EVALUATION OF TUBERCLE OF ZUCKERKANDL AS A LANDMARK FOR RECURRENT LARYNGEAL NERVE AND SUPERIOR PARATHYROID GLAND AND ITS IMPLICATIONS ON COMPLETE REMOVAL OF THYROID

By

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DISSERTATION SUBMITTED TO SRI DEVARAJ URS ACADEMY OF HIGHEREDUCATION AND RESEARCH, KOLAR, KARNATAKA

In partial fulfillment of the requirements for the degree of

MASTER OF SURGERY
IN
OTORHINOLARYNGOLOGY

Under the Guidance of

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PRIOR PERMISSION TO START OF STUDY

The Institutional Ethics Committee of Sri Devaraj Urs Medical College, Tamaka, Kolar has examined and unanimously approved the Synopsis entitled **"Evaluation of Tubercle of Zuckerkandl as a Landmark for Recurrent Laryngeal Nerve and Superior Parathyroid Gland and its Implications on Complete Removal of Thyroid"** being investigated by Dr.IRFAN AHMED NIWAS & Dr. S. M. Azeem Mohiyuddin in the Department of ENT at Sri Devaraj Urs Medical College, Tamaka, Kolar. **Permission is granted by the Ethics Committee to start the study.**

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ACKNOWLEDGEMENT

First and foremost, I thank God Almighty for showering his blessings on me and giving me the strength to perform all my duties. As I complete this humble contribution to scientific pursuit, it gives me immense pleasure to acknowledge all those who helped me in this endeavor.

It is my proud privilege to express my gratitude and sincere thanks to my Guide Dr. S M AZEEM MOHIYUDDIN, Professor, Department of Otorhinolaryngology, for providing constant guidance, encouragement and valuable insights during the entire period of this study andmy post-graduation course.

I would like to express my earnest gratitude to Dr. K.C Prasad, Professor and Head of thedepartment, Department of Otorhinolaryngology for his constant enthusiasm for teaching especially through dissections.

I would like to express my gratitude and sincere thanks to Dr Sagayaraj A – Associate Professor and Dr Prashanth babu – Assistant professor for helping me out with my dissertation & allowing me to evaluate my thesis in a right way by operating plenty of thyroid cases and guiding me for the same.

I am highly obliged by the constant support provided by Dr. Kouser Mohammadi– Assistant Professors, Dr Ashok B, Dr. Indu Varsha, Dr. Arjun Gupta, Dr Kunal Thakur, Dr Lini Joseph– Senior Residents, Department of Otorhinolaryngology for their never-ending support, guidance and constant encouragement in the preparation of this dissertation and throughout my post-graduation course.

I express my most sincere regards and heartiest gratitude to my wife Aisha Binth Hussain, my beloved parents Niwas Ahamed and Rubeena Niwas, my parents in law M Hussain & Rahumath S & my siblings Farsin Ahmed Niwas, Nihal Niwas Ahmed, Muhammed Shan, Muhammed Shadil & Aysha Farheena who have always supported and nurtured me to become the person who I am today and helped me to get through this phase.

I would like to thank my juniors Dr Anirudh P B, Dr Indranil Paul, Dr Diana Ann Jose, Dr Sharukh Aushekhar, Dr Akshaya Rajan, Dr Zuali Ralte, Dr Nisha and Dr Sanjana Reddy for their constant encouragement, support and help.

I would like to thank all my colleagues for their technical support, encouragement and help.

I am grateful to Honorable Principal Sir for permitting me to utilize the resources of the institution in the completion of my work.

I thank the Operation theatre Staff, Library staff, Hospital Staff and Departmental Staff for their support and cooperation in my study.

I would also like to place on record my gratitude Dr Mahesh Babu for help & guidance in statistics in my dissertation.

Last but not the least I would be failing in my duty if I did not express my gratitude to all my patients and their families who are the backbone of this Dissertation.

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LIST OF ABBREVIATIONS

ABBREVIATIONS	EXPANDED FORM
TZN	TUBERCLE OF ZUCKERKANDL
RLN	RECURRENT LARYNGEAL NERVE
PTH	PARATHYROID HORMONE
PTG	PARATHYROID GLAND
PTC	PAPILLARY CARCINOMA THYROID
MTC	MEDULLARY CARCINOMA THYROID
FTC	FOLLICULAR CARCINOMA THYROID
STN	SOLITARY THYROID NODULE

ABSTRACT

BACKGROUND:

Thyroidectomies are a commonly performed surgery in our institution and preservation of Recurrent laryngeal nerve and parathyroid glands is an important & delicate part of the surgery. A small posterior extension of thyroid gland near the - ligament of Berry is called as tubercle of Zuckerkandl.

Zuckerkandl's tubercle, is an anatomical landmark by which surrounding important structures such as - the recurrent laryngeal nerve can be identified during the surgery.
Various studies have been carried out to find out the relationship between tubercle of Zuckerkandl and recurrent laryngeal nerve.

However, complete dissection of this thyroid tissue (tubercle of Zuckerkandl) can be challenging due to its close relationship to recurrent laryngeal nerve and dense fascia in this region. This can significantly affect the outcome in thyroid malignancies.

In this study we intend to document the impact of size & shape and as well as the relationship of tubercle of Zuckerkandl to recurrent laryngeal nerve and superior parathyroid gland and the reliability of this structure as a surgical landmark & its effect on complete removal of thyroid tissue in this region.

This study will therefore help in understanding the surgical anatomy of tubercle of Zuckerkandl & help to develop all possible approaches for complete removal of thyroid lobe without increasing morbidity.

It also helps us in understanding that the excision of the tubercle requires fine and meticulous dissection with utmost care because of its close relationship to recurrent laryngeal nerve and superior parathyroid gland.

OBJECTIVES:

1. To document the prevalence of tubercle of Zuckerkandl in patients undergoing total or hemi thyroidectomies.
2. To document size and shape of tubercle of Zuckerkandl and its relationship to recurrent Laryngeal nerve and superior parathyroid gland during total or hemi thyroidectomies.
3. To document usefulness of tubercle of Zuckerkandl as a surgical landmark for recurrent laryngeal nerve & difficulties encountered in its complete removal.

MATERIALS AND METHODS:

It is a cross- sectional observational study where 60 patients planned for total and hemi thyroidectomy in the Department of Otorhinolaryngology for the study at R.L.Jalappa Hospital & Research Centre, Tamaka, Kolar from December 2019 to July 2021 were taken study after fulfilling the inclusion criteria and signing an informed consent.

In all patients undergoing hemi and total thyroidectomies, the size and shape of the tubercle of Zuckerkandl were measured using a sterile caliper.

The distance between tip of tubercle of Zuckerkandl and recurrent laryngeal nerve were measured in millimeters using the tip of the sterile caliper.

We documented whether the tubercle of Zuckerkandl was overlying the recurrent laryngeal nerve or not.

Distance between tip of Zuckerkandl tubercle with superior parathyroid gland were documented.

The difficulty in separating Zuckerkandl tubercle from adjacent structures like recurrent laryngeal nerve, branches of inferior thyroid artery & Berry's ligament were documented by noting the time taken & bleeding at this site.

Statistical analysis:

Data was entered into Microsoft excel data sheet and was analyzed using SPSS 22 version software. Categorical data was represented in the form of Frequencies and proportions. **Chi-square test** was used as test of significance for qualitative data.

Continuous data was represented as mean and standard deviation.

Graphical representation of data: MS Excel and MS word was used to obtain various types of graphs such as bar diagram, Pie diagram.

p value (Probability that the result is true) of <0.05 was considered as statistically significant after assuming all the rules of statistical tests.

Statistical software: MS Excel**,** SPSS version 22 **(**IBM SPSS Statistics, Somers NY, USA) was used to analyze data.

RESULTS:

Majority of subjects were in the age group 41 to 50 years (43.1%). TZN was identified in all of the cases (100%). Grade I and II together constituted about 96.1% of all TZN.

TZN is like an arrow pointing towards the RLN & if mobilized medially it allows easy identification of the nerve before it turns below the inferior cricothyroid joint.

TZN in all cases was pyramidal in shape and all RLN ran either anterior or medial to the

TZN. The TZN was lying anterior to Recurrent laryngeal nerve in 7 cases (6.9%). The tubercle was lying medial to Recurrent laryngeal nerve in 95 cases (93.1%). More than 50% of the cases took an average time between 8 to 10 minutes for dissecting the TZN from its underlying structures & the remaining 36% cases took more than 10 minutes. Blood loss at the site of dissection was found to be not significant.

