

INTRODUCTION

Surgical destruction of the parathyroid glands is the most common cause of hypoparathyroidism. Hypoparathyroidism can occur after any surgical procedure that involves the anterior neck, but it is most gravely seen as a complication of parathyroid surgery or thyroid surgery or after extensive resection for head and neck cancer. Trauma to the parathyroid vascular pedicles or inadvertent removal of the glands leads to either transient or permanent hyperparathyroidism (*Clark et al., 2005*).

Hypocalcaemia is the most common complication of thyroidectomy. The incidence of transient hypocalcaemia ranges from 10% to 50%, and permanent hypocalcaemia usually occurs in 0%–2% of patients according to different definitions. It is known that not all patients with hypocalcaemia will have associated symptoms such as numbness and spasm. Some surgeons advocated prolonged stays that are not cost-effective nowadays. Meanwhile, when most of the surgeons' discharge patients within 24 hours, more emergency room visits or emergency calcium intravenous infusions would also occur. With the increasing preference for shorter stays, identifying patients at high risk is essential for their timely and safe discharge (*Noordzij et al., 2009*).

Several anatomical considerations must be considered during thyroid surgery, the arteries and veins of the thyroid gland; the position of the parathyroid glands and the position of the laryngeal nerves. The most significant complication is recurrent laryngeal nerve palsy, which can cause severe dysphonia and dysphagia, with serious social repercussions. However, permanent hypoparathyroidism is another serious complication which can sometimes be difficult to manage (*Sasson, Pingpank, 2011*).

In recent years, multiple retrospective studies have approved that the absolute value of postoperative serum parathyroid hormone (PTH) is an accurate predictor of hypocalcaemia in postoperative patients (*Vescan et al., 2005*).

Iatrogenic injury of the parathyroid glands is an unintended consequence of total thyroidectomy. Measuring the serum parathyroid hormone (PTH) immediately after surgery is a sensitive and specific method of assessing the function of the parathyroid glands and for identifying patients at risk for hypocalcaemia. If the postoperative PTH level is low, then administering calcium and activated vitamin D (calcitriol) can reduce the incidence of symptomatic hypocalcaemia, the incidence of a low postoperative PTH after total thyroidectomy has been highly variable in the literature, ranging between 7% and 37%. Part

of this variability is related to the variety of methods used to define this complication (*Edafe et al., 2014*).

Traditional methods for detecting hypocalcaemia during the postoperative period after total thyroidectomy include frequent monitoring of Ca and ionized Ca (iCa), as well as close clinical monitoring for hypocalcaemia symptoms. These traditional methods can take 24 hours to reveal hypocalcaemia, which prolong hospitalization. Many endocrine surgeons are interested in predicting hypocalcemia early to prevent serious complications and begin early treatment to hasten hospital discharge. Intraoperative or early postoperative intact parathyroid hormone (iPTH) levels are reliable for predicting postoperative hypocalcemia.¹⁵⁻²⁴ Thus; an early PTH assay can facilitate early discharge, and prospectively treat symptomatic hypocalcaemia (*Diez et al., 2009*).

A careful surgical technique, including peripheral ligation of the thyroid arteries and meticulous dissection of the parathyroid glands, remains the best approach to preventing hypocalcaemia after total thyroidectomy (*Erwin et al., 2017*).

AIM OF WORK

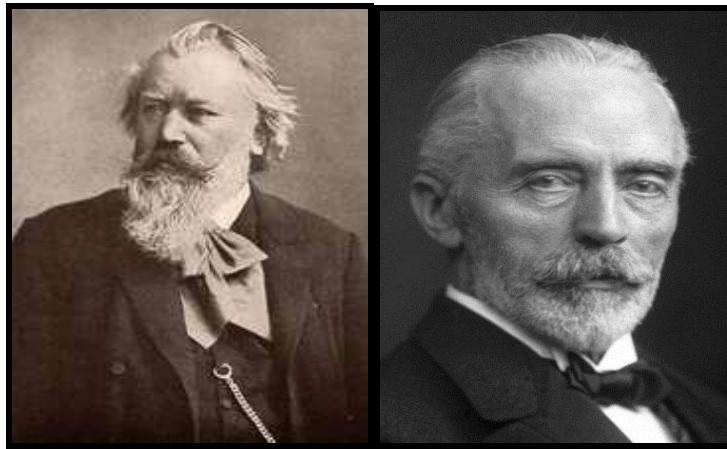
To evaluate the risk of hypocalcaemia (transient or permanent) after total thyroidectomy for goiter, the frequency and impact of unintentional parathyroidectomy.

