# A STUDY OF THE TOPOGRAPHICAL ANATOMY OF THE EXTERNAL LARYNGEAL BRANCH OF SUPERIOR LARYNGEAL NERVE IN PATIENTS UNDERGOING THYROIDECTOMY

*Dissertation submitted in partial fulfilment of the regulations of*

**M.S. DEGREE EXAMINATION**

**BRANCH 1 GENERAL SURGERY**

**Department of General Surgery**

**GOVT.STANLEY MEDICAL COLLEGE AND HOSPITAL**

**CHENNAI – 600001**


**THE TAMILADU DR.M.G.R MEDICAL UNIVERSITY**

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**APRIL 2017**

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# CERTIFICATE

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is the bonafide work done by Dr.Sukhdev D.B. Singh, Post Graduate student(2014-2017) in the department of General Surgery, Government Stanley Medical College and Hospital, Chennai under my guidance and supervision, in partial fulfilment of the regulations of The Tamilnadu Dr.M.G.R Medical University, Chennai for the award of M.S. Degree(General Surgery) Branch – I, Examination to be held in April 2017.

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# DECLARATION

I, DR.SUKHDEV D.B. SINGH solemnly declare that this dissertation titled **"A STUDY OF THE TOPOGRAPHICAL ANATOMY OF THE EXTERNAL LARYNGEAL BRANCH OF SUPERIOR LARYNGEAL NERVE IN PATIENTS UNDERGOING THYROIDECTOMY"** is a bonafide work done by me in the Department of General Surgery, Government Stanley Medical College and Hospital, Chennai under the guidance and supervision of my unit chief.

**Prof.D.NAGARAJAN,M.S.,**
Professor of Surgery

This dissertation is submitted to the Tamilnadu Dr.M.G.R. Medical University, Chennai in partial fulfilment of the university regulations for the award of M.S., Degree (General Surgery) Branch – I, Examination to be held in April 2017.

Place: Chennai
Date: September 2016 Dr.SUKHDEV D.B.SINGH

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It is my earnest duty to thank my parents without whom accomplishing this task would have been impossible.

I am extremely thankful to my patients who consented and participated to make this study possible.

## INTRODUCTION

Thyroidectomy is a frequently performed surgery all over the world. Numerous complications plague the surgeon post thyroidectomy. One forgotten and usually ignored complication is voice change. This can either be due to recurrent laryngeal nerve injury or external laryngeal nerve injury. The pattern of voice change varies in each of these injuries. Identifying the nerves during the surgery and a comprehensive knowledge about the variants of the nerves can be beneficial to the surgeon.

# TABLE OF CONTENTS

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Thyroidectomy is a frequently performed surgery all over the world. Numerous complications plague the surgeon post thyroidectomy. One forgotten and usually ignored complication is voice change. This can either be due to recurrent laryngeal nerve injury or external laryngeal nerve injury. The pattern of voice change varies in each of these injuries. Identifying the nerves during the surgery and a comprehensive knowledge about the variants of the nerves can be beneficial to the surgeon.

## ANATOMY

The word thyroid is derived from the Greek word thyreos which means shield [1]. The Germans call it the *Schilddruse,* which also means shield [1]. The normal thyroid gland weighs about 20 g and is a highly vascular structure owing to its endocrine function. It is intimately related to parathyroid glands, recurrent laryngeal nerves and external laryngeal nerves. The external laryngeal nerve is a branch of superior laryngeal nerve, which in turn is a branch of vagus nerve. The recurrent laryngeal nerve is also a branch of vagus nerve.

The thyroid gland has two types of cells: follicular cells and parafollicular cells, the former secreting thyroid hormones and the latter secreting calcitonin.

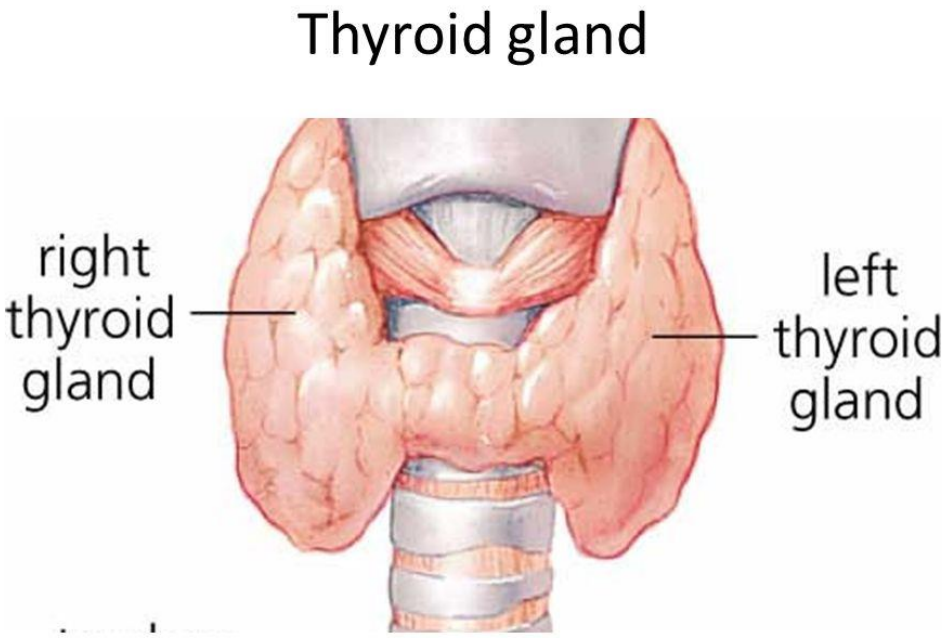



**Figure 1: The Thyroid gland**

## BLOOD SUPPLY OF THYROID

Thyroid has a blood flow rate of 31 ml/min [2]. Thyroid is principally supplied by 2 arteries: Superior thyroid artery and Inferior thyroid artery. It can also be supplied by thyroid ima artery, an inconstant midline vessel.

## ARTERIAL SUPPLY

## SUPERIOR THYROID ARTERY

Superior thyroid artery arises from the external carotid artery in 66.67% of cases. In 31.81% of cases, it arises from the carotid artery bifurcation and in 1.51% of cases, it arises from the common carotid artery [3]. The superior thyroid artery usually originates at the level of upper border of thyroid cartilage. It passes anteroinferiorly to reach the apex of thyroid lobes. There are six branches of superior thyroid artery namely: infrahyoid, sternocleidomastoid branch, cricothyroid branch, superior laryngeal branch and inferior pharyngeal constrictor branch and terminal glandular branches. The terminal glandular branches divide into anterior and posterior branches at the apex of thyroid gland. The ipsilateral anterior branch anastomoses with contralateral anterior branch and the ipsilateral posterior branch anastomoses with ipsilateral branch of inferior thyroid branch. The superior thyroid artery is intimately related to external branch of superior laryngeal nerve. Various patterns of relation exist between the superior thyroid artery and external branch of superior laryngeal nerve.

## INFERIOR THYROID ARTERY

In 85% of people, inferior thyroid artery arises from thyrocervical trunk, a branch of subclavian artery. But in 15% of people, the inferior thyroid artery arises directly from the subclavian artery [4]. The inferior thyroid artery passes posteromedial to carotid artery and internal jugular vein and pierces the prevertebral fascia. It is intimately related to recurrent laryngeal nerve. The inferior thyroid artery, in addition to supplying the thyroid, also supplies the parathyroid glands.

## THYROID IMA ARTERY

It is an unpaired and inconstant artery which may arise from brachiocephalic artery, right common carotid artery or even from the aortic arch. Its prevalence is about 10% [5].

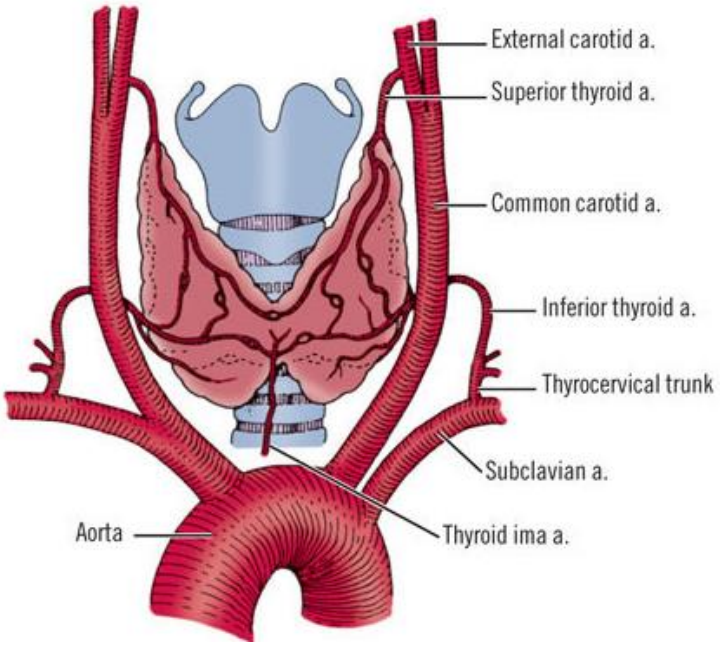



**Figure 2: Thyroid blood supply – anterior view**

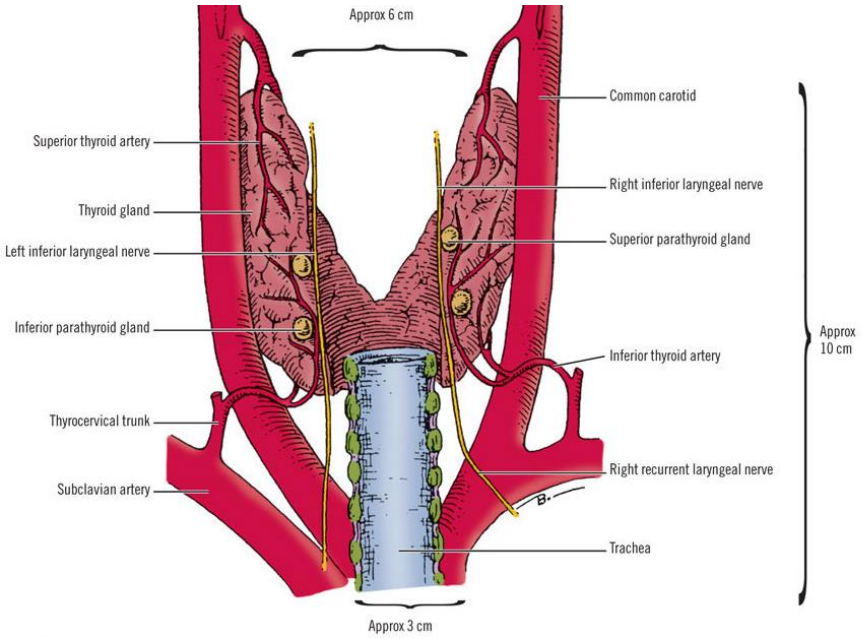


**Figure 3: Thyroid blood supply – posterior view**

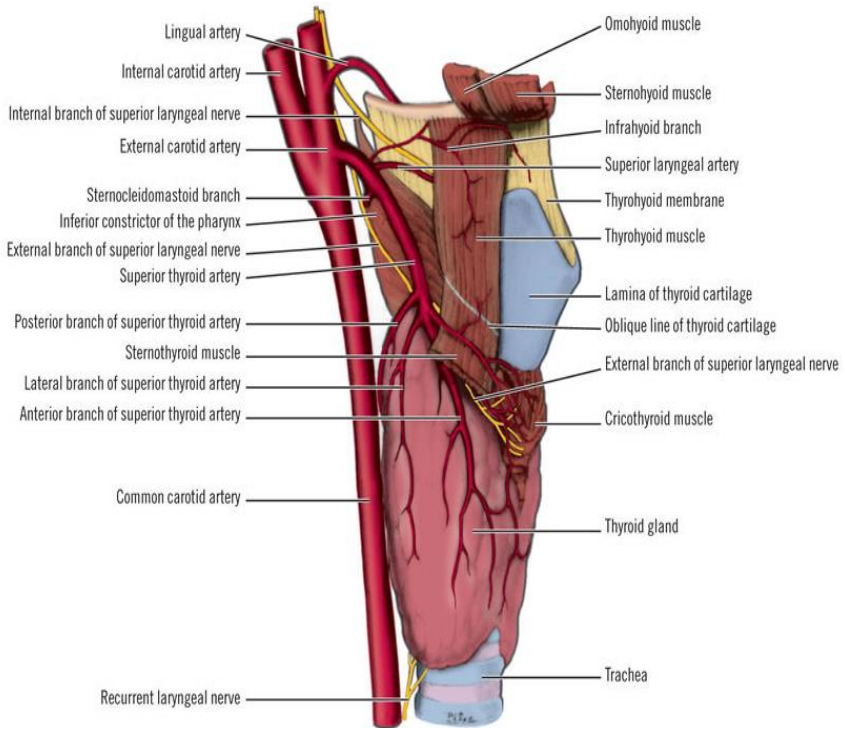



**Figure 4: Thyroid blood supply – lateral view**

## VENOUS DRAINAGE

Venous drainage of thyroid starts as a vascular plexus on the surface of the gland. Superior thyroid vein escorts the superior thyroid artery and exits from the upper pole of thyroid to drain into internal jugular vein or the facial vein. The middle thyroid vein which is not accompanied by any artery drains from the lateral surface of the thyroid gland into the internal jugular vein. The inferior thyroid vein, which is the largest of the thyroid

veins, drains into brachiocephalic veins[6]. The fourth thyroid vein which is occasionally present, lies between middle thyroid vein and inferior thyroid vein.

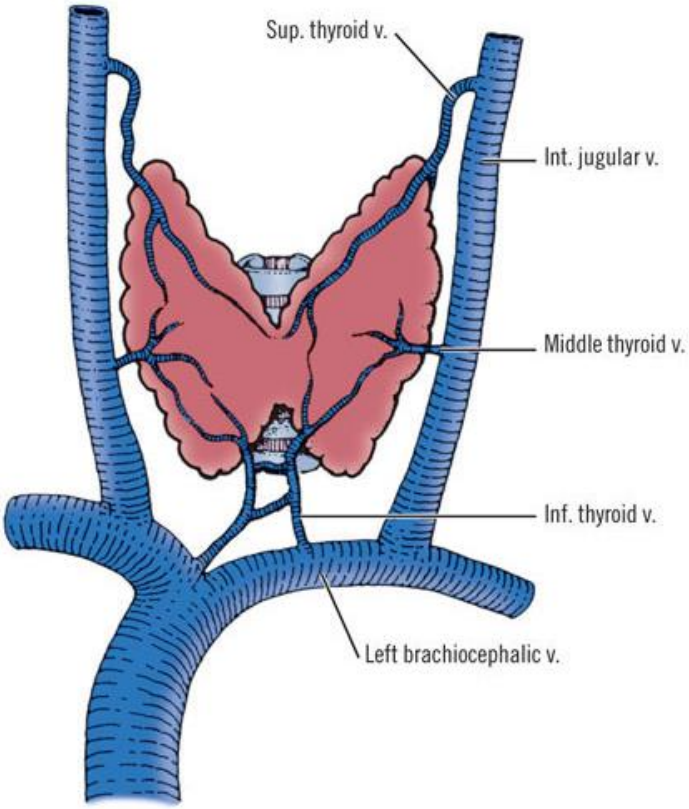



**Figure 5 : Venous drainage of thyroid**

## LYMPHATICS

The thyroid gland has a rich network of lymphatics and they predominantly drain into pretracheal and prelaryngeal lymph nodes. These nodes in turn drain into level 2,3,4,5 and mediastinal nodes.

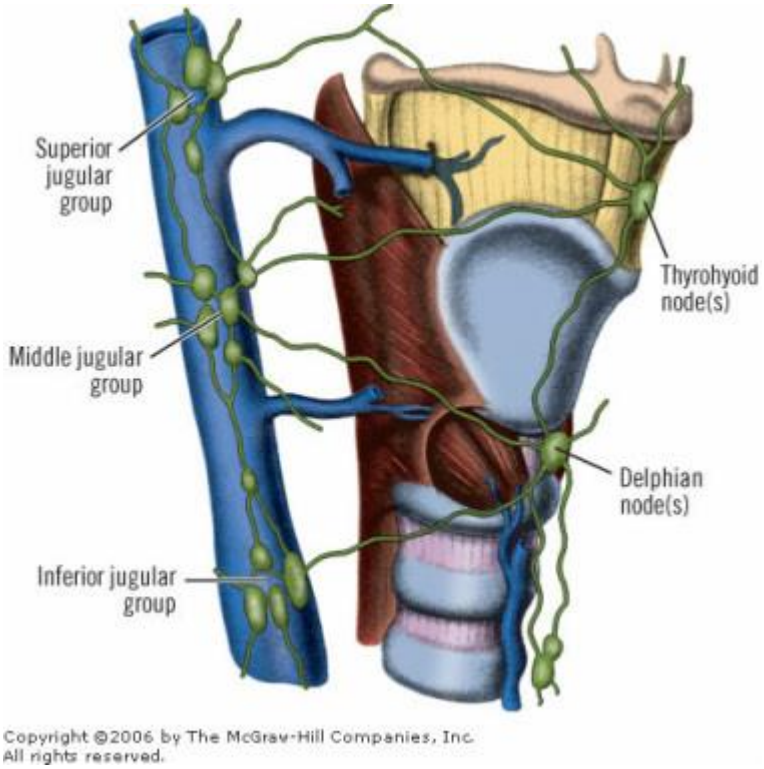



**Figure 6 : Lymphatics of thyroid**

## INNERVATION

The thyroid gland is supplied by sympathetic cervical chain comprising of superior, middle and inferior ganglia. But the recurrent laryngeal nerve and superior laryngeal nerve, which has no role in innervation of thyroid, are the most important nerves for surgeons during thyroidectomy surgeries.

## RECURRENT LARYNGEAL NERVE

Recurrent laryngeal nerve was first described by Galen by stopping a pig squealing by cutting its recurrent laryngeal nerve in front of live audience [7]. This nerve is also known as the inferior laryngeal nerve. The RLN arises from the vagus nerve and recurs around

the subclavian artery in the right and the aortic arch on the left. The RLN, before penetrating the larynx, ascends in the tracheoesophageal groove while crossing the inferior thyroid artery [8]. Simon et al found the most common relation of inferior thyroid artery to RLN is the nerve passing posterior to the branches of inferior thyroid artery [9] but the nerve can also pass anterior or between the branches of inferior thyroid artery.

