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METABOLIC INTERPLAY BETWEEN DIABETES AND THYROID DISORDERS: A DETAILED CLINICAL OVERVIEW

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ABSTRACT

Diabetes and thyroid disorders are two hormonal conditions that often occur together and strongly influence each other's course. When thyroid hormone levels are either too high or too low, they can disturb glucose regulation, alter insulin sensitivity and make diabetes more difficult to control. At the same time, long-standing diabetes and poor glycemic control can interfere with normal thyroid function, leading to changes in TSH levels, hormone conversion and thyroid gland structure. This two-way interaction increases the risk of complications such as cardiovascular disease, neuropathy and metabolic instability. Certain diabetes medications-especially metformin-may also affect thyroid hormones, while others need to be used cautiously in individuals with thyroid disease. Studies show that thyroid dysfunction is more common in people with diabetes, particularly women, older adults and those with metabolic syndrome. Because of these overlapping effects, routine screening, early detection and integrated management of both conditions are essential. Understanding this metabolic connection helps clinicians provide more effective, individualized care and improves overall patient outcomes.

KEYWORDS

Diabetes, Thyroid disorders and Metabolic interplay.

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INTRODUCTION

Diabetes is becoming more frequent worldwide, and it's projected that by 2030, about 370 million people will have it. This growth is linked to the increased numbers of persons coping with obesity. Many diverse behaviour's are involved in managing diabetes, particularly for people who require insulin treatment. Managing diabetes is a significant issue that necessitates carefully weighing the advantages and disadvantages. For the sake of both public health and individual well-being, it is imperative

that we address the many issues related to diabetes treatment in the future[1].

Knowing one's HbA1c levels is beneficial for both patients and physicians. It enables them to better understand their health and budget for future medical expenses[2].

Diabetes mellitus is a serious and widespread health problem that affects many people globally. In 2010, around 285 million individuals were estimated to have this condition. The main reasons for its rise are getting older and being overweight. This trend poses significant challenges for healthcare systems worldwide, as managing diabetes requires on-going medical care, education, and lifestyle changes. Public health initiatives aimed at prevention and early intervention are essential to curb the increasing prevalence of this disease[3].

The World Health Organisation describes diabetes mellitus as a chronic metabolic disorder in which blood glucose remains persistently elevated, affecting the body's ability to process carbohydrates, fats, and proteins. Without proper treatment, high blood sugar can eventually damage crucial organs-including the heart, kidneys, and nervous system. Effective control of the disease typically involves medications, lifestyle modification and consistent monitoring of glucose levels[4].

Microvascular issues in diabetes are largely dependent on the activation of a class of protein kinases called protein kinase C (PKC). These issues primarily include diabetic peripheral neuropathy, diabetic retinopathy and diabetic nephropathy. High glucose levels dramatically boost PKC activation in lab settings. Redox stress accumulates when PKC triggers NADPH oxidase, which initiates a redox reaction. PKC mainly affects the glomeruli's vascular permeability in diabetic nephropathy. The underlying causes of diabetic microvascular complications can be better understood and addressed with this understanding of PKC activation[5].

At the same time, research in diabetes treatment is expanding rapidly. Nearly one hundred new anti-diabetic medications are currently under investigation. While traditional treatments like metformin and insulin remain widely used, the past decade has seen a significant rise in combination therapies. Newer agents-including SGLT2 inhibitors and DPP-4 inhibitors-are increasingly being prescribed alongside metformin to achieve better blood-glucose control.

This explosive growth in pharmacological research has resulted in the development of numerous compounds aimed at managing hyperglycaemia, highlighting major progress in diabetes care and future potential for even more effective therapies. In addition to drug-based treatments, scientists are also studying how dietary habits and physical activity can enhance diabetes control. As our knowledge of these therapeutic strategies deepens, more personalised and targeted treatment options are expected to emerge[6].

One popular and secure anti-diabetic medication is metformin. It is frequently advised as the initial course of treatment for diabetes mellitus (DM). Research has indicated that TSH levels decrease following metformin use. This is crucial because, when combined with other drugs to treat thyroid cancer, metformin's capacity to reduce TSH levels may have major clinical ramifications. However, it's crucial to understand that side effects like arrhythmias and bone loss can occur in patients taking thyroxine medication for TSH suppression. The rising incidence of hypothyroidism in people with diabetes is another crucial point. In order to comprehend and control this trend, the effect of metformin on thyroid function tests becomes increasingly important. It's important to remember that obesity and weight loss can affect thyroid function tests. As a result, metformin's use in the treatment of diabetes extends beyond controlling blood sugar levels because it may also have advantages for thyroid health. When treating patients with diabetes, especially those who have thyroid dysfunction, these interrelated factors emphasise the necessity of a comprehensive approach. Improved management of both conditions and better overall health outcomes can result from addressing these issues[7].

