A COMPARATIVE STUDY OF IMPACT OF GRADING OF TUBERCLE OF ZUCKERKANDL ON THYROID SURGERIES AND ITS OUTCOME

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MAY 2020

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I hereby certify that this dissertation entitled **"A COMPARATIVE STUDY OF IMPACT OF GRADING OF TUBERCLE OF ZUCKERKANDL ON THYROID SURGERIES AND ITS OUTCOME"** is a record of work done by **Dr.R.KEERTHANA PRIYATHARSHINI** in the Department of General Surgery, Madurai Medical College, Madurai, during his postgraduate degree course period from 2017- 2020.

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DECLARATION

I solemnly declare that this dissertation titled **"A COMPARATIVE STUDY OF IMPACT OF GRADING OF TUBERCLE OF ZUCKERKANDL ON THYROID SURGERIES AND ITS OUTCOME"** submitted by me for the degree of M.S, is the record work carried out by me during the period of 2018-2019 under the guidance of **Prof Dr.D.MARUTHUPANDIAN, M.S., FICS., FAIS., & Prof Dr.V.SELVARAJ MS., DcH** Professor of General Surgery, Department of General Surgery, Madurai Medical College, Madurai. The dissertation is submitted to The Tamilnadu Dr. M.G.R. Medical University, Chennai, towards the partial fulfillment of requirements for the award of M.S. Degree (Branch III) General Surgery examination to be held in May 2020.

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CONTENTS

INTRODUCTION

Thyroid diseases has increased in incidence since the last decades. The reasons may be various including hormonal imbalance, changes in lifestyle, change in food habits and early detection of the disease. Due to this reason thyroidectomy has become one of the surgeries which has evolved recently, with very high technical variations. The technique of thyroidectomy largely varies from surgeon to surgeon, although the basic principle remains the same. But it is recently known that thyroid surgery has to be done meticulously removing the whole of thyroid gland, including **pyramidal lobe and tubercle of Zuckerkandl.**

Safety of thyroid surgeries requires the whole knowledge of its anatomy. A Viennese anatomist, Emil Zuckerkandl in 1902 described the thyroid tubercle of zuckerkandl, which has become an important landmark in thyroid surgeries now. Zuckerkandl's tubercle (ZT) is defined as posterior extension of the lateral lobes composing of only thyroid tissues and is derived from the 4th branchial cleft. It contains thyroid tissue only [1]. When enlarged, it may become nodular and lies lateral to the RLN which lies in the tracheoesophagial groove. Thyroidectomy is complete only with excision of TZ. Close proximity of recurrent laryngeal nerve (RLN) and parathyroid increases its

surgical importance and injury to it can cause complications like nerve injury which leads to voice loss and hypocalcemia if parathyroids are injured. Visualising RLN reduces vocal paresis by 1-6 fold[2]. RLN palsies cannot be recognized intra operatively.

Location of RLN using different landmarks have been proposed which includes Simones triangle in relation with inferior thyroid artery which lies at the inferior pole of the thyroid gland. Traction maneuver can also be used to identify RLN. Berry's ligament is also an important landmark for identification of RLN. Left RLN recurves around aortic arch usually in tracheoesophageal groove, posterior or anterior to the inferior thyroid artery. Right RLNrecurves around right subclavian artery at the root of neck slightly lateral to groove at lower border of the thyroid and pass anterior or posterior to the inferior thyroid artery or between its branches. Aberrant non recurrent laryngeal nerve (0.5%) is a surgical hazard, and arise directly from vagus and course medially towards larynx.

TZ has been reported by many authors. It is an important landmark in identification of parathyroid and RLN [3].It is seen facing the tracheoesophageal groove. TZ indicates the point of fusion of ultimobronchialbody and principal median thyroid process.TZ is present in most of the thyroid lobes especially large thyroid lobes. Recognition

and adequate excision is a necessity for total thyroidectomies. It is better visible when the grading is more.

Injury to the parathyroid glands, recurrent laryngeal nerve or superior laryngeal nerve may result in life long consequences for the patients. Appropriate identification andpreservation of the function of these structures are most important in improving the safety and efficacy of thyroid surgery [4].

Injury to the recurrent laryngeal nerve (RLN) is an important but avoidable complication following thyroidectomy. Deliberate identification of the RLN minimizes the risk of injury facilitated by important landmarks found along its course. Permanent RLNP occurs in 0.3–3% of cases, with transient palsies in 5–8% [5] in the previous studies. The rate of RLN palsy after thyroidectomy among endocrine surgeons is 1–2%, but the incidence of RLN injury can peak up to 14% [6,7].

The most common mode of injury to recurrent laryngeal nerve is perhaps more frequently due to edema or stretching than to actual severance. When the nerve is identified and dissected, the reported RLN injury rate during thyroidectomy is 0–2.1%. This is reportedly higher in revision surgery (2–12%) or if the nerve is not clearly identified (4–6.6%) [8].

The surgical importance of ZT can be summarized as [9,10]:

1. Close relationship between ZT and recurrent laryngeal nerve (RLN), Parathyroids.
2. Dissection and excision of ZT for total thyroidectomy.

Grading of ZT

ZTs were classified according to size:

- Grade 0 (unrecognizable)
- Grade I (</=5 mm)
- Grade II (6–10 mm)
- Grade III (>10 mm)

If tubercle of Zuckerkandl is not removed during thyroid surgery, it may be a source of persistent unrelieved symptoms or recurrence as it contains thyroid tissues. An understanding of the anatomy of the tubercle ofZuckerkandl lead to the safe surgical dissection. It usually enlarges lateral to the recurrent laryngeal nerve, with the nerve passing into the cleft medial to it— some surgeons used to describe as the nerve passing into the thyroid substance. Early identification of the tubercle of Zuckerkandl usually allows the recurrent nerve to be easily and safely "encountered" even though it was not initially visible. However an uncommon but high risk situation is where the recurrent laryngeal nerve

runs lateral to an enlarged Tubercle of Zuckerkandl, placing it at increased risk of damage during dissection. Superior parathyroid gland, being derived from the 4th branchial cleft, is commonly found in close association, and it is usually cephalad to the Tubercle of Zuckerkandl.

AIM OF THE STUDY

The aim of the study is to compare and grade the tubercle of zuckerkandl and its outcome in thyroid surgeries.

Tubercle of zuckerkandl were graded according to the size. The injury to RLN and parathyroids were taken into account. Overall impact of the size of TOZ on RLN and parathyroid injury were considered.

REVIEW OF LITERATURE

Total thyroidectomy is defined as the total extracapsular removal of both the lobes, isthmus, pyramidal lobe, and the tubercle of zuckerkandlleaving behind the parathyroid glands, intact recurrent laryngeal nerves and superior laryngeal nerves[11]. Due to the vulnerability and variation of anatomy of the structures involved in this surgery and adhesions and fixity to nearby structures, thyroid surgery used to be a morbid operation in the past[12]. A thorough understanding of the thyroid anatomy and its variations is the key hole to increase safety of thyroid surgeries[11].

*Billroth had a 40% had mortality for thyroidectomy for goiter before 1867 and8.3% had mortality during the anti-septic period from 1877 to 1881. 10.5% patients were tracheotomized. There had 25% unilateral nerve injuries and4.5% had bilateral nerve injuries in the latter group.

*The French academy of Medicine banned its practice in 1850 because the reputation of thyroid surgery was so poor, with a mortality rate of more than 20%.

*Janowski reported a case withthe incidence of 14% recurrent nerve injuries for goiter operations before 1885.

*Halstead later commented that the number was huge because routine laryngeal examinations were not done.

*It was Theodore Kocher who brought the operative mortality from 14.8% to 0.18% and an incidence of recurrent nerve injury and parathyroid injury comparable to surgeons as of today because of his meticulous surgical technique [12].

*In 1938,Lahey reported more than 3,000 thyroidectomies operated by his team during a 3- year period. The recurrent laryngeal nerve was dissected in almost all the cases. He wrote that careful dissection would not increase but definitely decrease the number of injuries to the recurrent laryngeal nerves[13]

The recurrent laryngeal nerves are much softer compared to the peripheral nerves, and therefore the slightest direct or indirect pressure on the nerves interfere with nerve conduction. The nerve is exposed in the course of the operation, and the exposed nerve will be covered with scar formation which is capable of producing a block in the action current[12].

THYROID GLAND – EMBRYOGENESIS

Normal Development

The thyroid gland appears by the end of the third week as an epithelial thickening of the floor of the pharynx at the level of the first pharyngeal pouch. This, the large median thyroid anlage, may be a diverticulum or a solid bud. Cranial growth of the tongue, together with elongation of the embryo, carries the origin of the thyroid gland far cranial to the gland itself. The origin is the foramen cecum of the adult tongue. In some individuals it is not grossly visible. The thyroid gland remains connected with the foramen cecum by a minute, solid hypoglossalduct that passes through, or anterior to, the hyoid bone. By the fifth week of gestation, this duct usually becomes fragmented; persistence of any portion is not unusual. In about 50 percent of the population, the duct can be traced distally to the pyramidal lobe of the thyroid.

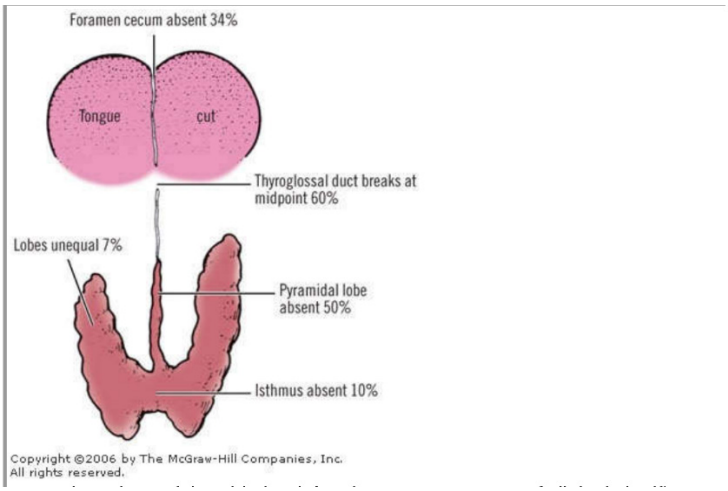


FIG 1: EMBRYOLOGY OF THYROID GLAND

The developing gland, at first an irregular plate, develops two lateral wings connected by the isthmus. Follicles appear during the second month of gestation and increase throughthefourmonth. Colloid formation and uptake of radioactive iodine begin at aboutthe eleventh week.Epithelial structures, the paired lateral anlages, are formed from the ventral portions of the fourth and fifth bronchial pouches. This structure, the well-known ultimobranchial body (caudapharyngeal pouch complex), becomes lost in the developing thyroid gland, and its cells become dispersed as the C-cells (calcitonin) among the thyroid follicles.

SURGICALANATOMY

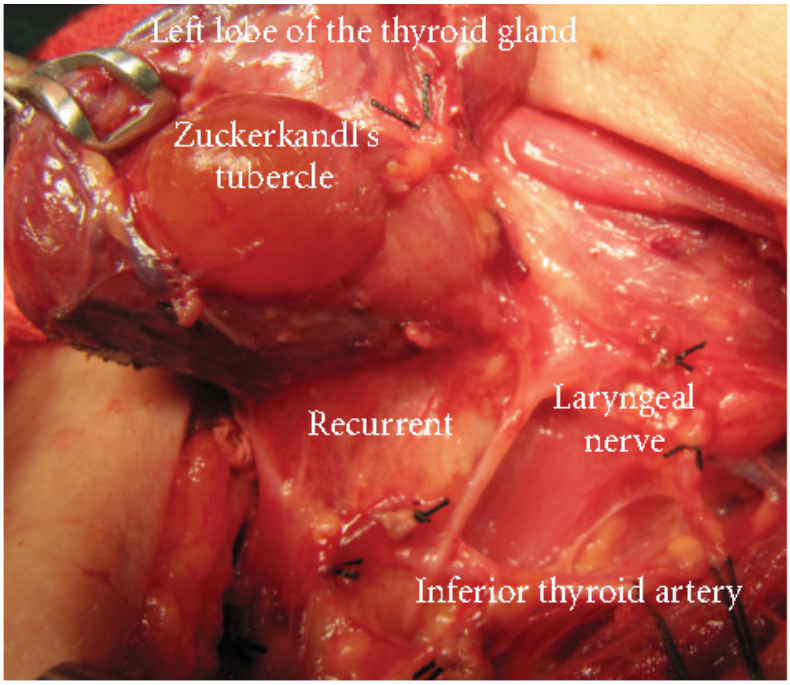


FIG 2: SURGICAL ANATOMY OF THYROID

The thyroid gland consists typically of two lobes, a connecting isthmus, and an ascending pyramidal lobe. One lobe, usually the right, may be smaller than the other (7 percent) even be completely absent (1.7 percent). The isthmus is absent in about 10 percent of thyroidglands, and the pyramidal lobe is absent in about 50 percent .The thyroid gland normally extends from the level of the 5th cervical vertebra to the body of the 1st thoracic vertebra. It may lie higher (lingual thyroid), but rarely lower[14].The normal thyroid gland weighs about 30 g in the adult — somewhat more in females than in males. Each lobe is approximately 5 cm in length, 3 cm at its greatest width, and 2-3 cc thick[15]. The isthmus connecting the two lobes is about 1.3 cm in breadth.

CAPSULE OF THE THYROID GLAND

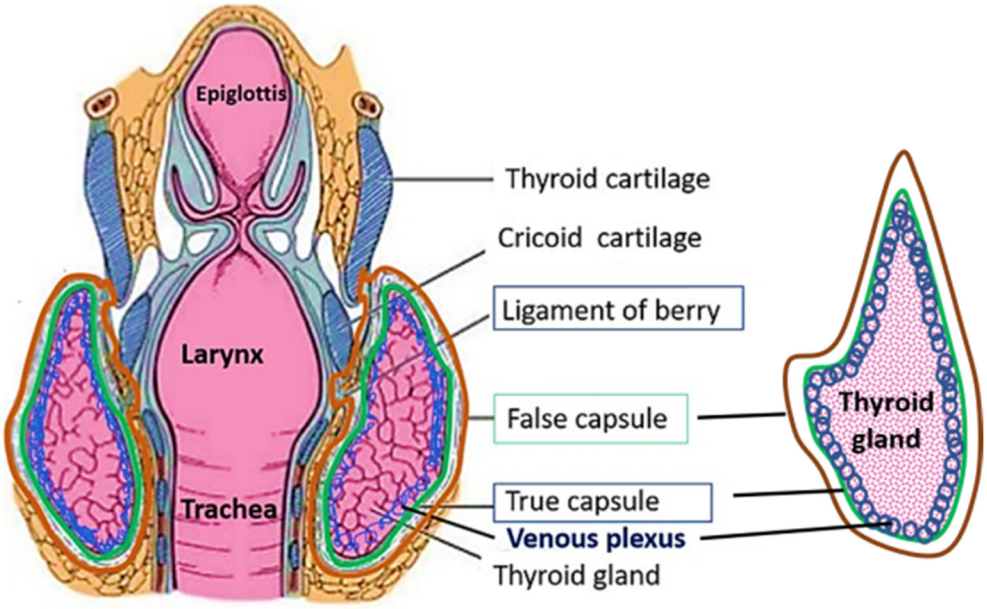


FIG 3: CAPSULE OF THYROID GLAND

Like many other organs, 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 capsule of thyroid. External to the true capsule is a well developed (to a lesser or greater degree) layer of fascia derived from the pretracheal fascia. This is the false capsule, also called the perithyroid sheath or surgical capsule. Anteriorly and laterally this fascia is well developed; posteriorly it is thin and loose, permitting enlargement of the thyroid gland posteriorly. There is a thickening of the fascia that fixes the back of each lobe to the cricoid cartilage. Such thickenings are the ligaments of Berry. The false capsule or fascia is not removed with the gland during thyroidectomy. The superior parathyroid glands normally lie between the true capsule of the thyroid and the fascial false capsule. The inferior parathyroids may be between the true and false within the thyroid parenchyma or lying on the outer surface of the fascia.