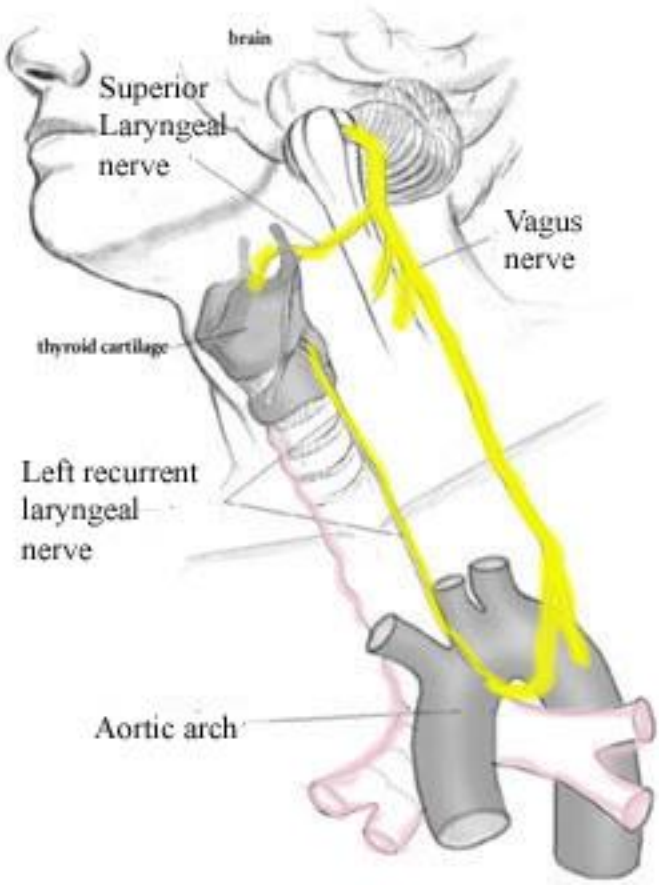



**Figure 7 : Recurrent laryngeal nerve**

**SUPERIOR LARYNGEAL NERVE**

Superior laryngeal nerve arises just external to the jugular foramen of the skull from the nodose ganglion of the vagus nerve. It divides into a motor external laryngeal nerve and a sensory internal laryngeal nerve at the level of superior cornu of hyoid bone.

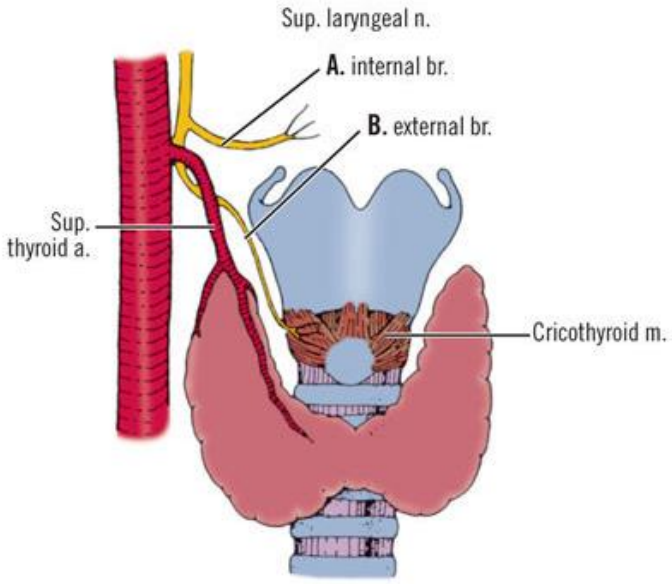



**Figure 8 : Superior laryngeal nerve**

## INTERNAL LARYNGEAL NERVE

The internal laryngeal nerve penetrates the thyrohyoid membrane and carries sensory fibres to the larynx.

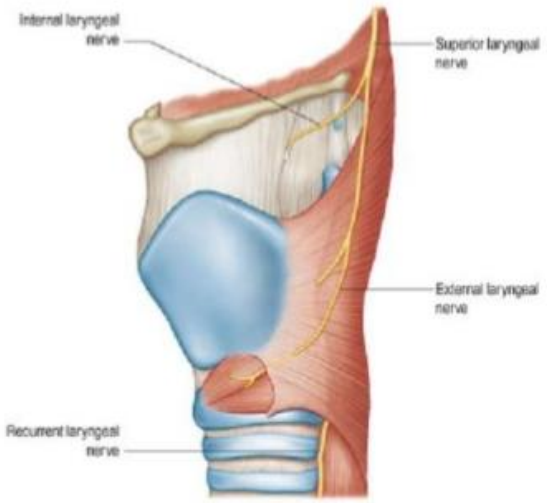



**Figure 9 : Internal laryngeal nerve**

## EXTERNAL LARYNGEAL NERVE

The external laryngeal nerve passes under thyrohyoid muscle after passing posteromedial to Superior thyroid vessels to innervate the cricothyroid muscle. The external laryngeal nerve is said to lie in the Joll's triangle. The Joll's triangle is bounded laterally by the upper pole of thyroid and STA, medially by the midline and superiorly by the strap muscles getting attached to the thyroid cartilage. The floor of the triangle is formed by the cricothyroid muscle which is supplied by the external laryngeal nerve [10]. The external laryngeal nerve supplies the cricothyroid muscle. Injury to this nerve will make the patient to have a breathy voice and inability to attain high pitched sounds.

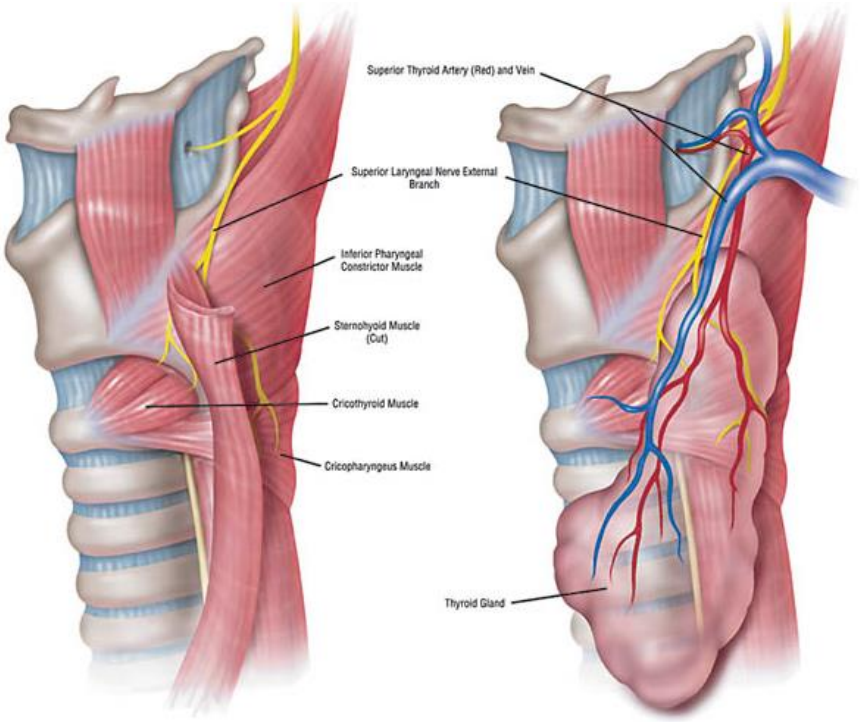



**Figure 10: External laryngeal nerve**

Different classification systems [ Cernea, Kierner, Friedman] have been used to describe the course of external branch of superior laryngeal nerve in relation to superior thyroid artery.

## EMBRYOLOGY

The thyroid gland appears as an epithelial thickening in the floor of primitive pharynx by the end of 3rd week. The foramen caecum of the tongue is the place of origin of thyroid gland. Due to cranial growth of tongue and elongation of embryo, the gland gets displaced

caudally. The vagus nerve forms by the end of fifth week. The superior laryngeal nerve is a component of 4th pharyngeal arch whereas the recurrent laryngeal nerve is a component of 6th pharyngeal arch. As the embryo grows, the larynx stays cranially and the aortic arch and the associated vessels along with the vagus moves caudally into the thorax. So, the laryngeal nerve which initially went directly to the larynx now recurs to form the classical loop of recurrent laryngeal nerve [11]. The neural crest gives rise to parafollicular C cells and these become included in the thyroid gland to secrete calcitonin.

**THYROID HISTOLOGY**

The thyroid gland is made up of variably sized follicles and shaped round or ovoid. The follicles are lined by cuboidal cells. These cells have pale staining cytoplasm. The greater is the gland's activity, the greater is the amount of cytoplasm. The cytoplasm also has numerous granules ultrastructurally. These granules are actually accumulated mitochondria. Higher the activity of the follicle, higher the granularity. The intraluminal colloid is pale staining and scalloped in areas of the follicle which are extremely active.

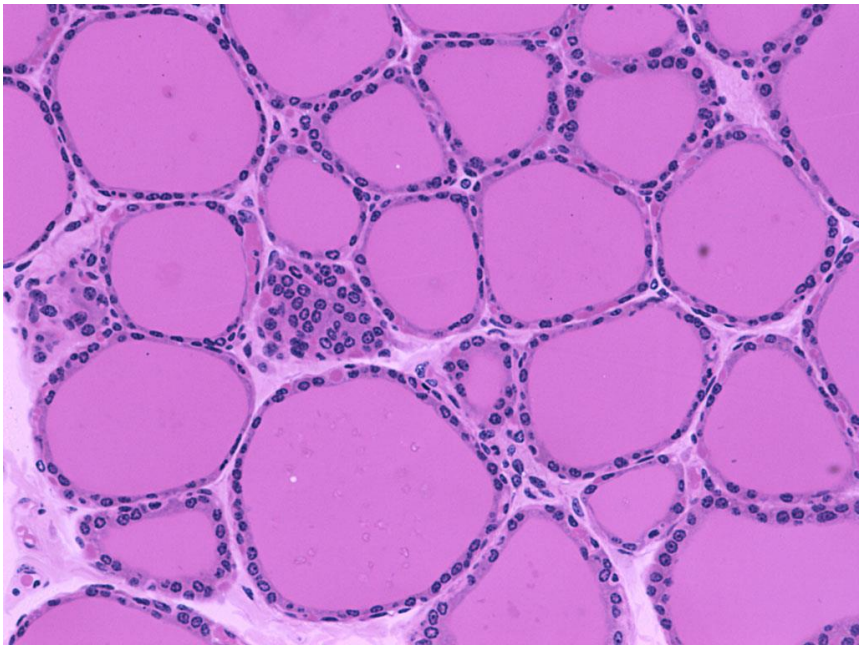


**Figure 11: Normal thyroid follicles**

## PHYSIOLOGY

The thyroid gland secretes thyroxine(T4) and triiodothyronine(T3).

Steps of thyroid hormone synthesis:

- Trapping of iodide – it is an energy dependent mechanism by which iodide is actively transported into follicular cells. This mechanism is inhibited by thiocyanates and flouroborates.

- Oxidation of iodide – iodide is oxidised into iodine by an enzyme called thyroid peroxidase. This step is inhibited by most antithyroid drugs like propylthiouracil, carbimazole and methimazole.
- Coupling – mono and di iodotyrosines are coupled in various ways to form thyroxine(T4) and tri iodothyronine(T3)
- The formed thyroid hormones are stored with thyroglobulin and released in times of need. This step is inhibited by Lugol's iodine.

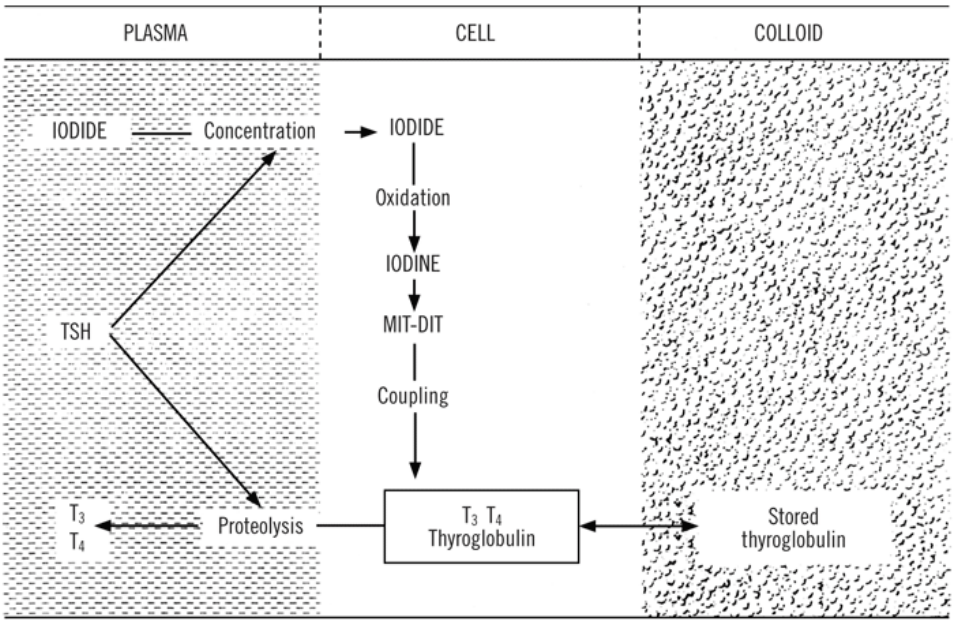



**Figure 12: Normal thyroid hormone synthesis**

These hormones are measurable in the serum of foetuses as early as11-12 weeks of gestation [12]. These hormones are transported conjugated to 3 types of proteins: albumin, prealbumin and globulin. Among these three, globulin has the highest affinity for thyroid

hormones. T4 is most bound to globulin and least bound to albumin. T3 is most bound to albumin and least bound to prealbumin.

Thyroid hormones are master hormones which are essential for normal growth and regulation of metabolic processes. Thyroid hormones act via nuclear receptors and exert their actions on various systems in a tightly controlled manner. Thyroid hormones increase the Basal Metabolic Rate(BMR) by increasing the ATP production necessary for all metabolic processes [13]. Thyroid hormones have their hands on carbohydrate, fat, protein metabolism.

**METABOLIC EFFECTS OF THYROID HORMONES**

- Increases glycogenolysis
- Increases gluconeogenesis
- Increases lipolysis
- Increases protein synthesis
- Increases growth of bones
- Increases ionotropicity of heart
- Increases basal metabolic rate

## REGULATION OF THYROID HORMONES

Thyroid hormones are controlled by TSH – Thyroid Stimulating Hormone, secreted by anterior pituitary cells called thyrotropes, via a negative feedback mechanism. TSH in turn is controlled by Thyrotropin Releasing Hormone(TRH) secreted by hypothalamus by a negative feedback loop

## GOITRE

Goitre is derived from the latin word *guttur* which means throat [14]. Normal gland with a discrete nodule is called solitary goitre. Otherwise abnormal gland with discretely palpable nodules is called dominant nodule. Goitre can have various causes. The most common ones are simple(euthyroid), toxic, inflammatory and neoplastic.

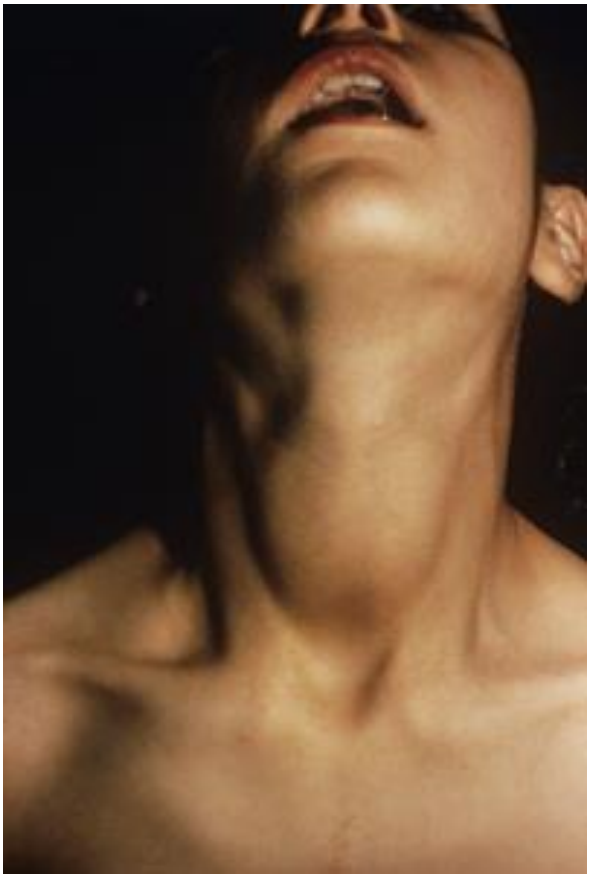


**Figure 13 : Goitre**

Simple Goitre

Simple goitre can be physiological, pubertal or can be due to pregnancy. Simple goitre occurs as a result either due to iodine deficiency in endemic areas which causes increase in TSH, which in turn stimulates thyroid follicles or due to TSH producing adenomas in pituitary gland. Iodine deficiency occurs in mountainous areas where the population's staple food are inherently low in iodine content. Calcium is also goitrogenic and so, goitre

can also occur in areas rich in limestone. Other well known goitrogens are cabbage and drugs like para amino salicylic acid.

Dyshormogenesis is one another cause of simple goitre. This is most often associated with a family history because of genetic defects.

Toxic goitre

Toxic goitre can be diffuse toxic goitre(Grave's disease), toxic multinodular goitre or toxic adenoma.

Grave's disease

Grave's disease is the most common cause of hyperthyroidism is North America [15]. Grave's disease was first described by Robert Graves. Grave's disease is a triad which comprises hyperthyroidism, ophthalmopathy and dermopathy. Grave's disease is basically due to antibodies against TSH receptor which activate the TSH receptor causing increased thyroid hormone production by the gland. The antibodies can be TSH binding immunoglobulin, Thyroid growth stimulating immunoglobulin or TSH binding inhibitor

inhibiting immunoglobulin. As it is an autoimmune disease, it can also be associated with other autoimmune diseases like pernicious anemia, type 1 diabetes mellitus and addison's disease [16]. It is the higher extreme of autoimmune thyroiditis spectrum with Hashimoto's disease in the lower end of the spectrum. A patient with Grave's disease can have insomnia, irritability, palpitations, blurring of vision, heat intolerance, diarrhoea, amenorrhoea, infertility, tremors and fatigue. They can also have opthalmopathy – proptosis, which is characteristic of Grave's disease. Dermopathy can occur as pretibial myxedema and thyroid acropachy.

Grossly, the gland appears grey and diffusely enlarged. Under microscope, the glands are hyperplastic and there is scalloping of colloid.

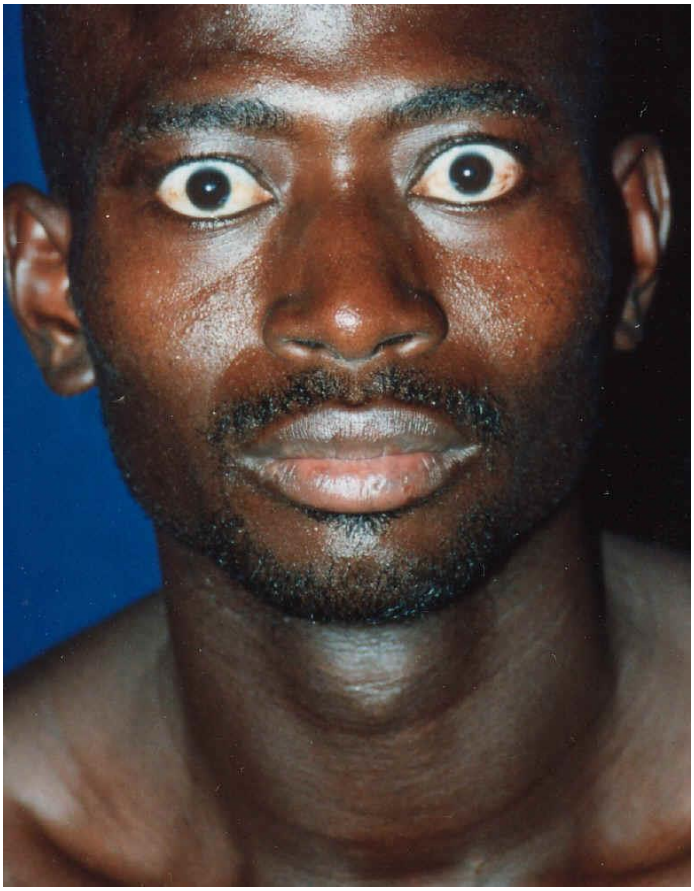


**Figure 14 : Grave's disease**

Toxic nodular goitre

Nodule formation is a predominant feature of this condition which is most often due to intermittent TSH stimulation by iodine deficiency. Preferential multiplication of different clones of daughter follicles produce clinically evident nodules. Toxic adenoma is an autonomously functioning thyroid nodule. Grossly, there are numerous nodules and there is disparity in size between the two lobes of the gland. The capsule is stretched but is intact. Secondary changes like haemorrhage, calcification and cystic degeneration can be seen in the nodules.