Emerging evidence suggests that metformin may influence the effectiveness of radioactive iodine (RAI) therapy by reducing the ability of thyroid cells to absorb iodine. Many studies show that metformin can lower TSH levels in patients who already have thyroid disorders, although this effect does not typically occur in individuals with normal thyroid function. Interestingly, metformin has also been linked to a slowing of tumour progression in several types of thyroid cancer.

However, laboratory data indicate that it might diminish the therapeutic response to RAI, which raises concerns about its routine use during treatment of certain thyroid cancers. Because of this uncertainty, more research is needed to clearly understand how metformin interacts with RAI therapy. Until stronger evidence is available, healthcare professionals must carefully balance the TSH-lowering advantage of metformin against its possible reduction in RAI effectiveness when planning thyroid cancer management[8].

According to some reports, metformin may have an impact on thyroid hormone function. Thyroid function tests are frequently performed by medical professionals to look for any abnormalities or problems[9].

The condition known as hypothyroidism occurs when the body's metabolism slows down as a result of a prolonged lack of thyroid hormones or, in rare instances, when the body's tissues are resistant to these hormones' effects[10].

Hypothyroidism is a common condition caused by a shortage of thyroid hormones. If not treated, it can be serious and even fatal in extreme cases, but the good news is that it's easy to detect and treat. In adults, typical symptoms include tiredness, feeling sluggish, sensitivity to cold, weight gain, constipation, voice changes, and dry skin. However, the signs may vary depending on factors like age and gender. The main medication used for thyroid hormone replacement therapy is levothyroxine. It helps manage the condition effectively.

The most common cause of hypothyroidism is Hashimoto's disease, which is a chronic autoimmune thyroiditis. Understanding and treating hypothyroidism is crucial for maintaining overall health and well-being[11].

TRH, a tripeptide with components like pyroglutamate, histidine and proline, stimulates the anterior pituitary to release TSH. TSH then prompts the thyroid gland to release vital thyroid hormones, T3 and T4, which regulate important bodily functions[12].

Older individuals and those with metabolic syndrome should also be cautious, as statins may increase the risk of developing diabetes. Despite these considerations, statins play a significant role in managing long-term issues in diabetes and are recommended for individuals with normal low-density lipoprotein levels. This is important because dyslipidemia, an imbalance in cholesterol levels, is a common consequence of type 2 diabetes mellitus. Overall, statins are widely used to lower serum cholesterol levels and are beneficial in both primary and secondary prevention of cardiovascular illnesses[13].

Protein synthesis

Thyroid hormones, acting like steroid hormones, help make proteins by activating DNA. This promotes growth and development by maintaining a positive balance of nitrogen in the body.

Carbohydrate Metabolism

Thyroid hormones make the body absorb and use glucose more. They also increase the production of glucose and break down stored glycogen, leading to higher blood sugar levels (hyperglycemia).

Lipid Metabolism

Thyroid hormones speed up the use of fats in the body. When someone has low thyroid function (hypothyroidism), it can cause higher levels of cholesterol in the blood. Treating it with thyroid hormones can reverse this.

Regulation of T3 and T4 synthesis

The body controls the making of thyroid hormones through feedback. T3 plays a more active role than T4 in this regulation.

Diabetes Insipidus

This condition, where the body produces a lot of dilute urine (polyuria), can happen if there's not

enough antidiuretic hormone (ADH) or if the receptors in the cells don't work properly[14].

Thyroid disorders (TD) and diabetes mellitus (DM) are common hormonal problems that often occur together. People with type 2 diabetes (T2DM) are more likely to have thyroid issues than those without diabetes. If not treated, thyroid problems can make diabetes harder to control, leading to more complications. High insulin levels in the body, seen in diabetes, can make the thyroid gland grow and form nodules. The medicine metformin can help in managing both diabetes and thyroid issues, but some other diabetes drugs may have negative effects on the thyroid. There's a possible link between thyroid cancer and T2DM, especially in women. This review aims to explain the connection between thyroid disorders and type 2 diabetes, considering their impact on health. It emphasizes the importance of regular screening and proper management for both conditions to ensure the best care for patients[15].