VASCULAR SUPPLY

The thyroid gland competes with the adrenal glands for having the greatest blood supply per gram of tissue[16]. One consequence is that hemostasis is a major problem of thyroid surgeryespecially in patients with toxic goiter.

ARTERIALSUPPLY

Two paired arteries, the superior and inferior thyroid arteries and an inconstant midline vessels, the thyroid ima artery supply the thyroid

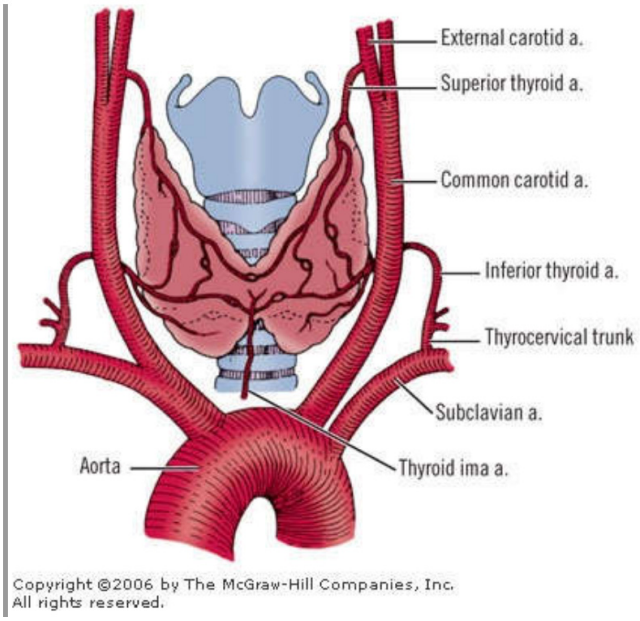


FIG 4: ARTERIAL SUPPLY OF THYROID

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 part of its course, the artery parallels the external branch the superior laryngeal nerve which supplies the cricothyroid muscle and the cricopharyngeusmuscle, the lowest voluntary part of the pharyngeal musculature.

There are six branches of the superior thyroid artery: the infrahyoid, sternocleidomastoid, superior laryngeal, cricothyroid, inferior pharyngeal constrictor and terminal branches of the artery for the blood supply of the thyroid and parathyroid glands.

Usually there are two branches to the thyroid —the anterior and posterior— but occasionally there may be a third, the so-called lateral branch.

The anterior branch anastomoses with the contralateral artery[17] 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. In a study of thyroid glands removed at autopsy from Japanese patients.

*Nobori et al. observed that an anastomosing vessel from the posterior branch of the superior supplied the superior parathyroid in 45% of cases. The majority of 92 glands (67%) had a single artery of supply; 1/3 had two or more small vessels which entered the gland. In the specimen, the branching pattern of the primary vessel supplying the gland appeared that its origin was from the superior thyroid artery.

*Weiglein[18] reported a rare variation of blood supply to the thyroid gland. In this case, the inferior thyroid artery was replaced by an artery

originating from the right internal thoracic artery. The left inferior thyroid artery was replaced by an artery arising from the vertebral artery.

INFERIOR THYROID ARTERY

The inferior thyroid artery usually arises from the thyrocervical trunk, but in about 15 percent of the individuals it arises directly from the subclavian artery[19].The inferior thyroid artery ascends behind the carotid artery and the internal jugular vein, passing medially and posteriorly on the anterior surface of the longus coli muscle. After piercing the prevertebral fascia, the artery divides into two or more branches as it crosses the ascending recurrent laryngeal nerve.

The recurrent laryngeal nerve may pass anterior or posterior to the artery, or between its branches (Fig. 1-57). The lowest branch sends a twig to the inferior parathyroid gland and it supplies the lower pole of the thyroid gland. The upper branch supplies the posterior surface of the gland, usually anastomosing with a descending branch of the superior thyroid artery. On the right, the inferior thyroid artery is absent in about 2 percent of individuals. On the left, it is absent in about 5 percent (Hunt et al.).[20] The artery is occasionally double[21].

THYROID IMA ARTERY

The thyroid ima artery is unpaired and inconstant. It arises from the brachiocephalic artery, the right common carotid artery, or the aortic arch. It occurs in about 10 percent of individuals. According to Montgomery,it may be as large as an inferior thyroid artery or it may be a meertwig. Its position anterior to the trachea makes it importantintracheostomy.

VENOUS DRAINAGE

Veins of the thyroid gland form a plexus of vessels lying in the substance and on the surface the gland. The plexus is drained by three pairs of veins, the superior, middle, and veins.

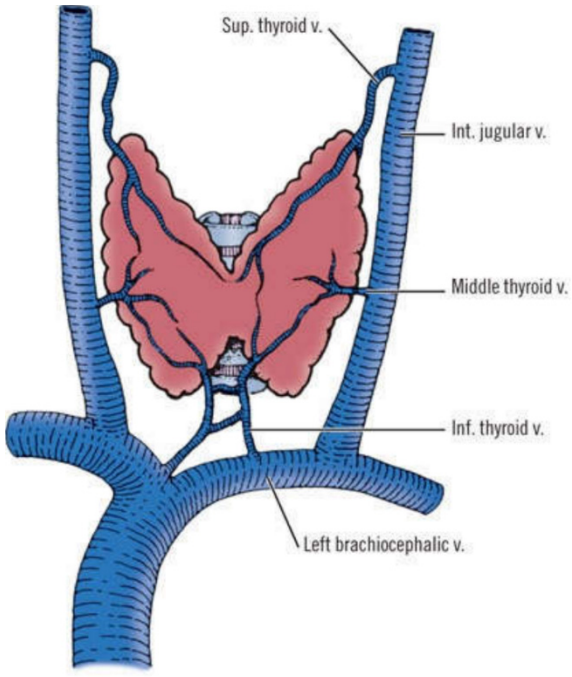


FIG 5: VENOUS DRAINAGE OF THYROID

SUPERIOR THYROID VEIN

The superior thyroid vein accompanies the superior thyroid artery. Emerging from the superior pole of the thyroid, the vein passes superiorly and laterally across the omohyoid muscle and common carotid artery to enter the internal jugular vein alone or with the common facial vein.

MIDDLE THYROID VEIN

The middle thyroid vein arises on the lateral surface of the gland at about two-thirds of its anteroposterior extent. No artery accompanies it. It crosses the common carotidand drains into the internal jugular vein. This vein may be absent or occasionally double. The extra vein is inferior to the normal one it has been called the "fourth" thyroid vein. The importance of thesemiddle thyroid veins is in their vulnerability during thyroidectomy.

INFERIOR THYROID VEIN

The inferior thyroid vein is the largest and most variable of the thyroid veins; the right and left sides are usually asymmetric. The right vein leaves the lower border of the thyroid gland, passes anterior to the brachiocephalic artery and enters the right brachiocephalic vein. The left vein crosses the trachea to enter the left brachiocephalic vein. Rarely, the

right vein crosses the trachea to enter the left brachiocephalic vein, sometimes `forming a common trunk with the left vein. This common trunk is called the thyroid ima vein.

LYMPHATICS

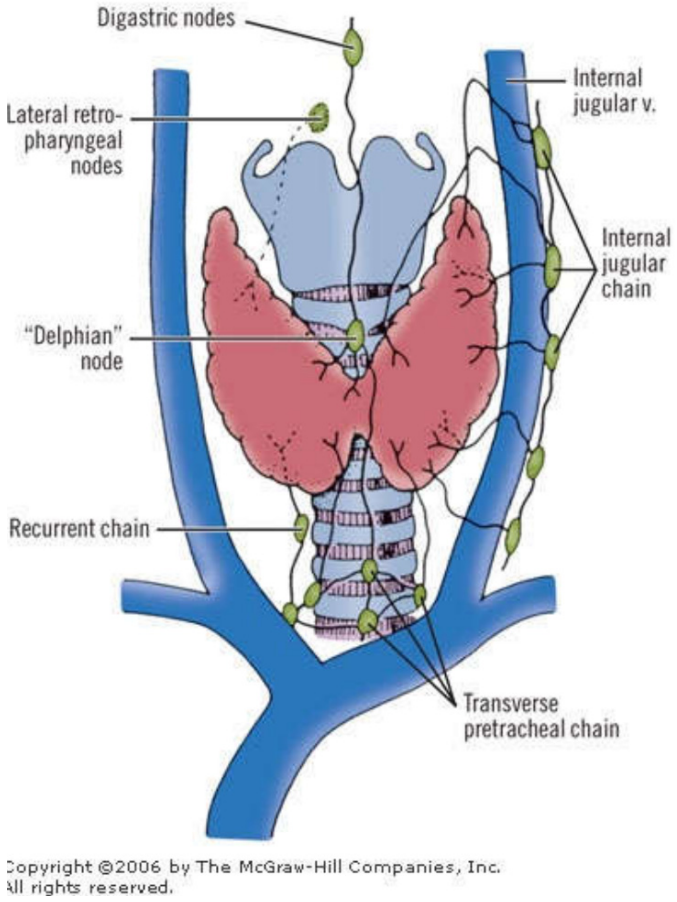


FIG 6: LYMPHATIC DRAINAGE OF THYROID GLAND

INNERVATION

The thyroid gland is innervated by the sympathetic system from the superior, middle and inferior ganglia of the cervical chain. But in thyroid surgery the recurrent and superior laryngeal nerves of the

parasympathetic (vagus) system (which play no role in the innervation of the gland) are of utmost importance.

RECURRENT LARYNGEAL NERVE (INFERIOR LARYNGEAL NERVE)

ANATOMY

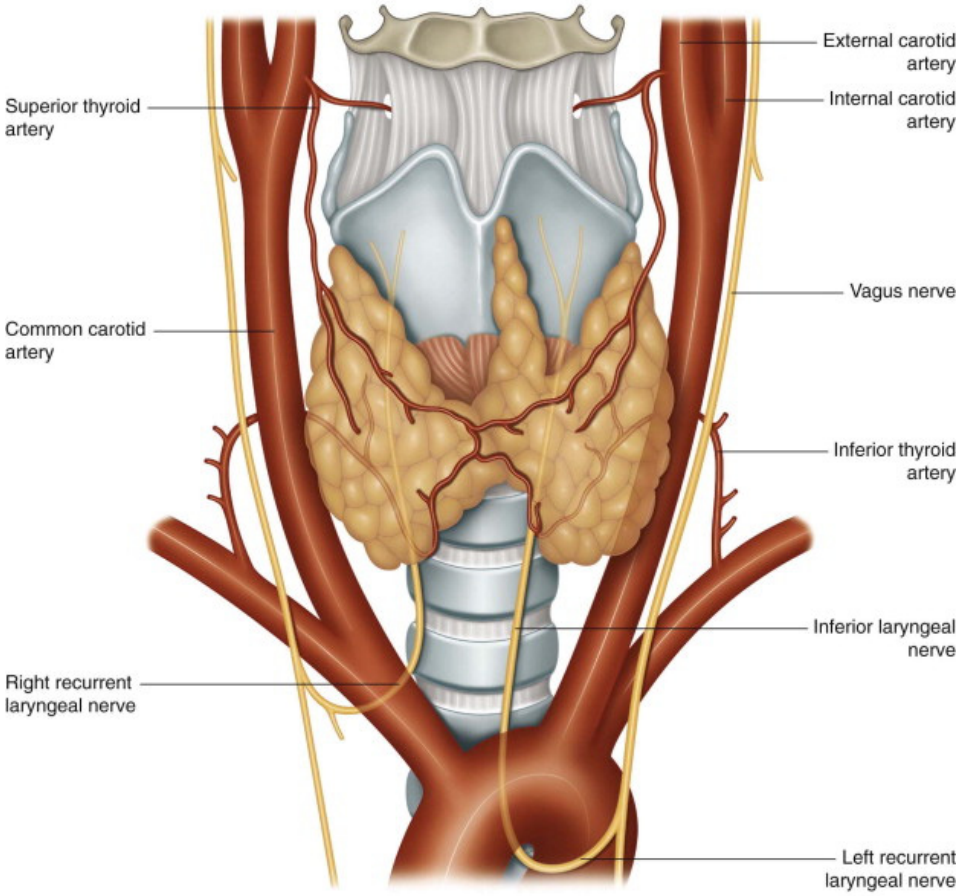


FIG 7 : COURSE OF RECURRENT LARYNGEAL NERVE

The right and left recurrent laryngeal nerves are intimately related to the thyroid gland. The rig of recurrent nerve branches from the vagus as it crosses anterior to the right subclavian artery. The right recurrent

nerve loops around the subclavian artery from posterior to the anterior, crosses behind the right common carotid and ascends in or near thetracheoesophageal groove. It passes posterior to the right lobe of the thyroid gland to enter the larynx behind the cricothyroid articulation and the inferior cornu of the thyroid cartilage.

The left recurrent nerve arises where the vagus nerve crosses the aortic arch, just distal to the origin of the left subclavian artery from the aortic arch. It loops under the ligamentumarteriosand the aorta, and ascends in the same manner as the right nerve. Both nerves cross the inferior thyroid arteries near the lower border of the middle third of the gland.

It is interesting to note that it is in the last 2 cm of the extralaryngealcourseofthe nerve lies structures of importance such as the ligamentofberry, thetubercle of zuckerkandl, the superior parathyroid gland and the nerve itself reveals its extralaryngeal branching here. Precise surgical technique and understanding of anatomy of this compact space is critical to successful thyroid surgeries.The motor fibers responsible for the adduction and abductionof the vocal cords are located in the anterior branches of the nerve.

VARIATIONS:

Several variations may occur in the courses of the recurrent nerves. All serve to increase the possibility of injury to the nerve during thyroid surgery. Katz and Nemiroff visualized 1,[22] recurrent laryngeal nerves. They reported that 747 (63%) bifurcated or trifurcated more than 0.5 cm from the cricoid cartilage. Bilateral nerve bifurcation was observed in 170 patients. In an earlier version of this research, these authors wisely concluded that "extralaryngeal branches of the recurrent laryngeal nerve are not an anatomic rarity. Therefore, thyroid surgery must include identification and preservation of the recurrent laryngeal nerve and all of itsdivisions."[23].In about 1 percent of patients, the right recurrent nerve arises normally from the vagus, but passes medially almost directly from its origin to the larynx without looping under artery. In these cases, the right subclavian artery arises from the descending aorta and passes to the right behind the esophagus. This anomaly is asymptomatic, and the surgeon will rarely be aware of it prior to operation. Even less common is a nonrecurrent left nerve in the presence of a right aortic arch and a retroesophageal left subclavianartery .

In the lower third of its course, the recurrent laryngeal nerve ascends behind the pretracheal fascia at a slight angle to the tracheoesophageal groove. In the middle third of its nerve may lie in the

groove, medial to the suspensory ligament of thethyroid gland (ligament of Berry) within the ligament or within the substance of the thyroid gland.