CONCLUSION:

Tubercle of Zuckerkandl is a consistent and a sturdy structure which is identified in majority of cases. The TZN is a useful guide when it comes to identification of RLN. Surgeons should be well aware about the incidence, shape, grade and its relation to RLN when it comes to thyroidectomies. Thus it is a very useful landmark in thyroid surgery for saving the Recurrent laryngeal Nerve.

Key words: Parathyroid, Zuckerkandl, Recurrent laryngeal nerve, thyroid, parathyroid

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INTRODUCTION

INTRODUCTION

All recent population studies have shown that about 12% of adult population have a palpable goiter.[1] The age-adjusted incidence rates of thyroid cancer per 100,000 population are about 1 for males and 1.8 for females according to the Mumbai Cancer Registry.

Emil Zuckerkandl who was an Hungarian anatomist has described "processus posterior glandulae thyroideae" in 1902.[3] The Zuckerkandl tubercle is the posterior extension of the gland composed of thyroidal tissue.[4]

In the development of goiters, the Zuckerkandl tubercle almost always enlarges synchronously at posterior site of the thyroid. First and foremost the surgical importance of Zuckerkandl tubercle involves total resection of the gland in patients requiring total thyroidectomy.[3] Completeness of resection requires thourough knowledge of thyroid development including remnants of thyroglossal ducts & abnormalities associated with Zuckerkandl tubercle.

Another surgical importance of the Zuckerkandl tubercle is its close proximity & relationship with the recurrent laryngeal nerve. Although Zuckerkandl tubercle is classified into four grades according to its size, this grading is mainly considered for cadaveric anatomical studies.[5]

Surgeons generally perform thyroid operations on large goiters, where larger tubercles of Zuckerkandl are observed during surgery. Therefore, from surgical point of view, an enlarged Zuckerkandl tubercle parallel to goiter arouses interest when compared to a smaller one. It makes surgical dissection challenging mainly at the posterior site of the lateral lobes around recurrent laryngeal nerve and inferior thyroid artery.

Recurrent laryngeal nerve is consistent in position and posterior to Zuckerkandl tubercle almost all the time. Recurrent laryngeal nerve injury may be prevented by its full isolation based on intimate knowledge of the anatomy including all its variations.[6]

Some anatomical landmarks help surgeons to identify recurrent laryngeal nerve. Zuckerkandl tubercle appears to be a pointer for the nerve and neurovascular crossing point in some patients. Many authors have stated before that the Zuckerkandl tubercle is a reliable and constant anatomical landmark. The site of greatest risk during thyroidectomy to the recurrent laryngeal nerve is almost always in the last 2-3 cm extralaryngeal course of the nerve before its laryngeal entry and above the trunk of the inferior thyroid artery.[8]

Mobilization of the tubercle medially allows easy identification of the nerve at this dangerous site. Therefore, understanding the relationship between the nerve and TZN ensures safer thyroid surgery.[6]

At times the recurrent laryngeal nerve is uncommonly located on anterior surface of the tubercle. This unusual lateral course increases the risk of injury. Based on the occurrence of unusual variations, it is safe to identify the recurrent laryngeal nerve before going ahead with dissection of adjacent structures. Excision of Zuckerkandl tubercle is mandatory for completeness of thyroidectomy.[7]

It is also observed in different studies that uptake of Radioiodine is usually seen near ligament of Berry following thyroid surgery, showing that remnants of thyroid tissue in mainly this region are left behind. This can be potentially an area of recurrence in malignancies.[9] Surgery for such recurrence will be very risky due to its proximity to Recurrent laryngeal nerve and superior parathyroid glands. Recurrence in this area grows in the tracheoesophageal groove making revision surgeries challenging & dangerous.

The size of the Zuckerkandl tubercle was graded according to the classification which was proposed by Pellizo.[5]

Grade 0 (no tubercle),

Grade 1 (thickening) ,

Grade 2 - the presence of a tubercle smaller than 1 cm,

Grade 3 - the presence of a tubercle greater than 1 cm.

There is no significant study till date that documents relationship of tubercle of Zuckerkandl to superior parathyroid glands.

In this study the size and shape of the tubercle of Zuckerkandl will be analysed and the distance between tip of tubercle of Zuckerkandl and recurrent laryngeal nerve will be measured in millimeters and documented. It will also be documented whether the tubercle of Zuckerkandl was overlying the recurrent laryngeal nerve or not.The relationship of branches of inferior thyroid artery with recurrent laryngeal nerve adjoining the tubercle of Zuckerkandl will also be assessed along with the distance between tip of Zuckerkandl tubercle with superior parathyroid gland.

AIMS & OBJECTIVES

OBJECTIVES OF THE STUDY

1. To document the prevalence of tubercle of Zuckerkandl in patients undergoing total or hemi thyroidectomies.

2. To document size and shape of tubercle of Zuckerkandl and its relationship to recurrent Laryngeal nerve and superior parathyroid gland during total or hemi thyroidectomies.

3. To document usefulness of tubercle of Zuckerkandl as a surgical landmark for recurrent laryngeal nerve & difficulties encountered in its complete removal.

REVIEW OF LITERATURE

REVIEW OF LITERATURE

THYROID GLAND

EMBRYOLOGY

During the fourth week of development, the foramen cecum develops as an endodermal thickening in the floor of the primitive pharynx at the junction between the first and second pharyngeal pouches, dorsal to the aortic sac. The medial thyroid primordium derives like a ventral diverticulum at the level of foramen cecum. During the fourth to seventh week of gestation, this primitive thyroid tissue enters the mesenchymal tissue which is underneath it and descends anterior to the hyoid bone and the laryngeal cartilages to reach the final adult pre- tracheal position. During its pathway of descent, it is first spherical, and becomes bilobed as it grows caudally. The proximal portion of the diverticulum which connects the gland and the foramen cecum retracts and forms a solid fibrous stalk early in the fifth week. This thyroglossal duct ultimately atrophies, but most portion of it persists to become the site ofthyroglossal duct cyst. The distal portion of this duct later becomes the pyramidal lobe in adults. The lateral thyroid primordia descends down to join the central component during the fifth week of gestation.

Calcitonin-secreting parafollicular C cells arises within the ultimobranchial bodies mainly from neural crest cells of the fourth pharyngeal pouch. They fuse with the medial thyroid anlage during the fifth week of gestation. These cells are hence restricted to a zone deeper within the middle to upper third of the lateral lobes.

The thyroid primordium primarily consists of a solid mass of endodermal cells, which later

break up into a network of cords by the invasion of the surrounding mesenchyme. The epithelial cords later organize into clusters of cells with a central lumen

Follicles starts to appear at the beginning of the second month, and most of the follicles have been formed by the end of the fourth prenatal month. After that, additional growth is achieved by enlargement of existing follicles. So by the end of the third month the gland begins to function and is able to synthesize iodothyronines.

ANATOMY

The thyroid gland has derived its name from its resemblance to a shield as in Greek "thyreos" meaning "shield" and "eidos" means "form". The thyroid gland weighs anywhere between 15 and 25 g in adults and comprises two lateral lobes connected by - central isthmus. Each lobe is approximately 4 cm in length and 2 cm in width. The isthmus measures about 2 cm in width and 2 cm in height

A pyramidal lobe may be present in about 50% of patients, which arises from either lobe or the isthmus, and is directed upward, usually to the left side.

Location

The Thyroid gland lies basically on the anterolateral aspect of the cervical trachea, with the isthmus being related to the second, third, and fourth tracheal rings posteriorly. The superior pole lies lateralto the inferior constrictor muscle, and posterior to the sternothyroid muscle. The inferior pole extends uptill the level of the fifth or sixth tracheal ring. Posteriorly and also laterally the gland overlaps the carotid sheath and its contents.

The gland is enveloped completely by the layers of the deep cervical fascia, and is covered by the strap muscles anteriorly and the sternocleidomastoid muscle laterally.

The true thyroid capsule is tightly adherent to the gland, and continues into the parenchymato basically form fibrous septae that seperates the gland into lobules.

Posteriorly the middle layer of the deep cervical fascia condenses to form the posterior suspensory ligament of Berry which connects the lobes of the thyroid to the cricoid cartilage and the first two tracheal rings.

