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New Technology To Thyroidectomy: A Literature Review Of Previous Studies.

Luai Farhan Zghair*, Jihad Anad Khalef, and Muhammad Qasim Qazaal.

Faculty Of Medicine, AL- Iraqia University, Baghdad, Iraq.

ABSTRACT

The traditional approach to thyroidectomy involved a long, low cervical incision. The Impact of New Technology evolved to a shorter incision placed in a skin crease higher in the neck. However, a resultant neck scar remains. Multiple approaches have been developed to eliminate the neck scar. New technologies have allowed for various approaches.
Keywords: Thyroid Gland, New Technology, Bleeding, Scar.

**Corresponding author*

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INTRODUCTION

The thyroid gland is located in the **anterior neck**, spanning between the C5 and T1 vertebrae. It is an **endocrine** gland, divided into two lobes which are connected by an **isthmus**. It is said to have a butterfly shape. It lies behind the sternohyoid and sternothyroid muscles, **wrapping** around the cricoid cartilage and superior tracheal rings. It is inferior to the thyroid cartilage of the **larynx**. The gland is in the **visceral compartment** of the neck, along with the trachea, oesophagus and pharynx. The compartment is bound by pretracheal fascia. During **development,** the thyroid gland initially forms in the floor of the primitive pharynx, near the base of the tongue. It **descends** down the neck to lie in its adult anatomical position. The thyroid gland secretes hormones directly into the blood. Therefore it needs to be **highly vascularised**. Blood supply to the thyroid gland is achieved by two main arteries, the superior and inferior thyroid arteries. These are **paired** arteries arising on both the left and right. The **superior thyroid artery** is the first branch of the external carotid artery. After arising, the artery descends toward the thyroid gland. As a generalisation, it supplies the **superior and anterior** portions of the gland. The **inferior thyroid artery** arises from the thyrocervical trunk (which in turn is a branch of the subclavian artery). The artery travels superomedially to reach the inferior pole of the thyroid. It tends to supply the **postero-inferior** aspect. In a small proportion of people (around 10%), there is an additional artery present, the **thyroid ima artery**. It comes from the brachiocephalic trunk of the arch of aorta, supplying the anterior surface and isthmus. Venous drainage is carried out by the superior, middle and inferior thyroid veins, which form a **venous plexus**. The superior and middle veins drain into the **internal jugular veins**, whereas the inferior drains into the **brachiocephalic** vein.The thyroid gland is innervated by branches derived from the **sympathetic trunk**. However, these nerves do not control endocrine secretion – release of hormones is regulated by pituitary gland. The tissue of the thyroid gland is composed mostly of thyroid follicles. The follicles are made up of a central cavity filled with a sticky fluid called colloid. Surrounded by a wall of epithelial follicle cells, the colloid is the center of thyroid hormone production, and that production is dependent on the hormones' essential and unique component: iodine. Hormones are produced in the colloid when atoms of the mineral iodine attach to a glycoprotein, called thyroglobulin, that is secreted into the colloid by the follicle cells. The following steps outline the hormones assembly.

1- Binding of TSH to its receptors in the follicle cells of the thyroid gland causes the cells to actively transport iodide ions (I^-) across their cell membrane, from the blood stream into the cytosol. As a result, the concentration of iodide ions trapped in the follicular cells is many times higher than the concentration in the blood stream.

2- Iodide ions then move to the lumen of the follicle cells that border the colloid. There, the ions undergo oxidation (their negatively charged electrons are removed). The oxidation of two iodide ions (2 I^-) results in iodine (I_2), which passes through the follicle cell membrane into the colloid.

3- In the colloid, peroxidase enzymes link the iodine to the tyrosine amino acids in thyroglobulin to produce two intermediaries, a tyrosine attached to one iodine and a tyrosine attached to two iodines. When one of each of these intermediaries is linked by covalent bonds, the resulting compound is **triiodothyronine** (T_3), a thyroid hormone with three iodines. Much more commonly, two copies of the second intermediary bond, forming tetraiodothyronine, also known as **thyroxine** (T_4), a thyroid hormone with four iodines. The release of T_3 and T_4 from the thyroid gland is regulated by thyroid-stimulating hormone (TSH). low blood levels of T_3 and T_4 stimulate the release of thyrotropin-releasing hormone (TRH) from the hypothalamus, which triggers secretion of TSH from the anterior pituitary. In turn, TSH stimulates the thyroid gland to secrete T_3 and T_4. The levels of TRH, TSH, T_3, and T_4 are regulated by a negative feedback system in which increasing levels of T_3 and T_4 decrease the production and secretion of TSH. These hormones remain in the colloid center of the thyroid follicles until TSH stimulates endocytosis of colloid back into the follicle cells. There, lysosomal enzymes break apart the thyroglobulin colloid, releasing free T_3 and T_4, which diffuse across the follicle cell membrane and enter the bloodstream. In the bloodstream, less than one percent of the circulating T_3 and T_4 remains unbound. This free T_3 and T_4 can cross the lipid bilayer of cell membranes and be taken up by cells. The remaining 99 percent of circulating T_3 and T_4 is bound to specialized transport proteins called thyroxine-binding globulins (TBGs), to albumin, or to other plasma proteins. This packaging prevents their free diffusion into body cells. When blood levels of T_3 and T_4 begin to decline, bound T_3 and T_4 are released from these plasma proteins and readily cross the membrane of target cells. T_3 is more potent than T_4, and many cells convert T_4 to T_3 through the removal of an iodine atom, as showed in fig 1.