*Skandalakiset al.[24]examined the course of the recurrent laryngeal nerve in 102 cadavers (204 sides). In about half of the specimens, the nerve lay in the tracheoesophageal groove. In the other half, most were anterior to the groove (paratracheal); a few lay posterior (paraesophageal). In 8 of the 204 sides, the nerve lay within the gland (Fig. 1-64).Workers have found a slightly higher percentage of intraglandularnerves[25].

It is particularly interesting for laryngeal surgeons to notice the minor variability of branching of the inferior laryngeal nerve and of its mode of entrance into the hypopharynx. Even in the case of a unilateral single trunk, the nerve passes just behind the cricothyroidjoint and can be easily identified. Variations...were mainly limited to the level of the extralaryngeal division of the inferior laryngeal nerve. Thus, the surgeon can rely on precise and consistent landmarks in this part of the body, as in other anatomical locations.The recurrent laryngeal nerve is safest and least visible when it lies in the tracheoesophagealgroove. It is most vulnerable when it traverses the thyroid parenchyma. Where itsuspensory ligament of the thyroid, it must be identified and protected before the

ligament isdivided. The recurrent laryngeal nerve crosses the inferior thyroid artery at the middle third of the gland. It may lie anterior or posterior to, or between the branches of the artery[26].

*Kreyer and Pomaroli[27] reported an anastomosis between the external branch of the superior laryngeal nerve and the recurrent laryngeal nerve.*Sturniolo et al.[28] emphasized that the secret to avoiding injury to the recurrent laryngeal nerve during thyroid surgery is as follows: (1) deep knowledge of the surgical anatomy of the thyroid region; (2) total extracapsular thyroidectomy; (3) a thorough search, identification, and exposure of the nerve itself and (4) following the course of the nerve with care.

*According to Procacciante and colleagues,[29] after the recurrent laryngeal nerve is brought by upward and medial traction of the thyroid, it may be palpated caudally to the inferior pole of the gland. This maneuver aided safe dissection in the region of the inferior thyroid artery.

*Marchesiet al.[30] reported an occurrence rate of 0.34% for a nonrecurrent inferior laryngeal nerve on the right side, and extreme rarity on the left side. They report seven cases of non recurrent laryngeal nerve and emphasize the diagnostic accuracy of angio-MR for the anatomic identification of the vascular anomaly that invariably occurs with the nerve malformation.

The nonrecurrent nerve (left or right, when present) may pass directly to the larynx with no relation to the inferior thyroid artery or such a nerve may loop around the artery.

*Avisseet al.[31] reported 17 cases of a right nonrecurrent inferior laryngeal nerve. In two of these cases an aberrant right subclavian artery coexisted with a nonrecurrent inferior laryngeal nerve.

*Sanders et al.,[32] who found seven cases of nonrecurrentlaryngeal nerves in 1,000 thyroidectomies, reported the following: In two of these seven cases, both a nonrecurrent nerve and an additional recurrent branch were present on the right side. This double nerve presentation has not been described before. Unless one is aware of this possibility, one might inadvertently injure the major nonrecurrent trunk, having identified only a small recurrent branch. We emphasize the need for a complete nerve identification technique.

*Miyauchiet al.[33] reported good results with simple neurorrhaphy or with graft (vagus nerve/ansacervicalis) of the injured recurrent nerve. Their 8 patients recovered from hoarseness, maximum phonation improved. Steinberg et al.[34]stated that branches of the recurrent laryngeal nerve (motor as well as sensory), together with sympathetic nerves, supply the larynx beneath the cords, pharynx, cervical esophagus, and cervical trachea.

EXPOSURE

Exposure of the recurrent nerve during any procedure on the thyroid is a sound surgical principle and should be done wherever possible. If the nerve cannot be found readily, the surgeon must avoid the areas in which it may be hidden. Fibrosis, increased bleeding, and lack of clear anatomic relationships are responsible for most nerve injuries. Postoperative exploration for hemorrhage also is associated with a higher risk of nerve injury.[35]

At one time the recurrent nerve was considered so delicate that "if a recurrent laryngeal nerve seen during thyroidectomy, it is injured."[36] At the other extreme are those who would require demonstration of the nerve by direct stimulation during laryngoscopic observation of the vocal cords.[37]We believe that visual identification, with avoidance of traction, compression, or stripping the connective tissue is all that is necessary. The recurrent laryngeal nerve forms the medial border of a triangle bounded superiorly by the inferior thyroid artery and laterally by the common carotid artery. The nerve can be where it enters the larynx just posterior to the inferior cornu of the thyroid cartilage. The nerve is not found, a nonrecurrent nerve should be suspected, especially on the left.

SUPERIOR LARYNGEAL NERVE

The superior laryngeal nerve arises from the vagus nerve just inferior to its lower sensory ganglion just outside the jugular foramen of the skull. The nerve passes inferiorly, carotid artery. At the level of the superior cornu of the hyoid bone it divides into a large, sensory internal laryngeal branch and a smaller, motor, external laryngeal branch, serving the cricothyroid muscle[38] and the cricopharyngeus. The point of division is usually within the bifurcation of the common carotid artery.

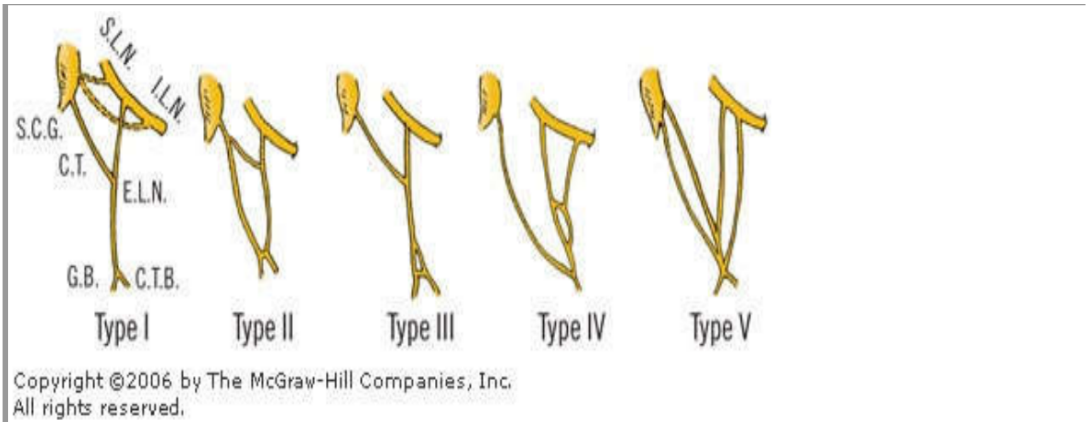


FIG8 : VARIATION IN SUPERIOR LAYNGEAL NERVE

To prevent iatrogenic injury of the superior laryngeal nerve during surgical dissection near the thyroid apex in the neck, el-Guindy and Abdel-Aziz [39] recommended anatomical localization of the nerve in the viscerovertebral angle, functional identification, and post-operative analysis.

BRANCH OF SUPERIOR LARYNGEAL NERVE

INTERNAL LARYNGEAL NERVE

The internal laryngeal branch pierces the thyrohyoid membrane with the superior laryngeal branch of the superior thyroid artery to enter and supply the larynx. The internal branch is rarely identified by the surgeon; identification occurs only in those cases where a greatly enlarged upper pole of the thyroid gland rises above the superior border of the thyroid cartilage. The internal laryngeal nerve provides general sensory fibers to the larynx and the area of the piriform recess of the laryngopharynx. It also provides parasympathetic fibers for the glandular elements and some taste fibers that supply taste buds around the epiglottis.

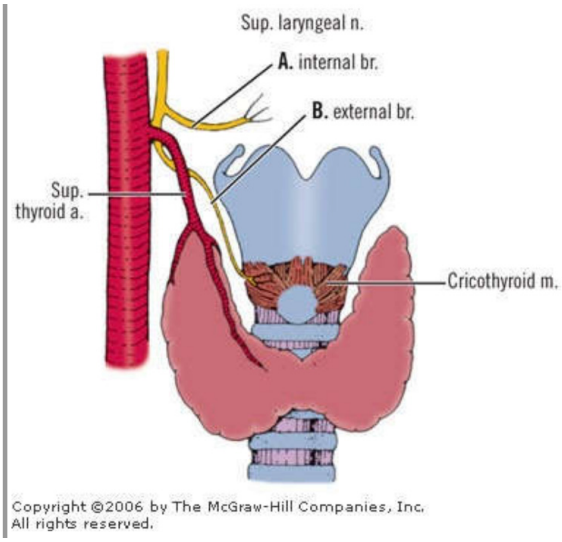


FIG9 : RELATIONSHIP BETWEEN EXTERNAL AND INTERNAL

EXTERNAL LARYNGEAL NERVE

The external laryngeal branch, together with the superior thyroid vein and artery, passes under the sternothyroid muscles, posterior and medial to the vessels. The nerve then passes through the lower border of the thyrohyoid muscle to continue inferiorly to innervate the cricothyroidmuscle. In addition to its contribution to phonation, the cricothyroid muscle plays a major and the overall regulation of breathing by its control of expiratory resistance and flow.An investigation by Wu et al.[40] suggested that in some individuals a branch of the external laryngeal nerve may also contribute to the innervation of the thyroarytenoid muscle and to the sensory supply of the vocal fold of the larynx. They postulated that the communicating branch of this nerve might represent the nerve of the 5th embryonic branchialarch. Cerneaet al.[41] stated that injury to the external branch of the superior laryngeal nerve will most likely endure, causing a permanent voice change for professional vocalists. Fatigue, alsis common after injury to the external branch of the superior laryngeal nerve.Cernea et al advised nerve identification in the operating room, especially for patients with large goiters. Ttopographic anatomy and relations of the nerves and thyroid vessels are presented in Figure

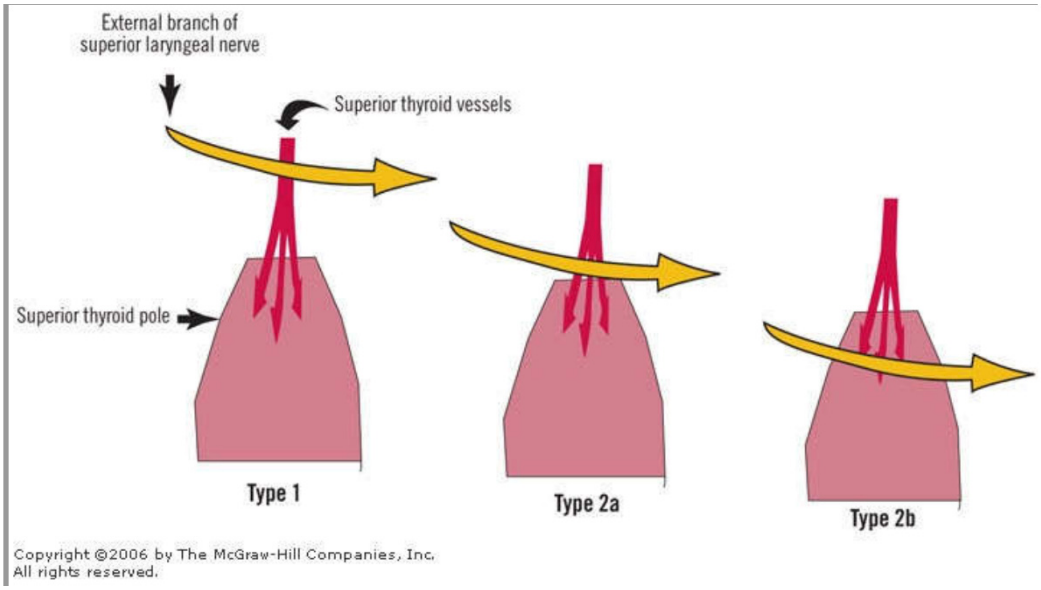


FIG 10: CLASSIFICATION EXTERNAL BRANCH OF SUPERIOR LARYNGEAL NERVE

Type 1- Nerve crosses the superior thyroid vessels 1 or more centimeters above a horizontal plane passing the upper border of the superior thyroid pole.

Type 2a- Nerve crossing the vessels less than 1 cm above the plane.

Type 2b- Nerve crossing the vessel below the plane

In most patients, the blood vessels lie within the visceral compartment of the neck beneath the pretracheal fascia, while the external laryngeal nerve lies between the fascia and the pharyngeal constrictor muscle. There is thus a plane of dissection between the

vessels and the nerve. In about 25 percent of individuals, the nerve lies beneath the fascia together with the vessels.[42]

PARATHYROID GLANDS

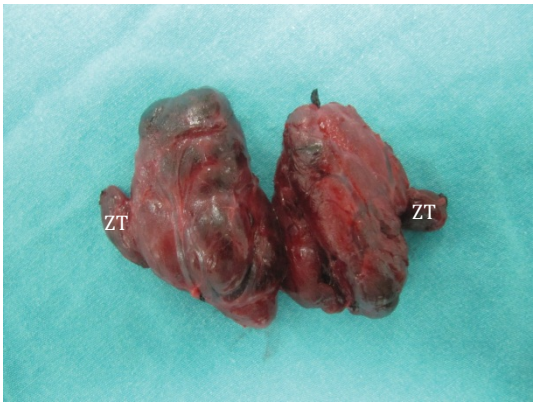
There are 4 parathyroid glands in close association with the thyroid gland.The number and positions of the glands may vary among individuals. Akerstrom et al described a 13% incidence of a supernumerary fifth parathyroid. The superior parathyroid glands are derived from the fourth branchial pouch and are in close association with the lateral lobes of the thyroid. They have a short line of descent and remain close to the lateral lobe of thyroid, along the posterior capsule in the region of the inferior thyroid artery. The inferior parathyroid glands are derived from the third branchial pouch and descend along the developing thymus. Therefore they have a long line of descent, and consequently their position is much more variable. An inferior parathyroid gland can be carried along with the thymus into the anterior mediastinum or the pericardium. Conversely, it may be left behind high in the carotid sheath. Most of the times the inferior parathyroid gland are found near the inferior pole of the thyroid within the capsule. They may also be found within clefts of thyroid tissue. Despite the variability in its anatomy, frequently there is a asymmetric

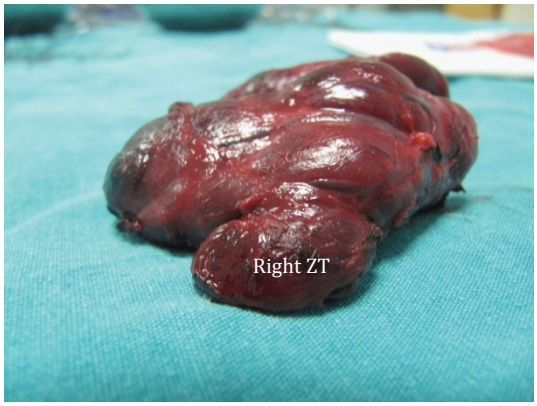
arrangement between the positions of the gland on either side. Symmetry of the superior glands is about 80% and in 70% of inferior glands[43].

There is a single arterial supply in 80% of the parathyroid glands, a dual supplyin 15% and multiple arteries in the remaining. These arteries originate from the inferior thyroid artery in most cases, although in 20% of cases the superior thyroid artery supplies the superior parathyroid, sometimes associated with an anastomosing branch between the superior and inferior thyroid arteries[44].

