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Biochemical Effects After Thyroidectomy

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A B S T R A C T

Although the operation to remove the thyroid gland, whether as a result of the multinodular goiter, papillary thyroid cancer or benign thyroid disease. It has benefits for patients have not responded to antithyroid drugs, or patients with hyperthyroidism. However, removing the thyroid gland leads to changes in some metabolic processes within the body, including: liver function affect, the triglyceride TG and LDL values that worsen significantly. In addition, uncontrolled hypertension.

Introduction

The thyroid gland is the second largest endocrine gland in the human body. It is located directly below the larynx in the front of the trachea and extends on both sides of it, and there are many diseases that affect it. Among these are the chief diseases of the thyroid gland are goiter (nodular or diffuse), hypothyroidism, hyperthyroidism, neoplasm, and autoimmune thyroiditis [1], as well as common thyroid disorder Graves' disease (GD), it is the most frequent cause of hyperthyroidism [2]. Graves' disease is associated with a thyrotropin receptor-stimulating antibody (TSH), for which there is no therapeutic agent. This disease is currently being treated by inhibiting thyroid hormone synthesis or destroying the thyroid gland. Recurrence after treatment with thyroid medication is common. Recent studies have shown that the longer an medication is used, the higher the recovery rate. Given the relationship between clinical outcomes and iodine intake, recurrences of Graves' disease are more common in iodine-deficient areas than in iodine-depleted areas.[3]. Current therapeutic options for GD include antithyroid drugs (AD), radioactive iodine (RI), and total thyroidectomy (TTH) [4].

These diseases have effects on many physiological aspects, where it has been noted that GD and thyroid cancer are associated with higher rates of hypocalcemia following thyroidectomy [5]. Hashimoto's thyroiditis [6] the causative mechanism for postoperative tetany in patients. Tetanus occurs in patients through the duration of bone restoration and is caused by the continued influx of calcium inside the bone associated with transient surgery induced hyperparathyroidism [7].

The parathyroid gland suffers from permanent insufficiency due to its damage during total thyroidectomy, either due to its unintended removal or as a result of direct damage during surgery, or by removing the blood vessels. Some literature also indicated that risk factors result of lymphadenectomy correlating to thyroidectomy due to pernicious disease [8].

When comparing the pre-and post-operative periods during the first year, diastolic blood pressure (DBP) and systolic blood pressure (SBP) increased. The triglyceride (TGC) and LDL values worsened significantly. In addition, uncontrolled hypertension. It has been found that liver function may be affected by acute hypothyroidism resulting from thyroidectomy, some recent study suggests that TSH has direct effect on coronary artery smooth muscle cells in human [9], [10].

A significantly decreases in parathyroid hormones, calcium levels and osteopontin (OPN) also a significant increase in BMI occur in women with hypothyroidism as a result of TTH. The results in the different BMI category groups showed that there was a significant raise in the level of TSH and a significant reduction in the levels of both OPN and T4 in the post-thyroidectomy groups when comparison to the groups pre-hyroidectomy [11].

Approximately 54% of patients who undergo TTH develop transient hypocalcemia, and this is the most common complication. It is a challenge for thyroid surgeons because resulting often in frequency increased of biochemical tests and recovery time [12].

Some researchers have reached the conclusion that low 25(OH)D values in the tetany group cannot be attributed to deficiency of calcium alone. Because the deficiency of vitamin D also led to increasing activity of 25(OH)D-1 hydroxylase of kidneys [7].

Hypocalcemia is one of the most common complications next TTH, in which the occurrence of hypoparathyroidism has varied above 50%. Several factors cause hypocalcemia after TTH, some of these include iatrogenic surgical trauma to the parathyroid glands, remaining number of well-functioning glands, surgeon's experience, surgery extent, inadvertent removal of the parathyroid glands, hyperparathyroidism, neck anatomy concomitant, retrosternal goiter and thyroid cancer [13].

Additionally, various studies have showed that the reduction in iPTH to a lower-than-normal level in the postoperative period (<24 hours) after total thyroidectomy is a dependable proof for transient postoperative hypocalcemia [8].

Day after surgery and then daily until it stabilizes. If hypocalcemia evolves, the patient will need calcium supplementation (500) mg three times a day with daily calcium monitoring [14], [15] and Vitamin D metabolites (calcitriol or 1, 25-[OH]2 Vitamin D). It must be pointed out that conventional therapy of hypocalcemia with supplementation of calcium and active Vitamin D does not improve quality of life parameters significantly nor does it reverse abnormalities in bone remodeling characteristic of the disease [16].