Blood supply:

The blood supply to the thyroid gland is derived mainly from two pairs of arteries. The superior thyroid artery which is the first branch of the external carotid artery which travels along with inferior constrictor muscle with the superior thyroid vein and supplies the upper pole of the gland. In this position, the artery lies superficial to the external branch of the superior laryngeal nerve as it supplies the cricothyroid muscle.

The larger inferior thyroid artery is a branch of the thyrocervical trunk that arises from the subclavian artery. This courses along the anterior scalene muscle, turns medially behind the common carotid artery to descend on the posterior aspect of the lateral lobes before entering the inferior thyroid pole. In its course behind the common carotid artery, the artery can have avariable relationship to the sympathetic chain. This vessel may be absent in 6% of patients. The thyroid ima artery is inconsistently present, and can arise from the innominate artery, subclavian artery, right common carotid artery, internal mammary, or aortic arch to supply the thyroid gland near the midline. It may occasionally replace the inferior thyroid artery as one of the principle vessels supplying the gland. It is more common on the right side. Because of its relation to the anterior aspect of the trachea, the thyroid ima artery is in danger of injury during a tracheostomy.

There is a dense network of connecting vessels within the thyroid capsule, with branches passing into the connective tissue between the lobules to form extensive capillary plexuses around individual follicles.

The veins draining the capillary plexuses give rise to the inferior, middle, and superior thyroid veins. These join the internal jugular or innominate veins. The paired inferior thyroid veins lie on the anterior aspect of the trachea and anastomose freely with each other before draining into the innominate veins. They represent a potential source of bleeding during thyroidectomy or tracheostomy.

Lymphatics:

Lymphatics traveling with the superior and middle thyroid vessels drain into the upper and middle deep cervical chain nodes respectively while the Lymphatics draining with the inferior thyroid vessels empty into the lower deep cervical chain nodes and the supraclavicular, pre-tracheal, and pre-laryngeal nodes.

Nerve supply:

The thyroid gland has a predominantly sympathetic innervation, from the superior, middle, and inferior cervical ganglia

BRIEF HISTORICAL REVIEW

ANATOMY

During the second century A.D., Galen described a nerve that came from the brain on each side of the neck, went down toward the heart, and then reversed course and ascended to the

larynx and caused the vocal cords to open. He called these ‘‘reversivi’’ (or recurrent nerves) and stated that he was the first to discover ‘‘these wonderful things.’’ Demonstrating before the elders of Rome, he showed that cutting the recurrent laryngeal nerve in the neck caused a live pig to stop squealing—an extraordinary feat. Because of Galen’s fame and influence, this nerve retained great importance in dissections by later anatomists and surgeons before and throughout the Renaissance. This paper documents many of these ana- tomical findings and highlights the importance of a careful, delicate, recurrent laryngeal nerve dissection during thyroidectomy, as popularized by Dr. Frank Lahey in 1938.

The first reference found of the control of voice is in the Sushruta Samhita, written in India in the sixth century B.C. [3]. Sushruta was the founder of the Ayurevda system of medicine, which still exists. In his Samhita, one reads, There are four Dhamanis (arteries) about the two sides of the Kantha-Nadi (wind pipe). Two of them are known as Nila (meaning glistening-white in Sanscrit), and the other two as Manya (meaning purple). One Nila and one Manya are situated on either side of the larynx.

An injury to any of them produces dumbness and a change of voice (hoarseness) and taste.[10] An important Marma, or critical area, number 16 occurs at the angle of the jaw. Thus, in 600 B.C., injuries to the vessels of the neck were thought to cause hoarseness.

In 100 A.D., Rufus the Ephesian noted that it was the nerves and not the vessels that were responsible for the faculty of voice. He wrote:

The ancients applied the name carotid (drowsy or stupor) to the vessels that cross the neck because their compression produces drowsiness and aphonia. Now, however, we realize that these symptoms result from compression of the nerves and not the vessels.[11]

SURGERY

Around 2700 BC, ‘goitre’ was appreciated in China, and in as early as 1600 BC, the Chinese used burnt sponge and seaweed to treat goitres. Pliny the Elder noted goitre epidemics in the Alps and also mentioned the use of burnt seaweed in their treatment which supposedly they learnt from the Chinese. The Artharva Veda (2000 BC), an ancient Hindu collection of incantations, also contains exorcisms for goitre. It termed the swelling of the neck (goitre) as ‘galaganda’.

Exophthalmic goitre was first described by Caleb Hiltier Parry of Bath in 1768 in his write-up in ‘Enlargement of the Thyroid Gland in Connection with Enlargement or Palpitation of the Heart’.[12] This subject was then further scrutinised by Robert James Graves and Carl Adolf von Basedow who published their observations independently in 1835 and 1840, respectively. Their publications dealt with the association of goitre, exophthalmos, palpitation, irritability, weight loss, wild hunger, hyperactivity, warmth and sweating. [13,14]

Toxic thyroidectomies were performed by surgeons like Theodor Kocher, Frank Hartley, Charles Mayo, Thomas Peel Dunhill and George Washington Crile. To provide greater safety, Kocher practised initial ligation of the thyroid arteries.[15] Hartley was a pioneer in removing the second lobe partially in a select number of patients.[16] Mayo practised uni-lateral or bilateral pole ligation prior to partial thyroidectomy in patients with severe thyrotoxicosis.[17]

Minimal access thyroid surgery (MITS) is a recent addition to the surgical techniques of thyroid surgery. Minimal access surgery is well accepted in other surgical specialties, but in head and neck surgery, its acceptance has been rather slow.[18] Garner et al., in 1996, generated much interest in this field after he reported feasibility of endoscopic approach to the

parathyroid glands.[19] His focus shifted to thyroid surgery as well to the quest for less invasive techniques and better aesthetic outcome. The concept attracted the attention of patients who appreciated the prospect of a better cosmetic outcome, less hospital stay and less postoperative pain.

TUBERCLE OF ZUCKERKANDL

The TZN is posterior extension of the gland composed of thyroidal tissue. In case of goiter formation the TZN generally enlarges synchronously at posterior site of the thyroid. First surgical importance of TZN is for 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 including attention to pyramidal remnants, to abnormalities associated with TZN.[45] Second surgical importance of the TZN arises from its relations with RLN. The resection of enlarged tubercle at posterior site of the thyroid requires delicate and careful dissection adjacent to the nerve. Identification of TZN and an understanding of the relationship between the TZN and RLN are essential for safety of thyroid surgeries.[46-48]

Although TZN is classified into four grades according to size, this grading is mainly for cadaveric anatomical studies. Surgeons generally perform these thyroid operations on voluminous goiter that when present larger tubercles are observed on surgical specimens. Therefore, on a surgical point of view an enlarged TZN parallel to goiter formation merits more interest than smaller one. It makes surgical dissection challenging at posterior site of the lateral lobes around RLN and inferior artery.

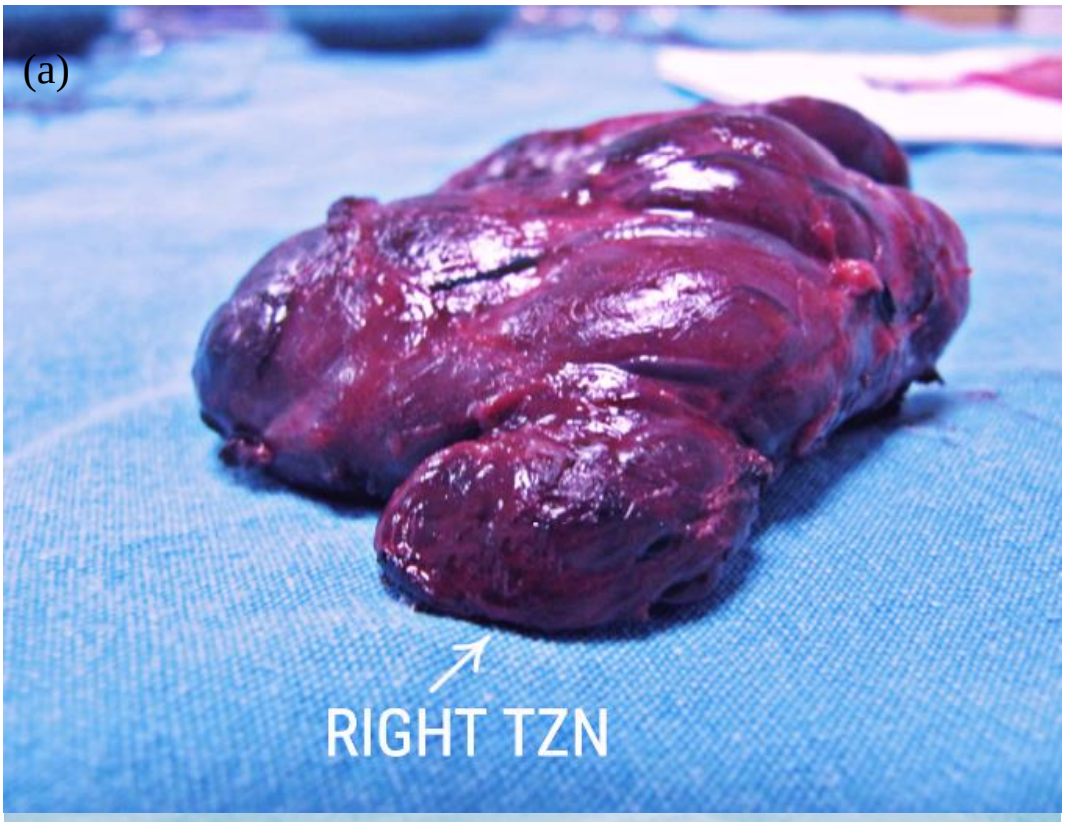
When present, mobilization of a prominent TZN has surgical importance in completeness of thyroidectomy and identification and isolation of the RLN.