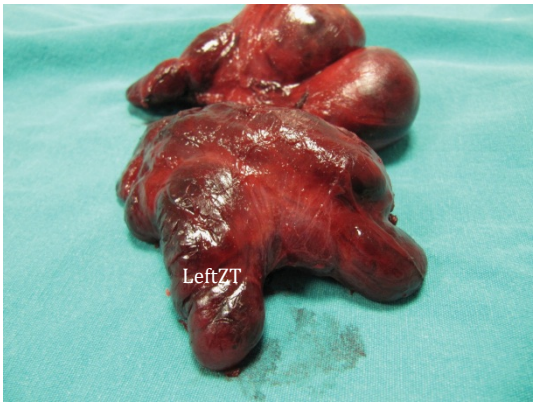
TUBERCLE OF ZUCKERKANDL

Pelizzo et al.[45] advised that the best way to locate the recurrent laryngeal nerve during thyroidectomy is the Zuckerkandl' stuberculum, which is located on the lateral portion of each of the thyroid lobes, and according to these authors is the constant anatomic landmark when present.





(a) (b)



(b) (d)

Figure : These figures show enlarged Zuckerkandl's tubercles (ZT) in the total thyroidectomy specimen. (a) Bilateral ZT, (b) right ZT, and c) left ZT of the same patient. (d) An example of a large ZT as posterior extension of the left lobe.

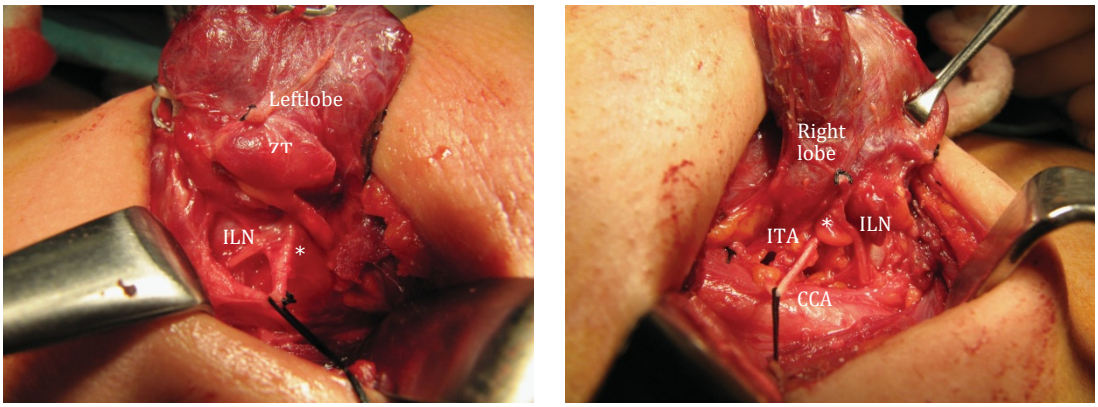


Figure the inferior laryngeal nerve (ILN) passes posterior (medial) to the Zuckerkandl's Tubercle (ZT) near neuro vascular crossing point (∗) with inferior thyroidartery(ITA). a) Right side and (b) left side of two different patients.

The tubercle of Zuckerkandl is present in all thyroid glands. It is represented as a thickening where the ultimobranchial body fuses with the median thyroid process. When enlarged, it develops into a nodular process with the recurrent laryngeal nerve passing medial it into a fissure. This constant anatomic relationis stressed in many studies that emphasize the use of the tubercle to locate the recurrent laryngeal nerve. The recurrent laryngeal nerve branches off the vagus nerve in the mesenchyme between the fourth and fifth pharyngeal pouches. It rejoins the pharyngeal cartilages running around the fourth aortic arch and is immediately covered by the thyroid tissue arising from the lateral anlages of the fourth branchial pouch. This explains the constant anatomical relationship between the recurrent laryngeal nerve and the tubercle of Zuckerkandl

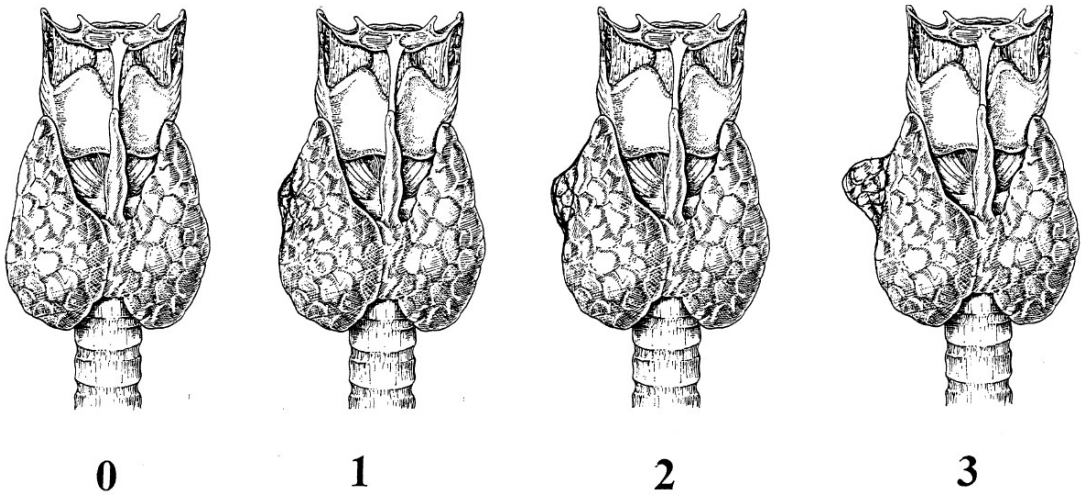


FIG 11: PELIZZO CLASSIFICATION OF GRADING OF TUBERCLE OF ZUCKERKANDL

Grade 0 - unrecognizable

Grade 1 - only a thickening of the lateral edge of the thyroid lobe

Grade 2 - smaller than 1cm

Grade 3 - larger than 1 cm [46]

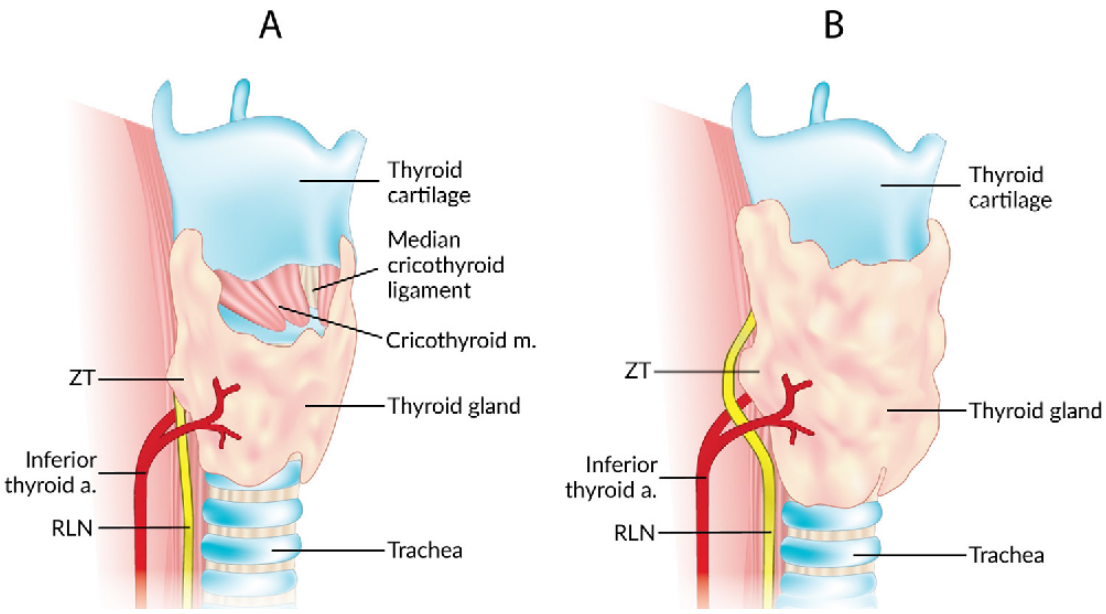


FIG 12: RELATIONSHIP OF RECURRENT LARYNGEAL NERVE AND INFERIOR

THROID ARTERY WITH TZ

*The extent to which a tubercle is positively identified differs greatly in the few series reported in the medical literature, being: 7% for Page, 14% for Pelizzo[46], 55% for Hisham[47], 59% for Kaisha, 63% for Gauger, 66% for Gurleyik, 65% of grade 3 tubercles for Yalcin, 68% of grade 2 and 3 tubercle for Yun.

*In Page et al's series,5 right tubercles of Zuckerkandl were distinctly recognised in 71 right lobectomies (i.e. 7 per cent of right-sided cases) and were very useful for locating the recurrent laryngeal nerve situated just beneath.

*In Gurleyik's study, the RLN was medial to the TZ in 94% of the visualized TZ's [48]. In another study the RLN was posterior to the TZ in96.2%[49] .

*According to Page, these differences in the frequency of discovery of a clearly visible tubercle of Zuckerkandl can be explained by several factors.

1. The first factor is the state of awareness of the thyroid surgeon, as the tubercle of Zuckerkandl is poorly described in the standard anatomical literature.
2. The second factor is the surgical procedure itself. The exposure and identification of a tubercle of Zuckerkandl is possible when the lateral lobe is exposed laterally after complete ligation of the superior pedicle, which was always our first-line procedure. In such cases, when the lobe is mediallydisplaced, the tubercle will appear as a small nodule, visibly distinct from the thyroid parenchyma. Cautious capsular dissection of the tubercle will then reveal the inferior laryngeal nerve immediately underneath. For lobectomies performed in the craniocaudal direction, with final ligation of the superior pedicle, the tubercle may not be clearly identified.

3. The third factor is related to the fact that, a well individualised tubercle of Zuckerkandl is not found as frequently as one might think. Moreover in our experience, the tubercle was found only on the right side, whereas in theory it should be found bilaterally. The fourth and final factor is that the existence of this tubercle also depends on the goitre itself. When a hypertrophic nodule involves the tubercle itself, the latter is particularly prominent [50].

*Yalcin et al. have reported an incidence of grade 2 and 3 tubercles as 64% and 65% in lateral lobes.

*Yun et al. have found grade 2 and 3 tubercles in 68% (right side 72% and left side 64%) of lateral lobes [51] .

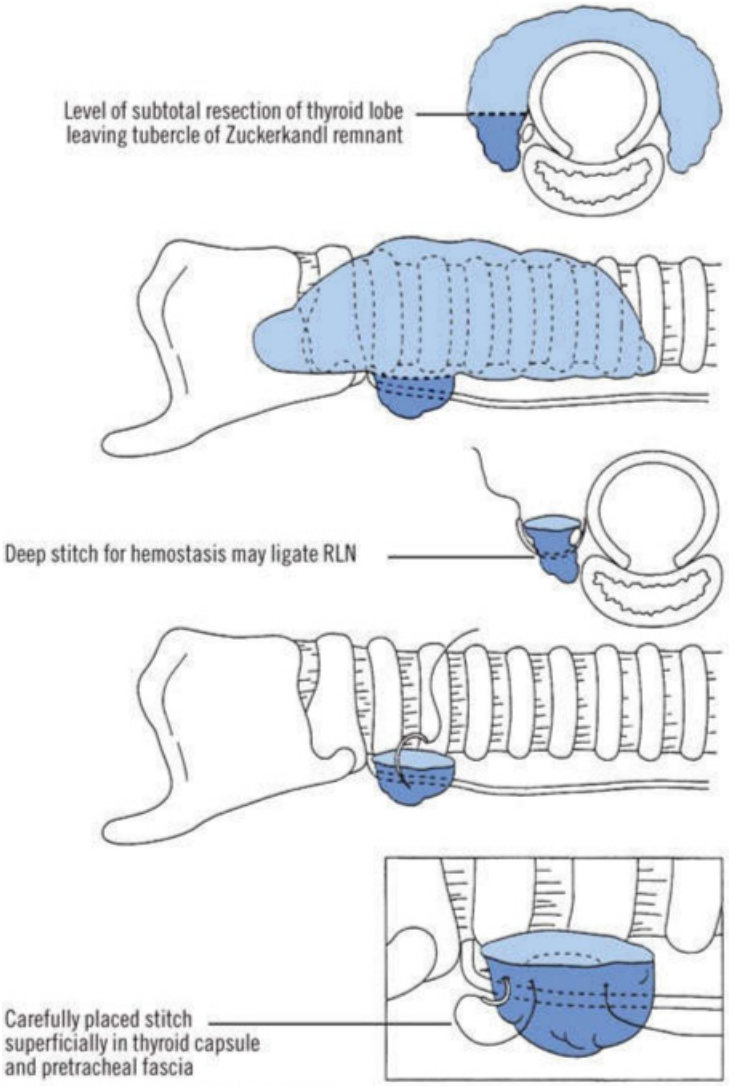


FIG 13: DISSECTION NEAR TUBERCLE OF ZUCKERKANDL

COMPLICATIONS OF THYROID SURGERY

The surgical procedures for thyroid pathology are total bilateral lobectomy, total unilateral with partial contralateral lobectomy, and partial or subtotal lobectomy (unilateral or bilateral). There much controversy as to which is the most appropriate choice for each patient and each disease. The surgical profession agrees to disagree about all these procedures. Recently, minimally invasive thyroid surgery has been performed successfully.

*Ferzli et al.reported feasible and safe mini-thyroidectomy on glands no larger than 7 cm.We agree with the advice of Bliss and colleagues,[52] "Minimally invasive thyroidectomyendoscopic techniques may also affect the practice of thyroid surgery. Even so, understand in the surgical anatomy of the thyroid gland and its possible variations is paramount to safe and effective surgery."

ANATOMIC COMPLICATIONS OF THYROIDECTOMY

In a series of thyroid operations in which 217 recurrent laryngeal nerves were involved.

*Holtand coworkers [53] found 9 nerve injuries, of which 4 were permanent. In the same serieswere three injuries to superior laryngeal nerves; one was permanent.Most recurrent laryngeal nerve injuries occur

‘just below that point where the nerve passesunder the lower fibers of the inferior constrictor muscle to become intralaryngeal."cause is a hemostatic stitch. Another source of injury is mass ligation of the vessels of thelower pole of the thyroid. Such ligation may include a recurrent nerve more anterior than usual. The nerve should be identified before ligating the inferior thyroid vein. The specific causes ofrecurrent laryngeal nerve injury have been evaluated by Chang-Chien [54].

Recurrent Laryngeal Nerve Vulnerability

Cause of Vulnerability	Percent Encountered
Lateral and anterior location	1.5-3.0
Tunnelling through thyroid tissue	2.5-15.0
Fascial fixation	2.0-3.0
Arterial fixation	5.0-12.5

*The results of injury to the recurrent laryngeal nerve and the external branch of the superior laryngeal nerve have been outlined by Esmeraldo and coworkers.[55]

In unilateral recurrent nerve injury, the affected vocal cord is paramedian in position due totension on the vocal ligament by the cricothyroid muscle. Voice is preserved not with unilateral injury to both

the recurrent laryngeal and superior laryngeal nerve, the affectedcord is in an intermediate position, resulting in hoarseness and inability to cough. The cord will move toward the midline with time. Voice improves, but is followed by narrowing of the airway. Loss of the superior laryngeal nerve leaves the tissues of the larynx and piriformrecesses insensate, resulting in loss of the cough reflex and difficulties with aspiration and clearing the airway. With bilateral recurrent nerve injury, because of the narrowing of the airway produced by unopposed cricothyroid muscles, tracheostomy becomes necessary.

*Scanlon and colleagues[56] reported a series in which 6 of 245 patients who had undergone total thyroidectomy experienced recurrent laryngeal nerve paralysis. All but one recovered within a year. *Postoperative hoarseness is not always the result of operative injury to laryngeal nerves. From1 to 2 percent of patients have a paralyzed vocal cord prior to thyroid operation.[53]

*Coworkers at the Mayo Clinic[57] examined 202 cases of vocal cord paralysis, of percent) followed thyroidectomy, 36 (18 percent) were of various known etiologies, and 13 (6percent) were of idiopathic origin.