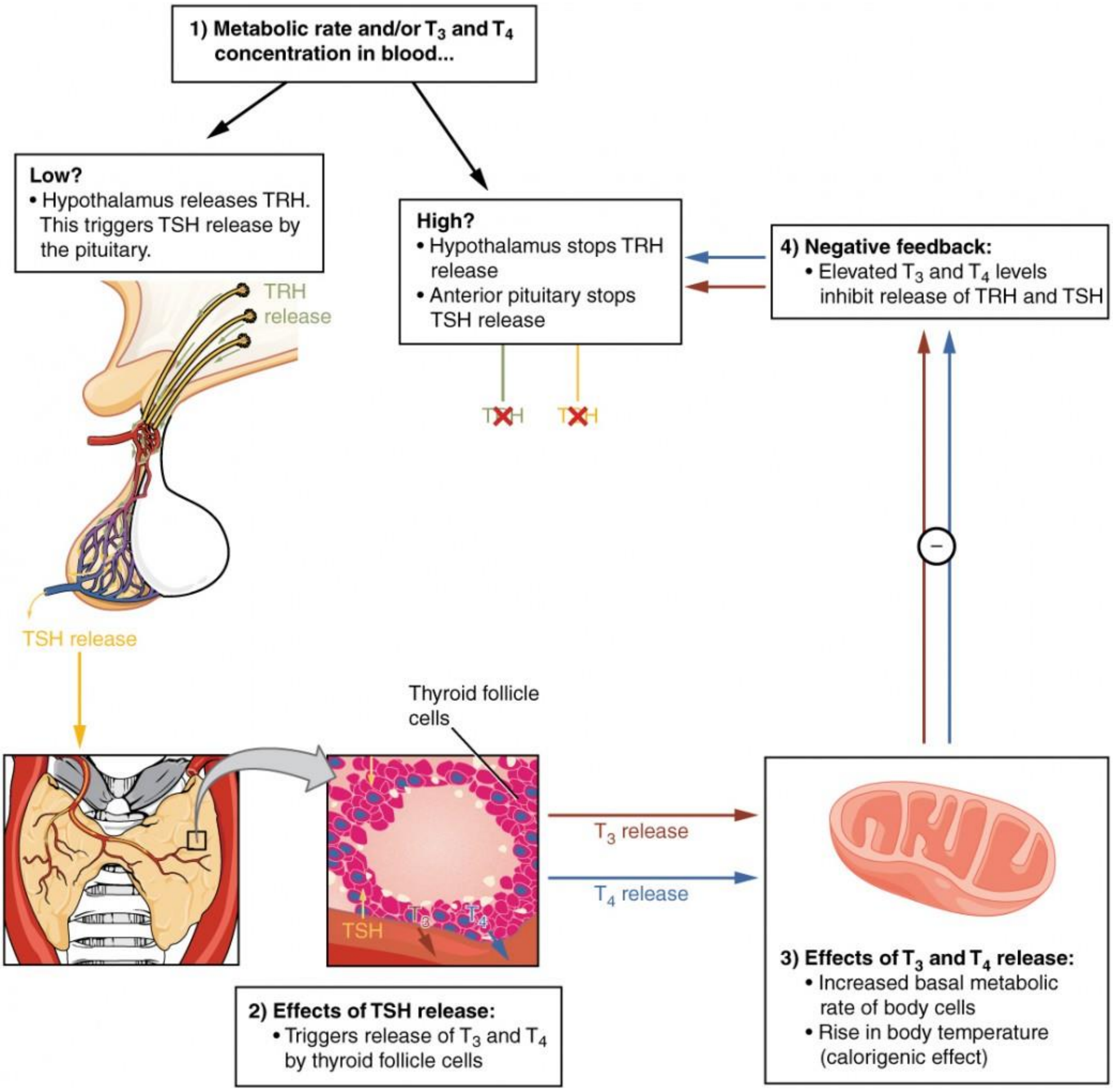

Figure 1: A classic negative feedback loop controls the regulation of thyroid hormone levels.