It is estimated that the lateral thyroid anlage contributes almost 1% to 30% to the thyroid weight. Residual posterolateral projection from the lateral thyroid component is known as the ZT. In the last 20 years, hemithyroidectomy and total thyroidectomy are the procedures of choice for the management of patients with goiter. Delbridge has stated that the completeness of resection has acheived by moving from an anatomically based approach to an embryologically based approach.

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 identify RLN. TZN appears as an indicative pointer for the nerve and neurovascular crossing point in some patients. After medial mobilization of the lobes, when present, TZN may be used as a landmark which facilitates identification of the nerve. Many authors have previously stated that the TZN is a reliable and constant anatomical landmark as an arrow pointing the RLN.[49-52]

The site of greatest risk during thyroidectomy to the RLN is in the last 2-3 cm extralaryngeal course of the nerve before its laryngeal entry which is above the trunk of the inferior thyroid artery. Based on how the TZN points, like an arrow head, neurovascular crossing point of the nerve promotes surgeon's skill to identify the RLN. On the other hand, larger tubercle generally covers anterior surface of the nerve.

Mobilization of the tubercle medially allows easy identification of the nerve at this dangerous site. Understanding the relationship between the nerve and the tubercle ensures safer thyroid surgery.


(a)
RIGHT TZN


(b)
LEFT TZN

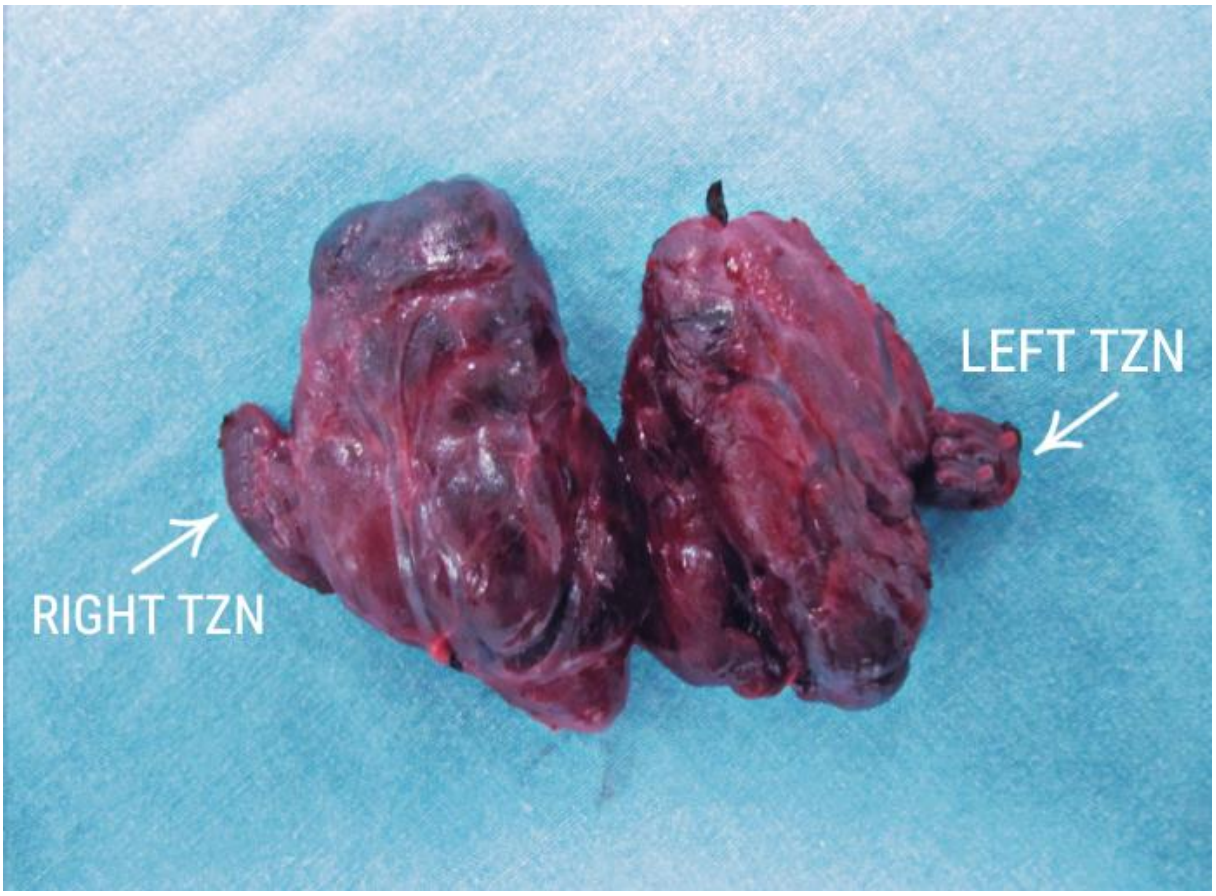


FIG:1 TUBERCLE OF ZUCKERKANDL (a) Right side (b) left side

The anatomy of TZN and RLN is another important point for their relation. The resection of TZN for total thyroidectomy requires a well refined and meticulous dissection adjacent to the nerve. When enlarged by causative disease, the tubercle passes over the nerve like a bridge. This normal anatomical relationship may be retained in the majority of cases. Thyroidectomy technique can be improved due to the constant relationship between these two structures at a level where the risk of injury is highest. An enlarged TZN usually covers a segment of the distal part of the nerve which passes in the tracheoesophageal groove. On the other hand, unusual position of TZN and RLN at both sides; RLNs are anterior (or lateral) to ZT in 6% of occurrences. Uncommon anatomical relations between RLN and ZT affects the safety of thyroid operations. All thyroid surgeons must be well aware of this uncommon variation mainly to prevent injury to the nerve during total resection of the thyroid gland. Hisham and

Lukman have previously reported that in 6% of their dissection, the RLN was lying on the anterior surface of the tubercle.[46] Gauger et al. have also reported that -in 93% of patients with enlarged TZN, the RLN lays almost medial to the tubercle, and the nerve was found lateral to it in almost remaining 7% of the cases.[47] Anteriorly lying course of RLN is at highest risk of injury. The surgeon should always be aware of the tubercle, and he must face the TZN without fear but with utmost care. Identification of TZN, an understanding of the relationship between the tubercle and RLN, and isolation of the nerve before dissection of TZN are mainly essential for performing safe thyroid surgery.

The RLN is uncommonly located on anterior surface of the tubercle. This unusual lateral course may increase the risk of injury to underlying structures. Based on the occurrence of unusual variations, it is safer to identify the RLN before attempting dissection of adjacent structures. Excision of TZN is mandatory for completing thyroidectomy. Fine and delicate dissection with utmost care around the TZN is also mandatory after identification and isolation of the RLN for preventing RLN injury.

The recurrent laryngeal nerve (RLN) is important for airway and voice quality. Unilateral injury of the RLN during thyroid sur-gery causes hoarseness of voice akong with dysphagia. The conse- quences are more severe and life-threatening if it is bilateral injuries, which compromises the airway and requires immediate tracheostomy. Rates of RLN injury are reported to be around 10%.

The RLN identification and protection during thyroid surgery is essential for avoiding intraoperative RLN injury.