Inflammatory goitre

Hashimoto's thyroiditis

It is the most common cause of hypothyroidism in iodine replete areas [17]. It is associated with HLA DR5 phenotype [18]. This condition is also known by the names lymphocytic thyroiditis and struma lymphomatosa. It is most often due to antibodies against thyroid peroxidase. Patients with Hashimoto's disease are usually hypothyroid but can also be hyperthyroid during the phase of hashitoxicosis. Patients with Hashimoto's disease also have the risk of developing lymphoma of thyroid. Grossly, there is diffuse enlargement of the gland with the cut surface of the gland virtually resembling a lymph node. Histologically, there is extensive infiltration by lymphocytes of the gland and there can also be formation of germinal centres. The cells lining the follicles display extensive oncocytic changes. Complications of Hashimoto's thyroiditis comprise lymphoma and leukemia.

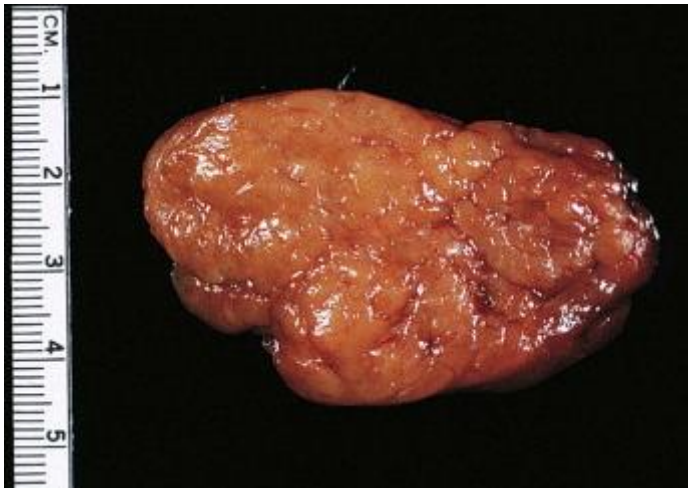


**Figure 15: Macroscopic appearance of Hashimoto's thyroiditis**

Granulomatous (de Quervain's) thyroiditis

It is also known as pseudotuberculous thyroiditis because of richness of granulomas [19]. It is a form of subacute thyroiditis which is painful and unlike Hashimoto's disease, rarely causes permanent hypothyroidism [20]. This disease is characterised by intrafollicular cell infiltration and loss of colloid.

Riedel's thyroiditis

Riedel's thyroiditis is an unusual inflammatory form of thyroiditis involving the thyroid and can also involve the extrathyroidal tissues like malignancy. It is a condition which can be associated with other forms of systemic fibrosis like retroperitoneal fibrosis. It can also involve the parathyroidal glands. The inflammatory tissues give rise to a hard woody feeling. This condition can present with dyspnea, dysphonia, hoarseness of voice which almost mimics like malignancy of thyroid gland. Histologically, the thyroid gland has extensive fibrosis causing colloidal atrophy. There can even be thrombosis of veins. Patients can have hypothyroidism and hypocalcemia [21]. Patients can also have acute presentation like stridor which will necessitate an emergency tracheostomy. Steroids and tamoxifen are found to have a role in the treatment of Riedel's thyroiditis [22].

NEOPLASTIC GOITRE

BENIGN NEOPLASMS

FOLLICULAR ADENOMA

Follicular adenoma of the thyroid is a benign, encapsulated neoplasm with no vascular or extracapsular invasion [23]. This can be differentiated from follicular carcinoma by histological examination and not by cytological examination. It is the most common neoplasm involving the thyroid gland. Follicular adenomas are usually euthyroid. But if hyperthyroid, it is called toxic adenoma also known as Plummer's disease.

Most patients present with a solitary nodule. Histologically, the adenoma is encapsulated and there is complete intactness of the capsule which is a differentiating factor compared to follicular carcinoma. Treatment of follicular adenoma is hemithyroidectomy which gives the histological picture to differentiate the neoplasm from follicular carcinoma.

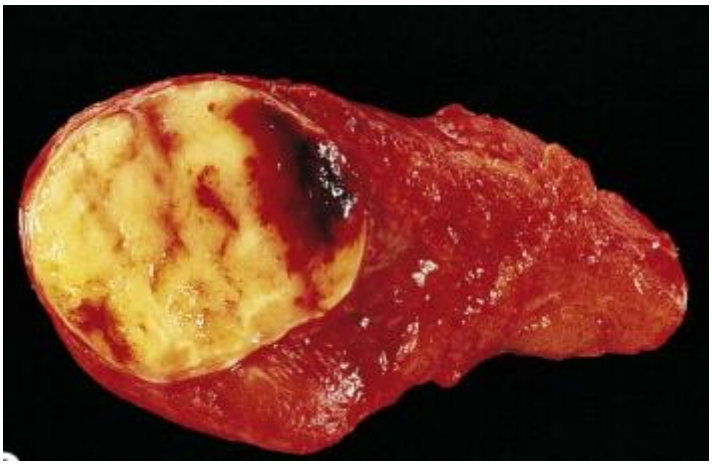


**Figure 16 : Follicular adenoma**

MALIGNANT NEOPLASMS

Risk factors for malignant neoplasms of thyroid include age, radiation history, family history of thyroid nodules. Around 10-15% of thyroid nodules are malignant [24]. patients who present with thyroid nodules and who age more than 70 and less than 14 are at increased risk for thyroid malignancy [25]. Family history of thyroid cancer in first degree relatives is also a specific risk factor for thyroid malignancies. History of irradiation particularly to head and neck is also an important risk factor. Clinical examination findings which suggest the possibility of malignancy include hard thyroid, hard cervical lymphadenopathy and vocal cord palsy.

Dunhill historically classified thyroid malignancies into differentiated and undifferentiated tumors. Differentiated malignancies are of 2 basic types : follicular and papillary. Other tumors are undifferentiated tumors and anaplastic carcinomas. Medullary carcinomas are derived parafollicular cells.

## DIFFERENTIATED THYROID TUMORS

The most common differentiated thyroid tumor is papillary carcinoma which has an incidence of 80-85% [26]. The second most common thyroid tumor is follicular carcinoma which has an incidence of 10-15% [26].

## PAPILLARY CARCINOMA

### PATHOLOGY:

Grossly, papillary thyroid carcinomas can have a variety of appearances ranging from subscapular scar to huge nodules. They can also have cystic degeneration and calcification. Microscopically, there are numerous papillae, which if absent, represent a variant of PTC, called follicular variant of PTC. The most characteristic feature of PTC is Orphan Annie nuclei [27], where the nucleus is cleared out giving a ground glass

appearance, as the chromatin is finely dispersed and lies in the margin of nuclear membrane. Other characters are nuclear grooving and intranuclear pseudoinclusions [27]. There are many variants of papillary carcinoma which include papillary microcarcinoma, encapsulated variant, follicular variant, diffuse sclerosing variant, oncocytic variant, tall cell variant and cribriform-morular variant.

Extrathyroidal extension is found in 25% of cases [28]. Cervical lymphadenopathy is extremely common in papillary carcinoma and may be the only presenting feature in this tumor. Hematogenous metastasis is not unusual in papillary carcinoma but relatively rare compared to other carcinomas. The most common site of blood borne metastasis is lungs.

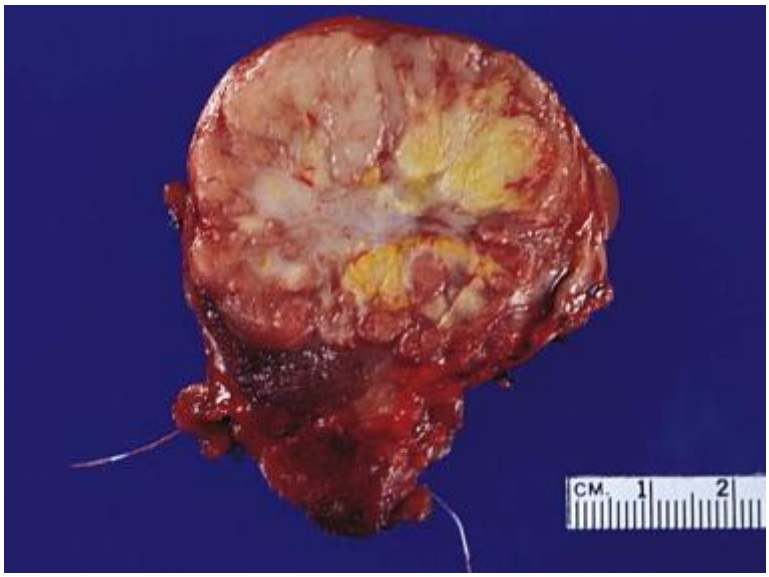



**Figure 17 : Gross appearance of papillary carcinoma**

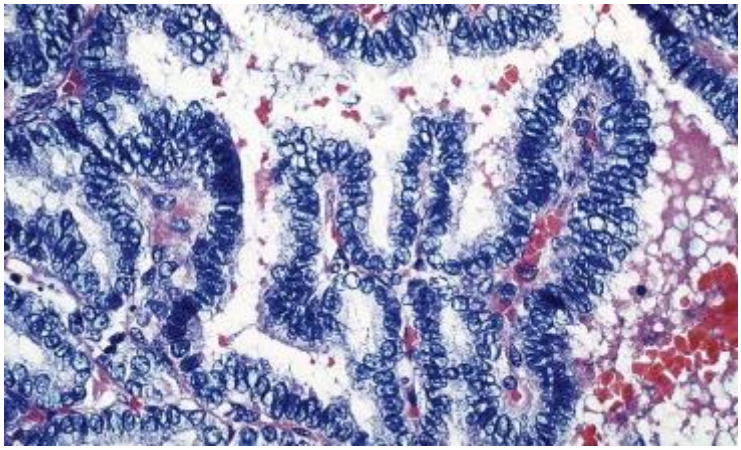


**Figure 18 : Microscopic appearance of papillary carcinoma**

FOLLICULAR CARCINOMA

Follicular carcinomas are malignancies with cells having follicular differentiation. Its identification is relied upon vascular and capsular invasion and adjacent thyroid. Compared to papillary carcinomas, they occur a decade later [29].

Histologically, the tumor can have focal or diffuse cytoplasmic changes. Psammoma bodies are lacking. Mitotic activity and nuclear atypia may or may not be seen. Follicular

carcinoma can be further divided into minimally invasive and widely invasive follicular carcinoma.

Minimally invasive follicular carcinoma can be grossly encapsulated, almost resembling an adenoma. It can indeed be the malignant transformation of follicular adenoma. So, the diagnosis of follicular carcinoma depends entirely on the capsular and vascular invasion [30]. Widely invasive follicular carcinoma shows extensive vascular invasion and thyroid tissue.

Follicular carcinomas are mostly solitary lesions. Metastases are usually hematogenous in contrast to papillary carcinoma, the most common site being lung. The bony metastases are commonly multicentric and pulsatile similar to renal cell carcinoma.

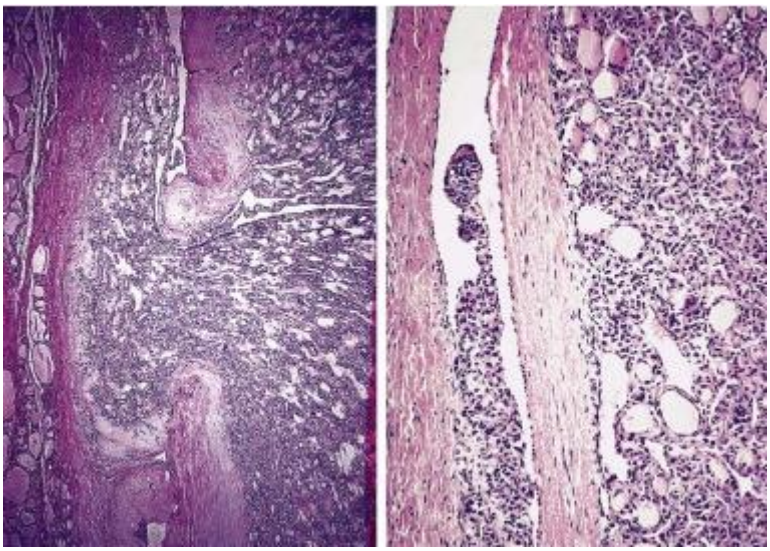


**Figure 19 : Follicular carcinoma**

POORLY DIFFERENTIATED CARCINOMA

Theses tumors lie in the spectrum between well differentiated tumors(papillary and follicular) and undifferentiated tumors(anaplastic carcinoma). Insular carcinoma is one among the poorly differentiated tumrors which behave aggressively clinically and pathologically [31]. Insular carcinomas have a necrotic background and variable nuclear atypia.

UNDIFFERENTIATED CARCINOMA

Also known as anaplastic carcinoma. It is an extremely aggressive carcinoma with hoarseness, dyspnea and dysphagia as the intial presentation. There are two variants of anaplastic carcinoma : squamoid – which has undifferentiated cells but still has an epithelial appearance, and sarcomatoid – which has spindle cell like pattern and differentiation into bone, cartilage or skin [32].

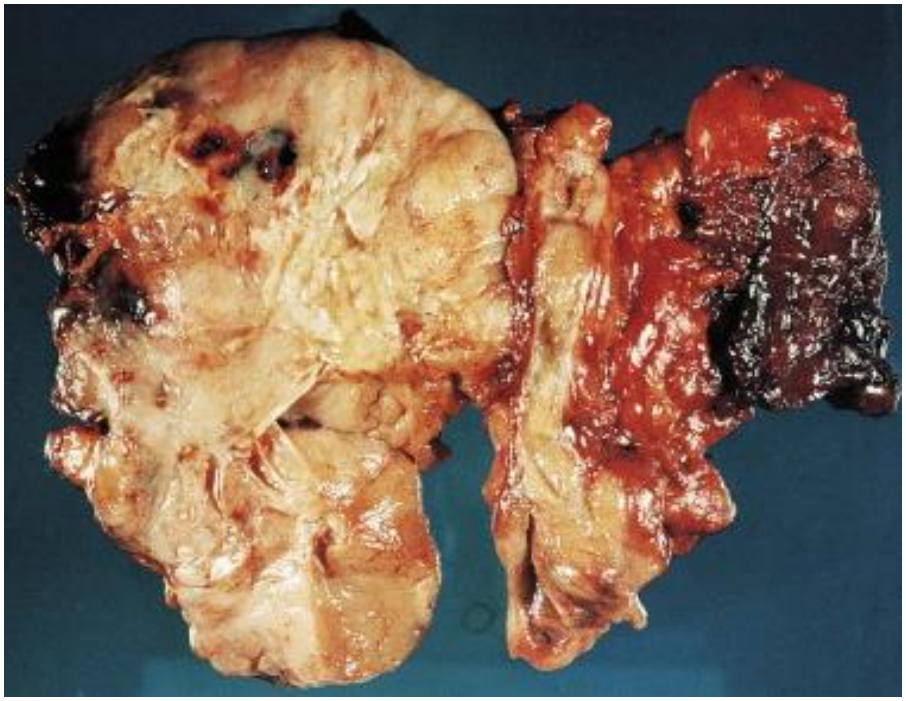


**Figure 20 : Anaplastic carcinoma**

MEDULLARY CARCINOMA

Medullary carcinoma is the tumor of parafollicular C cells in thyroid. It has also been called as C cell carcinoma and hyaline carcinoma [33]. Medullary carcinoma can occur as a sporadic carcinoma or as a hereditary form associated with MEN2a and MEN2b [34]. The mutation which is responsible for inherited form of medullary carcinoma is called RET gene, found in chromosome 10. The tumor is usually non encapsulated and gray colored in cut section. If it is encapsulated, it is called encapsulated variant of medullary carcinoma. When the tumor is less than 1 cm, it is called medullary microcarcinoma [35].

Microscopically, the tumor has small round cells with granular cytoplasm and moderately sized nucleus and the cells are separated by hyalinised collagen, hence the name hyaline carcinoma. In FNAC specimens, cells of medullary carcinoma have eccentric nuclei, unremarkable nucleoli, neuroendocrine like chromatin with a clean background [36].

Medullary carcinoma can spread to cervical and mediastinal lymph nodes. They can also present with distant metastases like lung, liver and bone metastases.

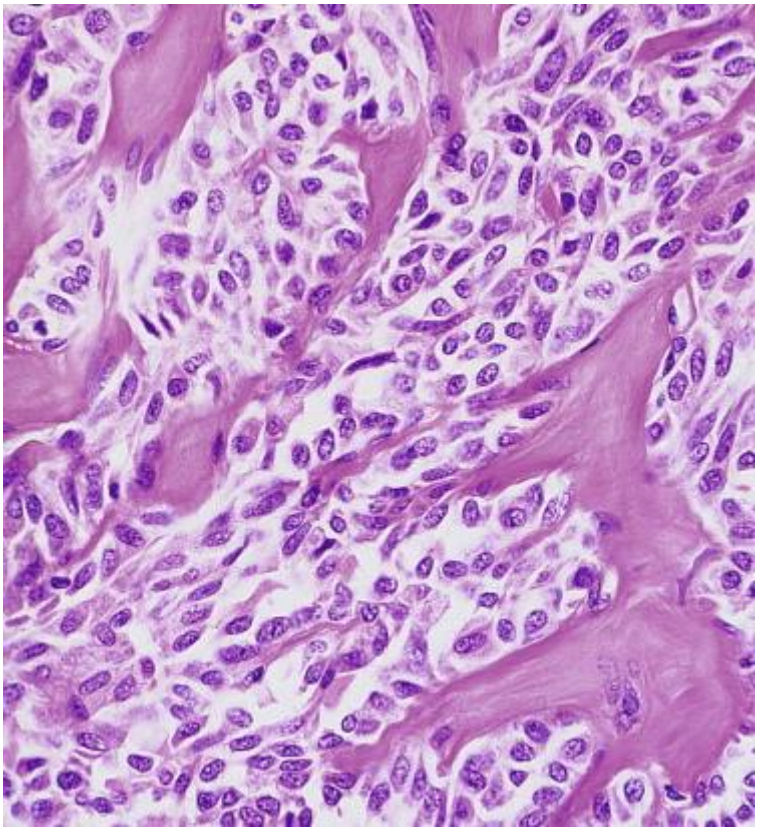


**Figure 21 : Medullary carcinoma**

INVESTIGATIONS FOR THYROID DISEASE:

The battery of investigations for thyroid disease is large. So, the ivnestigations should be kept to the least to design a management plan.