EPIDEMIOLOGICAL DATA

In the year 2000, diabetes was the fifth leading cause of death in the United States. Diabetes is connected to an increased risk of kidney problems, kidney failure, stroke and even sexual difficulties. Over the last 40 years, the number of people diagnosed with diabetes has grown a lot in the United States and worldwide.

Back in 1985, about 30 million people worldwide had diabetes. By 1995, this number had jumped to 135 million. Currently, more than 17 million Americans have been diagnosed with diabetes and there are 5.9 million people who don't know they have it.

It's essential to screen people who might be at risk of getting diabetes because making lifestyle changes, like losing weight and taking medication, can lower the chance of going from having some trouble with blood sugar to full-blown diabetes[16].

Many people, about 5%, have a common condition called hypothyroidism, where the thyroid doesn't work as well as it should. There might be an additional 5% who have it but don't know yet. This thyroid problem is much more common in women, almost ten times more than in men. Some diseases show a difference between men and women. For example, some studies suggest that about 1% of men have thyroid nodules, but in women, it's higher - around 5%[17].

The role of AMPK, a key player in insulin sensitivity and how thyroid hormones affect appetite and energy use. Women, especially those aged 45-70, less active, overweight, and with a family history, were more likely to have diabetes and thyroid disorders. About 3% of those with diabetes and thyroid disorders also had cardiovascular diseases[18].

Studies suggest that women with diabetes may have a higher chance, whether significant or not, of getting thyroid cancer. For men with diabetes, the risk seems to be either not significant or doesn't change at all. When we look at the overall numbers, people with diabetes have a higher rate of thyroid disorders compared to the general population. Recent research indicates that folks with type 2 diabetes are more likely to have a condition called primary hypothyroidism compared to those without diabetes[19].

Not noticing problems with your thyroid can mess up how your body controls things like metabolism, making it more likely to have heart issues, especially if you're already prone to cardiovascular diseases.

The prevalence of thyroid dysfunction in all diabetic patients was noted at 14.7%[20].

ETIOLOGY

Diabetes is a condition that affects the entire body, not just the pancreas. It can cause problems in different parts of the body like the eyes, kidneys, nerves and blood vessels.

Diabetes and thyroid issues often happen together in the field of health and metabolism. Both type 1 and type 2 diabetes can be linked to thyroid problems.

For type 1 diabetes, there's a connection with autoimmune thyroid diseases, forming a condition called autoimmune polyglandular syndrome type 3

variant. In type 2 diabetes, the relationship with thyroid function is complex. Both an overactive thyroid (hyperthyroidism) and an underactive thyroid (hypothyroidism) can affect how the body handles sugar.

Understanding these connections is important for managing the health of people dealing with both diabetes and thyroid issues[21].

Too much cortisol can make the liver produce extra glucose, raising blood sugar levels. This can cause problems like insulin resistance and less insulin being released[22].

Diabetes can be divided into three types

Insulin essential for survival

People in this group need insulin to stay alive.

Insulin necessary for control

Some require insulin to manage their diabetes, but not for survival.

No insulin needed

Others can control diabetes without insulin, using different methods like lifestyle changes or medications.

There are different types of diabetes based on why it happens

Type 1 Diabetes

The body's immune system destroys insulin-producing cells. Insulin is needed to stay alive. It's also called juvenile onset diabetes when it starts in childhood.

Example: Autoimmune Attack-The immune system attacks insulin- producing cells in the pancreas, causing Type 1 diabetes.

Type 2 Diabetes

This type involves problems with insulin action and secretion. People with type 2 diabetes don't have enough insulin, but it's not a complete lack like in type 1. It used to be called adult- onset diabetes. Factors include obesity, inactivity, diet, hormones, and genetics.

Other types: Some types have specific causes that can be identified.

Hormonal Changes (Gestational Diabetes)

Pregnancy-related hormones can lead to insulin resistance, causing gestational diabetes. Other conditions like acromegaly and Cushing syndrome can also contribute to Type 2 diabetes.

Pancreatic Damage (Type 3c Diabetes)

Physical harm to the pancreas from conditions, surgeries, or injuries can hinder insulin production.