The thyroid hormones, T_3 and T_4, are often referred to as metabolic hormones because their levels influence the body's basal metabolic rate, the amount of energy used by the body at rest. When T_3 and T_4 bind to intracellular receptors located on the mitochondria, they cause an increase in nutrient breakdown and the use of oxygen to produce ATP. In addition, T_3 and T_4 initiate the transcription of genes involved in glucose oxidation. Although these mechanisms prompt cells to produce more ATP, the process is inefficient, and an abnormally increased level of heat is released as a byproduct of these reactions. This so-called calorigenic effect (calor- = "heat") raises body temperature. Adequate levels of thyroid hormones are also required for protein synthesis and for fetal and childhood tissue development and growth. They are especially critical for normal development of the nervous system both in utero and in early childhood, and they continue to support neurological function in adults. As noted earlier, these thyroid hormones have a complex interrelationship with reproductive hormones, and deficiencies can influence libido, fertility, and other aspects of reproductive function. Finally, thyroid hormones increase the body's sensitivity to catecholamines (epinephrine and norepinephrine) from the adrenal medulla by upregulation of receptors in the blood vessels. When levels of T_3 and T_4 hormones are excessive, this effect accelerates the heart rate, strengthens the heartbeat, and increases blood pressure. Because thyroid hormones regulate metabolism, heat production, protein synthesis, and many other body functions, thyroid disorders can have severe and widespread consequences. The thyroid gland also secretes a hormone called **calcitonin** that is produced by the parafollicular cells (also called C cells) that stud the tissue between distinct follicles. Calcitonin is released in response to a rise in blood calcium levels. It appears to have a function in decreasing blood calcium concentrations by:…………………………………………..

1-Inhibiting the activity of osteoclasts, bone cells that release calcium into the circulation by degrading bone matrix……………………………………………….

2-Increasing osteoblastic activity…………………………………………………….

3-Decreasing calcium absorption in the intestines…………………………………….

4-Increasing calcium loss in the urine……………………………………………….

However, these functions are usually not significant in maintaining calcium homeostasis, so the importance of calcitonin is not entirely understood. Pharmaceutical preparations of calcitonin are sometimes prescribed to reduce osteoclast activity in people with osteoporosis and to reduce the degradation of cartilage in people with osteoarthritis. Of course, calcium is critical for many other biological processes. It is a second messenger in many signaling pathways, and is essential for muscle contraction, nerve impulse transmission, and blood clotting. Given these roles, it is not surprising that blood calcium levels are tightly regulated by the endocrine system. The organs involved in the regulation are the parathyroid glands.

PATIENTS AND METHODS:- A literature review of previous studies…………….

DISCUSSION

The traditional approach to thyroidectomy involved a long, low cervical incision. This has evolved to a shorter incision placed in a skin crease higher in the neck. However, a resultant neck scar remains. Multiple approaches have been developed to eliminate the neck scar. New technologies have allowed for various approaches.

Minimally invasive video-assisted thyroidectomy…………………………………..

The development of video laparoscopic surgery in the last decade has allowed several operations to be performed with minimally invasive techniques. After the first parathyroidectomy procedure was performed endoscopically in 1996, this minimally invasive approach was applied to thyroid surgery. Minimally invasive video-assisted thyroidectomy (MIVAT) was described in 1998. The technique was described using a central access with a 1.5-cm incision and external retraction. Video-assisted thyroidectomy was tested successfully in animals and has been performed safely in human patients. Postoperative morbidity rates in patients seem to be equivalent to those of patients who have undergone conventional surgery. prospectively compared video-assisted thyroid lobectomy and conventional lobectomy in 116 patients with thyroid nodules **(Chao TC, 2004).** No deaths, hematomas, wound infections, cases of hypothyroidism, or RLN palsies were reported. Damage to the SLN occurred in 6 (10.2%) patients after conventional surgery and in no patients in the video-assisted group. Transient RLN palsy occurred in 5 (8.5%) patients who underwent conventional surgery versus 3 (5.8%) patients in the video-assisted group; the difference was not significant. Patients in both groups were discharged home on the second postoperative day. In a 5-year study, Miccoli et al (2004) selected 579 patients to undergo MIVAT **(Miccoli P, 2004).** The operation consisted of total thyroidectomy in 312 patients and lobectomy in 267. The mean operative time was 41 minutes (range, 15-120 min) for lobectomy and 51.6 minutes (range, 30-140 min) for total thyroidectomy. The postoperative hospital stay was 24 hours (overnight discharge) for all patients. Complications included postoperative bleeding (0.1%), recurrent nerve palsy (1.3%), and definitive hypoparathyroidism (0.2%). Some have suggested that pain following VAT is less when compared with conventional thyroidectomy because of limited dissection, retraction, and injury to tissues. MIVAT provides endoscopic magnification of nerves and vessels, potentially decreasing the risk of injury to these structures. This approach may also help improve aesthetic results. However, the cosmetic result obtained with an appropriately sized and placed conventional incision is also good. The endoscopic technique cannot be used in nodules larger than 35 mm or in goiters because the specimen is too large to retrieve through the incision. In addition, this technique is not ideal for removing carcinomas in which an intact capsule is desired for oncologic reasons and for accurate histologic assessment. Postoperative voice and swallowing have also been shown to differ according to the method of surgery. A published study of patients undergoing total thyroidectomy who were randomized into 2 groups. Twenty-nine patients underwent VAT and 24 underwent conventional thyroidectomy. Three months postoperatively, acoustic voice analysis showed that patients who were treated with conventional thyroidectomy had significantly lower fundamental frequencies, maximum phonation time, and number of semitones. Additionally, the mean voice impairment score from a specifically designed questionnaire was higher for 3 months after surgery, and the mean swallowing impairment score was higher for one week after surgery. The authors concluded that short-term voice and swallowing outcome was improved for patients treated with VAT in their study **(Lombardi CP, 2008).** In summary, if the general principals of conventional thyroid surgery are followed, video assistance may help in identifying structures and in minimizing the incision. Experienced surgeons may consider using this technique when the equipment and additional surgical staff is available for patients with small follicular nodules/adenomas, or well-differentiated papillary carcinoma, or when prophylactic thyroidectomy is being performed in patients with ret protooncogene mutations…………………………………………….