Histological findings from thyroid follicles in the TZN and main thyroid tissue are similar. Reports describing histological findings of TZNs are few. Gurleyik and Gurleyik reported 2

cases of TZNs, describing the area as being composed simply of thyroid tissue.[53] Microscopically, the TZN is comparable with other areas of the thyroid tissue.[54] Nodular lesions may develop within the TZ just as in main thyroid tissues.[55] Various studies have found out that TZNs are microscopically similar to the main thyroid tissue,. In cases of chronic thyroiditis, both the TZN and main thyroid tissue showed chronic inflammatory cell infiltration and oxyphilic changes in follicular cells. There are no apparent microscopic difference between the TZN and main thyroid tissue in hematoxylin and eosin-stained sections.

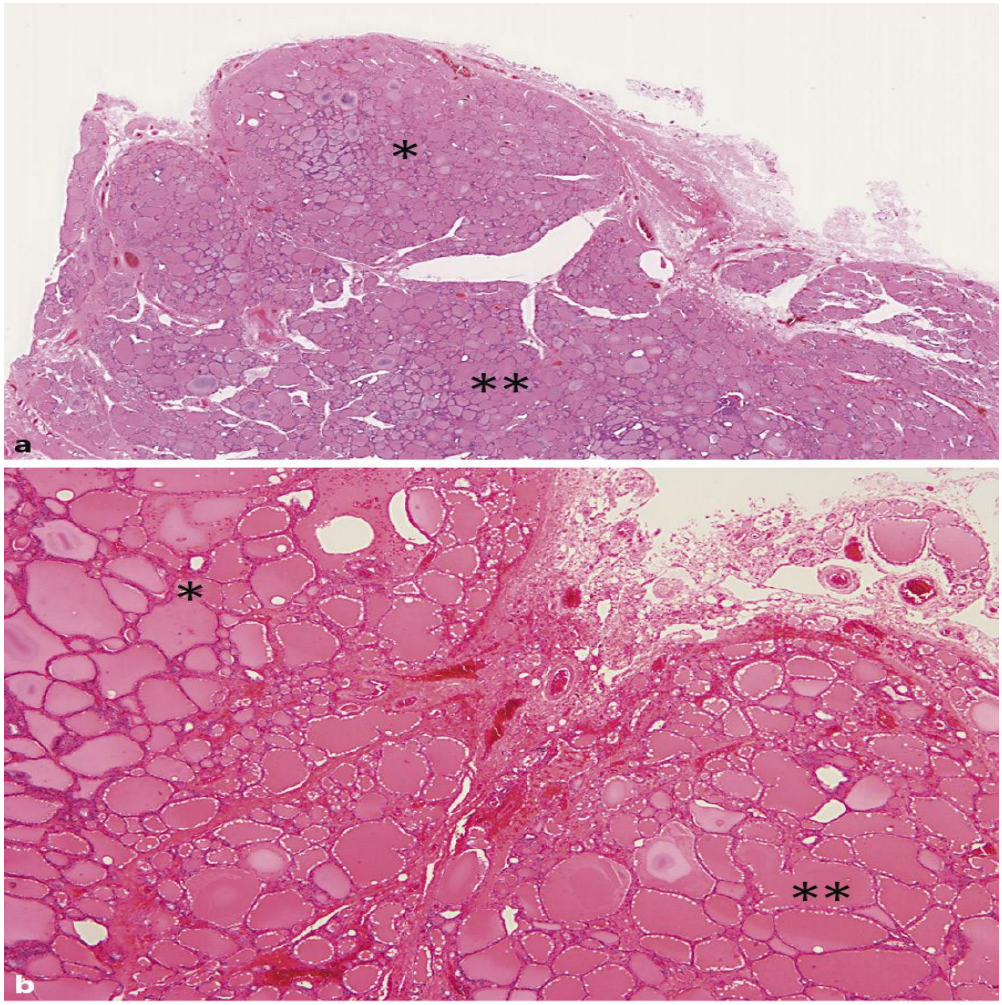


FIG:2 (a) Microscopic appearance of the thyroid tubercle of Zuckerkandl (TZ) (*) is similar to that of the main thyroid tissue (**).

(b) Thin, fibrous connective tissue bundle is present between the TZ and main thyroid tissue.

The size of the Zuckerkandl tubercle was graded according to the classification proposed by Pellizo:

Grade 0 (no tubercle),

Grade 1 (thickening <0.5cm) ,

Grade 2 is the presence of a tubercle 0.5-1.0 cm

Grade 3 is the presence of a tubercle greater than 1 cm.

Grades	*Size (cm)*
0	Unrecognizable
I	<0.5
II	0.5-1.0
III	>1.0

TABLE:1 - GRADING OF TUBERCLE OF ZUCKERKANDL ACCORDING TO ITS SIZE

RECURRENT LARYNGEAL NERVE

The recurrent laryngeal nerve (RLN) is the main motor nerve of all the intrinsic laryngeal muscles except for the cricothyroid muscle. After the nerve leaves the superior mediastinum, the RLN courses toward the larynx over the tracheoesophageal groove, keeping a close relationship with the thyroid gland, as well as with the parathyroid glands and branches of the inferior thyroid artery. As soon as it crosses the Berry's ligament, the RLN enters the larynx.

Because of its close anatomical relationships, the RLN is very vulnerable during operations involving the thyroid gland (especially in the Berry ligament, tubercle of Zuckerkandl, tracheoesophageal groove, and inferior and superior thyroid poles) and mainly during dissections of level VI lymph nodes. Several anatomical variations of the RLN are found, which further increases the jeopardy for inadvertent injury to the nerve.

The most dangerous anatomical variation associated with high complication risk during thyroidectomy is the nonrecurrent inferior laryngeal nerve. In 1823, Stedman was the first one to describe this anomaly.[20]

Because of an embryogenetic defect, the origin of the right subclavian artery maybe abnormal. In this disorder, traction is lost on the inferior laryngeal nerve, which then exits the vagus nerve directly toward the larynx. On the other side, the embryologic vascular anomaly on the left side which is absence of the ductus arteriosus will make it incompatible for survival of the fetus.

Emil Theodor Kocher established the basic and technical principles of thyroid surgery, transforming it into a safe- procedure. The main complications that occurs during or after a thyroidectomy are upper airway obstruction, unaesthetic scars, injury to the laryngeal nerves, and hypoparathyroidism.