SERUM THYROID HORMONES:

| *TSH* | *T3,T4* | *INTERPRETATION* |
|---|---|---|
| *High* | *High* | *Secondary hyperthyroidism* |
| *Low* | *Low* | *Secondary hypothyroidism* |
| *Low* | *High* | *Primary hyperthyroidism* |
| *High* | *Low* | *Primary hypothyroidism* |
| *High* | *Normal* | *Subclinical hypothyroidism* |
| *Low* | *T4 – normal*<br>*T3 – high* | *T3 toxicosis – earliest stages of primary hyperthyroidism* |

Serum markers:

- Serum thyroglobulin is done post operatively for thyroid neoplasms to gauge left out thyroid tissue
- Thyroid peroxidase antibodies – can be seen in Hashimoto's disease, but can also be seen in Grave's disease
- Serum calcitonin – a marker for medullary thyroid carcinoma, as it secreted by parafollicular C cells, from which medullary cancer arises.

# THYROID IMAGING:

## Chest radiograph:

For identification of retrosternal extension and pulmonary metastases in thyroid malignancies

## Ultrasonogram of neck:

Ultrasonogram is a cheap and economic investigation for swellings of the thyroid. It is also useful to evaluate parathyroid adenomas and lymphatic groups in case of thyroid malignancy.

American Thyroid Association divides the imaging features of thyroid into five types.

- High suspicion nodules are the ones which are hypoechoic and with microcalcifications, hypoechoic nodules with irregular margins, hypoechoice nodules with soft tissue extensions, hypoechoice nodules with cervical nodes, taller than wide nodules. These nodules are associated with 70-90% malignancy risk.
- Intermediate suspicion nodules are nodules which are hypoechoic with regular margins. These are associated with 10-20% malignancy risk

- Low suspicion nodules are the ones which are hyperechoic with regular margins, isoechoic nodules with regular margins, partially cystic nodules with eccentric solid areas. These nodules are associated with 5-10% malignancy risk
- Very low suspicion nodules are the ones which are spongiform, partially cystic with no suspicious features. These nodules are associated with less than 3% malignancy risk
- Benign nodules are usually completely cystic and are associated with less than 1% malignancy risk.

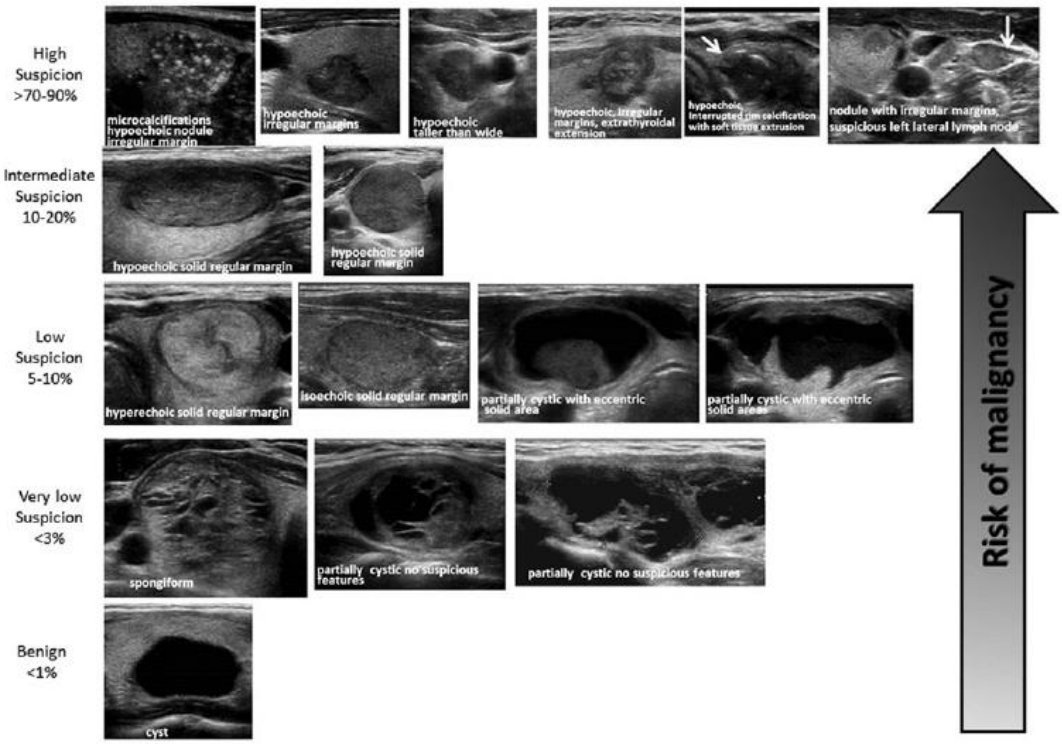



**Figure 22 : USG features of thyroid malignant nodules**

COMPUTED TOMOGRAPHY and MAGNETIC RESONANCE IMAGING:

These are used when there is necessity to assess the extent of malignancy and also for retrosternal extension.

## THYROID SCINTIGRAPHY:

Radioactive iodine and technetium are used in scintigraphy. These compounds are taken up the symporter in follicular cells, with the only difference that the latter is not organified.

## INDICATIONS FOR THYROID SCINTIGRAPHY:

- Grave's disease
- Multinodular goitre – to look for functional status
- Solitary thyroid nodule
- Congenital hypothyroidism
- Ectopic thyroid

- Thyroid malignancy – post surgery

FINE NEEDLE ASPIRATION CYTOLOGY:

FNAC has a sensitivity of 90% and specificity of 95%. FNAC is the initial investigation of choice in most of the euthyroid goitres.

Bethesda system of FNAC reporting:

1. Non diagnostic or unsatisfactory
2. Benign
3. Atypia of undetermined significance or follicular lesion of undetermined significance
4. Follicular neoplasm or suspicious of follicular neoplasm
5. Suspicious for malignancy
6. Malignant

Indications for FNAC:

- Diffuse non-toxic goitre to differentiate colloid goitre and autoimmune thyroiditis
- In small solitary nodules of thyroid, to differentiate benign and malignant nodules to avoid unnecessary surgery
- In confirming the type of malignancy, thereby helping in planning the surgery

The conditions that can be diagnosed solely with FNAC are colloid goitre, autoimmune thyroiditis, papillary and medullary neoplasms, anaplastic carcinoma and last but not the least, lymphoma.

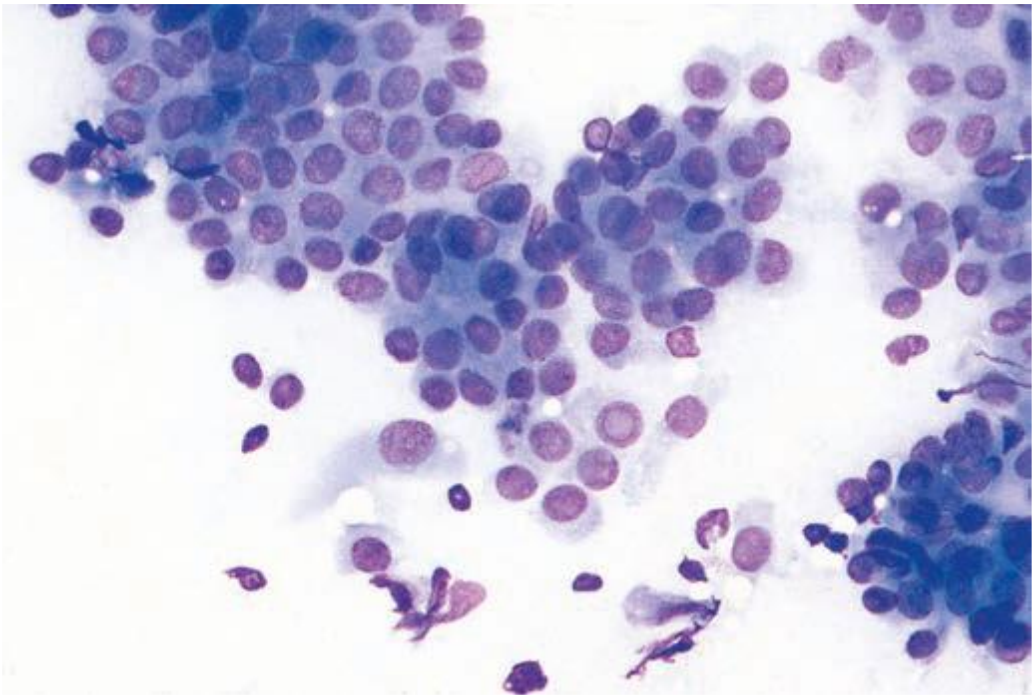


**Figure 23 : Thyroid cytopathology**

CYTOLOGICAL CHARACTERISTICS OF VARIOUS DISEASES OF THYROID:

SUBACUTE GRANULOMATOUS THYROIDITIS:

- Large granulomas with numerous nuclei with colloid which is phagocytosed
- Degenerate follicular cells
- Inflammatory infiltrate made of macrophages and lymphocytes
- Colloidal debris in the background

HASHIMOTO'S DISEASE:

- Oxyphylic transformation of the follicular cells
- Lymphocytic infiltration of the stroma
- T lymphocytes predominate over B lymphocytes
- Plasma cells, multinucleate giant cells and histiocytes can also be scattered throughout

GRAVE'S DISEASE:

- Hyperplastic follicles
- Prominent papillary infolding, which mimics papillary carcinoma of thyroid
- Columnar epithelium with basal normochromatic or hyperchromatic nuclei
- Cells may contain microvacuolated cytoplasm with fat and glycogen
- Oxyphilic cells may or may not be present

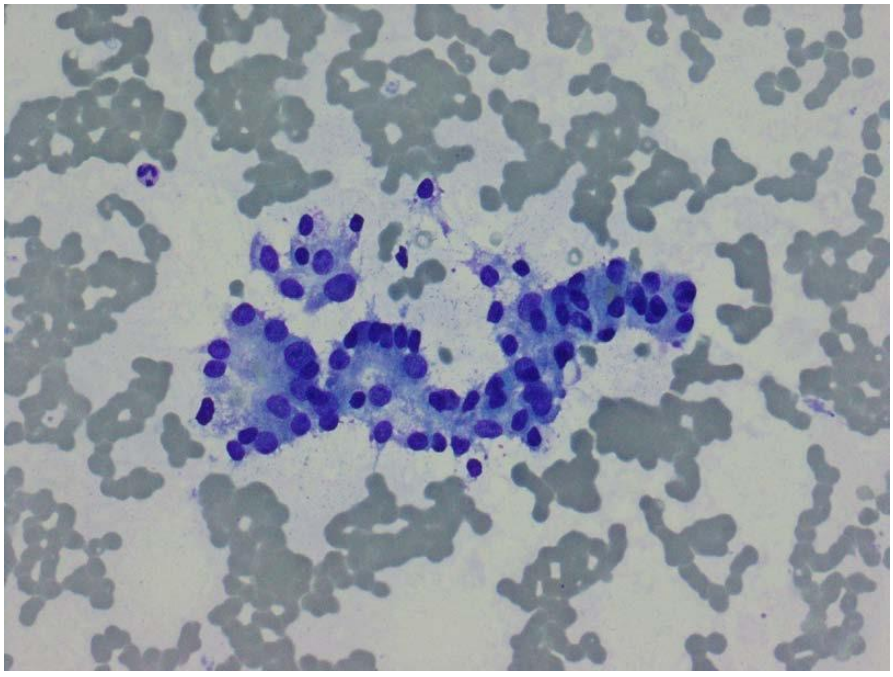


**Figure 24 : Cytopathology of Grave's disease**

SIMPLE GOITRE:

- Abundant colloid with normal appearing follicular cells

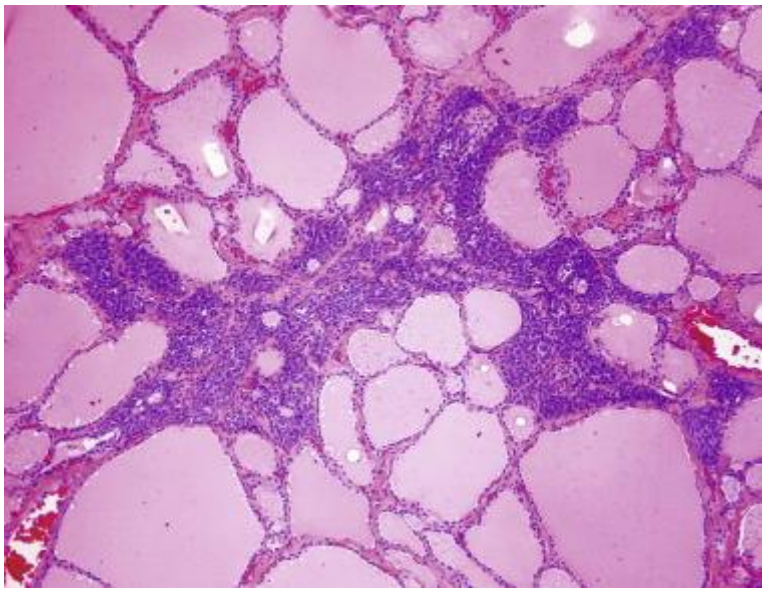


**Figure 25 : Simple Goitre**

MULTINODULAR GOITRE:

- Plentiful thick and thin colloid
- Moderate number follicular cells with loose cohesion between cells
- Both involutional and hyperplastic follicular cells
- Oxyphilic cells may or may not be present
- Degenerate changes

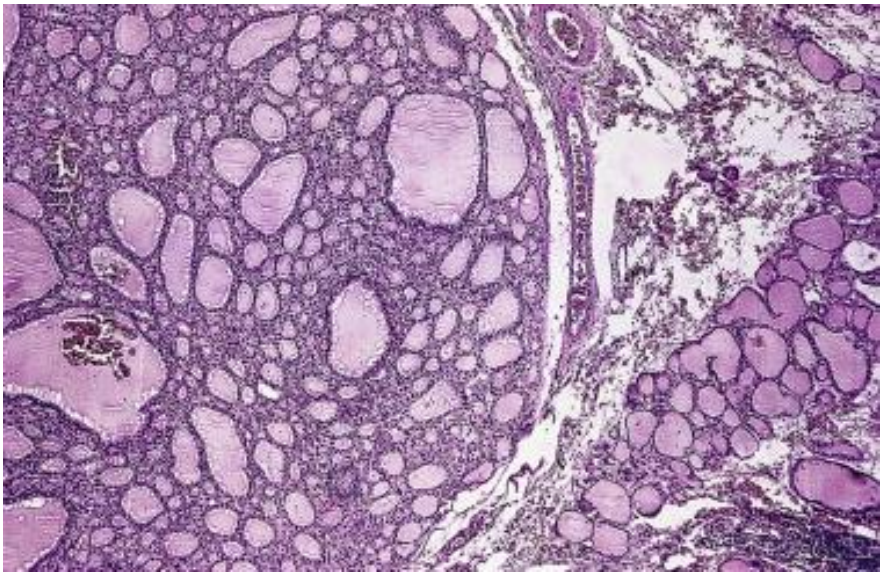


**Figure 26 : Multinodular Goitre**

FOLLICULAR ADENOMA:

- Cellular but often bloody smear
- Identical sized cellular clusters scattered throughout the smear
- Micro follicles
- Scant or null colloid

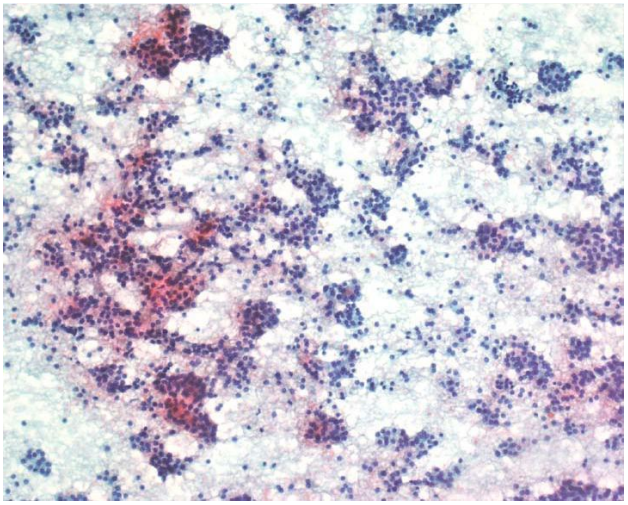


**Figure 27 : Follicular adenoma**

PAPILLARY CARCINOMA:

- Cellular smears
- Syncytial clusters of cells with a clear anatomical border
- Papillary fragment which may or may not exist with a fibrovascular core
- Large ovoid but strikingly pale nuclei
- Fine granular powdery chromatin
- Intranuclear cytoplasmic inclusions and nuclear grooves
- Dense cytoplasm with clear cellular border
- Psammoma bodies

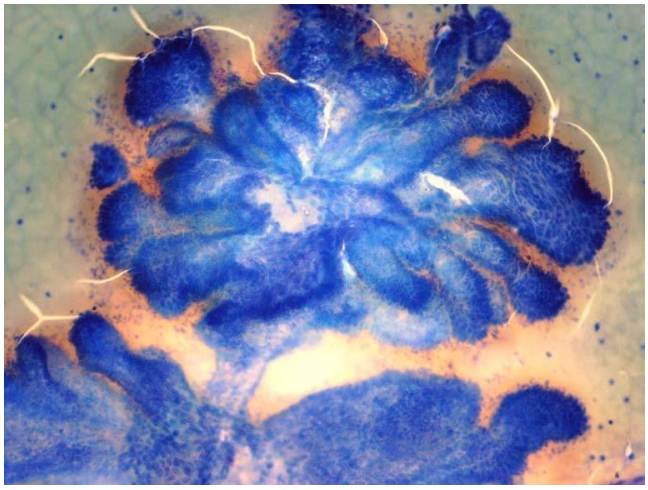


**Figure 28 : Papillary Carcinoma**

ANAPLASTIC CARCINOMA:

- Highly cellular smear
- Bizarre malignant cells with epithelial or sarcomatoid differentiation
- Background can have necrotic material and debris
- Prominent nuclear pleomorphism

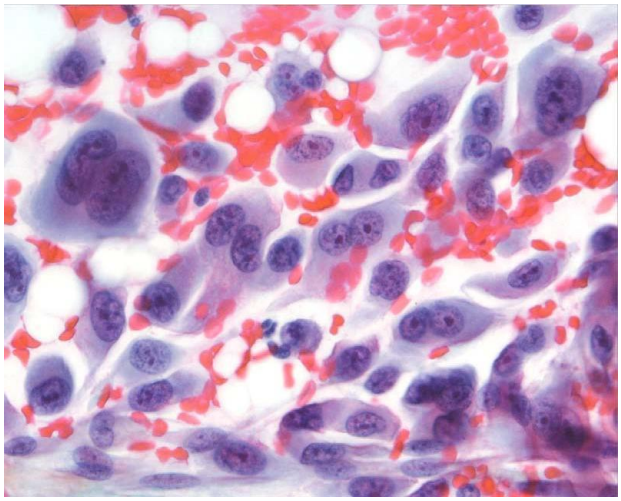


**Figure 29 : Anaplastic Carcinoma**

MEDULLARY CARCINOMA:

- Cellular smears with dispersed cells
- Plasmacytoid, spindle or small cells
- Cells with bi or multinucleate forms

- Uniformly stippled nuclear chromatin
- Amyloid background

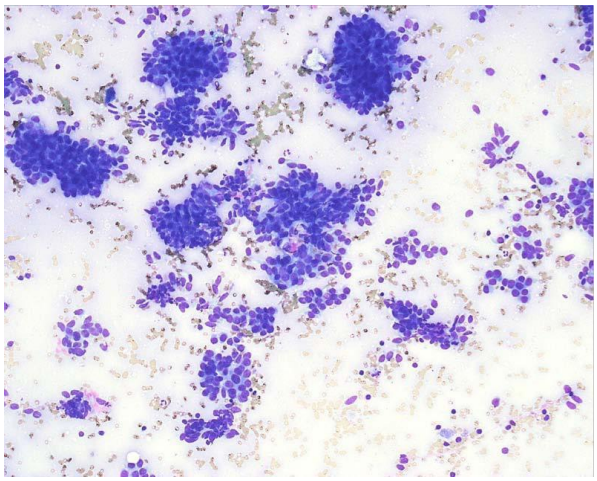


**Figure 30 : Medullary Carcinoma**

THERAPEUTIC APPLICATIONS OF THYROID HORMONES:

The major indications for thyroid hormone as a drug are as hormone replacement therapy in hypothyroid patients or cretins and as suppressive therapy in patients with thyroid malignancy.