Genetic Mutations (MODY and Neonatal Diabetes)

Certain genetic changes can result in specific types of diabetes, like Maturity- Onset Diabetes of the Young (MODY) and neonatal diabetes.

Causes of Diabetes

Genetics

Beta cell issues.

Mitochondrial DNA mutations.

Problems with insulin function.

Environment

Obesity from improved living standards.

Urban living and lifestyle changes.

Alcohol consumption and sedentary behavior.

Individual factors

Autoantibodies damaging beta cells.

Insufficient insulin production.

Unresponsiveness of cells towards insulin.

Diseases harming the pancreas.

Excess hormones countering insulin.

Insulin issues from drugs or infections[23].

Causes of Hypothyroidism

Autoimmune Disease (Hashimoto's thyroiditis)

When the immune system mistakenly attacks the thyroid, it can lead to hypothyroidism.

Treatment for Hyperthyroidism

Sing radioactive iodine or anti- thyroid drugs to treat an overactive thyroid can sometimes result in hypothyroidism.

Thyroid surgery

Removing part or all the thyroids can reduce or stop thyroid hormone production, causing hypothyroidism.

Radiation Therapy

Treating head and neck cancers with radiation may affect the thyroid gland.

Medications

Certain drugs, like lithium used for psychiatric disorders, can also cause hypothyroidism.

Causes of Hyperthyroidism

Graves' disease

An autoimmune condition where the immune system causes the thyroid to produce too much hormone.

Adenoma and Toxic Multinodular Goiter (TMNG)

Growths on the thyroid can lead to excessive hormone production.

Excessive Thyroid Hormone Intake

Taking too much thyroid hormone medication.

Overproduction of Thyroid Hormones

The thyroid gland making too much hormone.

Thyroiditis

Inflammation of the thyroid gland causing it to release too much hormone.

Excessive iodine intake

Consuming too much iodine can lead to hyperthyroidism[24].

SIGNS AND SYMPTOMS

Diabetes Symptoms

A rash, often itchy and painful, forms blister that scab in 7 to 10 days, disappearing completely in 2 to 4 weeks. It usually appears as a stripe on one side of the body. Before the rash, there might be pain, tingling, or itching, along with a fever. Shingles on the face can harm the eye, leading to blindness. Other signs include headache, chills, and upset stomach, pointing to diabetes[25].

It's unfortunate that damage can happen years before symptoms show up. Early detection helps prevent complications and control diabetes faster. Type 1 diabetes quickly causes high blood sugar, while type 2 diabetes has extremely high levels. Both types show classic symptoms like frequent urination, excessive thirst, and increased hunger. Type 1 rarely leads to severe weight loss unless type 2 is present for a long time. Other signs of undiagnosed diabetes include tiredness, restlessness, unexplained weight loss, and body pain. Mild or gradual symptoms may be overlooked[26].

Ketoacidosis and ketones in urine (resulting from insufficient insulin)

Glucose in urine-

Increased thirst (polydipsia)

Frequent urination (polyuria)

Extreme hunger (polyphagia)

Unexplained weight loss

Fatigue

Headache

Irritability

Blurred vision

Frequent infections with slow wound healing

Hyperthyroidism Symptoms

There are two main types of thyroid problems: hyperthyroidism (overactive thyroid) and hypothyroidism (underactive thyroid), caused by various conditions affecting the thyroid gland.

Nervousness, agitation, and anxiety

Trouble sleeping

Weight loss

Enlarged thyroid gland (goiter)

Tremors and weak muscles

Irregular or absent menstrual cycles

Feeling overly warm

Vision issues or irritated eyes

Hypothyroidism Symptoms

Fatigue

Weight gain

Forgetfulness

Heavy and frequent periods

Dry, coarse hair

Raspy voice

Intolerance to cold temperatures[27].

COMPLICATIONS OF THYROID AND DIABETES

Includes heart disease (stroke and heart attack).

Nerve damage may occur, leading to diabetic neuropathy and peripheral neuropathy.

Gastroparesis, caused by vagus nerve injury, can result in symptoms like heartburn, nausea, bloating, weight loss, and reduced appetite.

Dental problems, such as decay and gum disease, can arise.

Kidney disease, specifically chronic renal disease, is a potential complication.

Infections like sepsis can occur.

Vision issues may include glaucoma, cataracts, and diabetic macular edema.

Elevated cholesterol and blood pressure are common concerns.