HISTORY OF THYROID AND PARATHYROID SURGERY

History of Thyroid Surgery:

Evolution of modern surgical techniques together with an expanded understanding of anatomy and endocrinology are considered as the turning points in the history of thyroid surgery. The road has had many twists, early developments in thyroid surgery came from the school of Salerno, Italy, in the 12th and 13th centuries with the advent of surgical procedure to excise goiter; at those ages, patients often died from sepsis or hemorrhage (*Zimmermann, 2009*).

Wilhelm Fabricus reported in 1646 the first thyroidectomy performed using scalpels, however, the patient died, and the surgeon was imprisoned (*Halsted, 1919*). By the 1850s, the mortality rate following thyroid surgery was still high, approximately 40 % (*Mitrecic, 2013*). Landmark developments in anesthesia, antisepsis and surgical hemostatic instrumentations helped to convert surgery of the thyroid gland from a bloody and condemned procedure to a modern and a safe surgical intervention (*Becker, 1977*).



Theodor Billroth and Theodor Kocher improved mortality rates from 12.6% in the 1880s to 0.2% in 1898 using these advances (*Becker, 1977*).

Theodor Kocher was a meticulous surgeon with low complication rates. He has described the incision for thyroidectomy, as well as other surgical advances, he has been acclaimed "The father of modern thyroid surgery." and for his work, became the first surgeon to be awarded the Nobel Prize in 1909 (*Andrén-Sandberg, and Mai, 2001*).

History of Parathyroid Surgery:

Credit for recognition and identification of the parathyroid glands in humans went to Ivar Sandström who illustrated in 1887 the anatomic position, blood supply, and variability of the location of the parathyroid glands (*Organ, 2000*).

McCallum and Carl Voegtlin in 1909 demonstrated the connection between the parathyroid gland and calcium regulation. They found that tetany following parathyroidectomy was accompanied by calcium deficiency in tissues and this condition could be relieved by injections of parathyroid extract or calcium.

In 1925, Felix Mandl has performed the first parathyroidectomy, the procedure was initially successful. Unfortunately, patient developed recurrent hypercalcemia and died soon after a second surgical exploration (**Welbourn, 1990**).

In 1963, with development of the immunoassay measurement of parathyroid hormone by Berson and Yalow, a clear understanding of parathyroid hormone and calcium metabolism emerged, and they earned the Nobel Prize for their work (**Berson, 1963**).

Chapter 1

ANATOMY OF THE THYROID AND PARATHYROID GLANDS

A) THYROID GLAND

Developmental Embryology:

The thyroid gland has a dual embryonic origin, the thyroid primordium which is also called median thyroid component or medial analogue and the ultimobranchial body which is also called lateral thyroid component or caudal pharyngeal pouch complex (*Takashi et al., 2006*).

The thyroid primordium is derived from endodermal epithelium from the median surface of the pharyngeal floor. It arises at the foramen caecum at around 24th day of gestation. It remains attached to the tongue by the thyroglossal duct as it begins to descend the neck to its final position just inferior to the thyroid cartilage (*Judith et al., 2011*).

The thyroid primordium develops two lateral lobes connected by the isthmus. Follicles appear during the second month of gestation and increase through the fourth month (*Skandalakis et al., 2009*).

The ultimobranchial body (UBB) is an out pocketing of the fourth pharyngeal pouch that fuses with the thyroid diverticulum (*Takashi et al., 2006*).

Ultimobranchial body arises later in development than the median component. These fuse with the posterior portion of the median component on each side giving rise to the calcitonin-producing para follicular or C-cells. These series of events take place before the time that thyroid gland starts producing thyroid hormones (*Takashi et al., 2006*).