Thyroid gland

It is the largest endocrine organs, which are required for normal growth and metabolism it is located into neck, anterior to the trachea and below the thyroid cartilage. It has two lobes with an is thumbs, plus an embryonic remnant. The pyramidal lobe in the midline, as showing in figure (1). And each lobe pear-shaped and measures about (3 - 4 cm), (1.5- 2 cm) in length and width respectively, and (1-1.5 cm) in thick. The

average weight of the thyroid in humans is about 15 to 20 grams in adults. it may enlarge to many time this size in states of disease. The thyroid gland is composed of large numbers of spherical structures (follicles) with a diameter (of 100 to 300 μm), with a wall formed of simple cuboidal epithelial tissue filled with a secretory substance consisting mainly of the large molecular weight glycoprotein thyroglobulin. The secretory substance is called a colloid. As showing in figure (2). Complete hypothyroidism usually results in a basal metabolic rate of 40-50% below normal, and severe hyperthyroidism can increase basal metabolic rate to 60-100% exceeding normal [17], [18].

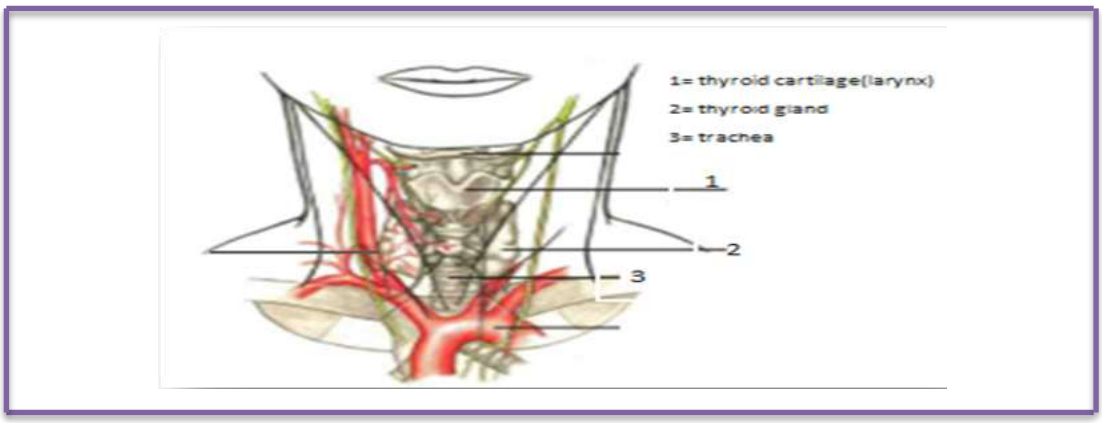

Figure 1. show the position of thyroid gland in neck [19]