Mental health issues like depression and diabetic ketoacidosis can also be complications[28].

THYROID HORMONES AND THEIR IMPACT ON GLUCOSE BALANCE

Too much thyroid hormone, found in conditions like hyperthyroidism, can disrupt how the body manages glucose, affecting both those with and without diabetes. Glucose levels are usually balanced by hormones like insulin and glucagon. Insulin lowers blood sugar, while glucagon raises it. Excess thyroid hormone speeds up metabolism, causing excess fat breakdown. This leads to increased release of insulin and glucagon, causing an imbalance. Elevated glucagon levels can impede glucose breakdown, raising blood sugar and possibly leading to insulin resistance, a precursor to diabetes. Regular monitoring of thyroid health is essential to reduce the risk of developing diabetes.

INTERPLAY OF THYROID AND DIABETES: TWO-WAY CONNECTION

The relationship between thyroid disease and diabetes is a two-way street, influencing the development and progression of each other. In type 2 diabetes, there might be lower levels of thyroid-stimulating hormone (TSH), reducing the conversion of T4 to T3 in the body tissues. This can lead to decreased circulating thyroid hormones, causing symptoms of hypothyroidism. Untreated type 2 diabetes can result in insulin resistance, prompting abnormal tissue growth in the thyroid gland. This growth increases the risk of developing thyroid nodules and inflammation, leading to goiter. Medications for diabetes, like sulfonylureas and thiazolidinediones, can also impact thyroid function. Some studies hint at a possible link between certain diabetes medications and an increased risk of thyroid cancer. Monitoring both conditions is essential for comprehensive health management[29].

TREATMENT

Management of Diabetes

Non-pharmacological approaches to diabetes management

Regular physical exercise helps reduce the risk of associated conditions like obesity, osteoporosis, cardiovascular disease, type 2 diabetes, and hypertension[30].

To enhance the lives of diabetes patients and meet treatment goals, it's crucial to include medical nutrition therapy (MNT), weight management, physical activity, quitting smoking, diabetes self-management education and support and psychological care in their care plan[31].

Complications associated with Diabetes Management

Metformin

Reduces serum TSH levels in diabetic patients. May decrease the size of thyroid nodules and slow thyroid cancer cell proliferation.

Sulfonyl urea's

First-generation sulfonylureas linked to a higher hypothyroidism incidence. Second-generation sulfonylureas (e.g., Glibenclamide, Gliclazide) have minimal impact on thyroid hormone metabolism.

Thiazolidinediones (TZDs)

May worsen Thyroid Eye Disease (TED), caution advised in T2DM patients with active TED.

Incretin Mimetics (GLP-1RAs)

GLP-1RAs do not increase medullary thyroid cancer in humans or monkeys. Caution in patients with a history of medullary thyroid cancer or MEN type 2.

Bile acid Sequestrants

Specifically, Colesevelam limits T4 reabsorption by increasing fecal excretion. Binds levothyroxine, reducing absorption; caution when used together[32].

Diabetes Medication Overview

Type 1 Diabetes

In type 1 diabetes, the body cannot produce insulin, requiring external insulin replacement.

Primary medication

Insulin

Administered through infusion under the skin (using an insulin pump) or injection.

Short acting (regular) insulin

Starts in 30 minutes, peaks in 2-3 hours, and lasts 3-6 hours. Examples: Humulin R U-100, Novolin R FlexPen, Novolin R ReliOn.

Rapid acting insulin

Begins in 15 minutes, peaks 1-2 hours later, lasting 2-4 hours. Includes inhaled insulin like Afrezza.

Intermediate acting insulin

Takes effect 2-4 hours post-use, with an average peak time of 12 hours. Example: Insulin isophane (Humulin N U-100).

Long-acting insulin

Provides extended blood glucose control for 24 hours or longer. Examples: Insulin degludec (Tresiba), Insulin detemir (Levemir)[33].

Type 2 Diabetes

Body produces insulin but doesn't use it effectively.

Medication

Alpha-glucosidase inhibitors

These medications assist in breaking down starchy foods and table sugar, helping to lower blood sugar levels. However, they may increase the risk of hypoglycemia when used alongside other diabetes medications. Common examples include acarbose and miglitol (Glyset).

Biguanides

This class of medication reduces glucose production by the liver, decreases glucose absorption in the intestines, and enhances muscle glucose uptake, thereby improving overall insulin sensitivity. A commonly used drug in this category is metformin (Glumetza, Riomet, Riomet ER).