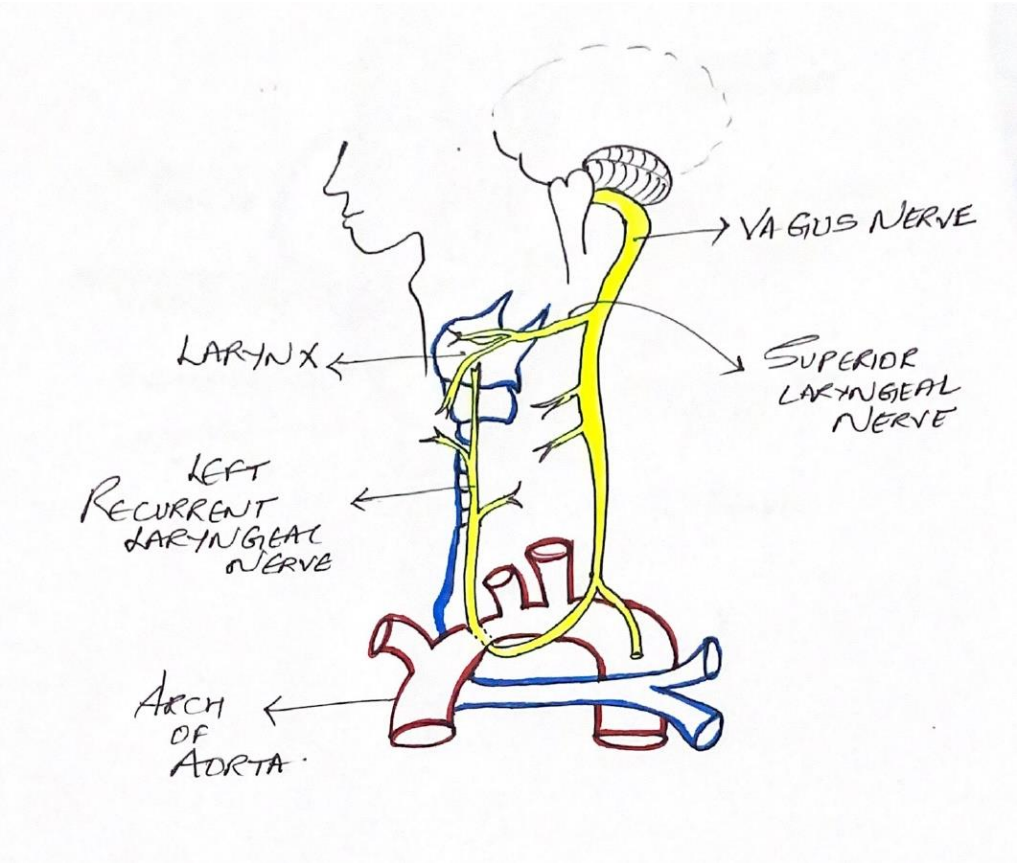


FIG:3: Diagrammatic representation of left recurrent laryngeal nerve

The first description of the RLN is attributed to Galen (during the second century BC): he stated it as a "nerve that descended from the brain to the heart, then reversed the course and ascended to the larynx and caused the vocal cords to move." [21] Despite this ancient description of the RLN, it was only after the publications by Kocher that morbidity associated with thyroidectomy reached safe levels.[22] The mainstay of recommended surgical technique of thyroidectomy is the active search for identification of the RLN at the beginning of the ipsilateral thyroid lobectomy. According to most of the published series, visual control and gentle dissection of the RLN are neccessary.[23] To minimize the complication rate, the otorhinolaryngology surgeon must be aware of the possible anatomical variations of the RLN, including its relationship with the branches of the inferior thyroid artery, the nonrecurrent inferior laryngeal nerve. The nonrecurrent inferior laryngeal nerve is a difficult

and dangerous anatomical variation for many reasons. The surgeon who always expects to find the RLN in its normal position might overlook a nonrecurrent inferior laryngeal nerve on the right side because of its strange direct transverse course towards the larynx. However, this anatomical variation is very uncommon. Its reported incidence ranges as less as 0.3% to 1.5%.[24-26,28-31]

In contrast to the rarity of the nonrecurrent inferior laryngeal nerve, External laryngeal branch of the RLN is a common anatomical variation. The first mention about the possibility of division of the RLN before entering the larynx was discovered only in the second half of the 20th century. In 1957, Gregg published a meta-analysis that included 669 RLNs, where 61.3% with ELB. Confirming this observation, Katz described 721 RLNs, 58.3% which showed ELB. A follow-up study[27] concluded a larger series of RLNs, 63.9% with ELB.

Hisham and Lukman[32] evaluated 502 RLNs in a clinical series of 325 thyroidectomies. The RLN was identified in 97.8% of their dissections; out of which 33.4% had 2 branches and 0.6% had 3 branches.

Page et al[33] reported their findings in a clinical series which was conducted in 251 patients undergoing thyroid surgery. The RLN was divided on the right side in 23.8% of women and in 21.6% of men in the study. The RLN was divided on the left side in 15.3% of women and in 14.6% of men. They concluded that there were proportional differences in External laryngeal nerve of the RLN related to side which is more common on the right side and sex which is slightly more frequent among women.

Wang et al[34] had published the findings of a small clinical series of 56 patients who underwent thyroidectomy, in whom 63 RLNs were identified. Bifurcation was present in 48 RLNs (76%).

Beneragama and Serpell analyzed 213 RLNs in 137 patients who underwent thyroid or parathyroid operations. 77 RLNs (36.1%) had bifurcated or trifurcated before entering the larynx. Bifurcations were more common on the right side (43.6%) compared to left side (28.1%) (P = .05). Trifurcations were seen in almost 8 RLNs, 7 on the right side and 1 on the left side (P=.05). Bilaterally branched RLNs were observed in 14 of 77 patients (18%) who underwent a bilateral procedure. The authors also evaluated the median distance from the cricothyroid joint to the point of division of the nerve, which was 18 mm on the right side and 13 mm on the left side.

Curiously, the highest percentages of external branch of the RLN were observed in series which involved anatomical cadaver dissection. Yalcin et al[35] performed an anatomical study comprising branching of the RLN before entering the larynx. They dissected almost 49 cadavers, comprising 96 aspects of the neck. In 82 dissections, the RLN divided before entering the larynx. In 7 of the dissections, there were 3 branches. In a follow-up study[23] the same group expanded their experience to 110 RLN dissections, where they observed 93.6% with external laryngeal branch.

The risk of injury to the recurrent laryngeal nerve is related to the level of knowledge about the anatomy and the experience of the surgeon. The larynx protects the lower respiratory tract, generating voice and provides a controlled airway, and generation of a high intrathoracic pressure which aids in coughing and lifting. Lahey was an advocate for identification of the RLN by introducing thorough dissection and demonstration of the RLN during thyroid surgery. A unilateral RLN palsy passes undetected and around one- third of the patients are asymptomatic. Others have some change in a bilateral abductor paralysis, both vocal cords lies in median or paramedian position due to unopposed action of the cricothyroid muscle.

Here the voice is good but can lead to dyspnoea or stridor which requires further management. The left RLN is more viable to injury than the right because of its longer course compared to right. The incidence of a unilateral vocal cord paralysis is comparatively more than a bilateral paralysis.[37]

As the rates of laryngeal and thyroid surgery increases and as technological advances and increase in incidence of laryngeal carcinoma the need to put more emphasis on the recurrent laryngeal nerve arises then. Preoperative assessment of vocal cord status will significantly help to determine the extent of injury to the nerve postoperatively, if any.[38]

EMBRYOLOGY OF RECURRENT LARYNGEAL NERVE

The nerve of the sixth pharyngeal arch later becomes RLN. The primitive RLN enters the 6th visceral arch on each side well below the 6th aortic arch artery.

On the left side, the arch artery retains its position as the ductus arteriosus so the nerve is found be on a lower side to the ligamentum arteriosum after birth.

On the right side, the 6th and 5th arch artery disappears leaving below the 4th arch artery and be- comes the subclavian artery.[39]

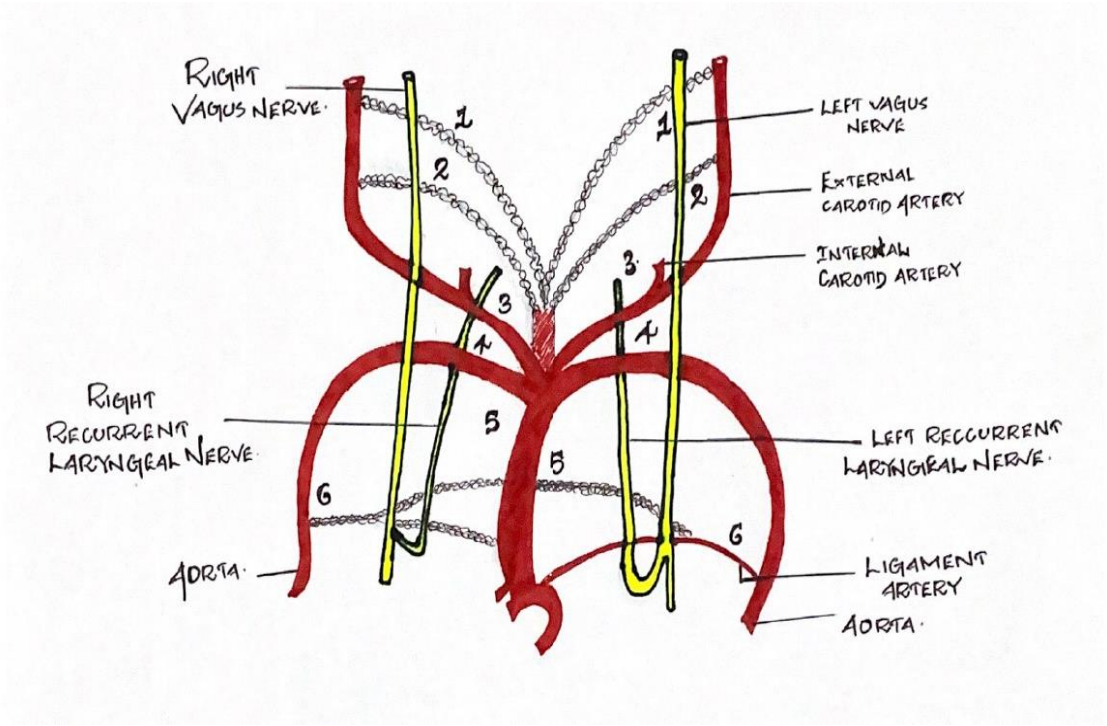


FIG 4: The relationship between development of the branchial arches and recurrent laryngeal nerves. The number indicates the number of the branchial arch.