The synthetic preparations are available as levothyroxine sodium and liothyronine sodium. Preparations containing a mixture of levothyroxine and liothyronine are also available. Animal derived dessicated thyroid preparations are less appropriate.

THYROID HORMONE REPLACEMENT THERAPY:

Levothyroxine is preferred over liothyronine for replacement therapy because of its unswerving potency and increased duration of action. 50-80% of the drug is absorbed from the gastrointestinal tract which is more when taken on empty stomach. Liothyronine is used when there is need for quick onset of action as in myxedema coma. It is also used when the duration of action requires is short as in patients with thyroid cancer who are being prepared for $I^{131}$ therapy. Otherwise, liothyronine is not preferred because of its expensive nature and frequent dosing.

The average daily requirement of levothyroxine for replacement therapy is 112 μg as a single dose while that of liothyronine is 50-75 μg is in divided doses. The aim is to keep TSH within normal range because suppression of TSH by overdosing can cause complications like osteoporosis and cardiac dysfunction.

ANTI-THYROID DRUGS:

Anti-thyroid drugs are basically classified into four categories:

1. drugs which interfere with synthesis of thyroid hormones
2. ionic inhibitors which interfere with iodide transport mechanism
3. iodine in high concentrations, which decrease thyroid hormone release and also suppress hormone synthesis
4. radioactive iodine, which ablates the thyroid gland

Propylthiouracil, methimazole, carbimazole inhibit iodination of thyroglobulin. Propylthiouracil, in addition to it, also inhibits peripheral deiodination of T4. The most serious complications of these drugs are agranulocytosis. This complication usually occurs in the first few weeks of initiation of therapy, but can also occur later. Complete blood cell count monitoring is essential to avoid this complication. Though this complication is devastating, it is reversible on withholding the drug. Other less common side effects include paresthesias, headaches, nausea.

The classic starting dose of propylthiouracil is 100 mg thrice a day. In simple hyperthyroidism, methimazole is preferred when given once a day in a dose of 10-30 mg.

## THYROIDECTOMY

Pierre Joseph Desault performed the first documented hemithyroidectomy in 1791 [37]. Discovery of iodine from seaweed's burnt ash led to non medical management of some goitres [37]. Emil Theodore Kocher(1841-1917), who is called the father of thyroid surgery and also the first surgeon to receive the Nobel Prize for his contribution to thyroid surgery and thyroid physiology, made way for a safe thyroidectomy. He described *cachexia strumipriva*, what is now called surgical hypothyroidism in patient by the name of Maria

Richsel [38]. It was not until 1914 when Edward Kindall of Mayo Clinic discovered thyroxine, making treatement of hypothyroidism easy and safe [37]

## INDICATIONS FOR THYROIDECTOMY

There are numerous indications for thyroidectomy. The most common indication for thyroidectomy is malignancy. Other common indications are toxic adenoma, pressure symptoms like dysphagia and dyspnea due to a large goitre, medically intractable Grave's disease and hyperthyroidism.

## THYROIDECTOMY

As early as 1170, thyroidectomy was done by cervical incision and inserting two setons at right angles to the thyroid with hot iron and manipulated towards kin twice a day until the gland exits through flesh , according to writings of Roger Frugardi [39]. Less barbaric ways of performing thyroidectomy using a cervical incision was introduced by Desault, who performed partial thyroidectomy using midline longitudinal incision [40].

Theodore Billroth, who was 12 years senior to Theodore Kocher, performed thyroidectomy using an incision parallel to medial border of sternocleidomastoid but with

a 40% mortality rate [40]. Theodore Kocher who had meticulously reduced the mortality rate of thyroidectomy using finer surgical techniques concentrated more on the cosmetic aspects of thyroidectomy incisions. He used a cervical collar incision which provided adequate exposure, but at the same time made him complete the surgery with less cosmetic blemish.

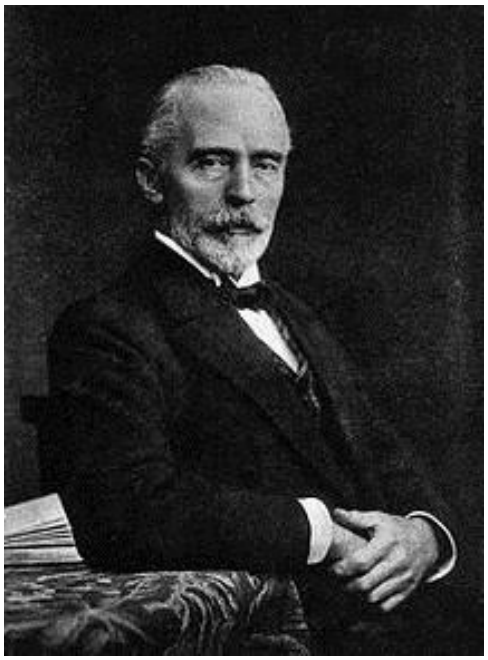


**Figure 31 : Theodor Kocher**

**Figure 32 : Theodor Billroth**

Nowadays surgeons have refined the long classical Kocher's incision into a smaller aptly placed cervical collar incision. Incisions made less than 2 cm or one finger breadth from sternal notch gave rise to high rates of hypertrophic scars, particularly if the incision came to overlie the manubrium [41]. Several techniques have aided the surgeons to place an optimal incision recently. They include 1 cm caudal to cricoid, 3-4 cm above sternal notch, midway between thyroid notch and sternal notch [42]. Based on recommendations made by Sturgeon et al., the optimal incision for thyroidectomy is 1 cm caudal to cricoid cartilage [43]. In supine extended neck, incision can be marked two fingerbreadths above sternal notch or 1 fingerbreadth above sternal notch in neutral upright posture [44].

Because of increasing demand for lesser pain and more comsesis, surgeons have now devised smaller incision without compromising exposure. Ferzli et al. introduced a 3 cm inicision for thyroidectomy and the procedure was named by them as mini thyroidectomy[45].

STEPS OF THYROIDECTOMY:

- Endotracheal general anesthesia is preferred
- Patient is placed with neck in a hyperextended manner
- The incision should be made 2 fingers above the sternal notch or 1 cm below the cricoid
- Incision is deepened sub platysmally in a avascular plane
- Sharp dissection combined with blunt gauze dissection is used to free the superior flap till thyroid cartilage's notch.

- The inferior flap is raised in a similar way along with counter traction from outside till suprasternal notch.
- The deep fascia is opened in the midline between the sternohyoid muscles and the muscles are retracted away
- In case the gland is large, the strap muscles can be divided in the junction of upper and middle third to avoid damaging the muscles' motor supply
- The loose fascia covering the thyroid is divided and pushed apart
- The middle thyroid vein is ligated and divided first to make medial traction easier
- The superior pole's fascia is pushed using blunt dissection and superior thyroid vessels are identified, ligated and divided taking care to avoid injury to external laryngeal nerve
- Next, the inferior pole is dissected to identify the inferior thyroid vessels which are ligated and divided taking care to avoid injury to recurrent laryngeal nerve
- The same procedure is repeated on the other side
- The thyroid tissue is teased off the trachea in an avascular plane
- Parathyroid glands, if found in the specimen are transplanted into sternocleidomastoid muscles
- Hemostasis secured
- Wound cavity irrigated with normal saline and hemostasis rechecked
- Drain is not necessary in a dry field
- Strap muscles are stitched together in midline

- Platysmal layer closed together
- Skin stiched together

POST OPERATIVE COMPLICATIONS:

EARLY POST OPERATIVE COMPLICATIONS:

- Bleeding
- Hematoma
- Respiratory distress
- Injury to recurrent laryngeal nerve or external branch of superior laryngeal nerve
- Hypoparathyroidism and hypocalcemia
- Thyrotoxic crisis

LATE POST OPERATIVE COMPLICATIONS:

- Hypothyroidism
- Hypoparathyroidism
- Recurrence

POST OPERATIVE COMPLICATIONS:

## HEMATOMA:

This may occur due to reactionary haemorrhage from any ligated vascular pedicles or from the surface of the gland or any unnamed veins. This becomes life threatening if it collects under the deep fascia compressing the trachea and causing asphyxiation. This tension hematoma is a surgical emergency. Management requires control of the airway by endotracheal intubation and the patient should be shifted to theatre immediately to re-open the thyroidectomy wound to find the source of the bleed. Intra operative drain placement is not a replacement for achieving perfect hemostasis during the surgery.

## RESPIRATORY DISTRESS:

This is most often due to laryngeal edema and seldom due to tracheomalacia, which is caused by large goitres. The cause of laryngeal edema are tension hematoma, rough handling of thyroid tissues and trachea and a large vascular goitre. Sometimes, elective endotracheal intubation may be necessary until the edema subsides. Steroids are supplemented to reduce the laryngeal edema. Repeat endotracheal intubation, if necessary, should be done very cautiously because, this by itself, can increase the laryngeal edema.

## RECURRENT LARYNGEAL NERVE INJURY:

Unilateral recurrent laryngeal nerve injury is a rare complication if the nerve is routinely identified and preserved intra operatively. Unilateral injury can cause hoarseness of voice. Bilateral nerve injury is devastating as it requires emergency tracheostomy for airway maintenance. RLN injury can be temporary or permanent. Temporary nerve palsy can remain till a month post operatively. So, vocal cord palsy evaluation should be done at least after a month post thyroidectomy. Redo thyroidectomy, neck exploration for hematoma, large goitres and Grave's disease are the conditions which harbour inherent risk of recurrent laryngeal nerve injury.

EXTERNAL LARYNGEAL BRANCH OF SUPERIOR LARYNGEAL NERVE INJURY:

This nerve supplies the cricothyroid muscle, which is responsible for altering the pitch in voice. If this nerve is not identified and preserved, accidental injury or inclusion in ligatures could occur and this will cause a breathy voice in patients post operatively.

HYPOCALCEMIA:

Hypocalcemia can be permanent or temporary. This is either due to inadvertent removal of parathyroid glands or due to ischemic injury to glands. Parathyroid glands found with the specimen should be removed from the thyroid gland and minced into small pieces

and autotransplanted into sternocleidomastoid muscle. Patients with mild hypocalcemia should be started on oral calcium and those with severe hypocalcemia should be started on intravenous calcium gluconate. As a rule, normal parathyroid tissue should never be removed.

## THYROTOXIC CRISIS:

Also known by the name of thyroid storm. This is a very unusual event in patients who are well prepared for thyroidectomy. Despite this, some patients may develop thyroid storm. This is supportively treated with cooling, intravenous fluids, steroids, digoxin for uncontrolled atrial fibrillation, antithyroid drugs like carbimazole and methimazole and propranolol.

## AIM and OBJECTIVES:

To find out the prevalence of various course of external laryngeal nerve in patients undergoing thyroidectomy.

## MATERIALS AND METHODOLOGY:

Place of study:

Govt. Stanley Medical College and Hospital, Chennai

Duration:

6 months

Study Design:

Cross sectional study

Inclusion criteria:

All thyroidectomy surgeries

Exclusion criteria:

Redo thyroidectomy surgeries

Previous penetrating/blunt trauma to neck

Methodology:

Ethical clearance was obtained from the institutional ethical committee. Written informed consent was obtained from all study subjects before enrolment in the study. Study of 50 patients undergoing thyroidectomy in the Department of General Surgery from April 2016 to September 2016 were included in the study.

A comprehensive history taking with emphasis on the indication for thyroidectomy, risk factors, if any, for the patient and co-morbidities was done.

Patient was subjected to basic investigations. Thyroid function test was done and all patients were ensured they were euthyroid at the time of surgery. Echocardiogram was also done as a routine for all patients undergoing thyroidectomy. Other investigations were serum calcium, chest radiograph and soft tissue radiograph of neck, ultrasonogram of neck and FNAC of thyroid gland.

Patient preparation included Inj. Tetanus toxoid if indicated, Inj. Lignocaine test dose and antibiotic test dose.

Procedure:

- All patients undergoing thyroidectomy were explained about this study.
- All patients were subjected to thyroidectomy under general anaesthesia.
- Skin crease incision was made 2 fingerbreadths above suprasternal notch.
- Incision deepened across platysma.
- Sub platysmal flap raised and deep fascia incised.
- Strap muscles retracted.
- Middle thyroid vein ligated and divided.
- Superior thyroid vessels isolated and before dividing it, external branch of superior laryngeal nerve was dissected free and its visible length measured from bifurcation of superior laryngeal nerve.

- The type of external laryngeal nerve was noted according to Kierner's classification.
- Care was taken to avoid any injury to external laryngeal nerve when ligating superior thyroid vessels
- Inferior thyroid vessels were ligated and divided
- Thyroid gland was excised
- Hemostasis was secured.
- Suction drain kept if necessary.
- Deep fascia closed.
- Subcutaneous suturing done with 3-0 or 2-0 vicryl.
- Skin closed with 3-0 prolene or 3-0 nylon.
- Sterile dressing done.
- Post operative voice changes if any were recorded

TABLES

**Table 1: Demographic characteristics of study population**

| | *All(n=50)* |
|---|---|
| *Mean Age* | *37.76* |
| *Diabetes* | *5* |
| *Hypertension* | *3* |

| | |
|---|---|
| *Known hypothyroidism and corrected before surgery* | *10* |

**Table 2: Age wise distribution of the study group**

| | |
|---|---|
| *21-30* | *9* |
| *31-40* | *22* |
| *41-50* | *15* |
| *51-60* | *2* |
| *61-70* | *1* |
| *71-80* | *1* |

**Table 3: Sex distribution of the study group**

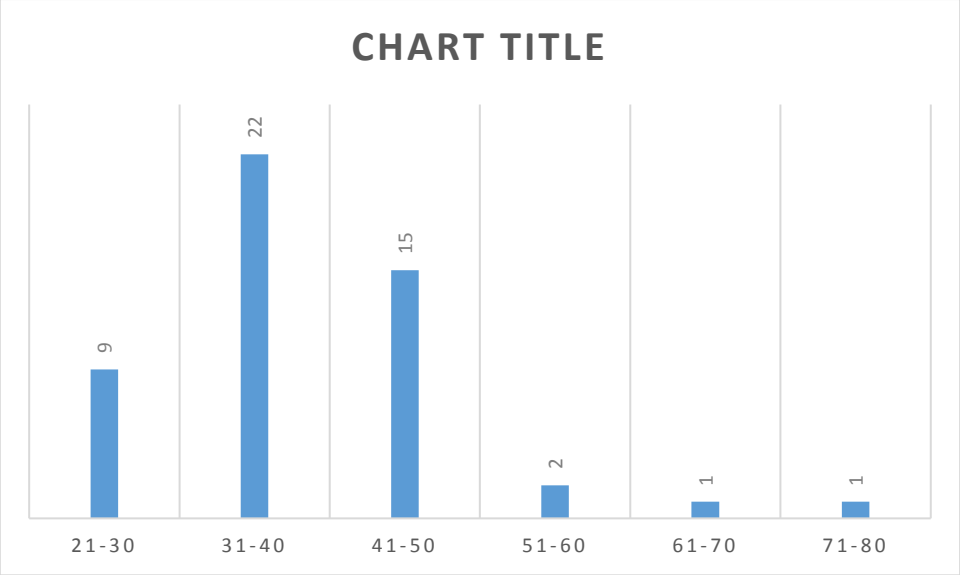
| | *N=50* |
|---|---|
| *Males* | *5* |
| *Females* | *45* |

**Table 4: Surgeries in the study group**

| | |
|---|---|
| *Total thyroidectomy* | *33* |
| *Right hemithyroidectomy* | *6* |
| *Left hemithyroidectomy* | *11* |