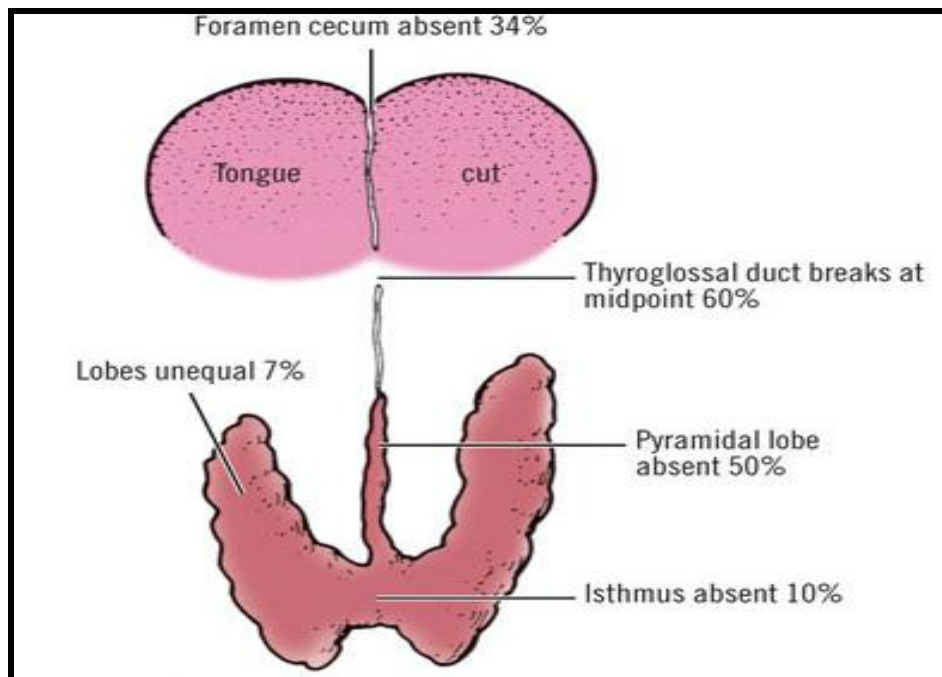


Figure (1): Vestiges of thyroid gland development (*Skandalakis et al., 2009*).

Gross Anatomy of the thyroid gland:

The thyroid gland is a butterfly shaped organ and has a weight of 15-20g; the thyroid of males is larger than that of females. It is soft and its color is red. This organ is located between the C5-T1 vertebrae of vertebral column, in front of the trachea and below the larynx. It is composed of two lobes and the isthmus that binds them together and the pyramidal lobe (*Jameson et al., 2010*).

The lateral lobes can be traced from the lateral aspect of thyroid cartilage down to the level of the sixth tracheal ring. The isthmus overlies the second and third tracheal rings (*Judith et al., 2011*).

The two lateral lobes are roughly conical, approximately 5 cm long and 2 to 3 cm in transverse and anteroposterior dimensions. The pyramidal lobe may attach to the center of the isthmus but often is found on a slightly lateral aspect (often the left) (*Bliss et al., 2000*).

Occasionally the pyramidal lobe is accompanied by a small group of skeletal muscle fibers, which has been termed the "levator glandulae superioris" (*Bliss et al., 2000*).

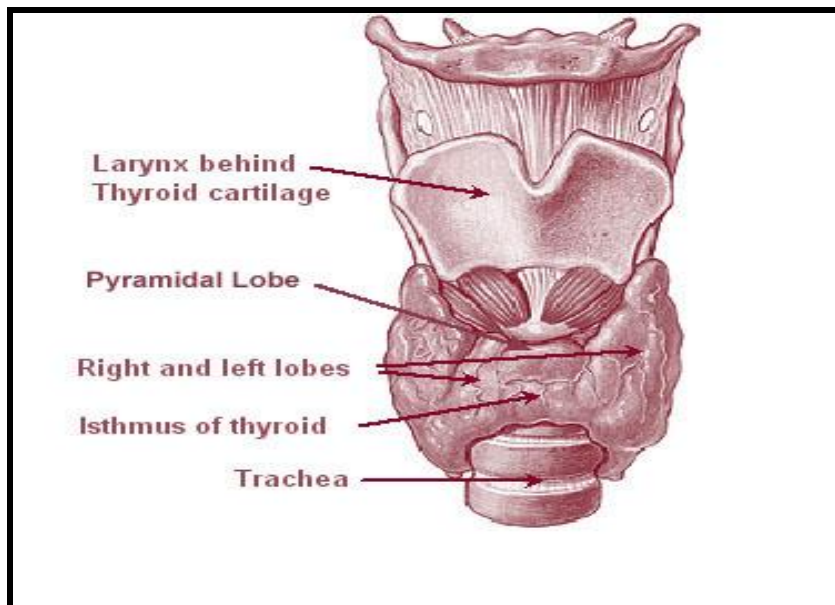


Figure (2): Thyroid gland – AP view (*Mulholland et al., 2011*).