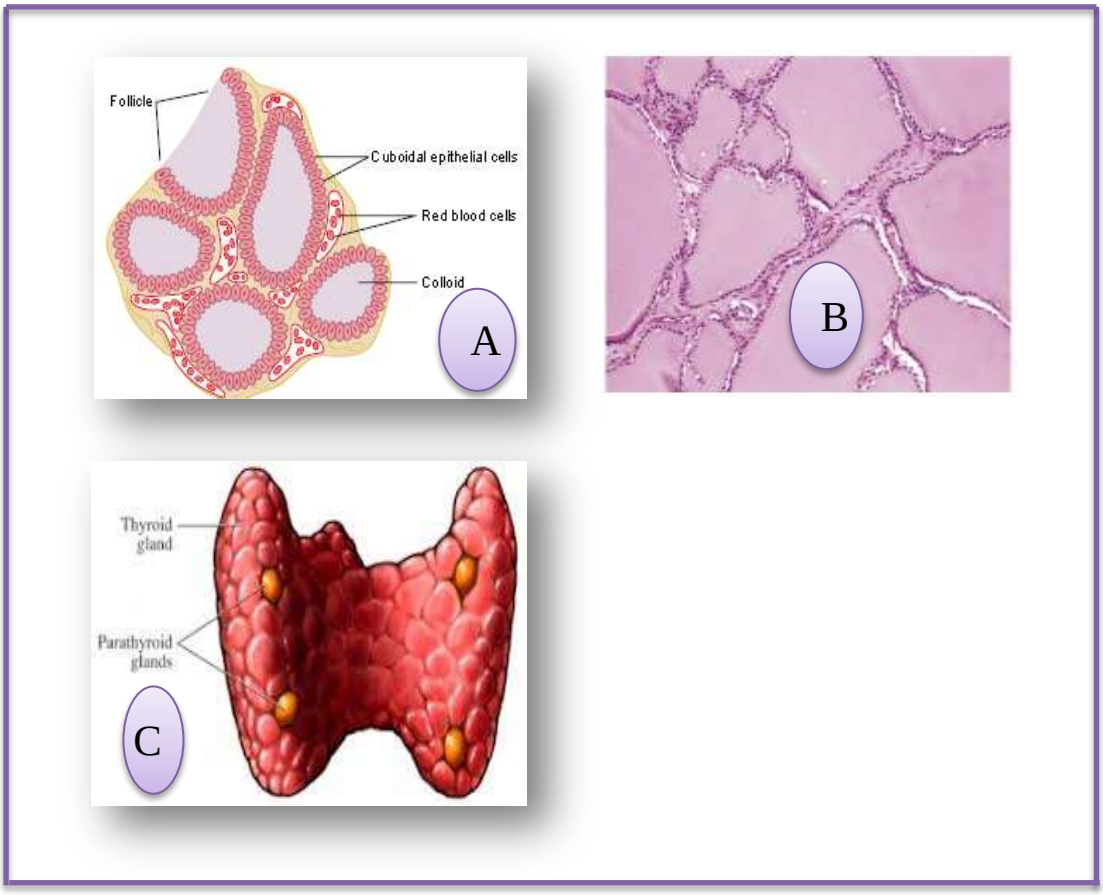

Figure 2. A. Microscopic appearance of the thyroid gland showing secretion of thyroglobulin into the follicles, B. Normal active thyroid gland [20], C. thyroid gland [18]

The main diseases affecting the human thyroid gland are nodular or diffuse goiter, hypothyroidism, hyperthyroidism, neoplasms and autoimmune thyroiditis [1], and it may treat some thyroid diseases by (AD) , (RI) or (TTH) [15], [21].

Why is the thyroid gland removed?

Multinodular goiter is one of the most common causes of thyroidectomy, accounting for about (75%) of cases, while papillary thyroid cancer or benign thyroid disease constitutes (15%) of cases of removal. [8], [15]. and TTH has the advantages of Low rate of thyroidectomy for symptomatic thyroid cancer and a decreased risk of recurrent nodular disease [9]. Surgical excision is usually performed for patients with graves' disease with an accompanying thyroid nodule or metastasis, as shown in figure 3, or in patients who fail to respond to thyroid medications. Some cases of thyroidectomy have better advantages over anti-thyroid drugs in terms of rapid and ultimate control of hyperthyroidism, avoidance of side effects of anti-thyroid drugs and avoidance of radiation exposure [21].

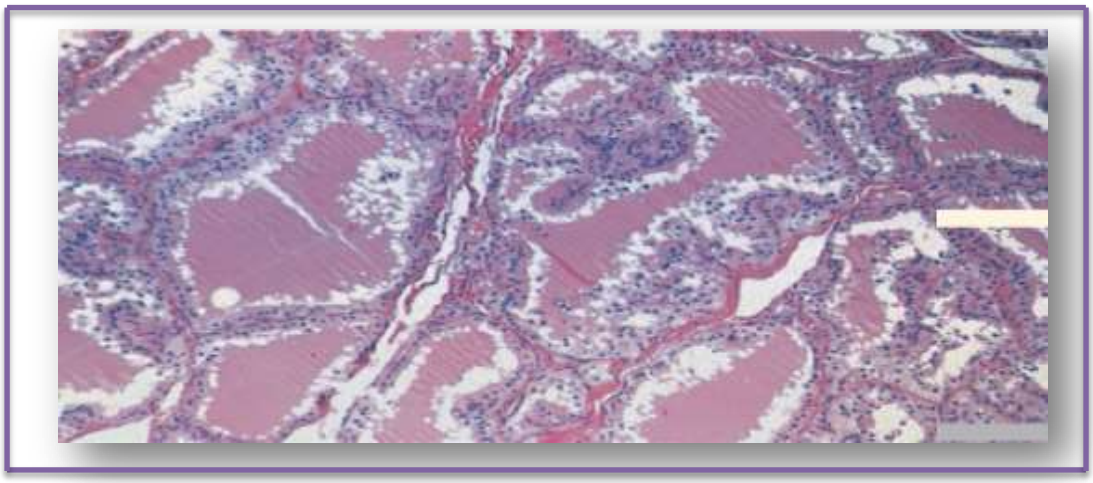

Figure 3. The thyroid gland of a patient with Grave's disease, note that the follicular cell are high columnar hyperplastic cells enclosing pinkish colloid (Gartner & Hiatt, 2014).