This developmental pattern mainly explains why on the left side the nerve leaves the vagus at the level of aortic arch and winds below the arch whereas the right RLN arises from the main trunk of vagus in front of the subclavian artery before passing superiorly to lie in close relation to tracheoesophageal groove (where it forms the third side of Beahrs' triangle, where as other two sides of the triangle are formed by the common carotid and inferior thyroid arteries). The nerve may be behind or within the Ligament of Berry.

Then the RLN passes deep to the lower border of inferior constrictor muscle and lies immediately behind the cricothyroid joint and finally enters into the larynx. The approximate length of the left RLN is around 12 cms and about 6 cms only on the right side.

It divides into mainly motor and sensory branches. The motor branch have fibres derived

from the cranial root of the accessory nerve which supplies all the intrinsic muscle of the larynx, except the cricothyroid.

The sensory branch supplies the laryngeal mucosa below the level of the vocal folds and also carries afferent fibres from the stretch receptors in the larynx.

In the neck region, it carries sensory, secretory and motor fibres to the cervical segments of the esophagus as well as the trachea.

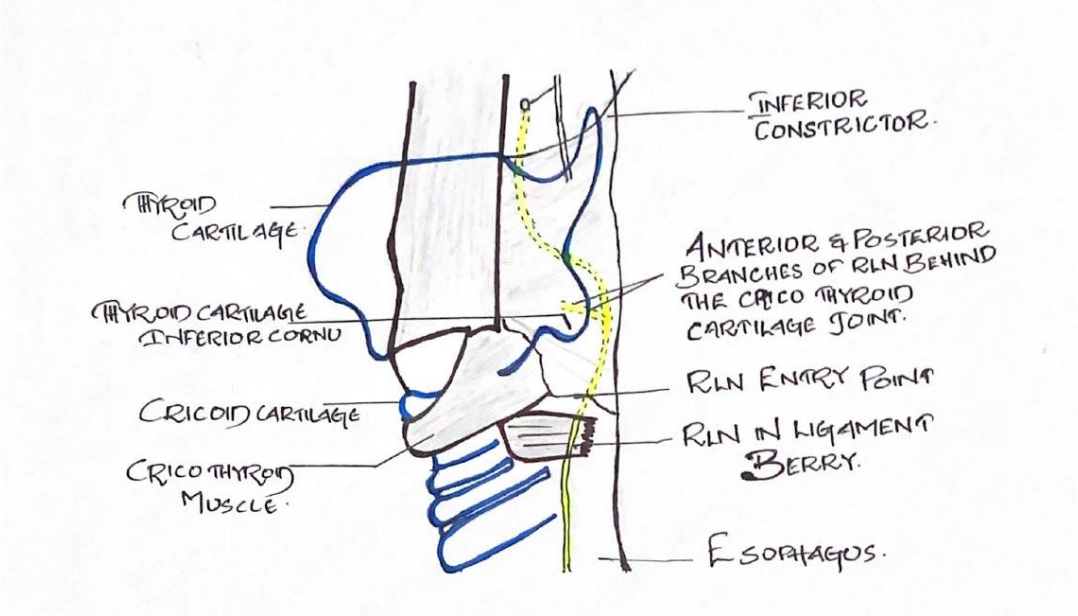


FIG 5: Figure showing relationship of recurrent laryngeal nerve with that of Berry's ligament

Because of its extensive course, the left RLN is more liable to injury compared to right and is especially vulnerable to pressure from aortic aneurysm, thoracic surgery and intrathoracic masses. It is also easily injured during thyroid surgery due to its viable relationship with the inferior thyroid artery i.e. it may lie behind, between or even superficial to it. It may lie lateral, medial or within the suspensory ligament of Berry just before its entry to larynx, therefore care must be taken during thyroid dissection.[4]

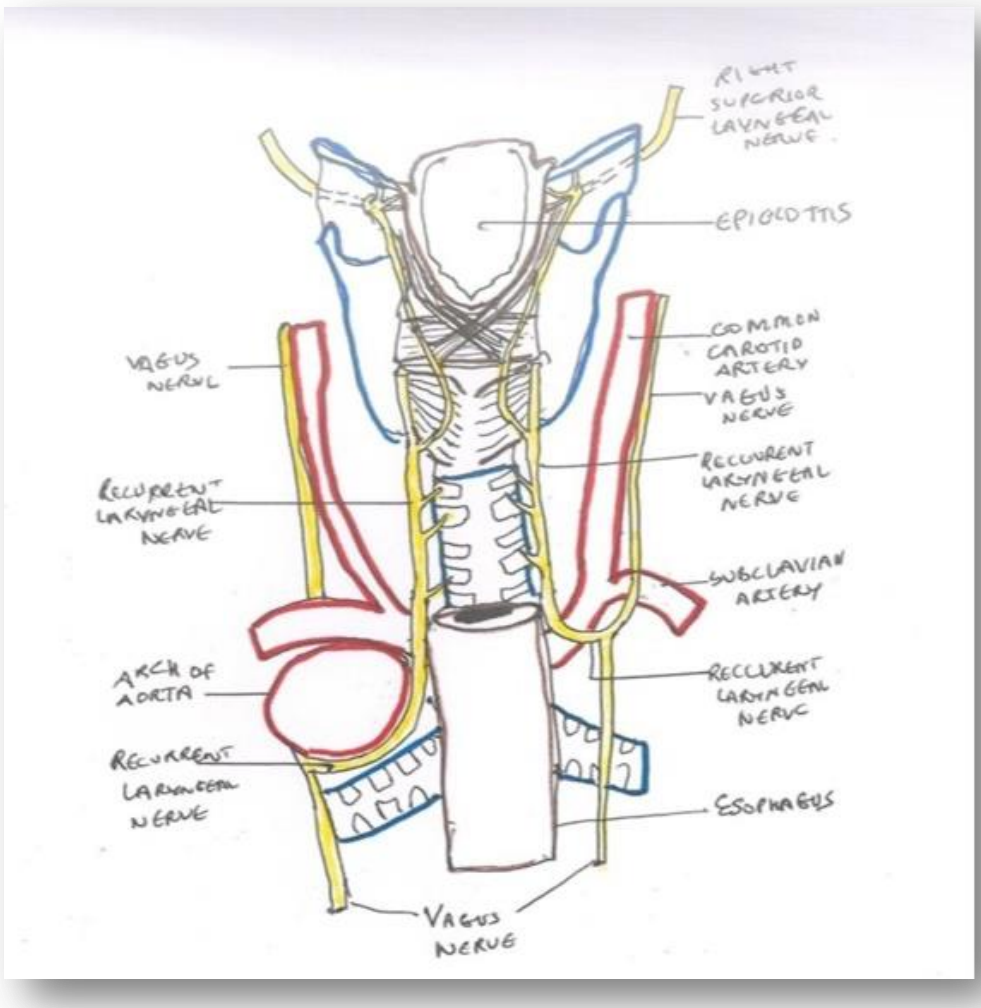


FIG 6: Figure showing the posterior view of the larynx showing the distribution of the RLN

ANATOMICAL VARIATIONS:

Extra-laryngeal branches, distorted RLN, which is intertwining between branches of the nerve, inferior thyroid artery and non-recurrent laryngeal nerve can be a potential cause of nerve injury due to visual misidentification especially in thyroid operation.

A rare anomaly that includes the non-recurrent laryngeal nerve, branching off the vagus around the level of the cricoid cartilage. Ideally, such a configuration is accompanied by variation in the arrangement of the major arteries in the chest; commonly, the right subclavian artery arises from the left side of the aorta and later crosses behind the esophagus.[41] A left non-recurrent inferior laryngeal nerve is even more uncommon, requiring the aortic arch to be on the right side, which is accompanied by an arterial variant which prevents the nerve from being drawn into the chest by left subclavian.

In about four people out of five, there is a connecting branch seen between the inferior laryngeal nerve, a branch of the RLN, and the internal laryngeal nerve, which is a branch of the superior laryngeal nerve. This is commonly known as the anastomosis of Galen.[42]

Following things are to be kept in mind during identification of the nerves:

1. To know the anatomy and its anatomical variants of the RLN.

2. To Identify the major landmarks for the RLN ‘s entry point which includes:

[a] which is located approximately 1cm below caudal to the thyroid cartilage’s inferior horn, which can be easily palpated.