We strongly advise the general surgeon to have an indirect laryngoscopy performed prior to thyroidectomy.

*Miyauchi et al. performed ansacervicalis-recurrent laryngeal nerve anastomosis in the ne for vocal cord paralysis due to mediastinal lesions. They reported excellent improvement in phonation without vocal cord movement.

We believe that the patient should be told that in spite of all precautions, there is a possibility that there may be some vocal disability following thyroidectomy. Dysphagia can result from damage to early rising branches of the recurrent laryngeal nerves that supply the esophagus.[58]

Superior Laryngeal Nerve Injury

*Lekacosetal.[59] noted 3 cases of superior laryngeal nerve injury after 54 classical high ligations of the superior thyroid artery. They observed that patients with loss of the external laryngeal nerve complained of voice instability, quick vocal fatigue and inability to produce high pitched sounds, with difficulty in singing. No injuries were recorded in 227 other cases in which the branches of the superior thyroid artery were ligated at the superior pole.

*According to Durham and Harrison,[60] the external laryngeal nerve closely parallels the superior thyroid vessels in about 20% of cases,

and even passes between the branches of the superior thyroid artery near the superior pole in 6-14% of cases.

* Johns and Rood[61] discussed classification of the paralyzed vocal cord. The paralyzed vocal cord may be paramedian (interruption of the recurrent laryngeal nerve alone [Wagner-Grossmann theory] or intermediate (interruption of the recurrent and superior laryngeal nerves). Injury to the superior laryngeal nerve alone can be identified by rotation of the superior glottis to the affected side, and by bowing of the vocal cord.

A thorough understanding of the anatomy of the larynx and the relationships of the laryngeal nerve supply to the intrinsic muscles of the larynx is a prerequisite to localization of the site of lesion in laryngeal nerve injury. Successful management of thepatient is based upon an accurate etiologic diagnosis.[61]

Postoperative complications were as follow:

-Transient hypoparathyroidism5.2%

-Permanent hypoparathyroidism 1.7%

-Transient recurrent laryngeal nerve palsy 2.6%

-Permanent recurrent laryngeal nerve palsy 1.7%

*We quote from Profanter et al.[62] on primary hyperparathyroidism (HPTH): Sonography had an overall accuracy to correctly localize enlarged parathyroid glands of 80% and scintiscanning had overall accuracy of 78.6%. The accuracy of localization was increased up to 84.6% if both diagnostic procedures were applied. In patients with normal thyroid residues the accuracy of sonography was 85.7% and it was 100% if scinti scanning was used. Preoperative localization techniques in patients with primary HPTH and previous thyroid surgery have high accuracy. This allows for an imaging- directed operative strategy, thus preventing unnecessary bilateral neck explorations, which carry a high risk of recurrent laryngeal nerve injury.

*We quote from Menegaux et al. about secondary thyroidectomy:[63] The permanent complication rate is higher in thyroid reoperations than in primary thyroid operations. However, we believe that this 2% rate is low enough to allow reoperation whenever it is necessary, provided precise operative rules are respected.

The branching can be observed both, before and after crossing the inferior thyroid artery. It commonly occurs distal to the crossing of the inferior thyroid artery. Therefore if the superior approach is used, one of these branches may be injured.

*Therefore Lekacos et al traced the branches to the trunk of the nerve in cases where the superior approach is used. Branched recurrent laryngeal nerves are a risk factor for both temporary and permanent nerve palsy.

*Berlin observed that more than 80% of the nerves was deep to the inferior thyroid artery[64].

The most common sites where the nerve is at risk of injury are near the inferior thyroid artery, ligament of berry and at the inferior pole of the thyroid gland. The cause for injury is presumed to be associated with stretching and compression at fixed points which causes neuropraxia, which is transient in most cases.

However, regardless of the cause of the palsy, permanent palsies are a debilitating complication. A permanent unilateral palsy will cause dysphonia, weakened cough, predisposition to aspiration, social and economic detrimental effects to the patient. A bilateral nerve palsy is potentially life-threatening which may necessitate a permanent tracheostomy at times. And therefore the key aim of thyroid surgery is to minimize the incidence of recurrent laryngeal nerve palsy[65].

In the case of immediate postoperative paralysis of the vocal cord, re-exploration of the wound and exploration of the nerve in its full course should be done and attempt to re-anastomosis should be made. But if continuity of nerve was ensured during the operation, re-exploration of the nerve is not needed. Only observation with regular follow-up is required and is expected to recover in the post-operative period by itself[66].

*In Serpell et al's study, he had revealed branching of the nerve in 64.5% with the help of intra-operative neuromonitoring[65]. Casella et al noticed that the nerve had branches 25.7% on the right side and 22.9% on the left[67].

Besides nerve damage there are other causes of change in voice. They are important in affecting reported nerve palsy rates and include the type of surgery (primary/re-do), extent of surgery (lobectomy/subtotal/ total thyroidectomy), formal identification of the recurrent laryngeal nerve, ESBLN injury and surgical volume (high/low)[68].

Post-operative hypocalcemia

Post-operative hypocalcemia is the most common complication following total thyroidectomy. The earliest symptom being perioral

and acralparesthesiaswhich if left untreated can become severe and manifest as carpopedal and generalized tetany. On examination one can elicit chvostek's and trousseau's sign.

*Chvostek's sign is described as the twitching of facial muscles in response to tapping over the area of the facial nerve.There are 4 grades for chvostek's sign.

Grade 1 - twitching of lip at angle of mouth

Grade II - Grade 1 + twitching of alanasi

Grade III - Grade II + twitching of lateral angle of eye

Grade IV - twitching of all facial muscles

*Trousseau's sign is carpopedal spasm that results from ischemia, such as that induced by pressure applied to the upper arm from an inflated sphygmomanometer cuff. Chvostek's sign is neither sensitive nor specific for hypocalcemia, since it is absent in about one third of patients with hypocalcemia and is present in approximately 10% of persons with normal calcium levels. Trousseau's sign, however, is more sensitive and specific. It is present in 94% of patients with hypocalcemia and in only 1% of persons with normal calcium levels[69].

The main cause of hypocalcemia is acute parathyroid insufficiency. This is due to intra-operative damage to the parathyroid glands by a combination of mechanical or thermal trauma, gland devascularisation or inadvertent removal, leading to reduction of the functional parathyroid parenchyma.

*According toLorente-Poch et al, there is higher risk of injury and inadvertent excision if the parathyroid glands are not identified intra-operatively. The fewer identified glands, the higher risk of post-operative hypocalcemia and permanent hypoparathyroidism. Extensive surgery and parathyroid autotransplantation resulted in higher rates of hypocalcemia in Lorente's study. The rate of permanent hypoparathyroidism was threefold higher among patients for whom autotransplantation was done. The incidence of post-operative hypocalcemiawas higher when total thyroidectomy was for carcinoma than goiter. Permanent thypoparathyroidism rates were however similar after thyroidectomy for benign or malignant disease[70].

The rate of parathyroidectomy during thyroidectomy ranges from 9-19%. The current acceptable hypoparathyroidism rate following total thyroidectomy is 1-2%.

* In Ebru's study, the risk of transient hypocalcemiawas significantly higher in patients who underwent autotransplantation as

compared to those who did not. There was no significant difference between the two groups in terms of development of permanent hypocalcemia. Thyroid cancer, substernal and recurrent goiter, Grave's disease, thyrotoxicosis, lymphadenectomy, radicalityof surgery and reoperation are reported as main risk factors for the development of transient and permanent hypocalcemia[71 , 72].

*Michie et al proposed that post-operative hypocalcemia was not only secondary to parathyroid damage and implicated bone absorption in patients with thyrotoxicosteodystrophy as the primary source of transient drops in serum calcium after thyroidectomy.

*In Donald's study, transient hypocalcemiaoccurred in total thyroidectomy patients with an overall incidence of 28.2%. The calcium levels were the lowest in the thyrotoxic group. The results of the study was consistent with their hypothesis that patients with grave's disease were at an increased risk of developing post-operative hypocalcemiasuggesting that an additional loss of calcium occurs in these patients[73].

*In Lorente's study, post-operative hypocalcemia was observed in 42.3% patients. Protracted hypoparathyroidism was reported in 18.4% and permanent hypoparathyroidism in 4.6%.

*In another study conducted by Puzziello et al, temporary hypocalcemia was reported in 37% out of which only 61% were symptomatic. 2% had permanent hypocalcemia.

*Puzziello also studied the relationship of hypocalcemia and the relative decrease in serum PTH. The study reported that the relative decrease in serum PTH (taken 2 hours surgery) was greater in patients with hypocalcemia arising on the 2nd post-operative day than in patients who remained normocalcemic post-operatively.

The relative decrease in serum PTH in the normocalcemic group was 44% whereas in the hypocalcemic group (serum calcium measured on the 2nd post-operative day) was 71%. The ROC curve for the relative decrease in PTH showed an excellent accuracy for predicting hypocalcemia compared with absolute decrease. A relative PTH >62% had a 100% sensitivity and specificity for predicting hypocalcemia on the 2nd post-operative day[74].

*Ebru et al studied the rates of hypocalcemia post, thyroidectomy with and without parathyroid autotransplantation. Parathyroid autotransplantation was done in 7.9% of patients. And the reasons for autotransplantation were vascular impairment of the gland, not being able to dissect the parathyroid from the thyroid gland and a suspicious gland. The majority underwentautotransplantation due

to vascular impairment. It was reported that 37% who underwent autotransplantation developed temporary hypoparathyroidism. The median calcium value was 7mg/dl and PTH value was 13pg/L.

METHODOLOGY

This is a PROSPECTIVE RANDOMIZED CASE CONTROL STUDY done for the period of one and half years from January 2018 to June 2019.Patients presenting with nodular goitre in GovtRajaji hospital both in general surgery OPD and Surgical Endocrinology OPD who has indication for surgery were selected for the study.

INCLUSION CRITERIA

Patients presenting with nodular goitre and who has indication for surgery in GRH Madurai.

Euthyroid patients.

FNAC-benign lesion.

Patients consented for inclusion in the study according to designated proforma.

EXCLUSION CRITERIA

Toxic goitre

FNAC proven/suspicious of malignancy

Previous thyroid surgery

USG- features of thyroiditis.

Following consent, a questionnaire will be filled to record the patients demographic data, duration of disease, symptoms, past history.

STUDY DESIGN

This is a prospective case control study comprising of patients with tubercle of zuckerkandl and absence of tubercle of zuckerkandl and their outcome on thyroid surgery. Patients were categorised into group A and group B depending on the following aspects.

GROUP A (STUDY GROUP)

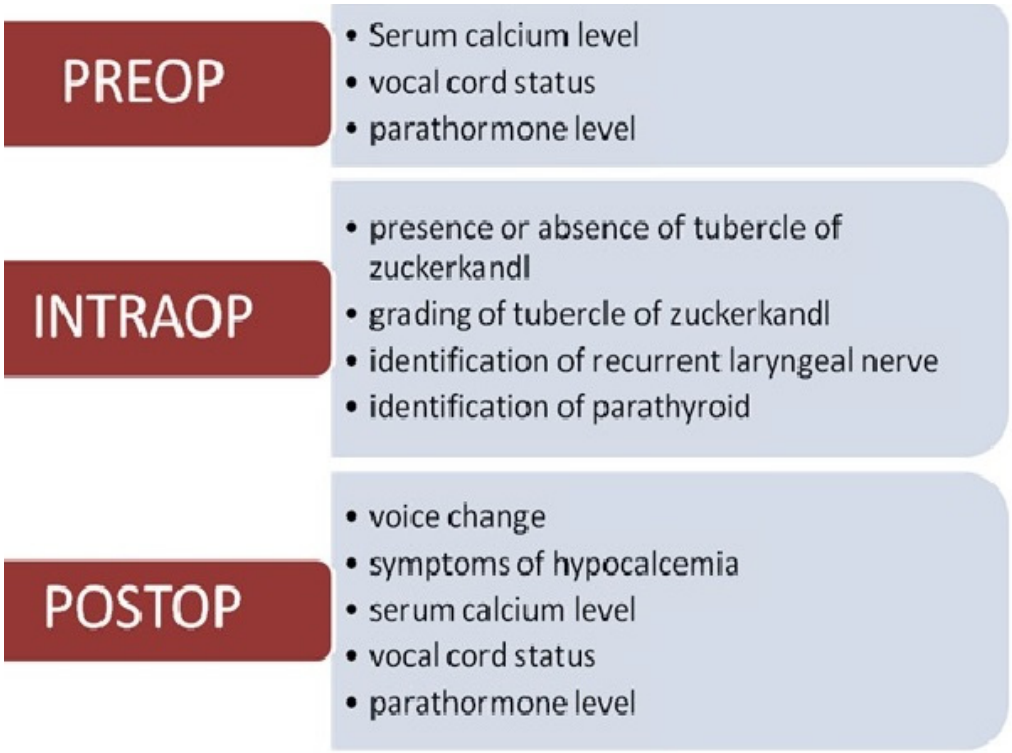
Patients with tubercle of zuckerkandl and they were graded depending on th size of tubercle of zuckerkandl.

GROUP B (CONTROL GROUP)

Patients without tubercle of zuckerkandl.

The patients with goitre were seen in surgical OPD and surgical endocrinology OPD. Patients were diagnosed on the basis of history, clinical examination and investigations likeTFT, USG-neck, FNAC. These investigations and clinical analysis were done for the patients recruited in the study.

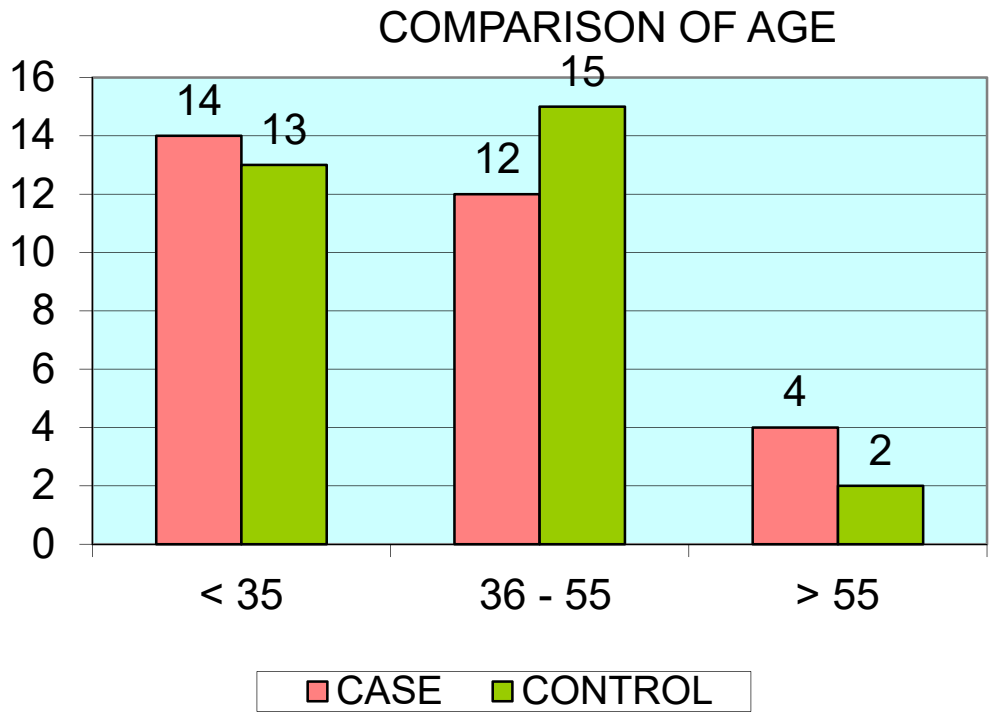
Categorization were done depending on the presence (along with the grading) and absence of tubercle of zuckerkandl and their impact on recurrent laryngeal nerve injury and post operativehypocalcemia are studied.