Meglitinides

These medications stimulate insulin release but are not suitable for everyone, as they may increase the risk of hypoglycemia, particularly in individuals with advanced kidney disease. Examples include nateglinide (Starlix) and repaglinide (Prandin).

SGLT-2 Inhibitors

These medications prevent the kidneys from retaining glucose, promoting its excretion through urine, and thereby aiding in overall glucose elimination[33].

Metformin

Common oral medication for type 2 diabetes. Lowers serum TSH levels; potential benefits in treating certain cancers, including thyroid cancer in diabetic individuals.

Sulfonyl ureas

Long used for type 2 diabetes treatment. Reports suggest both goitrogenic and antithyroid effects, but second- generation sulfonylureas like glibenclamide and gliclazide show minimal impact on thyroid hormone (TH) metabolism.

Thiazolidinediones

Insulin sensitizers for type 2 diabetes management. Caution advised in patients with active Thyroid Eye Disease (TED); rosiglitazone may potentially reduce thyroid cancer incidence.

GLP-1 Receptor Agonists and DPP4 Inhibitors

Incretin mimetics used for diabetes. Mimic or enhance natural incretin hormones. No reported impact on thyroid hormones; considered safe for individuals with diabetes.

Surgical Procedures for Diabetes Management

Roux-en-Y Gastric Bypass (Gastric Bypass): This procedure alters the gastrointestinal tract by bypassing most of the stomach and upper small intestine, leading to significant weight loss. It results in remission of type 2 diabetes in nearly 80% of patients, with an additional 15% experiencing substantial improvement.

Sleeve Gastrectomy

This surgery removes a portion of the stomach, creating a narrower food reservoir that leads to metabolic and hormonal changes. As a result, it promotes significant improvement in diabetes, with more than 60% of patients achieving remission.

Biliopancreatic Diversion with Duodenal switch

This malabsorptive procedure is less commonly performed due to its complexity and higher risk, but it is highly effective, achieving remission rates of over 85% for type 2 diabetes. It is particularly notable for producing early and sustained improvements that occur independently of weight loss[34].

Management of Thyroid

Goals of Thyroid Treatment

For hypothyroidism, treatment usually involves replacing thyroid hormones to restore normal levels. However, in some cases, like temporary underactive thyroid, medication may not be necessary.

The main goals of thyroid hormone replacement therapy are to:

Alleviate hypothyroidism symptoms.

Bring thyroid-stimulating hormone (TSH) levels back to normal. Shrink an enlarged thyroid (goiter) if present.

Avoid over-treatment to prevent becoming hyperthyroid.

Medication

Levothyroxine

Primary medication for hypothyroidism treatment.

Liothyronine(T3)

Less commonly prescribed due to T3 synthesis as liothyronine. In the United States, brand names for this medication include Cytomel and Triostat.

Natural Desiccated Thyroid (NDT)

Made from pig thyroid glands, containing both T4 and T3. Not widely endorsed due to differing T4 to T3 ratio in animals.

Anti-thyroid medications for Hyperthyroidism

Methimazole (Tapazole)

Used to treat hyperthyroidism. It blocks the thyroid's use of iodine from food for hormone production and is usually taken once a day. It has the benefit of faster reversal of hyperthyroidism with fewer side effects compared to PTU.

Propylthiouracil (PTU)

Authorized for hyperthyroidism treatment in the US. Prevents the thyroid from using iodine, similar to Tapazole. It is typically taken two or three times a day due to its short half life.

Radioactive Iodine Treatment

This treatment is typically given after surgery, particularly for large thyroid tumors, lymph node metastases, or cases with a high risk of cancer recurrence. It may also be considered for individuals who cannot or choose not to take PTU or methimazole. Administered in liquid or capsule form in a hospital setting, it works to eliminate cancer cells and any remaining thyroid tissue following surgery.

Chemotherapy

Uncommon thyroid cancers, such as medullary, lymphoma, and anaplastic types, can be treated by therapies that destroy rapidly dividing cancer cells. These approaches are typically reserved for specific cases where other treatments may be less effective[35].