Capsule of the Thyroid Gland:

The thyroid gland has a connective tissue capsule which is continuous with the septa, and which makes up the stroma of the organ. This is the true thyroid capsule of the thyroid.

External to the true capsule is a well-developed layer of fascia derived from the pretracheal fascia. This is the false capsule, also called the perithyroid sheath or surgical capsule (*Skandalakis et al., 2009*).

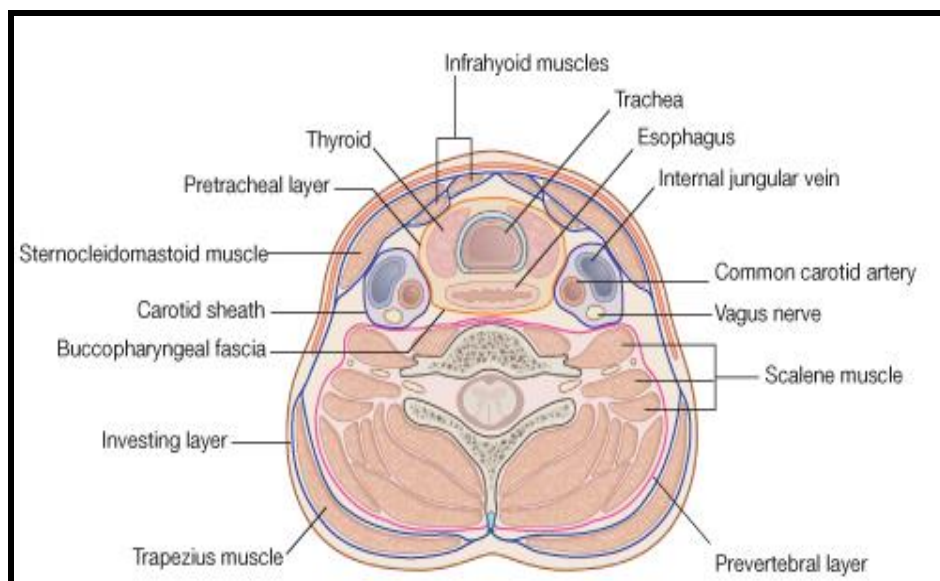


Figure (3): Relations of the thyroid gland – axial section (*Drake et al., 2007*).

Muscular, Fascial and Airway Relationships:

The thyroid lies in the central compartment of the neck bordered by the contents of the carotid sheath on each side. The anterolateral surface is covered by the sternothyroid muscles, which do not completely meet in the midline above the level of the isthmus. The oblique upper muscular insertion into the thyroid cartilage is the limiting factor preventing the lobes from encroaching further toward the midline and into the underlying thyrohyoid muscle. Superficial to that are the paired sternohyoid muscles that meet in the midline raphe marking the most common plane of dissection used to expose the thyroid gland. These muscles are innervated by the Ansa cervicalis (Ansa hyoglossi) (*Mulholland et al., 2011*).

The thyroid is invested in a thin layer of connective tissue that is an expansion of the pretracheal fascia (often called the “thyroid sheath”). The plane defined by this layer is usually easy to develop as the thyroid is mobilized away from surrounding structures (*Mulholland et al., 2011*).

The sheath is condensed as the anterior suspensory ligament above the isthmus. The sheath also suspends the inner surface of the thyroid gland to the tracheal rings and cricoid cartilage. It is condensed posteromedial into the ligament of Berry on each side. The ligament of Berry is often a very firm attachment to the trachea near the cricothyroid interval, which means that it is often intimately associated with the recurrent laryngeal nerve (RLN). It is in the course of dividing these attachments that the RLN is most vulnerable to iatrogenic injury (*Mulholland et al., 2011*).