PREOP
• Serum calcium level
• vocal cord status
• parathormone level
INTRAOP
• presence or absence of tubercle of zuckerkandl
• grading of tubercle of zuckerkandl
• identification of recurrent laryngeal nerve
• identification of parathyroid
POSTOP
• voice change
• symptoms of hypocalcemia
• serum calcium level
• vocal cord status
• parathormone level

RESULTS

COMPARISON OF AGE

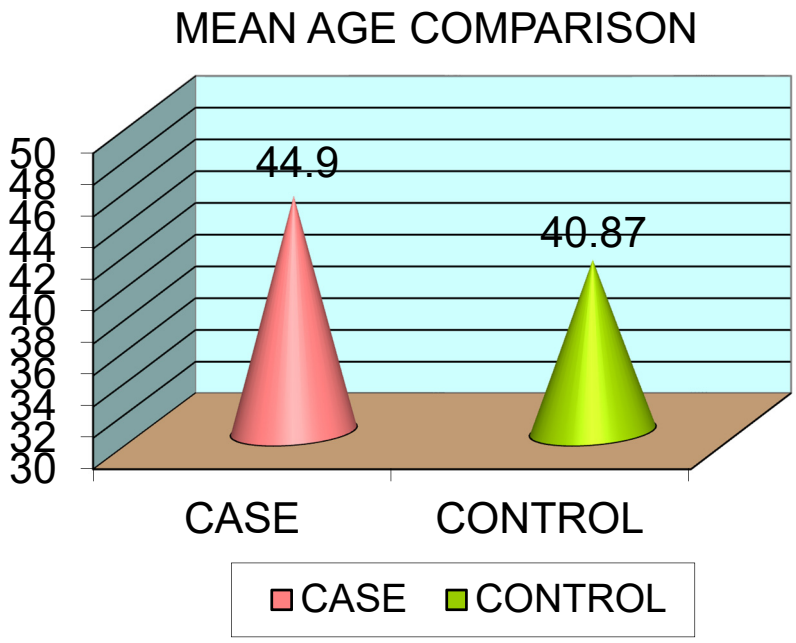
AGE	CASE	CONTROL
< 35	14	13
36 – 55	12	15
> 55	4	2
TOTAL	30	30
Mean	44.9	40.87
SD	11.42	10.75
P'value	0.164	Not significant



Among 30 cases who had tubercle of zuckerkandl 14 belongs to less than 35 years, 12 cases belongs to 36 to 55 years, 4 cases belongs to more than 55 years.

MEAN AGE COMPARISON

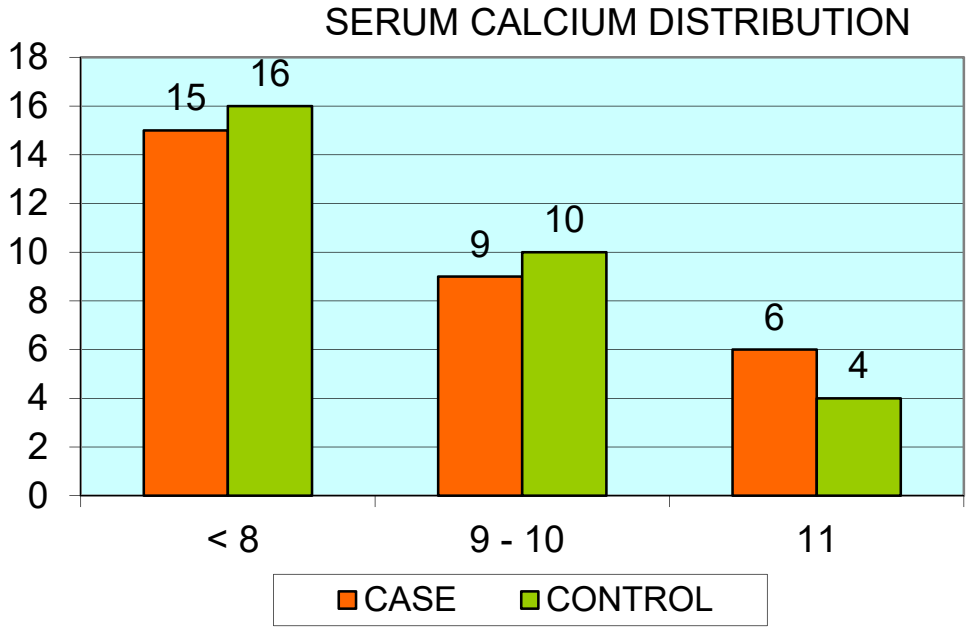
AGE	CASE	CONTROL
Mean	44.9	40.87



Among 30 cases, the mean age of the group is 44.9 years. The people of the case group was between 30 to 50 years.

SERUM CALCIUM DISTRIBUTION

Serum calcium	CASE	CONTROL
≤ 8	15	16
9 - 10	9	10
11	6	4
TOTAL	30	30
Mean	8.77	8.6
SD	1.5	1.38

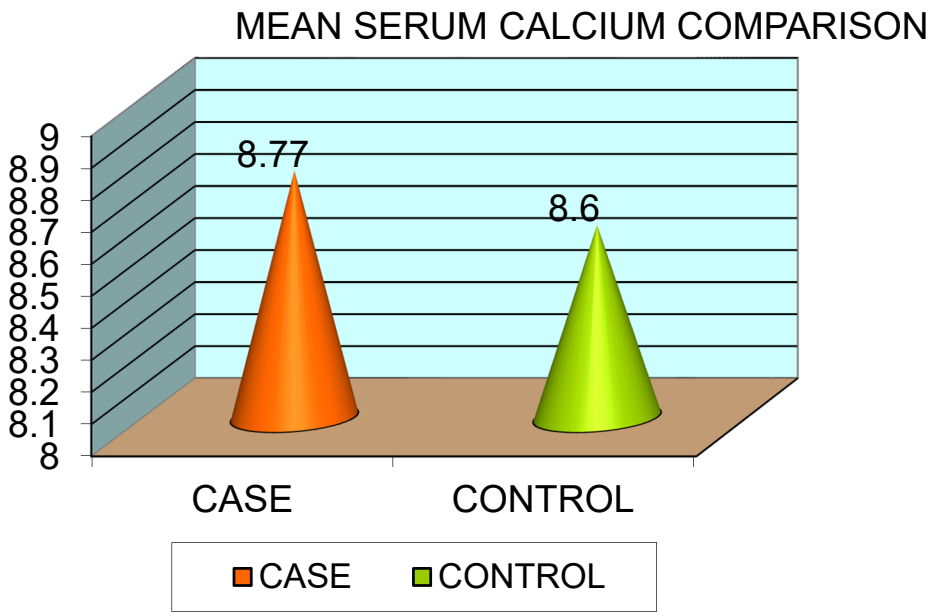


Among 30 cases, 15 people had serum calcium less than 8mEq/l. 9 people had serum calcium of level 9-10mEq/l. 6 people had serum calcium of 11mEq/l. All the patients had normal serum calcium level prior to surgery and had no symptoms or signs of hypocalcemia.

MEAN SERUM CALCIUM COMPARISON

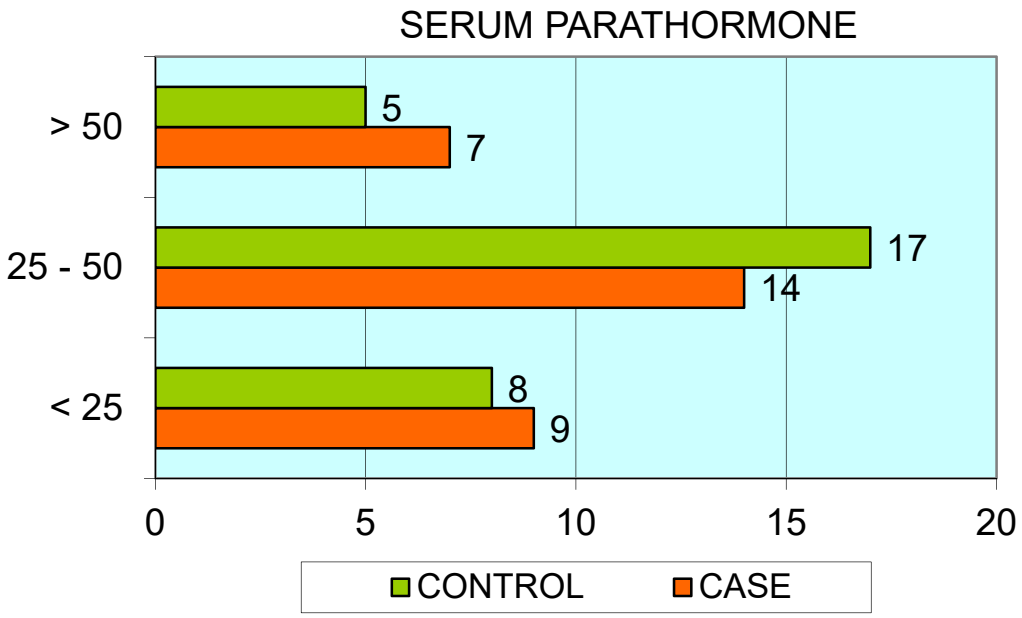
Serum calcium	CASE	CONTROL
Mean	8.77	8.6

Among 30 cases the mean serum calcium level prior to surgery was 8.77



SERUM PARATHORMONE LEVEL

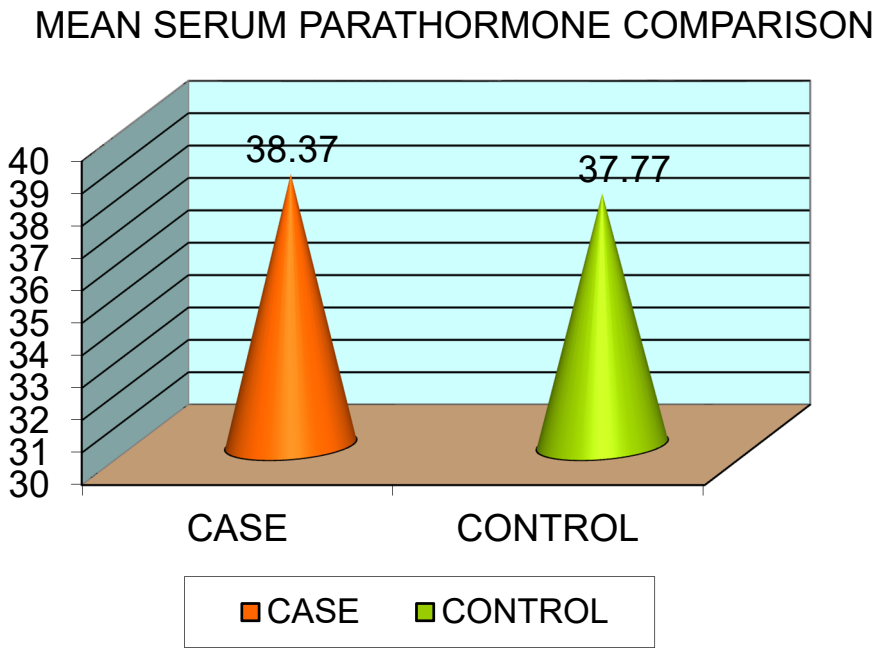
Serum parathormone	CASE	CONTROL
< 25	9	8
25 - 50	14	17
> 50	7	5
TOTAL	30	30
Mean	38.37	37.77
SD	16.05	13.9
P'value	0.878	Not significant



Among 30 patients 5 patients had serum parathormone level of less than 50 pg/Ml. 17 patients had serum parathormone level of 25 to 50 pg/Ml. 8 patients had serum parathormone level of less than 25.

MEAN SERUM PARATHORMONE COMPARISON

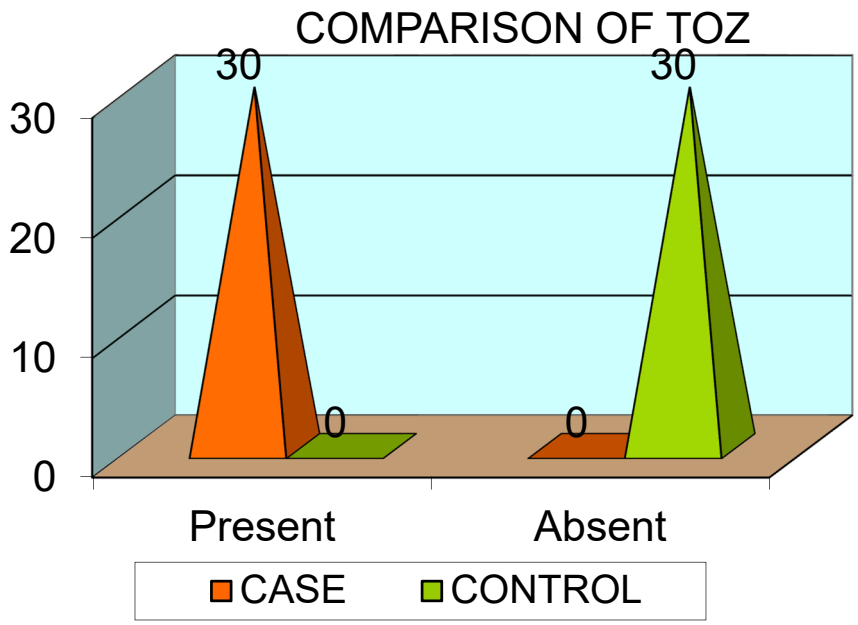
Serum parathormone	CASE	CONTROL
Mean	38.37	37.77



In this study we have taken 30 cases and the mean serum parathormone level is around 38.37

COMPARISON OF TZ

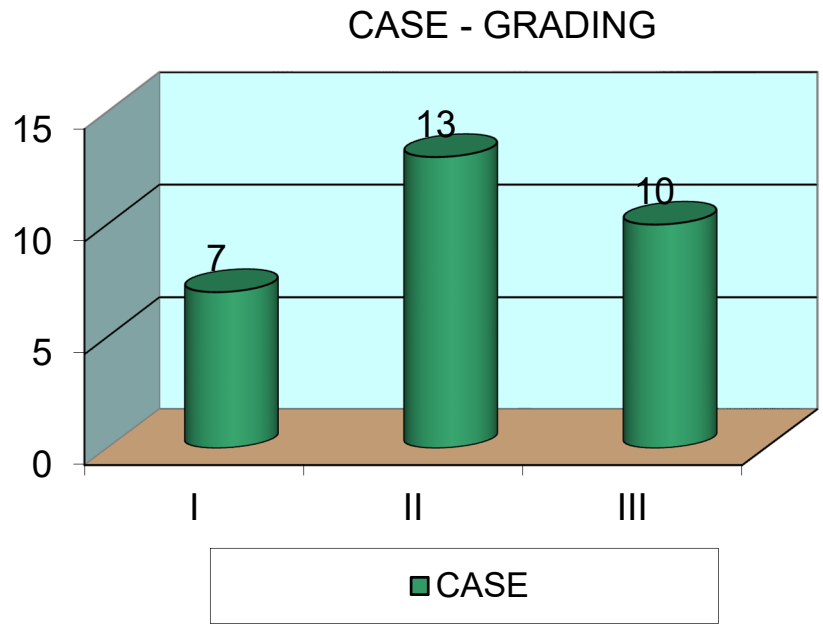
TOZ	CASE	CONTROL
Present	30	0
Absent	0	30
TOTAL	30	30
P'value	<0.001	Significant



Case group was divided according to the presence of grading of tubercle of zuckerkandl. And the control were taken who had absence of grading of tubercle of zuckerkandl.