Major Complications of Thyroidectomy:

Heart and Liver:

Thyroid hormones have effects on the circulatory system by affecting the force of heart contraction and a change in heart rate as well as vascular resistance. Triiodothyronine (T3) has a direct effect on a cell of vascular smooth muscle, which leads to expansion of blood vessels as a result of relaxation of their wall cells. Given the excess frequency of Metabolic syndrome after surgery in patients with high BMI, hypertension and DM, if possible, thyroidectomy and/or alternative therapy may be considered. The main outcome is thyroidectomy before thyroid hormone replacement therapy is achieved for severe hypothyroidism [9].

Heart rates were significantly increased, while the consequences of hyperthyroidism on the liver are widely documented, symptoms of hypothyroidism are less common [15]. Given the importance of thyroxine and triiodothyronine to maintain a normal basal metabolic rate in the body, other studies have shown that there is a significant increase in liver enzymes AST and ALT and marked decrease in ALP in patients with thyroidectomy. It was also found that when the liver is injured, hepatic stromal cells react by regulating deiodatase, and this leads to hypothyroidism [10].

Lipids:

The increase in the activity of lipoprotein lipase (LPL) is mainly due to the function of thyroid hormones, where this enzyme in turn works on the use of triglyceride substrates. There is a relationship between severe hypothyroidism and an increase in the total cholesterol and low-density lipoprotein (LDL-C) concentration, and it appears atherogenic lipoprotein as a result of increased triglycerides (TGC). High-density lipoprotein (HDL-C) levels usually drop. [9], [15].

It is worth noting that the imbalance or difference in the secondary blood lipids is caused by a disturbance in the secretions of the thyroid gland. The results of some studies have shown negative effects after surgery on both lipids and endothelial function due to severe hypothyroidism, which is associated with decreased efficacy of LPL, which reduces the clearance of TG-rich lipoproteins. Individuals with hypothyroidism also have higher values of TC and LDL-C [10] .

A decrease in both lipid formation and degradation occurs in hypothyroidism, and the reason for the impaired expression of LDL receptors, decreased activity of hepatic lipase, lipoprotein lipase, and cholesterol transporter protein predominates in reduced lipid metabolism [23].

In a study on rats, triglyceride levels were raised as a result of abnormally low activity in the thyroid gland that was removed. But T4 monotherapy normalized their levels and did not different from control group. Some studies showed that treated with T4, LDL-C levels rise after surgery in patients with normal TSH levels. Whereas levels of serum triglyceride were unchanged-findings and this corresponds to the results of thyroidectomized rats. In general, when hyperthyroidism occurs, it will lead to higher concentrations of total cholesterol in the blood [10], [15].

Insulin resistance and BMI:

Metabolic syndrome (MetS) is a public health problem. The major ingredients of the MetS are systemic disorders like abdominal obesity primarily due to insulin resistance, diabetes mellitus, glucose intolerance or dyslipidemia, and hypertension.

Both hormones and dysfunction of thyroid play effective role in nearly all of these disorders. Thyroid hormone replacement therapy (T4) which is used to avoid MetS after TT is a major concern in surgical practice and prevent hypothyroidism [9]. It is known that the preventing of metabolic complications after TT is just as important as the complications linked to surgery. Thyroid hormones are known to regulate basal metabolism, by acting directly on metabolism of lipid and carbohydrate, thus limiting metabolic rate, energy expenditure, and regulating thermogenesis. The cases of weight gain were accompanied when comparing patients during one year after TT, the BMI values and the proportion of patients with metabolic syndrome significantly increased over the first year next the operation. Regarding BMI, nearly half of the patients were overweight, while more than a third of the patients were obese. Also there was increase in homeostatic model assessment for insulin resistance (HOMA-IR) due to increases of level of insulin and blood sugar [24].

On the other hand, thyroxine stimulates hepatic glucose synthesis and excretion, while simultaneously increasing the expression of glucose transporters (GLUT) in the liver and peripheral tissues. Although hepatic gluconeogenesis is reduced in hypothyroidism and at the same time the function of GLUTs is impaired, hypothyroidism is considered a state of insulin resistance. There is an inverse relationship between Free-T4 levels and insulin resistance, even in the case of hypothyroidism. Decreased insulin metabolism, as observed in hypothyroidism, may exacerbate decreased glucose production [21], [24].