**Table 5: Type of external laryngeal nerve**

| | |
|---|---|
| *Type 1* | *46.98%* |
| *Type 2* | *25.3%* |
| *Type 3* | *4.81%* |
| *Type 4* | *0%* |
| *Could not be identified* | *22.89%* |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9
22
15
2
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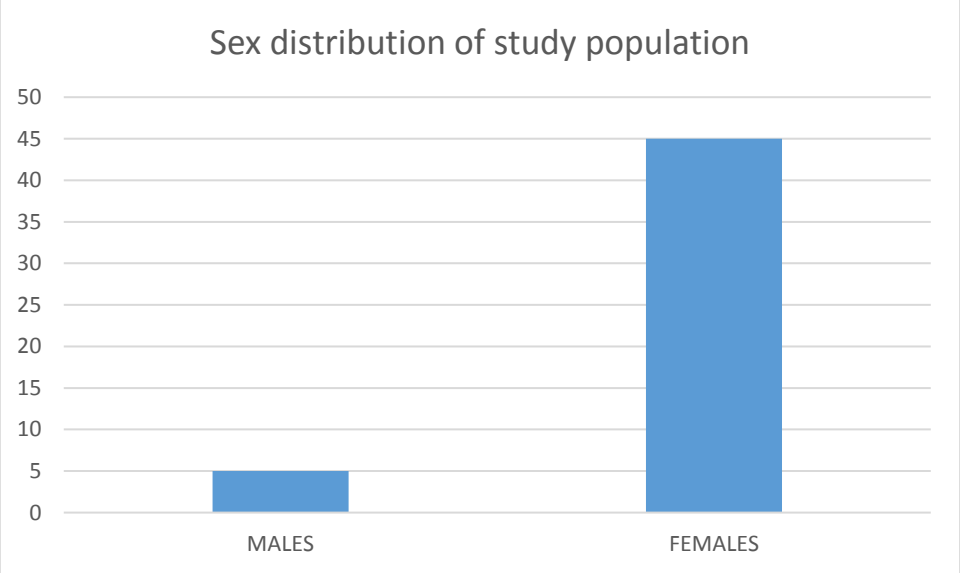
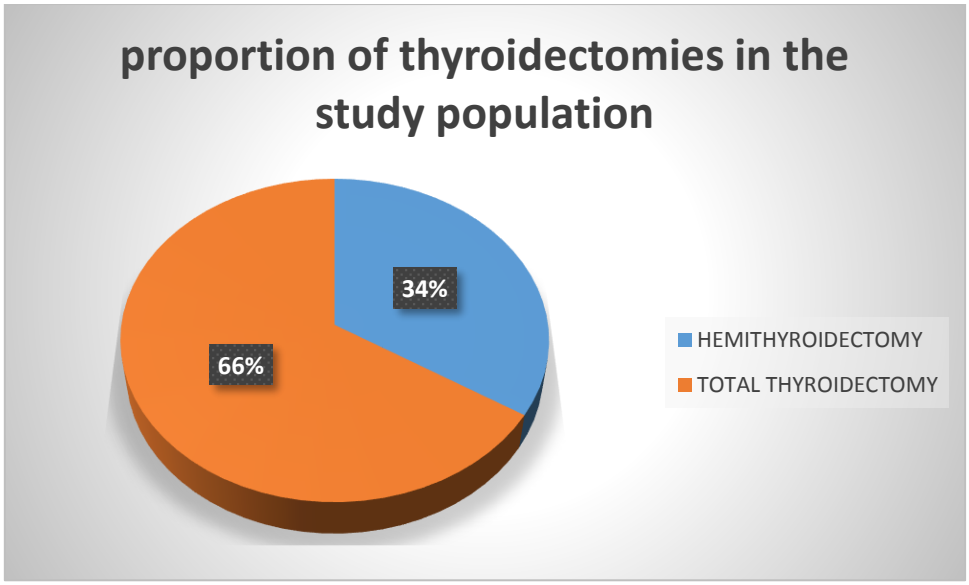
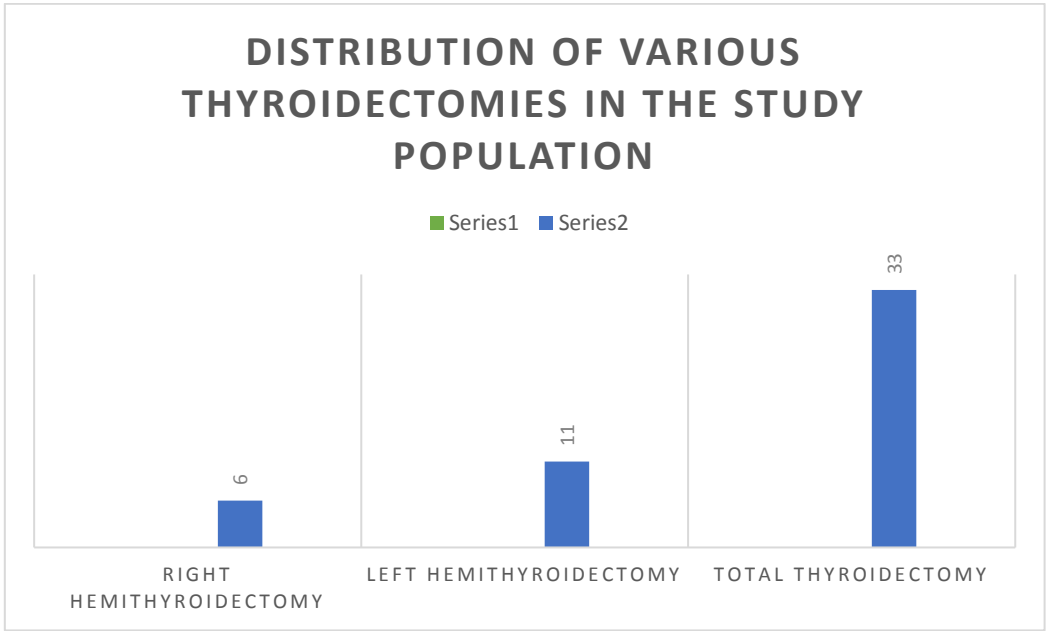
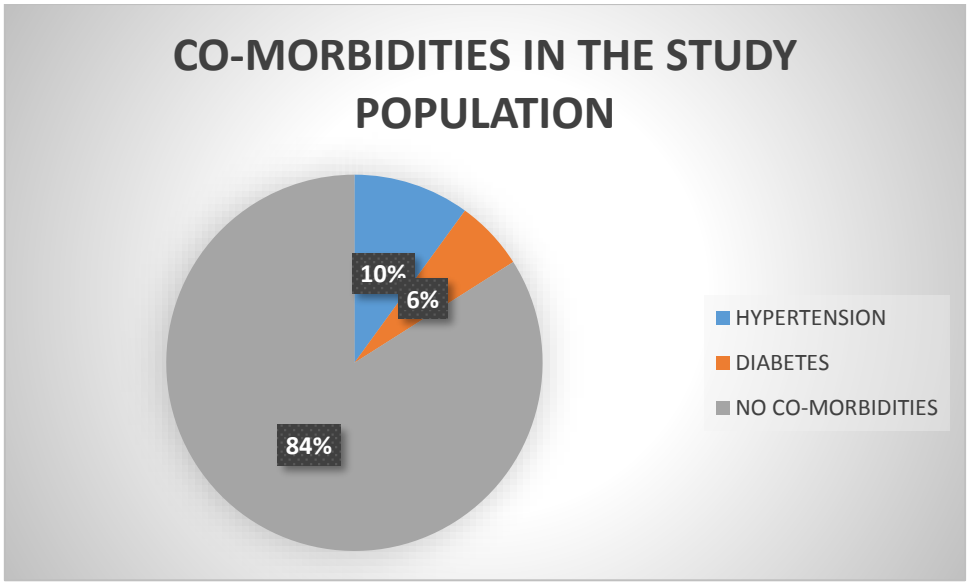
1
21-30
31-40
41-50
51-60
61-70
71-80

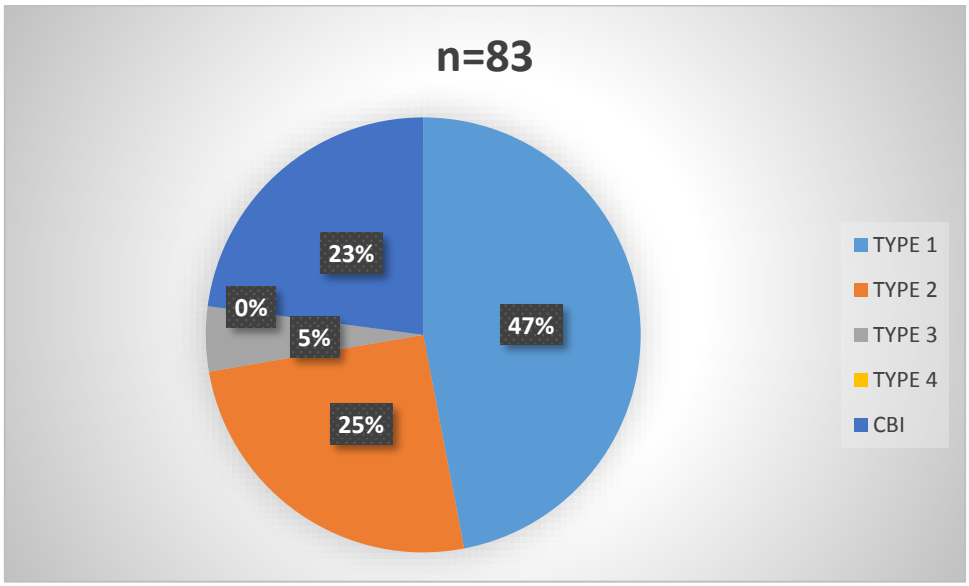

Sex distribution of study population
50
45
40
35
30
25
20
15
10
5
0
MALES
FEMALES


proportion of thyroidectomies in the study population
34%
66%
HEMITHYROIDECTOMY
TOTAL THYROIDECTOMY

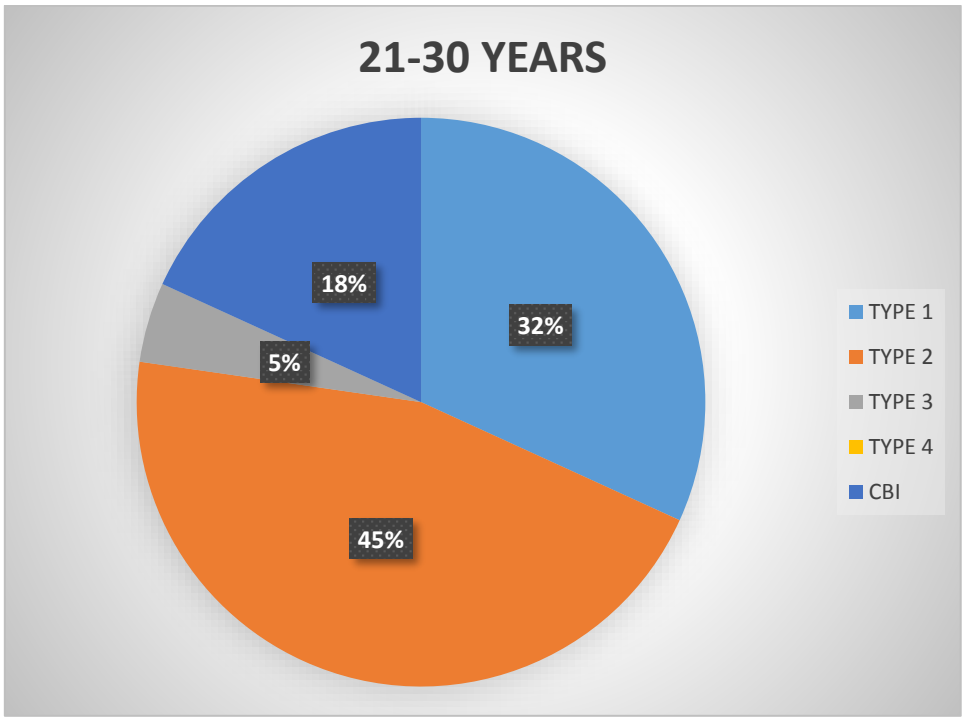

DISTRIBUTION OF VARIOUS THYROIDECTOMIES IN THE STUDY POPULATION
Series1
Series2
6
11
33
RIGHT HEMITHYROIDECTOMY
LEFT HEMITHYROIDECTOMY
TOTAL THYROIDECTOMY

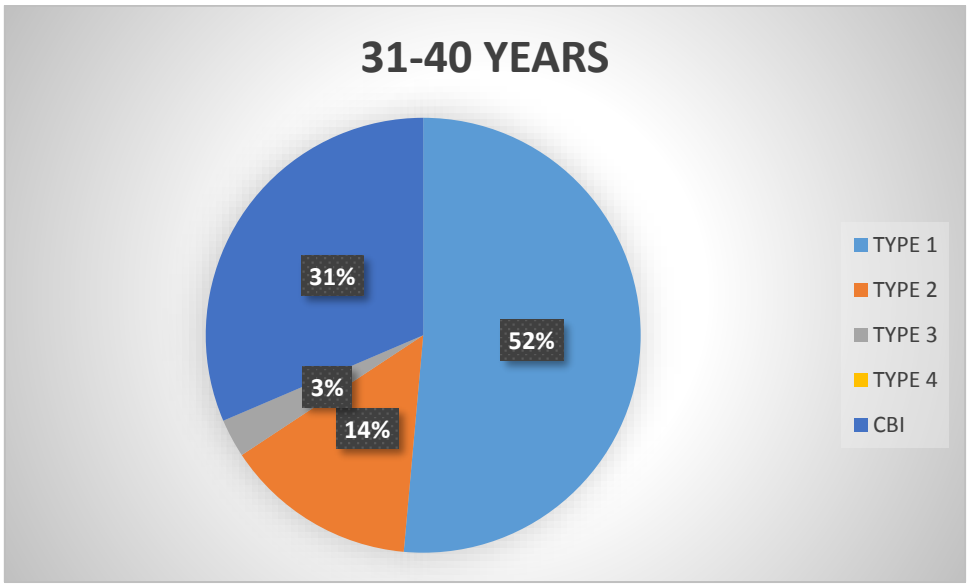


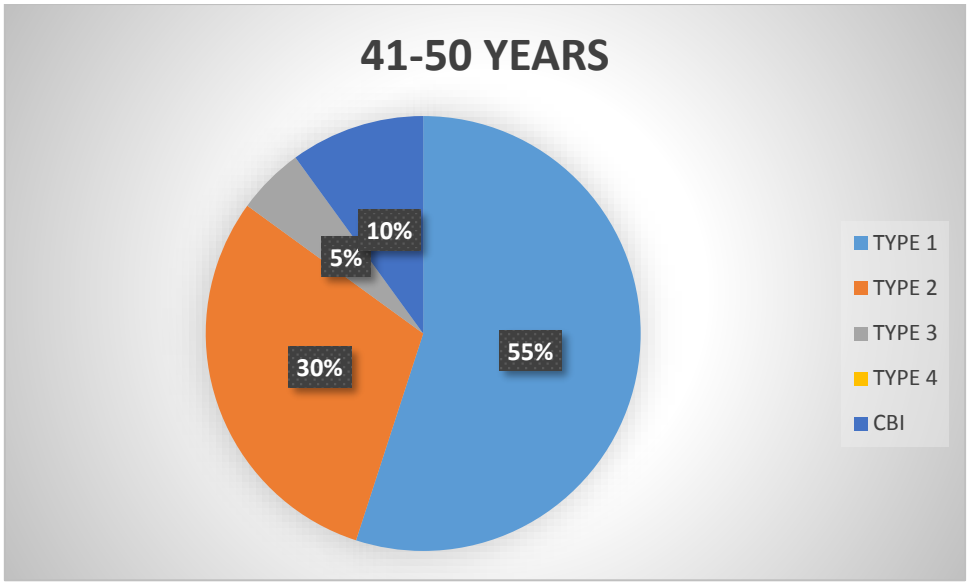

**DISTRIBUTION OF VARIOUS TYPES OF EXTERNAL BRANCH OF SUPERIOR LARYNGEAL NERVE IN THE STUDY POPULATION**

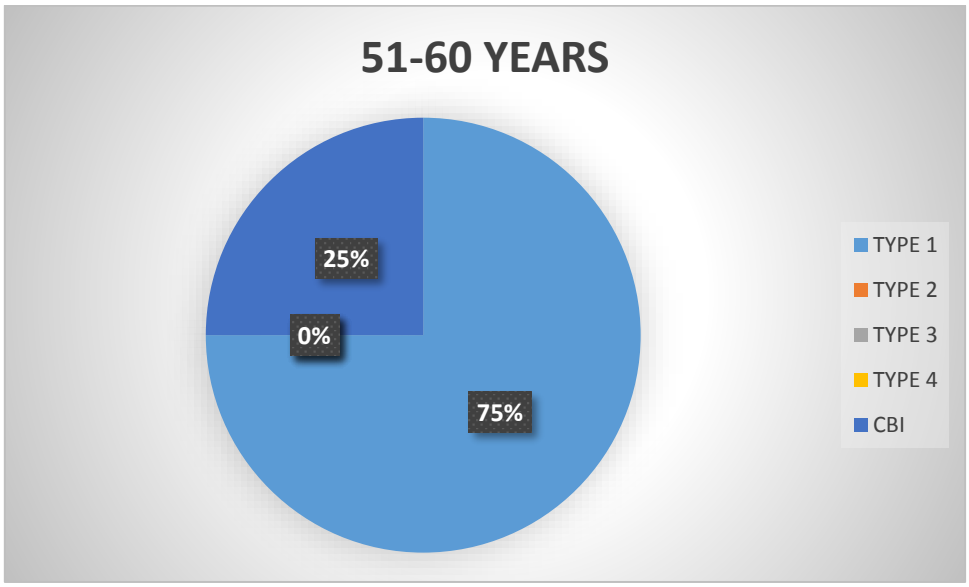


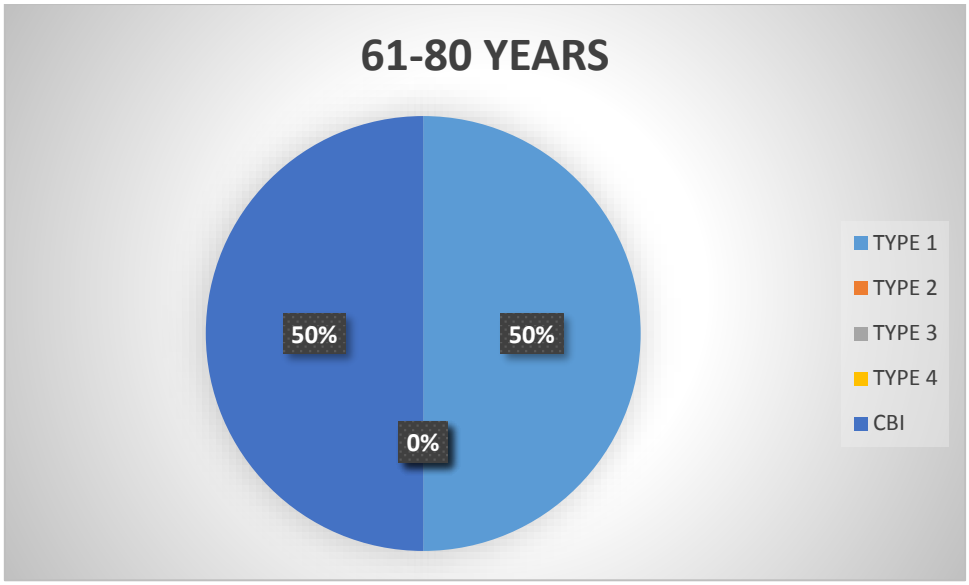
# AGE WISE DISTRIBUTION OF VARIOUS TYPES OF EXTERNAL BRANCH OF SUPERIOR LARYNGEAL NERVE