CASE GRADING

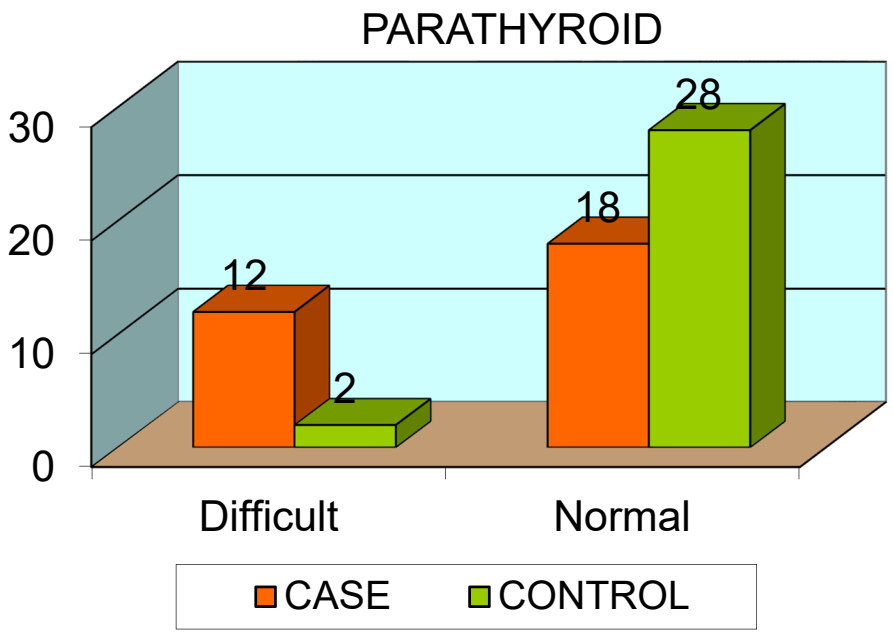
GRADING	CASE	CONTROL
I	7	0
II	13	0
III	10	0
TOTAL	30	0



Cases were chosen in such a way that 7 people had grade 1 TOZ. 13 people had grade 2 TOZ and 10 people had grade 3 TOZ.

IDENTIFICATION OF PARATHROIDS

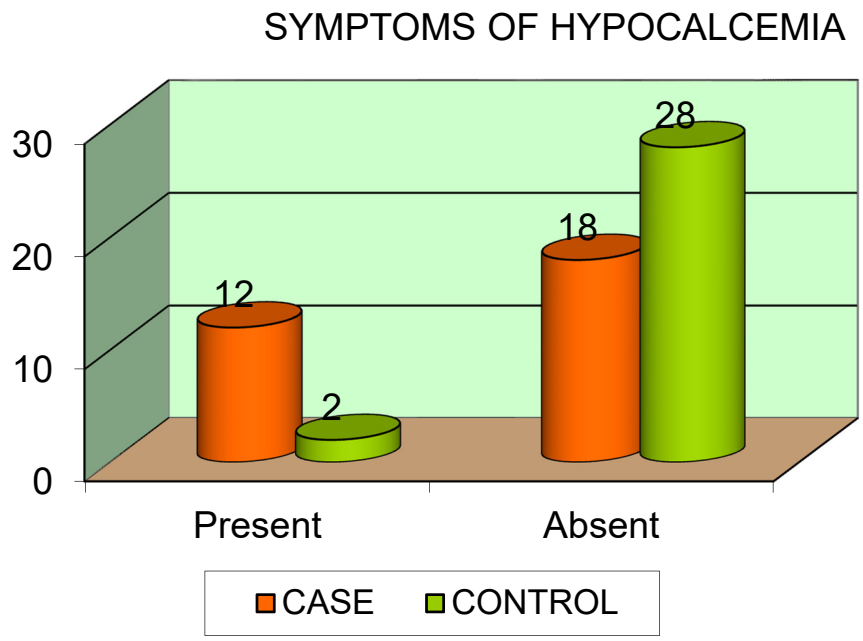
Parathyroid		
	CASE	**CONTROL**
Difficult	12	2
Normal	18	28
TOTAL	30	30
P'value	0.006	Significant



All these patients have undergone total thyroidectomy and intra operatively parathyroids identification were attempted. In the case group 12 people had difficulty in identification of parathyroid which is aound 40%. In the control group 2 people had difficulty in identification of parathyroid which is aroound 6.6%. P value is 0.006 and this is a significant value which also signifies the amount of injury to parathyroid and it is more in the case group.

POST OP SYMPTOMS OF HYPOCALCEMIA

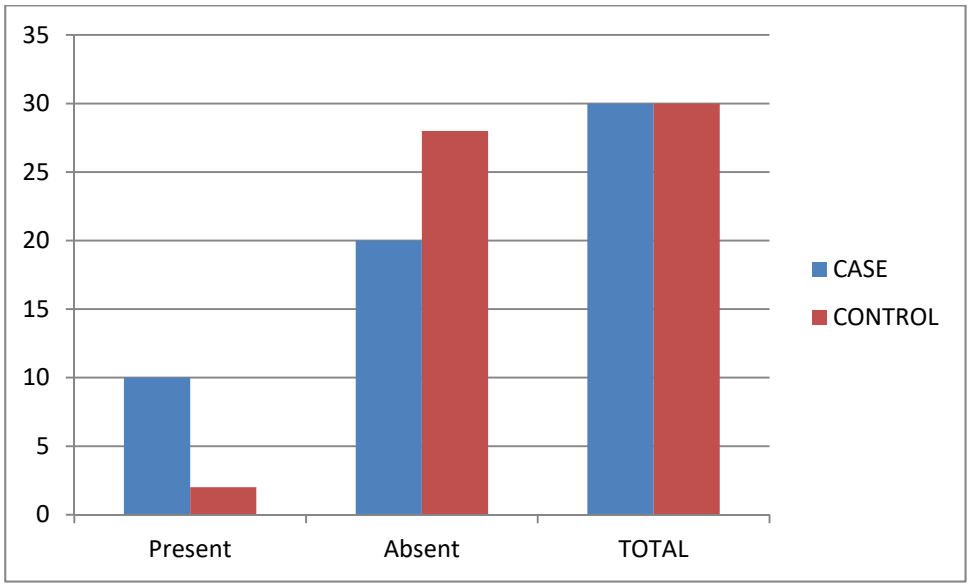
Symptoms of hypocalcemia	CASE	CONTROL
Present	12	2
Absent	18	28
TOTAL	30	30
P' value	0.008	Significant



The major complication after thyroidectomy is hypocalcemia which is observed in all the patients including case and control. Out of 30 in control groups 2 patients had symptoms of hypocalcemia which is approximately 6.6%. Out of 30 cases 12 patients had symptoms of hypocalcemia which amounts for about 40% which is a significant number.

POST OP TEMPERORY HYPOCALCEMIA

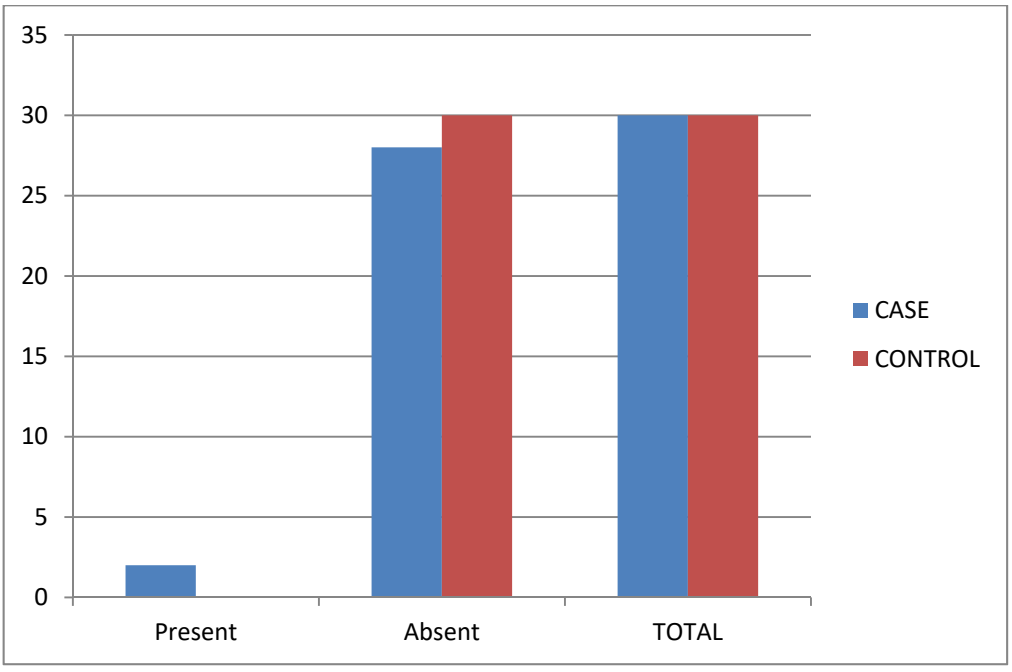
Temporary hypocalcemia	CASE	CONTROL
Present	10	2
Absent	20	28
TOTAL	30	30
P'value	0.024	Significant



All the patients were evaluated for hypocalcemia, according to the duration of the symptoms and signs they were graded as temperory and permament hypocalcemia. Among 30 paetients in the case group 10 cases presents with hypocalcemia which is approximately 33%. Among the control group 2 had temperory hypocalcemia which is around 6.6%, for which the p value comes around 0.024 and it is significant.

POST OP PERMANENT HYPOCALCEMIA

Permanent hypocalcemia	CASE	CONTROL
Present	2	0
Absent	28	30
TOTAL	30	30
P'value	0.472	Not significant



All the patients were followed up for the period of one and half years. Out of 30 cases had 2 cases permanent hypocalcemia 6.6%. In control group no one had permament hypocalcemia.

DISCUSSION

Otto Wilhelm Madelung had described in 1867 “posterior horn of the thyroid” [75]. Emile Zuckerkandl has been reported in 1902 as “processus posterior glandulae thyroideae” [75,76] . The ZT is posterior extension of the gland composed of thyroidal tissue only. In case of goiter formation the ZT generally enlarges synchronously at posterior site of the thyroid. First surgical importance of ZT emerges from indication of total resection of the gland that the completeness of thyroidectomy requires total removal of enlarged tubercle. Completeness of resection requires an awareness of thyroid development and anatomy including attention to pyramidal remnants, to abnormalities associated with ZT. Second surgical importance of the ZT arises from its relations with RLN and parathyroids. The resection of enlarged tubercle at posterior site of the thyroid requires delicate and careful dissection adjacent to the nerve and parathyroids. Identification of ZT and an understanding of the relationship between the ZT and RLN, parathyroids are essential for safety of thyroid operations. Although ZT is classified into three grades according to size. Surgeons generally perform thyroid operations on voluminous goiter that when present larger tubercles are observed on surgical specimens. Therefore, by surgical point of view an enlarged ZT parallel to goiter formation merits more interest than smaller one. It

makes surgical dissection challenging at posteriorsite of the lateral lobes around RLN and inferior thyroid artery.

When present, mobilization of a prominent ZT has surgical importance by completeness of thyroidectomy and identification and isolation of the RLN. The presence of larger tubercles in 66% of patients in previous study confirms that it is a common anatomical part of the gland. Many authors have recently reported the incidence of ZT as more than 50% of their patients; Kaishaetal.59%, Hishamand Lukman55%, and Gauger el al. 63% (grade 3 as 45%). On the other hand, Page et al. have identified ZT only in 7% of their patients. Yalc¸ in etal. have reported an incidence of grade 2 and grade 3 tubercles as 64% and 65% in lateral lobes. Yun et al. have found grade 2 and 3 ZT in 68% (right side 72% and left side 64%) of laterallobes. Bilateral occurrence of ZT isaless common observation as 25% in our series of total thyroidectomy cases. Gauger et al. have reported (bilateral) ZT in 15% of their patients. We can comment that enlarged ZT is a common anatomical structure situated at postero lateral site of thyroidal lobes of goiter cases. Therefore, in the majority of patients the tubercle can affect completeness of thyroid ectomye specially forless experienced hands. Some brief knowledge about embryogenesis of the thyroid gland may help understanding surgical importance of ZT. The thyroid gland develops

from two anlages; the larger median anlage and paired smaller lateral anlages which become attached to the posterior surface of the thyroid. Itisestimated that the lateral thyroid anlage contributes perhaps 1% to 30% to the thyroid weight. Residual postero lateral projection from the lateral thyroid component is known as the ZT [75]. In the last 20 years, hemithyroidectomy and total thyroidectomy are the procedures of choice for the management of patients with goiter. In this period, the operative technique has been moved from lateral to capsular dissection.

Delbridge[77] has stated that the completeness of resection has been assured by moving from an anatomically based approach to an embryologically based approach. This requires an awareness of RLN injury may be prevented by its full isolation based on intimate knowledge of the anatomy including all its variations. Some anatomical landmarks help surgeons identifying RLN. ZT appears as an indicative arrow for the nerve and neurovascular crossing point in some patients. We can comment that after medial mobilization of the lobes, when present, ZT may be used as a landmark facilitating identification of the nerve. Many authors have previously stated that the ZT is a reliable and constant anatomical landmark as an arrow pointing the RLN. Understanding the relationship between the nerve and the tubercle leads to perform safer thyroid surgery.

The neighboring of ZT and RLN is another important point for their relation. The resection of ZT for total thyroid- ectomy requires refined and meticulous dissection adjacent to the nerve. When enlarged by disease, the tubercle passes over the nerve like a bridge. An enlarged tubercle usually covers a segment of the distal part of the nerve passing in the tracheo- esophageal groove. On the other hand, we also observed unusual position of ZT and RLN at both sides; RLNs are anterior (or lateral) to ZT in 6% of occurrences. Uncommon anatomical relations between RLN and ZT may affect the safety of thyroid operations. All thyroid surgeons must be aware of this uncommon variation in order to prevent injury to the nerve during total resection of the gland. Hisham and Lukman [78] have previously reported that in 6% of dissection, the RLN was on the anterior surface of the tubercle. Gauger et al.[79] have also reported that in 93% of patients with enlarged ZT, the RLN lays medial to the tubercle, and the nerve was found lateral to it in the remaining 7% of their cases. Anterior course of RLN is at highest risk of injury. The surgeon must be aware of the tubercle, and he must face the ZT without fear but with care. Identification of ZT, an understanding of the relationship between the ZT and RLN, and isolation of the nerve before dissection of ZT are essential for performing safer thyroid surgery.