Robot-assisted thyroidectomy………………………………………………………..

Transaxillary thyroidectomy was initially performed with the assistance of endoscopic technology. Robotic technology was then introduced to this approach in 2007. This provided a 3-dimensional field of view with magnification, stabilized visual field, and the potential to use 3 arms under the control of a single surgeon. The robotic technology also provides tremor filtration and fine motion scaling to allow precise manipulation of tissues. A series of 338 patients that underwent a robot-assisted transaxillary thyroidectomy **(Kang SW, 2009).** This report indicated a significant learning curve with approximately 45 robotic procedures before length of surgery stabilized with surgeons that had previously used a transaxillary endoscopic approach. The complication rate was similar to historical open thyroidectomy approach. This approach has introduced new complications not associated with thyroidectomy in the past. Due to the transaxillary approach and the patient arm positioning, brachial plexus injuries have been reported. Additionally, this procedure typically has a longer operative time and increased blood loss. This approach has also been used for the treatment of well-differentiated thyroid carcinoma. Transient hypocalcemia has been found to be more frequent in the robotic approach. The transaxillary robot assisted thyroidectomy approach appears to be replacing endoscopic approaches. The overall experience of alternate approaches to thyroidectomy is in the early stages. Whether any of these approaches will replace the traditional open neck approach to thyroidectomy for benign or malignant disease remains to be seen. Overall complications are similar although the transaxillary approach introduces brachial plexus injuries as potential problems……………………………………………. ……

Electrothermal bipolar vessel sealing system……………………………………….

Electrothermal bipolar vessel sealing system (EBVSS) delivers precise amount of energy, resulting in limited thermal spread to adjacent tissues, including critical structures such as the parathyroid glands and recurrent laryngeal nerve. Some studies suggest that the use of EBVSS results in shorter operating time, decreased postoperative drain volume, decreased transient postoperative hypoparathyroidism and hypocalcemia, and decreased postoperative stay compared with suture ligature technique………………………………………….

Ultrasonic dissectors…………………………………………………………………..

Ultrasonic dissectors (USD) function by using ultrasonic motion to created heat and the resultant coagulation of proteins. USD may be used for cutting and coagulating tissue with decrease in thermal injury to surrounding tissue. Additionally, less manipulation of the thyroid tissue while transecting the vascular pedicles may lead to decreased inflammation. Studies have suggested the use of USD decreases operating time by 10-35%, decreases hospital stay, and decreases intraoperative and postoperative bleeding **(Lombardi CP, 2008)…………………………………………**

Inpatient versus outpatient surgery……………………………………………….

A study by comparing inpatient versus outpatient thyroidectomy in terms of readmission, reoperation, and complications suggested that the outpatient procedure is as safe as, and perhaps safer than, the inpatient surgery. The study, using data from the American College of Surgeons National Surgical Quality Improvement Program (ACS NSQIP), compared safety and outcomes in 8185 patients who underwent outpatient thyroidectomy and an equal number of individuals who underwent the inpatient procedure. Thirty-day postoperative morbidity was low in both groups, occurring in just 250 patients (1.5%); a total of 476 patients (2.9%) were readmitted within 30 days postsurgery. In comparing the inpatient and outpatient groups, however, the investigators found a higher likelihood of readmission, reoperation, and complications following inpatient surgery **(Khavanin, 2014), (Tucker ME, 2014).**

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