction. Patients underwent oral glucose tolerance tests after a 10-14 hour fast. The test begins with a measurement of fasting blood sugar levels, followed by consumption of a drink containing 75 grams of glucose. Timing starts upon ingestion of the glucose solution, and a blood sample is obtained exactly 2 hours later. The blood glucose concentration is then measured using an enzymatic method to determine the body's ability to regulate glucose levels. **Results:** Hypothyroidism was more prevalent (61%) than hyperthyroidism (39%). The overall prevalence of diabetes was 2.8%, impaired glucose tolerance was 27.8%, and normal glucose tolerance was 69.4%. Hypothyroidism patients had higher impaired glucose tolerance (36.3%) and diabetes (4.6%) rates than hyperthyroidism patients. A statistically significant association was found between thyroid dysfunction and impaired glucose tolerance.**Conclusion:** This study reveals a significant link between thyroid dysfunction and impaired glucose tolerance, particularly in hypothyroidism patients. Early evaluation and management of impaired glucose tolerance in thyroid dysfunction patients can prevent diabetes-related complications. Regular screening and follow-up are recommended for timely detection and management of prediabetes and diabetes in patients with thyroid dysfunction.

Keywords: thyroid dysfunction, impaired glucose tolerance, diabetes mellitus, hypothyroidism, hyperthyroidism.

Introduction

Thyroid disease and diabetes mellitus (DM) are two common endocrine disorders.[1] Thyroid hormones regulate glucose metabolism and pancreatic function, whereas diabetes affects thyroid function tests.[1] Thyroid dysfunction (hyperthyroidism and hypothyroidism) impairs

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glucose homeostasis, potentially leading to type 2 diabetes.[2] In India, over 42 million people suffer from thyroid problems, with prevalence rates of 2.9% for hypothyroidism and 9.4% for subclinical hypothyroidism.[3,4] Women are more affected than men.[3] Despite existing data on thyroid dysfunction in individuals with diabetes, little is known about impaired glucose tolerance in individuals with thyroid dysfunction. This study aims to investigate his knowledge gap and to determine the prevalence of impaired glucose tolerance in individuals with hypothyroidism and hyperthyroidism.

Materials and methods: This cross-sectional observational study was conducted at KR Hospital, Mysore, from October 2022 to September 2023 and involved patients with thyroid dysfunction. A relevant history, clinical examination, and oral glucose tolerance tests were conducted. The oral glucose tolerance test is performed in the morning after a 10-14 hour fast, during which only water is allowed and smoking is prohibited. The test begins with a measurement of fasting blood sugar levels, followed by the consumption of a drink containing 75 grams of glucose. Timing starts upon ingestion of the glucose solution, and a blood sample is obtained exactly 2 hours later. The blood glucose concentration was measured via an enzymatic method. The data were collected via a pretested proforma and analysed via SPSS 22.0 software.

Results

The study included 72 subjects, predominantly females (85%, n=61), with a mean age of 45.20 years. The majority (31.95%) were in the 41-50 years age range. Hypothyroidism was more prevalent (61%, n=44) than hyperthyroidism (39%, n=28).Females accounted for 36 hypothyroid and 25 hyperthyroid cases, whereas males accounted for 8 hypothyroid and 3 hyperthyroid cases. The overall prevalence of diabetes was 2.8% (n=2), impaired glucose tolerance was 27.8% (n=20), and normal glucose tolerance was 69.4% (n=50). Hypothyroidism patients had higher impaired glucose tolerance (36.3%) and diabetes (4.6%) rates than hyperthyroidism patients. A statistically significant association was found between thyroid dysfunction and impaired glucose tolerance (chi-square value: 4.66, $p<0.05$), indicating a link between thyroid dysfunction and glucose metabolism disorders.

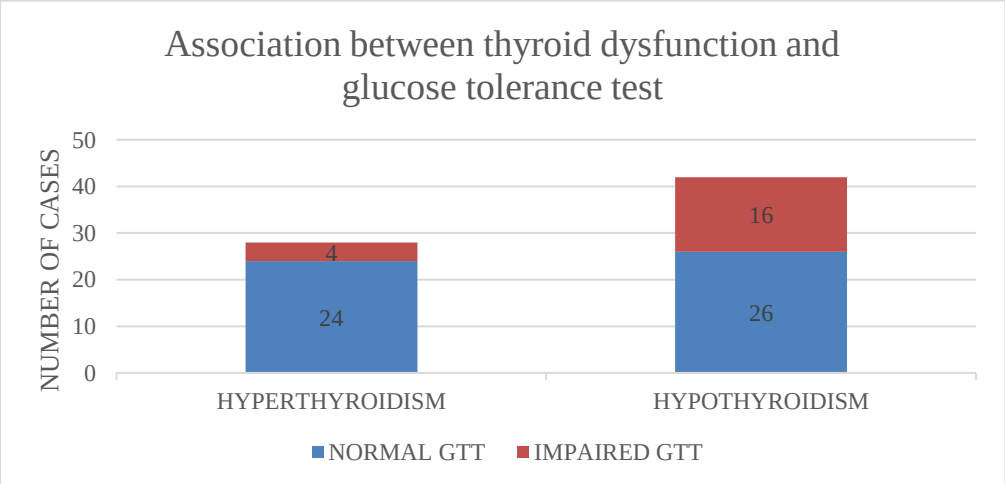

Figure 1: Association between thyroid dysfunction and glucose tolerance test.