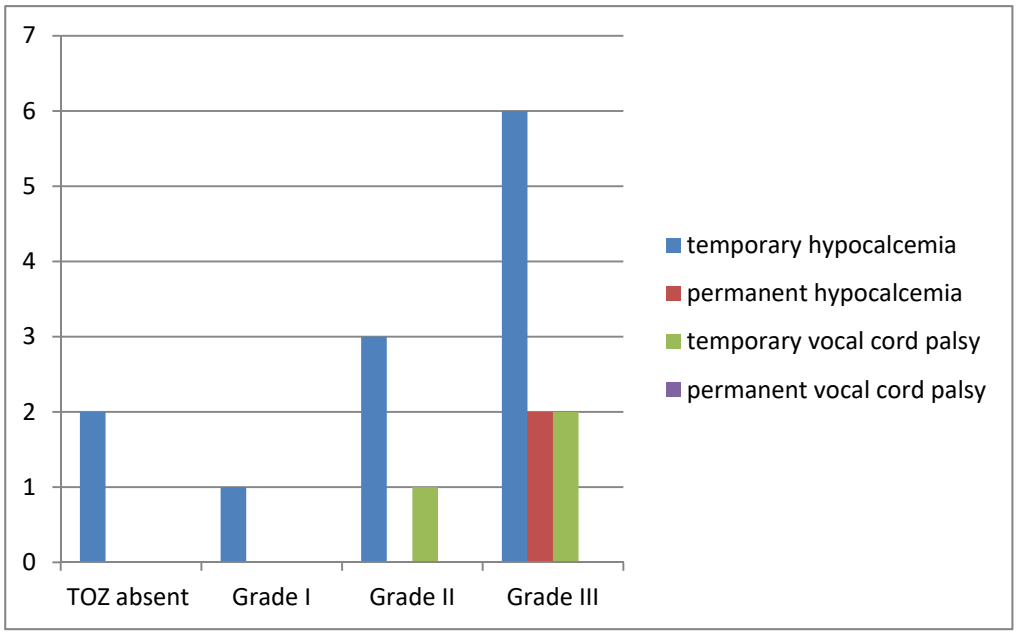
In a study of 104 lobectomies by Pelizzo et al. the tubercle of Zukerkandl was identified in 78.2% of the lobectomies on the right and 75.5% of the cases on the left. The authors concluded that identifying this tubercle will make identification of RLN easier.

Gil Carcedo stated that the Zuckerkandl tubercle is a residue from the embryological development of the thyroid gland. He highlighted the importance of the Zuck- erkandl tubercle, as it has proven tobe a reliable point of reference to **locate the superior parathyroid, the inferior thyroid artery and the RLN**.

Recognition and removal of the TZ is clearly important for the adequate performance of a total thyroidectomy. In cases where the recurrent laryngeal nerve is identified at the level of the inferior thyroid artery and followed superiorly into Berry's ligament, with division of overlying tissue, it is easy to also transect the tubercle where this overlies the nerve, leading to separation of the tubercle from the main thyroidectomy specimen.

The TZ has been described as theoretically separating the parathyroid glands into the superior parathyroids (located cranial and posterior) and inferior parathyroids (located caudal and anterior).The TZ has thus been suggested as a pointer to the superior parathyroid gland.

	TOZ absent	Grade I	Grade II	Grade III
temporary hypocalcemia	2	1	3	6
permanent hypocalcemia	0	0	0	2
temporary vocal cord palsy	0	0	1	2
permanent vocal cord palsy	0	0	0	0



In contrast to the other studies so far, this study states that more the grading of tubercle of zuckerkandl more is the injury to the recurrent laryngeal nerve and the inferior thyroid artery. In our study 6.6% of the people in the control group presented with temperory hypoglycemia. In case group 3.3% in grade 1 TZ shows temperory hypocalcemia. 10% of

people with grade 2 TZ shows temperory hypocalcemia. 20% with grade 3 TZ had temperory hypocalcemia.

No people in control group and grade 1 and grade 2 TZ permanent hypocalcemia. Only 2 people with grade 2 TZ had permanent hypocalcemia which amounts for about 6.6%.

People in conStrol group and TZ 1 has no temperory vocal cord palsy. Patient who had grade 2 TZ had temperory vocal cord palsy which is approximately 3.3%. And 6.6% patients with grade 3 TZ showed temperory vocal cord palsy.

No patient both in control and case have permanent vocal cord palsy.

CONCLUSION

There were so many studies done on tubercle of zuckerkandl – its anantomical relationship with recurrent laryngeal nerve and inferior thyroid artery, location, grading and about incidence. Almost all the studies presented the TZ as the landmark for identifying the recurrent laryngeal nerve and inferior thyroid artery.

But in contrast to the other studies, in this study we have stated that TZ amounts to injury to recurrent laryngeal nerve and parathyroids if the grading is more.

“MORE THE GRADING OF TZ, MORE IS THE INJURY TO RECURRENT LARYNGEAL NERVE AND PARATHYROIDS THUS CAUSING VOICE CHANGE AND HYPOCALCEMIA”.

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PROFORMA

NAME:

AGE: SEX: IP NO:

ADDRESS:

PHONE NO:

DOA: DOS: DOD:

DIAGNOSIS:

PROCEDURE DONE:

FNAC:

USG NECK:

	RI GHT	**LEFT**
SIZE		
NODULE		
TUBERCLEOF ZUCKERKANDL		
GRADING		
SUPERIOR PARATHYROID		
INFERIOR PARATHYROID		
RECURRENT LARYNGEAL NERVE		

	PREOP	POSTOP
VOCAL CORD		
CHVOSTEK SIGN		
TROUSSEAU		

POSTOP:

HYPOCALCEMIA: Present/Absent

Calcium treatment: Given/Not

VOCAL CORD STATUS:

PICTURE:

`

ஆராய்ச்சி தகவல் அறிக்கை

மதுரை அரசு இராசாசி மருத்துவமனையில் வரும் நோயாளிக்கு ஒரு ஆராய்ச்சி இங்கு நடைபெற்று வருகிறது. நீங்களும் இந்த ஆராய்ச்சியில் பங்கேற்க விரும்பிகிறோம் .

உங்களை சி சிறப்பு பரிசோதனைக்கு உட்படுத்தி அதன் தகவல்களை ஆராய்வோம். அதனால் தங்களது நோயின் ஆய்வரிகையோ அல் து சிகிச்சையோ பாதிப்பு ஏற்படாது என்பதை தெரிவித்து கொள்கிறேன்.

முடிவுகளை வெளியிடும் போது அல் து ஆராய்ச்சியின் போதோ தங்களது பெயரோ அல் து அடையாளங்களோ வெளியிடமாட்டோம் என்பதை தெரிவித்து கொள்கிறோம்.

இந்த ஆராய்ச்சியில் பங்கேற்பது தங்களுடைய விருப்பத்தின் பேரில் தான் நடக்கும். மேலும் நீங்கள் எந்நேரமும் இந்த ஆராய்ச்சியில் இருந்து பின் வாங்க ாம் என்பதையும் தெரிவித்து கொள்கிறோம்.

இந்த சிறப்பு பரிசோதனை முடிவுகளை ஆராய்ச்சியின் போது அல் து ஆராய்ச்சியின் முடிவின் போது தங்களுக்கு அறிவிப்போம் என்பதையும் தெரிவித்து கொள்கிறோம்.

பங்கேற்பாளர் கையொப்பம்

ABBREVIATIONS

TZ	**-**	**TUBERCLE OF ZUCKERKANDL**
TOZ	**-**	**TUBERCLE OF ZUCKERKANDL**
STA	**-**	**SUPERIOR THYROID ARTERY**
ITA	**-**	**INFERIOR THYROID ARTERY**
RLN	**-**	**RECURRENT LARYNGEAL NERVE**
SLN	**-**	**SUPERIOR LARYNGEAL NERVE**
ILN	**-**	**INFERIOR LARYNGEAL NERVE**
EBSLN	**-**	**EXTERNAL BRANCH OF SUPERIOR LARYNGEAL NERVE**

MASTER CHART - CASE

s.no.	Sex	age	preop			intraop				postop						
			serum calcium	vocal cord status	serum parathormone	TOZ	grading	identification of		symptoms of hypocalcemia	voice change	temporary hypocalcemia	permanent hypocalcemia	temporary vocal cord palsy	permanent vocal cord palsy	PTH
								RLN	parathyroid							
1	F	65	7	N	25	present	II	easy	easy	-	-	-	-	-	-	Normal
2	F	72	9	N	34	present	III	easy	difficult	+	-	-	-	-	-	Normal
3	F	35	8	N	55	present	I	easy	easy	-	-	-	-	-	-	Normal
4	F	42	11	N	60	present	II	easy	easy	-	-	-	-	-	-	Normal
5	F	35	7	N	15	present	III	easy	difficult	+	-	-	-	-	-	Normal
6	F	52	8	N	13	present	I	easy	easy	-	-	-	-	-	-	Normal
7	F	28	11	N	32	present	II	easy	easy	-	-	-	-	-	-	Normal
8	F	39	11	N	35	present	III	easy	difficult	+	-	-	-	-	-	Normal
9	F	56	7	N	45	present	I	easy	difficult	-	-	-	-	-	-	Normal
10	F	42	9	N	45	present	II	easy	easy	-	-	-	-	-	-	Normal
11	F	35	10	N	47	present	II	easy	difficult	-	-	-	-	-	-	Normal
12	F	59	11	N	12	present	I	easy	easy	-	-	-	-	-	-	Normal
13	F	65	7	N	58	present	II	difficult	easy	-	-	+	-	+	-	Normal
14	F	30	9	N	18	present	II	easy	easy	-	-	-	-	-	-	Normal
15	F	35	11	N	50	present	III	easy	difficult	+	-	-	+	-	-	Normal

16	F	45	10	N	45	present	I	easy	easy	-	-	-	-	-	-	Normal
17	F	48	7	N	50	present	II	easy	easy	-	-	-	-	-	-	Normal
18	F	55	8	N	23	present	III	easy	difficult	-	-	-	-	-	-	Normal
19	F	34	8	N	16	present	II	easy	easy	-	-	-	-	-	-	Normal
20	F	44	8	N	15	present	III	difficult	difficult	+	+	+	-	+	-	Normal
21	F	47	9	N	25	present	I	easy	easy	-	-	-	-	-	-	Normal
22	F	53	7	N	35	present	II	easy	difficult	-	-	-	-	-	-	Normal
23	F	56	10	N	45	present	III	easy	easy	-	-	-	-	-	-	Normal
24	F	46	8	N	55	present	II	easy	easy	-	-	-	-	-	-	Normal
25	F	48	11	N	65	present	III	easy	difficult	+	-	-	+	-	-	Normal
26	F	32	7	N	42	present	I	easy	easy	-	-	-	-	-	-	Normal
27	F	31	9	N	54	present	II	easy	difficult	-	-	-	-	-	-	Normal
28	F	35	8	N	60	present	III	easy	easy	-	-	-	-	-	-	Normal
29	F	42	10	N	32	present	III	difficult	difficult	+	+	+	-	+	-	Normal
30	F	41	7	N	45	present	II	easy	easy	-	-	-	-	-	-	Normal

MASTER CHART - CONTROL

s.no.	Sex	Age	preop			intraop				postop						
			serum calcium	vocal cord status	serum parathormone	TOZ		identification of		symptoms of hypocalcemia	voice change	temporary hypocalcemia	permanent hypocalcemia	temporary vocal cord palsy	permanent vocal cord palsy	parathormone
								RLN	parathyroid							
1	F	34	7	P	15	absent		easy	easy	-	-	-	-	-	-	normal
2	F	45	9	P	25	absent		easy	easy	-	-	-	-	-	-	normal
3	F	56	7	P	45	absent		easy	easy	-	-	-	-	-	-	normal
4	F	25	8	P	12	absent		easy	easy	-	-	-	-	-	-	normal
5	F	32	8	P	19	absent		easy	easy	-	-	-	-	-	-	normal
6	F	56	8	P	45	absent		easy	easy	-	-	-	-	-	-	normal
7	F	55	9	P	55	absent		easy	easy	-	-	-	-	-	-	normal
8	F	47	11	P	25	absent		easy	easy	-	-	-	-	-	-	normal
9	F	49	10	P	35	absent		easy	easy	-	-	-	-	-	-	normal
10	F	40	11	P	45	absent		easy	easy	-	-	-	-	-	-	normal
11	F	50	8	P	65	absent		easy	easy	-	-	-	-	-	-	normal
12	F	54	9	P	45	absent		difficult	easy	-	-	-	-	-	-	normal
13	F	55	7	P	47	absent		easy	easy	-	-	-	-	-	-	normal
14	F	31	7	P	34	absent		easy	easy	-	-	-	-	-	-	normal
15	F	30	11	P	32	absent		easy	easy	-	-	-	-	-	-	normal
16	F	32	11	P	37	absent		easy	easy	-	-	-	-	-	-	normal

17	F	41	10	P	17	absent		easy	easy	-	-	-	-	-	-	normal
18	F	26	7	P	55	absent		easy	difficult	+	-	+	-	-	-	normal
19	F	54	8	P	56	absent		easy	easy	-	-	-	-	-	-	normal
20	F	28	8	P	60	absent		easy	easy	-	-	-	-	-	-	normal
21	F	31	8	P	50	absent		difficult	easy	-	-	-	-	-	-	normal
22	F	51	7	P	40	absent		easy	easy	-	-	-	-	-	-	normal
23	F	41	9	P	42	absent		easy	easy	-	-	-	-	-	-	normal
24	F	27	8	P	43	absent		easy	easy	-	-	-	-	-	-	normal
25	F	29	7	P	24	absent		easy	easy	-	-	-	-	-	-	normal
26	F	32	10	P	22	absent		easy	difficult	+	-	+	-	-	-	normal
27	F	33	7	P	46	absent		easy	easy	-	-	-	-	-	-	normal
28	F	43	10	P	34	absent		easy	easy	-	-	-	-	-	-	normal
29	F	55	9	P	32	absent		easy	easy	-	-	-	-	-	-	normal
30	F	44	9	P	31	absent		easy	easy	-	-	-	-	-	-	normal

ETHICAL COMMITTEE APPROVAL LETTER

MADURAI MEDICAL COLLEGE
MADURAI, TAMILNADU, INDIA -625 020
(Affiliated to The Tamilnadu Dr.MGR Medical University, Chennai, Tamil Nadu)

ETHICS COMMITTEE CERTIFICATE

Name of the Candidate	:	Dr.R.Keerthana Priyatharshini
Course	:	PG in MS., General Surgery
Course of Study	:	2017-2020
College	:	MADURAI MEDICAL COLLEGE
Research Topic	:	Comparative study on impact of grading of tubercle of zuckerkandl in thyroid surgeries and its outcome.
Ethical Committee as on	:	11.10.2018

The Ethics Committee, Madurai Medical College has decided to inform that your Research proposal is accepted.

Member Secretary Chairman / Convenor

Prof.Dr.V Nagaraajan
M.D., MNAMS, D.M., Dsc.,(Neuro), Dsc (Hon)
CHAIRMAN
IEC - Madurai Medical College
Madurai

DEAN
Madurai Medical College
Madurai-20

மதுரை மருத்துவக் கல்லூரி
22 OCT 2018
மதுரை - 625020

ANTI-PLAGIARISM CERTIFICATE

URKUND

Urkund Analysis Result

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Submitted:	10/21/2019 2:25:00 PM
Submitted By:	drkeerthana20@gmail.com
Significance:	4 %

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CERTIFICATE II

This is to certify that this dissertation work titled, entitled **"A COMPARATIVE STUDY OF IMPACT OF GRADING OF TUBERCLE OF ZUCKERKANDL ON THYROID SURGERIES AND ITS OUTCOME"** submitted by **Dr.R.KEERTHANA PRIYATHARSHINI** with registration number 221711112 for the award of MASTER DEGREE in the branch of GENERAL SURGERY has been personally verified by me in urkund.com website for the purpose of plagiarism check. I found that the uploaded thesis file contains from introduction to conclusion pages and result shows 4 percentage of plagiarism in the dissertation.

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