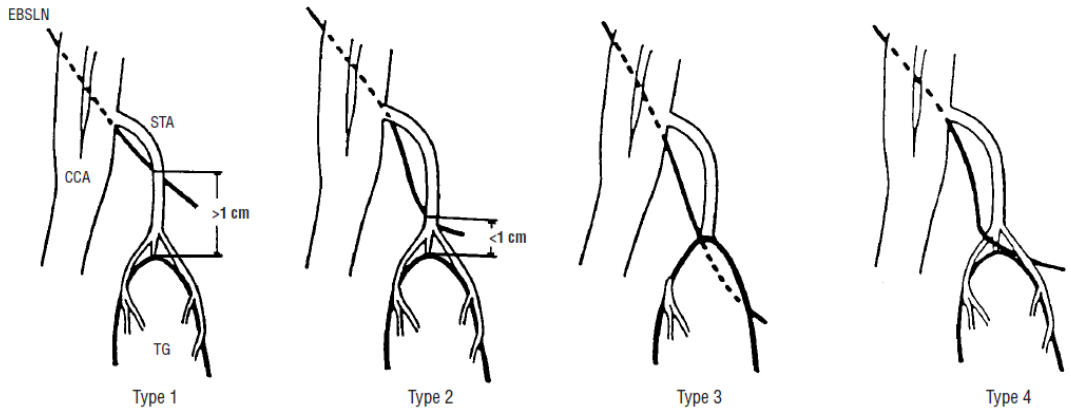



41-50 YEARS
10%
5%
30%
55%
TYPE 1
TYPE 2
TYPE 3
TYPE 4
CBI


51-60 YEARS
25%
0%
75%
TYPE 1
TYPE 2
TYPE 3
TYPE 4
CBI


61-80 YEARS
50%
50%
0%
TYPE 1
TYPE 2
TYPE 3
TYPE 4
CBI


EBSLN
STA
CCA
>1 cm
TG
Type 1
<1 cm
Type 2
Type 3
Type 4

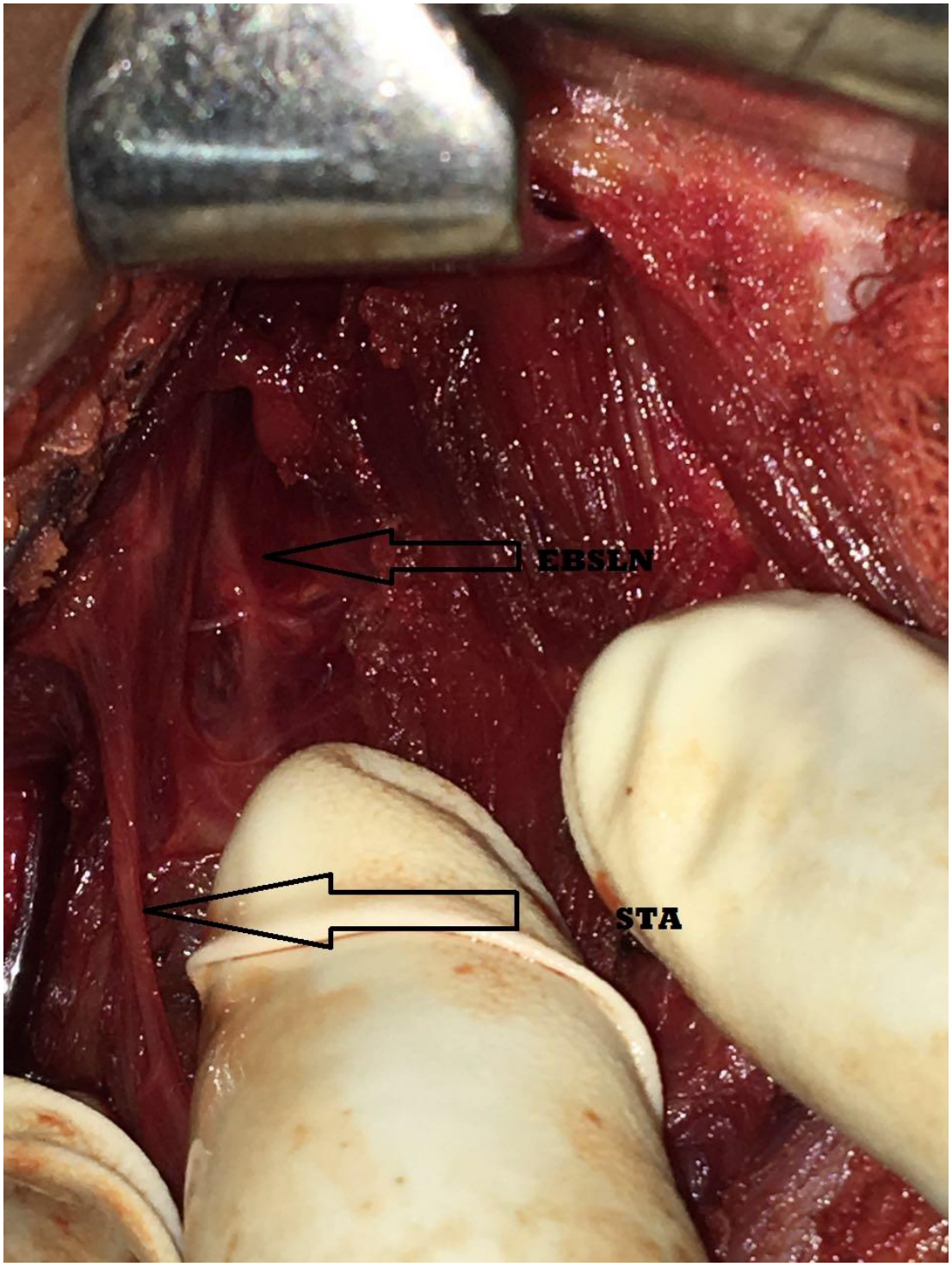



**Figure 33 : Type 1 external branch of superior laryngeal nerve**

**[** Mrs.Mary, 38/F, 1637141, Total Thyroidectomy ]

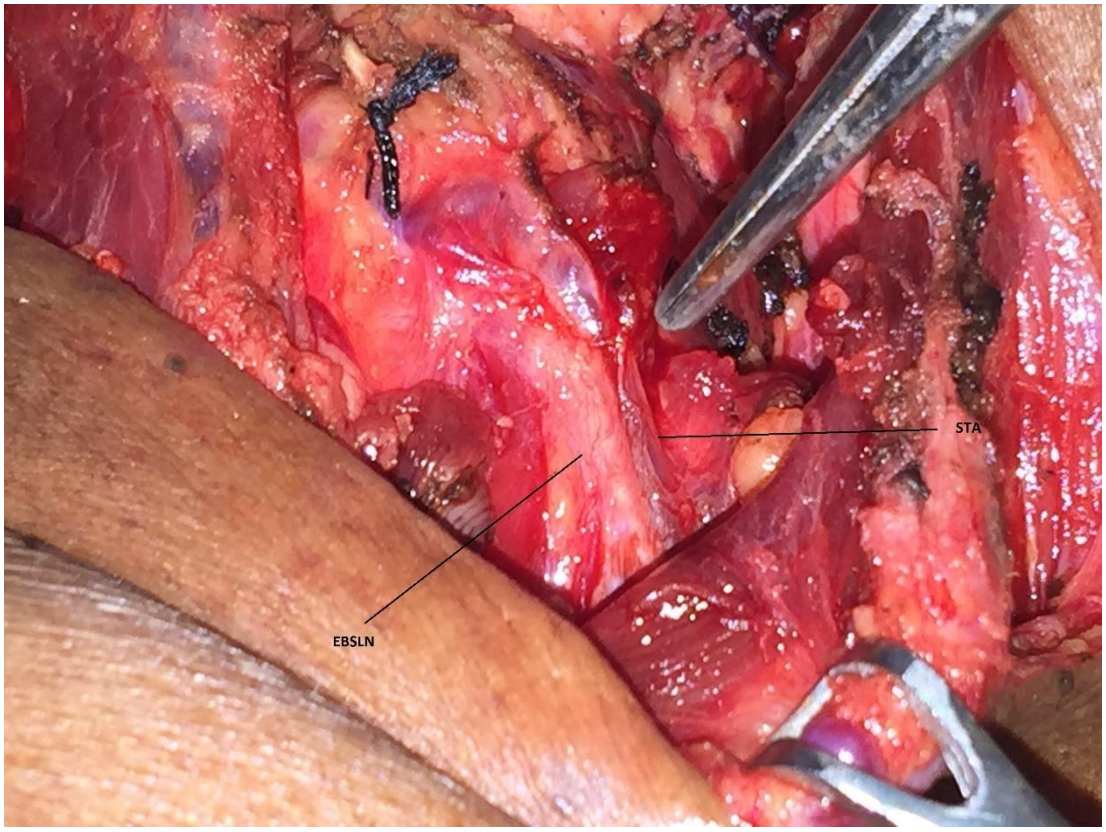



**Figure 34 : Type 2 external branch of superior laryngeal nerve**

[ Mrs.Manjula, 48/F, 1629054, Total Thyroidectomy ]

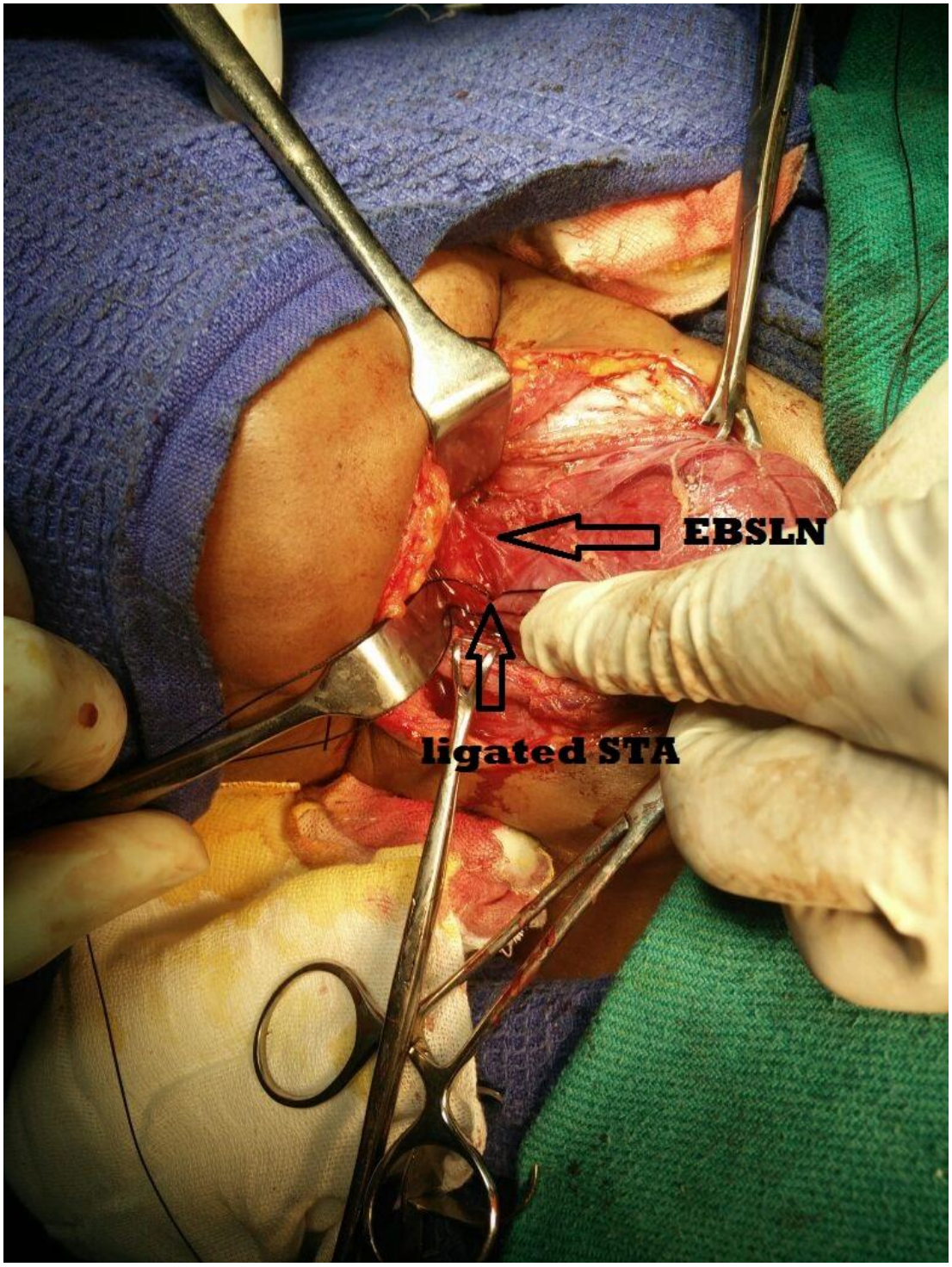



**Figure 35 : Type 3 external branch of superior laryngeal nerve**

[ Mrs. Ramalakshmi, 35/F, 1635807, Total Thyroidectomy ]

# RESULTS

From April 2016 to September 2016, a total of 50 patients underwent thyroidectomy surgeries in the Department of General Surgery, Government Stanley Medical College and Hospital, Chennai. Out of the 50 patients, 34% (n=17) underwent hemithyroidectomy surgeries and 66% (n=33) underwent total thyroidectomy surgeries. Out of the 17 patients who underwent hemithyroidectomy surgeries, 11 patients underwent left hemithyroidectomy and 6 patients underwent right hemithyroidectomy.

The mean age of the patients undergoing this study was 37.76. Among the study population, 10%(n=5) were males and 90%(n=45) were females. 10%(n=5) had hypertension and 6%(n=3) had diabetes.

The mean duration of surgery for hemithyroidectomies was 1.26 hours and the mean duration of surgery for total thyroidectomies was 1.98 hours.

The total number of nerves analysed were 83. The mean length of nerve was 2.21 cm. The most common type of EBSLN was type 1 [46.98%]. The second most common type of EBSLN was type 2[25.3%]. The third most common type of nerve was the

nerve could not be identified in 22.89% of cases. The fourth most common type of type 4 nerve [4.81%]. There was no type 4 nerve identified in this study.

The nerve types most commonly found in decreasing order of frequency in the age group of 21-30 were type 2, type 1, nerve could not be identified and type 3.

The nerve types most commonly found in decreasing order of frequency in the age group of 31-40 were type 1, nerve could not be identified, type 2 and type 3.

The nerve types most commonly found in decreasing order of frequency in the age group of 41-50 were type 1, type 2, nerve could not be identified and type 3.

The nerve types most commonly found in decreasing order of frequency in the age group of 51-60 were type 1 and nerve could not be identified.

Out of the 50 patients studied, 4 patients had voice change. Out of the four, two had unilateral vocal cord palsy which was documented by UGI scopy available in our department. The other two patients had voice change and their complaints were inability to raise the pitch of the voice when they needed to. So, these two patients had external laryngeal nerve injury. One of these two patients had no identifiable external branch of superior laryngeal nerve. The other patient had type 1 EBSLN on one side and the nerve on the other side could not be identified.

## DISCUSSION

Thyroid disorders afflict the entire population. Though various modalities of treatment have been suggested and practised for goitres, thyroidectomy remains one of the most vital and foremost method of treatment. Though performed widely, various

complications of thyroidectomy fret the surgeon who does it. Though hypocalcemia and respiratory compromise remains the most dangerous acute complications post thyroidectomy, voice change is agonising for both the patient as well as the surgeon. This matters if the patient has a profession related to his or her voice. Both recurrent laryngeal nerve and external branch of superior laryngeal nerve are related to changes in voice pattern. Though recurrent laryngeal nerve remains the most important nerve to be safeguarded during thyroidectomy owing to disastrous complications, external laryngeal nerve injury can be worrisome in long course.

## ANATOMY OF EXTERNAL BRANCH OF SUPERIOR LARYNGEAL NERVE

External laryngeal passes superficial to inferior constrictor muscle of pharynx and pierces it to supply the cricothyroid muscle [46,47]. The external laryngeal nerve lies in the triangle of Joll, bounded laterally by the thyroid and superior thyroid vessels, medially by the midline and superiorly by the strap muscles getting attached to thyroid cartilage [10].

## FUNCTION OF EBSLN

The function of external branch of superior laryngeal nerve is to add tension to vocal cords thererby raising the pitch of the voice. Damage to this nerve can cause breathy voice and add difficulty in raising the pitch of the voice, which becomes a problem when the patient is a professional vocalist.

## CLASSIFICATIONS OF EBSLN COURSE

Identification of external branch of superior laryngeal nerve routinely prevents the damage done to it by careless dissection. Various classification systems have been used to define the course of external laryngeal nerve. One among this is the Kierner classification system which classifies the course of EBSLN into 4 types [48]. Type 1 EBSLN crosses STA>1 cm above upper pole of thyroid. Type 2 EBSLN crosses STA < 1 cm above upper pole of thyroid. Type 3 EBSLN crosses STA under cover of upper pole of thyroid. Type 4 EBSLN descends dorsal to STA and crosses its branches above upper pole of thyroid. Another classification is the Cernea classification [49]. Type 1 EBSLN crosses STA > 1 cm above upper pole of thyroid. Type 2a EBSLN crosses STA < 1 cm above upper pole of thyroid. Type 2b EBSLN crosses STA under cover of upper pole of thyroid. The third classification is the Friedman classification [50]. Type 1 EBSLN runs superficial to inferior constrictor muscle. Type 2 EBSLN penetrates the lower part of inferior constrictor muscle. Type 3 EBSLN passes deep to inferior constrictor muscle. The type 3 variant of EBSLN of Friedman's classification has been the reason why EBSLN could not be identified in many cases of thyroidectomy.

The classification used in this study is the Kierner classification as it is the most recent and standardised classification.

**CONCLUSION:**

The fundamental norm of surgery is to identify a structure in order to preserve it. This holds good for thyroidectomy as well. Recurrent laryngeal nerve is routinely recognised and preserved in order to avoid the complication of vocal cord palsy and the more disastrous respiratory compromise in case of bilateral vocal cord palsy. But external branch of superior laryngeal nerve is one nerve which is neglected during thyroidectomy and this goes unnoticed because the patient presents with subtle post-operative voice changes. This becomes a problem legally if the patient is a professional vocalist. To circumvent this problem, external branch of superior laryngeal nerve should

be routinely identified and preserved to avoid any problems in voice of the patient and also to prevent any gratuitous lawsuits. Though this is recommended, occasionally external branch of superior laryngeal nerve can still not be identified even after near infinite search for it during thyroidectomy. This is explained by the Friedman type 3 variant [50]. This variant of nerve runs deep to inferior constrictor muscle of pharynx. So, careful extracapsular dissection of thyroid should be done in all cases to avoid any naïve injuries to external branch of superior laryngeal nerve.

LIMITATIONS:

Follow up period too short to assess the voice changes in the patient

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# INSTITUTIONAL ETHICAL COMMITTEE, STANLEY MEDICAL COLLEGE, CHENNAI-1

| | | |
|---|---|---|
| Title of the Work | : | A study of the Topographical Anatomy of the External laryngeal branch of superior laryngeal nerve in patients undergoing Thyroidectomy |
| Principal Investigator | : | Dr. Sukhdev D B Singh |
| Designation | : | PG, MS ( General Surgery) |
| Department | : | Department of General Surgery<br>Government Stanley Medical College,<br>Chennai-01 |

The request for an approval from the Institutional Ethical Committee (IEC) was considered on the IEC meeting held on 24.03.2016 at the Council Hall, Stanley Medical College, Chennai-1 at 2PM

The members of the Committee, the secretary and the Chairman are pleased to approve the proposed work mentioned above, submitted by the principal investigator.

The Principal investigator and their team are directed to adhere to the guidelines given below:

1. You should inform the IEC in case of changes in study procedure, site investigator investigation or guide or any other changes.
2. You should not deviate from the area of the work for which you applied for ethical clearance.
3. You should inform the IEC immediately, in case of any adverse events or serious adverse reaction.
4. You should abide to the rules and regulation of the institution(s).
5. You should complete the work within the specified period and if any extension of time is required, you should apply for permission again and do the work.
6. You should submit the summary of the work to the ethical committee on completion of the work.