Calcium and D Vitamin:

One of the most prominent clinical problems after thyroidectomy is hypocalcemia, which is a common phenomenon in patients undergoing thyroid surgery [25], [26]. As well post-surgery hypocalcemia or tetany also occurs in patients with a disease of nodal thyroid who have undergone partial thyroidectomy. This can be explained by the role of parathyroid hormones, that have an important effect on development and turnover of bone as well as the maintenance of calcium concentration [7].

Several factors have been hypothesized to increase the risk of post-TT hypocalcemia, although the mechanisms and causes of hypocalcemia post thyroidectomy are still unclear, several clinical, biological, and surgical factors may contribute to the low serum calcium level after surgery. It can always remain when it is caused by an irreversible injury to the parathyroid glands. Asymptomatic hypocalcemia is often observed within the first 12 hours of the operation, but it resolves spontaneously after 24 hours. At the same time, a marginal decrease in serum phosphorous is observed within the first 24 hours of surgery. There are several factors that

have been hypothesized to increase the risk of developing hypocalcemia after TT, which include removal of blood vessels, surgical trauma, size of the surgeon, extent of cervical lymph nodes anatomy, inadvertent error in removal of the parathyroid glands, etc. [12], [16].

The results of some studies show the developing hypocalcemia risk after surgery in patients over 50 years of age, When serum growth hormone level is less than 10 pg/mL and serum level of 25-OHD is less than 15 ng/mL are among the perioperative factors which can predict the development of hypocalcemia next thyroidectomy [13]. Others have also suggested that the underlying cause of low serum T3 levels in these patients after total thyroidectomy is the deficiency of T3 product within the thyroid gland due to the absence of the thyroid gland. The duration of serum calcium measurement is very important after thyroidectomy because it affects the prevalence of hypocalcemia rates, as hypocalcemia rates decrease as measurement sampling approaches surgery. According to the suggestion of some studies, the blood calcium level is less than 8 mg/100 ml 24 h. after total thyroidectomy [5].

In general, thyroid hormones clearly and directly influence bone strength (through calcium fixation) and mineral metabolism. Total thyroidectomy can also cause significantly decrease in OPN, calcium levels and thyroid hormones, in addition to significantly increase in hypothyroidism and BMI, especially in women as well it was noted that there was an increase in the level of TSH and a decrease in the levels of Free-T4 and OPN when comparing time periods during the first year and more than one year after thyroidectomy in all groups and for different BMI categories [11], [15] .

Effect of thyroidectomy parathyroid:

The most common and prolonged complication after complete thyroidectomy is permanent hypoparathyroidism. A decrease in iPTH, both in the immediate postoperative period and during the first 24 hours after thyroidectomy, is an important predictor of postoperative hypocalcemia. This is because iPTH has a relatively short half-life of (2-5) minutes with rapid plasma circulation and through liver and kidney metabolism, making it a good marker for parathyroid function [8].

Conclusions:

1. The main consequence of thyroidectomy was hypothyroidism, which causes direct disruption of lipid metabolism and liver enzymes, leading to secondary hyperlipidemia and liver dysfunction.
2. For hypocalcemia postoperative it is necessary uses selective calcium- vitamin D replacement therapy.
3. Tetanus occurs in patients through the bone restoration period and is caused by the continued influx of calcium inside the bone related with transitory surgery-induced hyperparathyroidism.

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التأثيرات الكيموحيوية بعد استئصال الغدة الدرقية

شيماء عبيد مصطفى هيثم لقمان الحيالي ثائر محمد المشهداني

الملخص:

على الرغم من أن عملية استئصال الغدة الدرقية ، سواء كانت نتيجة لتضخم الغدة الدرقية متعدد العقيدات ، سرطان الغدة الدرقية الحليمي أو مرض الغدة الدرقية الحميد له فوائد للمرضى الذين لم يستجيبوا للأدوية المضادة للغدة الدرقية أو مرضى فرط نشاط الغدة الدرقية. مع ذلك فإن استئصال الغدة الدرقية يؤدي إلى تغييرات في بعض عمليات التمثيل الغذائي داخل الجسم بما في ذلك التأثير في وظائف الكبد ، تفاقم مستويات الدهون الثلاثية TGC و LDL بشكل ملحوظ فضلا عن ارتفاع ضغط الدم غير المنضبط.

الكلمات المفتاحية: استئصال الغدة الدرقية ، عمليات التمثيل الغذائي ، قصور الغدة الدرقية ، فرط نشاط الغدة الدرقية.