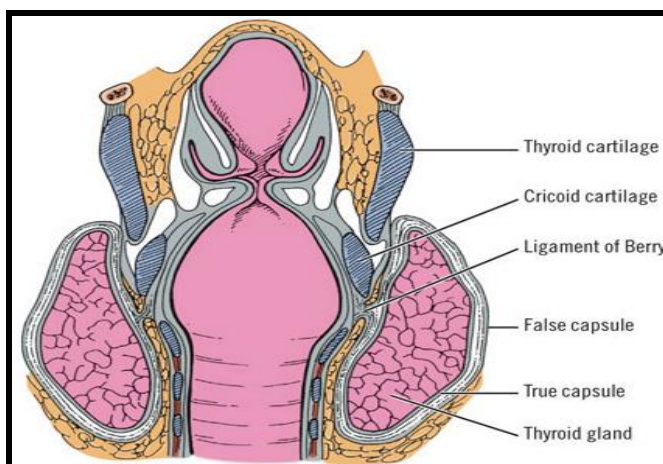


Figure (4): The anchor of the thyroid gland: the ligament of Berry (*Skandalakis et al., 2009*).

Vascular Supply:-

The thyroid gland competes with the adrenal glands for having the greatest blood supply per gram of tissue. One consequence is that hemostasis is a major problem of thyroid surgery, especially in patients with toxic goiter (*Skandalakis et al., 2009*).

Arterial Supply:

Two paired arteries, the superior and inferior thyroid arteries, and an inconstant midline vessel, the thyroid ima artery, supply the thyroid (*Skandalakis et al., 2009*).

Superior Thyroid Artery:

The superior thyroid artery arises from the external carotid artery just above, at, or just below the bifurcation of the common carotid artery. It passes downward and anteriorly to reach the superior pole of the thyroid gland in close relation to the external branch of superior laryngeal nerve (*Skandalakis et al., 2009*).

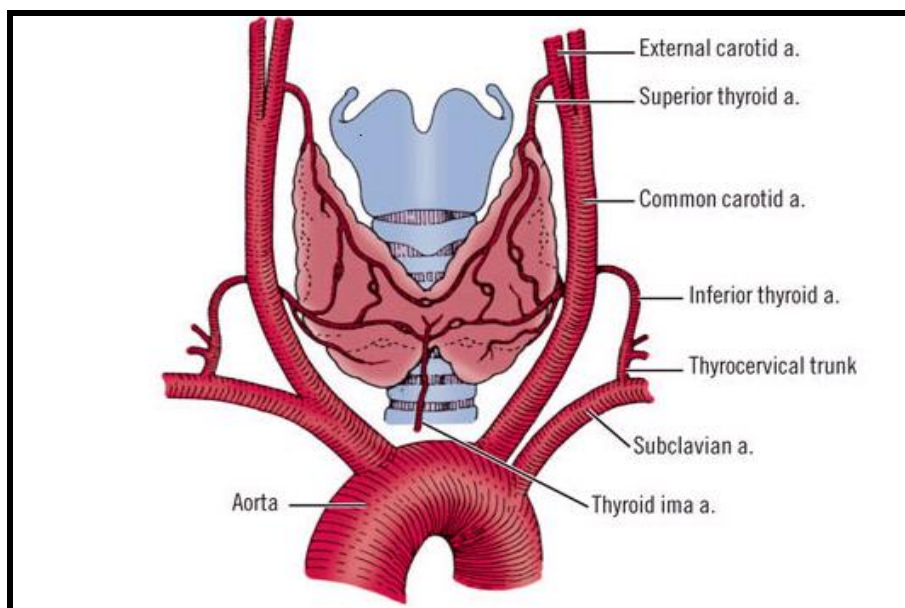


Figure (5): The arterial supply to the thyroid gland. The thyroid ima artery is only occasionally present (*Skandalakis et al., 2009*).

At the superior pole, the superior thyroid artery divides into anterior and posterior branches. The anterior branch anastomoses with the contralateral artery; the posterior branch anastomoses with branches of the inferior thyroid artery. From the posterior branch, a small parathyroid artery passes to the superior parathyroid gland (*Skandalakis et al., 2009*).

Inferior Thyroid Artery:

The inferior thyroid artery usually arises from the thyrocervical trunk, but in about 15 % of individuals it arises directly from the subclavian artery (*Skandalakis et al., 2009*).