MEMBER SECRETARY,
IEC, SMC, CHENNAI

# PROFORMA:

| | |
|---|---|
| *NAME* | |
| *AGE* | |
| *SEX* | |
| *IP NO* | |
| *CO-MORBIDITIES* | |
| *DRUG HISTORY* | |
| *DIAGNOSIS* | |
| *PROCEDURE DONE* | |
| *DURATION OF SURGERY* | |
| *MALIGNANT/BENIGN* | |
| *VISIBLE LENGTH OF THE NERVE FROM SUPERIOR LARYNGEAL NERVE BIFURCATION TO THYROID GLAND APEX* | |
| | |

| | |
|---|---|
| *TYPE OF EXTERNAL LARYNGEAL NERVE ACCORDING TO KIERNER CLASSIFICATION* | |
| *POST OP MORBIDITY INCIDENCE* | *TEMPORARY/PERMANENT* |

## GOVT.STANLEY MEDICAL COLLEGE, CHENNAI- 600 001

### INFORMED CONSENT

**DISSERTATION TOPIC:** "**A STUDY OF THE TOPOGRAPHICAL ANATOMY OF THE EXTERNAL LARYNGEAL BRANCH OF SUPERIOR LARYNGEAL NERVE IN PATIENTS UNDERGOING THYROIDECTOMY**"

PLACE OF STUDY: GOVT. STANLEY MEDICAL COLLEGE, CHENNAI

NAME AND ADDRESS OF PATIENT:

I, _____ have been informed about the details of the study in my own language.

I have completely understood the details of the study.

I am aware of the possible risks and benefits, while taking part in the study.

I understand that I can withdraw from the study at any point of time and even then, I will continue to receive the medical treatment as usual.

I understand that I will not get any payment for taking part in this study.

I will not object if the results of this study are getting published in any medical journal, provided my personal identity is not revealed.

I know what I am supposed to do by taking part in this study and I assure that I would extend my full co-operation for this study.

Name and Address of the Volunteer:

Signature/Thumb impression of the Volunteer

Date:

Witnesses:

(Signature, Name & Address)

Date:

Name and signature of investigator:

**(Dr .SUKHDEV D.B. SINGH)**

# *சுயஒப்புதல் படிவம்*

*அரசு ஸ்டான்லி மருத்துவ கல்லூரி*

*சென்னை – 1*

***ஆராய்ச்சியின் பெயர்**: தைராய்ட் அறுவை சிகிச்சை மேற்கொள்ளும் நோயாளிகளில் சுபீரியர் லாரிஞ்சியல் நரம்பின் எக்ஸ்டேர்னல் லாரிஞ்சியல் பிரிவின் முரண்பாடுகள்.*

***<u>ஆய்வு இடம்</u>**: அரசு ஸ்டான்லி மருத்துவ கல்லூரி*

_____ *என்கிற எனக்கு இந்த ஆராய்ச்சி பற்றிய முழு விவரங்களும் என் தாய்மொழியில் தரப்பட்டன.*

*இந்த ஆராய்ச்சி பற்றி முழுமையாக புரிந்து கொண்டேன்.*

*இதில் நான் பங்கு பெறுவதினால் ஏற்படக்கூடிய அசௌகரியங்கள் மற்றும் நன்மைகள் பற்றியும் தெரிந்து கொண்டேன்.*

இந்த ஆராய்ச்சியிலிருந்து என் சுய விருப்பபடி ,எந்த நேரமும் விலகி கொள்ள முடியும் என்றும், அதனால் இம்மருத்துவமனையில் எனக்கு கிடைக்க வேண்டிய மருத்துவ உதவிகள் அனைத்தும் எந்த பாரபட்சமும் இல்லாமல் தொடர்ந்து கிடைக்கும் என்றும் தெரிந்து கொண்டேன்.

இதில் பங்கு பெற எந்தவித சன்மானமும் தர பட மாட்டாது என்று புரிந்து கொண்டேன்.

இந்த ஆராய்ச்சியின் முடிவுகள், என்னை பற்றிய தனிப்பட்ட தகவல் ஏதும் தராமல் இருந்தால், மருத்துவம் சார்ந்த பத்திரிக்கைகளில் பிரசுரமாவதற்கு எதிர்ப்பு தெரிவிக்க மாட்டேன்.

இந்த ஆராய்ச்சியில் பங்கு பெற நான் என்ன செய்ய வேண்டும் என்று தெரிந்து கொண்டேன். அதன்படி முழு ஒத்துழைப்பு கொடுக்க தயாராக உள்ளேன்.

பங்கு பெறுபவரின் கையொப்பம்_____

தேதி_____

முகவரி_____

_____

சாட்சியாளரின் கையொப்பம்_____

தேதி_____

முகவரி_____

_____

ஆராய்ச்சியாளரின் கையொப்பம்_____

தேதி_____

# நோயாளி தகவல் தாள்

தைராய்ட் அறுவை சிகிச்சை மேற்கொள்ளும் நோயாளிகளில் சுபீரியர் லாரிஞ்சியல் நரம்பின் எக்ஸ்டேர்னல் லாரிஞ்சியல் பிரிவின் முரண்பாடுகள். - ஓர் ஆய்வு

**<u>ஆய்வின் நோக்கம்</u>**: தைராய்ட் அறுவை சிகிச்சை மேற்கொள்ளும் நோயாளிகளில் சுபீரியர் லாரிஞ்சியல் நரம்பின் எக்ஸ்டேர்னல் லாரிஞ்சியல் பிரிவின் முரண்பாடுகள். - ஓர் ஆய்வு

**<u>உண்டாக கூடிய இடர்கள்</u>**:

அனைத்து முறைகளிலும் இருப்பது போலவே இந்த முறையிலும் சில எதிர்பாராத இடர்கள் சம்மந்தபட்டுள்ளன.சிலருக்கு இருமல், மூச்சுத்திணறல் ஏற்படலாம்.

**அந்தரங்க தன்மை** :

உங்கள் மருத்துவ பதிவேடுகள் மிகவும் அந்தரங்கமாக வைத்து கொள்ள படும். பிற மருத்துவர்கள்/ விஞ்ஞானிகள், இந்த ஆய்வின் தணிக்கையாளர் அல்லது ஆராய்ச்சி ஆதரவாளர்களின் பிரதிநிதிகள் ஆகியோரிடம் அவை வெளிப்படும். இந்த ஆய்வின் முடிவுகள் அறிவியல் பத்திரிக்கைகளில் பிரசுரிக்கபடலாம். ஆனால் பெயரை வெளியிடுவது மூலம் நீங்கள் அடையாளம் காட்ட பட மாட்டீர்கள்.

**ஆய்வில் பங்கேற்கும் நோயாளியின் கடமைகள்** :

உங்களை கவனித்து கொள்ளும் மருத்துவருடன் நீங்கள் முழுமையாக ஒத்துழைக்க வேண்டும். என்னென்ன செய்ய வேண்டும் , என்னென்ன செய்யக்கூடாது என்றும் கூறப்பட்டுள்ளவற்றிலிருந்து சற்றும் விலக கூடாது என்றும் நீங்கள் எதிர்பார்க்கப்படுகிறீர்கள்.

**ஆய்வில் உங்கள் பங்கேற்பு மற்றும் உங்கள் உரிமைகள்**:

இந்த ஆய்வில் உங்கள் பங்கேற்பு தன்னிச்சையானது. காரணங்கள் எதையும் கூறாமலேயே நீங்கள் இந்த ஆய்விலிருந்து எந்த நேரத்திலும் விலகி கொள்ளலாம். எந்த ஒரு நேரத்திலும் உங்களுக்கு திருப்திகரமாக இல்லை என்று உணர்ந்தாலோ அல்லது

வேறு ஏதேனும் உடல் நல குறைவு உண்டானாலோ , உங்களை கவனித்து வரும் மருத்துவரிடம் உடனடியாக தெரிவிக்கவும். சிகிச்சை உங்களுக்கு பொறுத்தமாக இருக்காது என்று தோன்றினால் உடனடியாக நிறுத்தப்படும் . உங்கள் சம்மதம் இன்றியே கூட ஆய்வு நிறுத்தப்படுவது சாத்தியமே .

| S.No | name | age/sex | Ip no | co-morbidities | drug history | diagnosis | Procedure done | date of surgery | duration of surgery in hours | pathological diagnosis | length of nerve in cm | type of nerve right | left | post operative morbidity |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Mrs.Indira | 45/f | 1618627 | HTN | | Left SNG | Left hemithyroidectomy | 04-04-2016 | 1 | Nodular colloid goitre | - | CBI | | |
| 2 | Mrs.Shanthi | 48/f | 1619047 | DM | | Left SNG | Left hemithyroidectomy | 05-04-2016 | 1 | Nodular colloid goitre | 2.8 | 1 | | |
| 3 | Mrs.Manjula | 40/f | 1618083 | - | | Left SNG | Left hemithyroidectomy | 07-04-2016 | 1 | Nodular colloid goitre | 3 | 1 | | |
| 4 | Mrs.Anjali | 36/f | 1624206 | - | | Right SNG | Total thyroidectomy | 25-04-2016 | 2 | Follicular variant of Pap CA | 3.2 | 1 | CBI | |
| 5 | Mrs.Nagajothi | 30/f | 1624731 | - | | MNG | Total thyroidectomy | 25-04-2016 | 1.5 | Adenomatoid goitre | - | CBI | 3 | |
| 6 | Miss.suveetha | 25/f | 1626469 | | T thyroxine 100 µg OD | Left SNG | Left hemithyroidectomy | 03-05-2016 | 1 | Adenomatoid nodule | 3 | 1 | | U/L vocal cord palsy |
| 7 | Mrs.Lakshmi | 25/f | 1624477 | - | | Left SNG | Left hemithyroidectomy | 03-05-2016 | 1 | Hyperplastic nodule | 3 | 1 | | |
| 8 | Mrs.Sakthidevi | 45/f | 1625315 | - | T thyroxine 100 µg OD | Left SNG | Left hemithyroidectomy | 04-05-2016 | 1.5 | Hashimoto | 3.1 | 1 | | |
| 9 | Mrs.Anandhi | 72/F | 1626415 | HTn | | Right SGT | Total thyroidectomy | 04-05-2016 | 2.5 | Nodular colloid goitre | 2 | 1 | CBI | |
| 10 | Mr.Karthick | 29/m | 1626996 | - | | Right SNG | Right hemithyroidectomy | 06-05-2016 | 1.5 | Nodular colloid goitre | 2.5 | 2 | | |
| 11 | Mrs.Lakshmi | 38/f | 1627407 | - | | MNG | Total thyroidectomy | 06-05-2016 | 2 | Nodular colloid goitre | - | CBI | CBI | Voice change |
| 12 | Mrs.Senjiyammal | 52/m | 1629396 | HTN | | MNG | Total thyroidectomy | 07-05-2016 | 2 | Nodular colloid goitre | 3 | 1 | CBI | |
| 13 | Mrs.Yasodha | 50/f | 1626733 | DM | | MNG | Total thyroidectomy | 12-05-2016 | 1.5 | Adenomatoid nodule | 3.1 | 2 | 3 | |
| 14 | Mrs.Amul | 40/f | 1627083 | - | | Left SNG | Left hemithyroidectomy | 13-05-2016 | 1 | Nodular colloid goitre | 2.6 | 1 | | |
| 15 | Mrs.Mariammal | 35/f | 1626039 | - | T thyroxine 100 µg OD | MNG | Total thyroidectomy | 13-05-2016 | 1.5 | Nodular colloid goitre | - | CBI | 1 | |
| 16 | Mrs.Subhalakshmi | 60/f | 1627728 | DM | | MNG | Total thyroidectomy | 17-05-2016 | 2 | Nodular colloid goitre | 2 | 1 | 1 | |
| 17 | Mrs.Adhilakshmi | 35/f | 1630276 | - | | Right SNG | Right hemithyroidectomy | 19-05-2016 | 1 | Nodular colloid goitre | 2.5 | 2 | | |
| 18 | Mrs.Manjula | 48/f | 1629054 | - | T thyroxine 100 µg OD | MNG | Total thyroidectomy | 20-05-2016 | 2 | Hashimoto | 2.6 | 2 | 1 | |
| 19 | Mrs.Sathya | 33/f | 1627254 | - | | MNG | Total thyroidectomy | 21-05-2016 | 2.5 | Nodular colloid goitre | 1.8 | 1 | CBI | |
| 20 | Mrs.Gunasundari | 31/f | 1628715 | - | | MNG | Total thyroidectomy | 21-05-2016 | 3 | Nodular colloid goitre | - | CBI | 1 | |
| 21 | Mrs.Selvi | 39/f | 1630253 | - | | MNG | | 23-05-2016 | 2 | Adenomatoid nodule | 1.8 | 1 | CBI | |
| 22 | Mrs.Ravana | 45/f | 1623473 | - | T thyroxine 100 µg OD | MNG | Total thyroidectomy | 24-05-2016 | 2 | MNG with hashimoto | - | CBI | 1 | Voice change |
| 23 | Mrs.Rajeshwari | 30/f | 1631647 | - | | Diffuse goitre | Total thyroidectomy | 28-05-2016 | 2.5 | Adenomatoid goitre | 2.4 | 2 | 1 | |
| 24 | Mrs.Padma | 42/f | 1632707 | - | | MNG | Total thyroidectomy | 30-05-2016 | 1.5 | Nodular colloid goitre | 2.5 | 2 | 1 | |
| 25 | Mrs.Chithramma | 45/f | 1629438 | - | | MNG | Total thyroidectomy | 01-06-2016 | 1.5 | Nodular colloid goitre | 2.5 | 2 | 1 | |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 26 | Mrs.Parvathy | 35/f | 1.6E+07 | - | | Left SNG | Left hemithyroidectomy | 02-06-2016 | 1 | Adenomatoid nodule | - | CBI | | |
| 27 | Mr.Siva | 35/m | 1631857 | - | | Right SNG | Total thyroidectomy | 03-06-2016 | 1.5 | Nodular colloid goitre | 1.8 | 1 | 1 | |
| 28 | Mrs.Faridha banu | 35/f | 1633059 | - | | Right SNG | Right hemithyroidectomy | 04-06-2016 | 1.5 | Nodular colloid goitre | 2.5 | 1 | | |
| 29 | Mrs.Vijaya | 34/f | 1633592 | - | | MNG | Total thyroidectomy | 10-06-2016 | 2 | Nodular colloid goitre | - | CBI | CBI | |
| 30 | Mrs.Ayisha | 28/f | 1635355- | - | T thyroxine 100 µg OD | Left SNG | Total thyroidectomy | 16-06-2016 | 2 | Nodular colloid goitre | 2.5 | 2 | 1 | |
| 31 | Mrs.Sarala | 28/f | 1635333 | - | T thyroxine 100 µg OD | MNG | Total thyroidectomy | 17-06-2016 | 2 | Nodular colloid goitre | 3.5 | 2 | 2 | |
| 32 | Mr.Nagaraj | 48/m | 1635343 | - | | MNG | Total thyroidectomy | 18-06-2016 | 2.5 | Nodular colloid goitre | 3.2 | 2 | 1 | |
| 33 | Mrs.Ramalakshmi | 35/f | 1635807 | - | | MNG | Total thyroidectomy | 20-06-2016 | 3 | Nodular colloid goitre | 2 | 3 | 1 | |
| 34 | Miss.Lavanya | 21/f | 1636744 | - | T thyroxine 100 µg OD | MNG | Total thyroidectomy | 20-06-2016 | 2 | Hashimoto | - | CBI | 1 | |
| 35 | Mr.Viswanathan | 36/m | 1637181 | - | | Left SNG | Left hemithyroidectomy | 21-06-2016 | 1 | Nodular colloid goitre | 2.5 | 2 | | |
| 36 | Mrs.Mohanapriya | 30/f | 1638138 | - | | MNG | Total thyroidectomy | 21-06-2016 | 2 | Nodular colloid goitre | 2.8 | 1 | CBI | Vocal cord palsy U/L |
| 37 | Mrs.Anitha | 32/f | 1639036 | - | | Left SNG | Left hemithyroidectomy | 28-06-2016 | 1 | Adenomatoid nodule | 2.3 | 1 | | |
| 38 | Mrs.Ramalakshmi | 36/f | 1638045 | - | | Right SNG | Right hemithyroidectomy | 29-06-2016 | 1.5 | Adenomatoid nodule | - | CBI | | |
| 39 | Mrs.Anbu | 25/f | 1639806 | - | | MNG | Total thyroidectomy | 30-06-2016 | 2 | Nodular colloid goitre | 1 | 2 | 2 | |
| 40 | Mrs.Kumari | 48/f | 1639874 | HTN | | MNG | Total thyroidectomy | 08-07-2016 | 2 | Nodular colloid goitre | 1.5 | 2 | 1 | |
| 41 | Mrs.Madhu | 38/f | 1640809 | - | | Left SNG | Left hemithyroidectomy | 11-07-2016 | 1.5 | Adenomatoid nodule | 2 | 1 | | |
| 42 | Mrs.Gnanasundari | 26/f | 1642097 | - | | MNG | Total thyroidectomy | 15-07-2016 | 2.5 | Nodular colloid goitre | 2.2 | 2 | 2 | |
| 43 | Mrs.Sathya | 23/f | 1641443 | - | | Right SNG | Right hemithyroidectomy | 19-07-2016 | 2 | Nodular colloid goitre | 2.5 | 1 | | |
| 44 | Mrs.Jayarani | 45/f | 1644528 | - | T thyroxine 50 µg OD | Left SNG | Total thyroidectomy | 20-07-2016 | 1 | Nodular colloid goitre | 3 | 1 | 1 | |
| 45 | Mrs.Latha | 40/f | 1643587 | - | | MNG | Total thyroidectomy | 22-07-2016 | 1.5 | Nodular colloid goitre | 2.5 | 1 | 2 | |
| 46 | Mrs.Susila | 30/f | 1644369 | - | T thyroxine 100 µg OD | MNG | Total thyroidectomy | 26-07-2016 | 3 | Nodular colloid goitre | - | CBI | 2 | |
| 47 | Mrs.Mary | 38/f | 1637141 | - | | MNG | Total thyroidectomy | 26-07-2016 | 1.5 | Nodular colloid goitre | 2.2 | 1 | 1 | |
| 48 | Mrs.Anjala | 47/f | 1643865 | HTN | | Left SNG | Left hemithyroidectomy | 26-07-2016 | 2 | Adenomatoid nodule | 1 | 1 | | |
| 49 | Mrs.Latha | 40/f | 1643571 | - | | MNG | Total thyroidectomy | 29-07-2016 | 1.5 | Undifferentiated CA - T4aNxMx | 1.5 | 1 | 1 | |
| 50 | Mrs.Anusuya | 37/f | 1643993 | - | | MNG | | 30-07-2016 | 1.5 | Nodular colloid goitre | 2.5 | 2 | 2 | |

# Keys

RLN – Recurrent Laryngeal Nerve

STA – superior thyroid artery

TSH – Thryoid Stimulating Hormone

PTC – papillary thyroid carcinoma

FNAC – fine needle aspiration cytology

EBSLN – external branch of superior laryngeal nerve

SNG – Solitary Nodular Goitre

MNG – Multi Nodular Goitre

CBI – Could not Be Identified