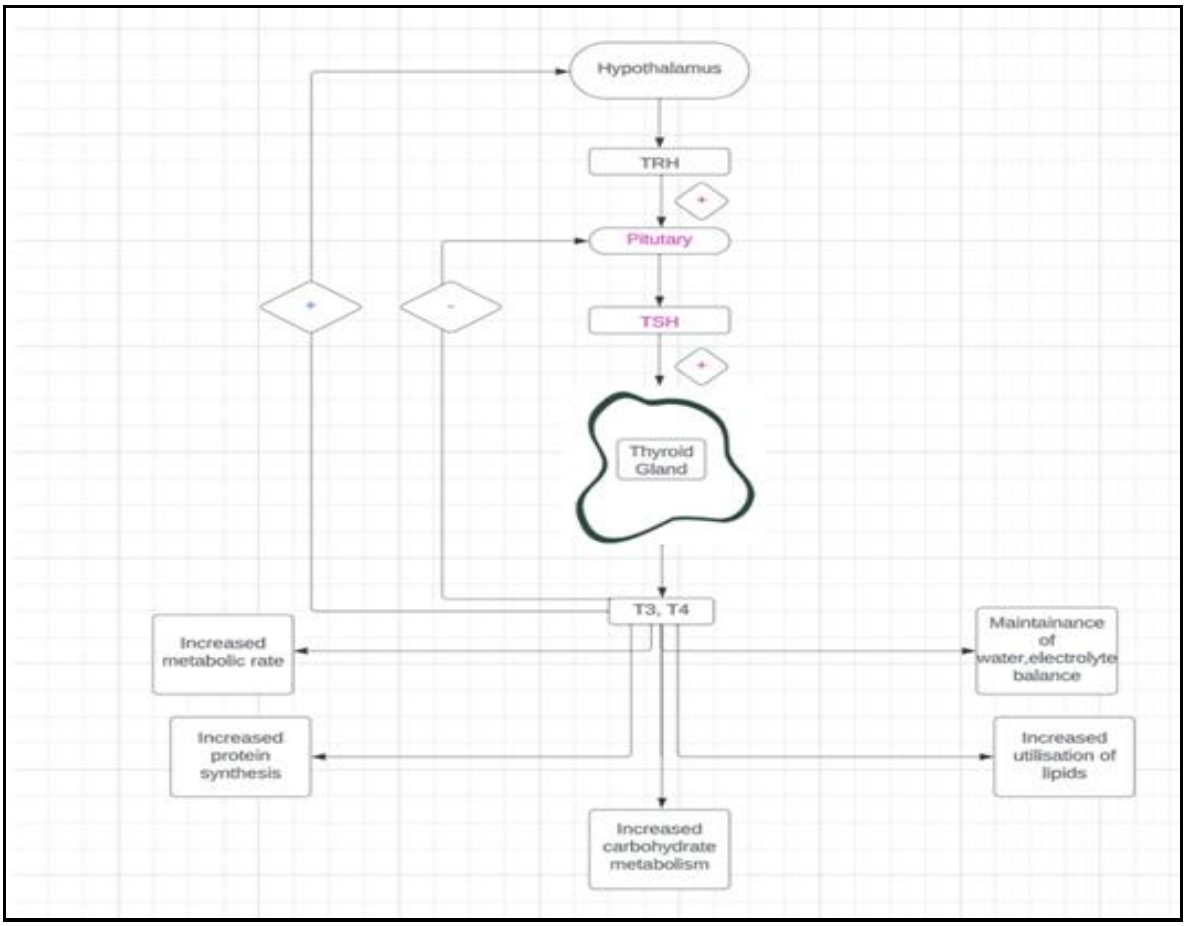

Figure No.1: Thyroid Gland

CONCLUSION

The coexistence of diabetes and thyroid disorders highlights the need for a broader understanding of metabolic health rather than viewing each condition separately. Although both diseases affect different endocrine pathways, their combined presence often reflects deeper hormonal imbalances and long-term metabolic stress. This connection emphasizes the importance of addressing lifestyle factors, early hormonal changes and overall metabolic resilience instead of focusing only on symptom control.

Moving forward, patient care should priorities timely evaluation, awareness of subtle clinical changes, and coordinated treatment planning across specialties. Strengthening patient education, encouraging regular follow-up and adopting personalized therapeutic approaches can significantly improve long-term wellbeing. Ultimately, better integration of diabetes and thyroid management has the potential to reduce complications, support healthier outcomes, and enhance the quality of life for individuals affected by both conditions.

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CONFLICT OF INTEREST

We declare that we have no conflict of interest.

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