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Discussion: Thyroid hormones significantly impact glucose metabolism, and thyroid dysfunction is linked to diabetes mellitus.[5,6] Hypothyroidism decreases glucose absorption, reduces insulin secretion, and increases insulin resistance, whereas hyperthyroidism increases glucose production, insulin demand, and hepatic insulin resistance.[7,8] Studies have shown a high prevalence of hypothyroidism in type 2 diabetes patients, particularly in South Asian populations.[9] Thyroid hormone imbalance can contribute to diabetes development and complications by disrupting glucose homeostasis.[10-20] Diagnosing thyroid dysfunction in diabetes mellitus patients is challenging because of the impact of DM on thyroid function assessment.[10-12] Diabetes affects T4-to-T3 conversion and TSH release, and can mask or delay the diagnosis of thyroid dysfunction.[12-16] Type 1 and 2 diabetes can cause "low T3" syndrome, which is characterized by low serum T3 levels.[17,18] Treating thyroid dysfunction in DM patients requires careful consideration of insulin treatment, thyroid function, and lipid profiles.[21] Hyperthyroidism alters insulin treatment, whereas hypothyroidism requires adjusted insulin doses and careful L-T4 treatment to avoid iatrogenic hyperthyroidism.[22] Hence, patients with diabetes and thyroid dysfunction require adjusted insulin dosages to prevent hypoglycemia or hyperglycemia.

This cross-sectional observational study was conducted at KR Hospital, Mysore, from October 2022 to September 2023 and involved 72 patients with thyroid dysfunction. The mean age was 45.2 years, with 85% females and 15% males. Hypothyroidism was more prevalent (61%) than hyperthyroidism (39%) was. The present study revealed a significant association between thyroid dysfunction and impaired glucose tolerance, with 27.8% impaired and 2.8% diabetic results. Hypothyroidism patients had higher impaired glucose tolerance (36.3%) and diabetes (4.6%) rates than hyperthyroidism patients did.

Research has consistently shown a link between thyroid dysfunction and diabetes risk. Studies have revealed that hypothyroidism increases diabetes risk (Gronich N *et al.*, 2015 [23]; Roa Dueñas OH *et al.*, 2022 [24]), and other studies have revealed associations between thyroid hormone levels and metabolic disorders: elevated TSH increases lipid and carbohydrate disorders (Korzeniowska K A *et al.*, 2019 [25]); thyroid dysfunction increases type 2 diabetes risk (Chen RH, 2019 [26]); and elevated serum TSH increases the incidence of prediabetes (Chang CH *et al.*, 2017 [27]). Hyperthyroxinemia also contributes to type 2 diabetes (Ittermann T *et al.*, 2017 [28]). Additionally, hypothyroid individuals showed a higher prevalence of impaired glucose tolerance and new-onset diabetes (Ashrafuzzaman SM *et al.*, 2012 [29]). These findings highlight the complex relationship between thyroid function and glucose metabolism. The findings of the present study align with those of previous studies, indicating a link between hypothyroidism and glucose metabolism disorders. A literature review revealed similar studies worldwide, highlighting the importance of screening for glucose intolerance in patients with thyroid dysfunction. Wenhua Du *et al.* (2019) reported the prevalence of thyroid disease in North China, suggesting the use of routine thyroid screening for diabetics and non-diabetics[30]. Similarly, Chaker L *et al.* (2016) linked low thyroid function to increased type 2 diabetes risk, suggesting that further research on hypothyroidism treatment and screening[31]. Additionally, Kabir *et al.*'s study in Bangladesh (2015) identified South Asian ethnicity and thyroid disease as risk factors for type 2 diabetes, emphasizing the importance of glucose intolerance screening[32]. The present study also recommends regular screening and follow-up for thyroid dysfunction patients to detect impaired glucose tolerance and manage its complications. Early detection and management can reduce the risk of diabetes mellitus and related complications in patients with thyroid dysfunction.

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Conclusion

This study revealed a significant link between thyroid dysfunction and impaired glucose tolerance, affecting 27.8% of patients. Compared with hyperthyroidism, hypothyroidism is associated with a greater prevalence of impaired glucose tolerance. Early evaluation of impaired glucose tolerance in thyroid dysfunction patients enables timely detection and management of prediabetes. This early intervention can prevent diabetes-related microvascular and macrovascular complications through dietary modifications and minimal medication.

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