[b] it is just lateral to the anterior arch of the cricoid cartilage which marks the lower edge of the cricoid cartilage.[43]

3. Good surgical field should be ensured for identifying the nerve by maintaining haemostasis.[44]

4. The Ligament of Berry: The dense, vascular nature of the ligament of Berry, the multiple branches of the RLN that can be present at this level, the potential for a bend or genu of the nerve at its laryngeal entry point and its close relationship of thyroid tissue to this ligament all makes this area the most difficult region of nerve dissection during thyroidectomy.

5. Keep in mind to adopt a particular approach: Locate the nerve where it enters the larynx, superior- inferior direction or locate the nerve in tracheoesophageal groove and trace it in the superior direction, inferior-superior direction.

6. During thyroidectomy, make sure to never cut any band of tissue in the distribution of the RLN that is not transparent without neural stimulation.

7. Usage of devices such as; Vagal stimulation provides a positive EMG signal so that neural mapping and search for the nerve can be achieved. Other devices include Operating loupes with at least 4 times magnification or intraoperative nerve monitoring (IONM).

PARATHYROID GLAND

DEVELOPMENT

The parathyroid glands develop from the endoderm of the third and fourth pharyngeal pouches. Both, the Inferior -parathyroids and the thymus develop from the third pharyngeal pouch between the 5^{th} -6^{th} gestational weeks, with the dorsal wing developing into the inferior parathyroid glands while the ventral wing becomes the thymus. The thymus and parathyroids ,both lose their connections to the pharynx at the gestational age of - 7^{th} week. During the migration of inferior parathyroid glands , and the thymus towards the mediastinum, they gets separated and the inferior parathyroid glands become localized near the inferior poles of the thyroid gland, and the thymus then continues to migrate towards the mediastinum.

The superior parathyroid gland and the ultimobranchial bodies are mainly derived from the dorsal wing of fourth pharyngeal pouch which is between the 5^{th} - 6^{th} gestational weeks. During the fifth week of development the ultimobranchial bodies detaches from the pharyngeal wall and fuses with the - posterior aspect of the main body of the thyroid as it descends into the neck. Later on - these cells differentiate into the parafollicular cells (C cells) that secretes calcitonin.

The superior parathyroid glands often migrate a shorter distance compared to inferior parathyroid glands, which results in a relatively more constant location in the - neck. At gestational week 7, the glands loses connections with the pharynx, and migrate caudally along with the thyroid gland. Since the superior parathyroid glands, travel with the ultimobranchial bodies, they remain in contact with the posterior part of the upper two-thirds of the thyroid lobes and thus they migrate far less than the - thymus and the inferior

parathyroids. Because of the shorter migration distance, the superior parathyroid glands are in a more constant location compared to - inferior parathyroid gland.

The superior parathyroid gland are generally located more posteromedial than the inferior parathyroids, and the final resting point of both parathyroids is usually on the dorsal surface of the thyroid gland, outside the fibrous capsule of the thyroid gland.

ANATOMY

The parathyroid glands are small endocrine glands which are located on the posterior aspect of each thyroid lobe. These glands are caramel (golden yellow) coloured and about 3-4mm in size. The shape of the glands can vary from flattened to oval to bean like, and together they weigh almost 20-40 mg. The parathyroids are responsible for the production of parathyroid hormone (PTH), which maintains - calcium homeostasis in the body.

Majority of people have four parathyroid glands; however, supernumerary glands as well as less than four glands have also been reported. Incidence of supernumerary glands in histopathology specimens could be 0.5% (6 glands), 25% (5 glands), 87% (4 glands), and 6.1% with only 3 glands. The majority of the supernumerary glands are either rudimentary or divided which can weigh as little as less than 5 mg and in close proximity of a normal gland.

The glands are classified into two pairs based upon their embryological development:

• Superior Parathyroid gland
• Inferior Parathyroid gland

Location:

These glands are situated, within the fibrous capsule of the thyroid (intracapsular), or outside the capsule (extracapsular). If the parathyroids are intracapsular in location, then the tumor involving the parathyroid have the tendency to expand locally within the thyroid capsule. While if it is extracapsular then the tumor growth is not constrained and can expand downwards into the mediastinum either anteriorly or posteriorly.

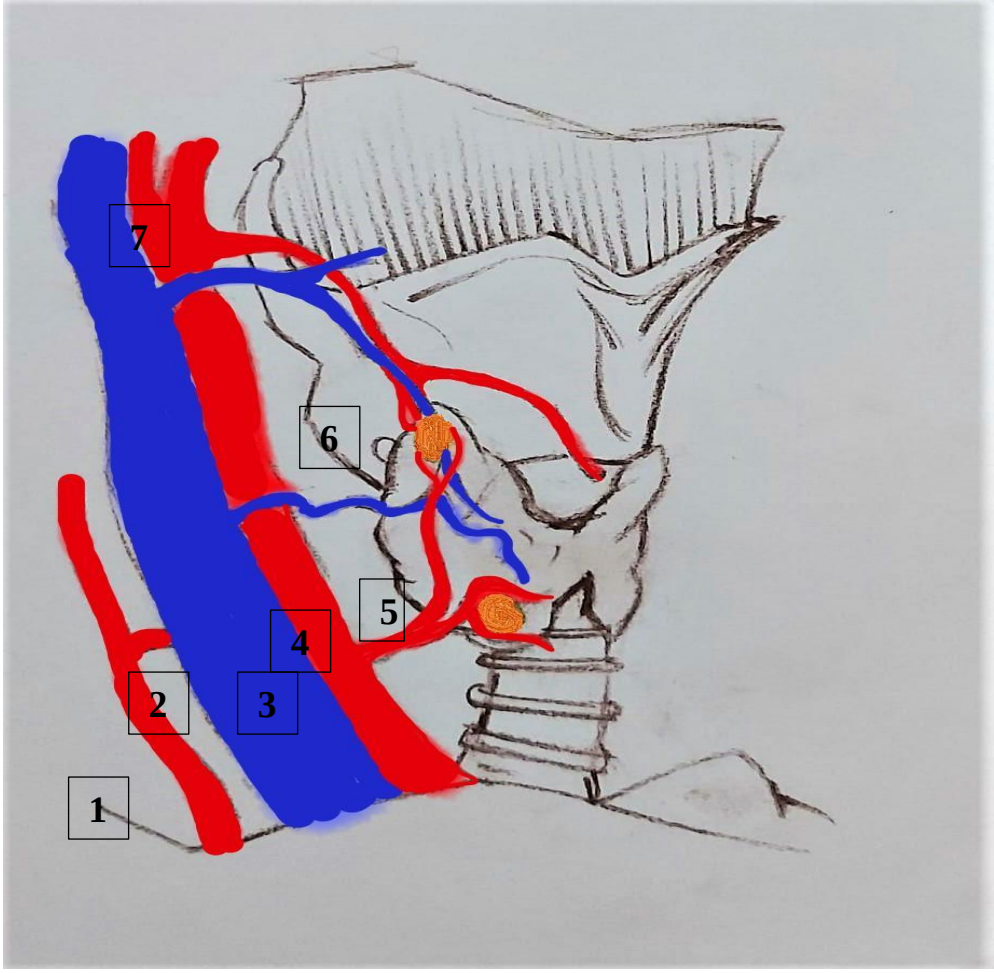


FIG:7: Anatomy of the Parathyroid glands. 1: Thyrocervical trunk;2: Internal Jugular vein; 3: Common carotid ; 4: Inferior thyroid artery; 5: Inferior parathyroid; 6: Superior Parathyroid; 7: Superior thyroid pedicle.

Superior Parathyroid Glands are found at the level of the upper two-thirds of the thyroid

gland posterior to the Tubercle of Zuckerkandl (which is an enlargement of the lateral edge of the thyroid lobe formed by the fusion of the lateral and medial thyroid anlages). In almost 80% of the people superior parathyroids are located on the posterior aspect of the thyroid gland within a circumscribed area of 2cm diameter and 1cm above the crossing point of the Recurrent Laryngeal Nerve (RLN) and inferior thyroid artery (ITA).

Ectopic superior parathyroids are very uncommon (1%), and can be found at the level of the upper pole of the thyroid gland in 2% of the subjects or above the pole in 0.8% of the subjects. The ectopic superior parathyroids can also be found in the posterior neck, retropharyngeal, retroesophageal spaces and within the thyroid stroma which is intra-thyroid.

Though mostly location of Inferior parathyroid glands is inconsistent, these can be usually be found near the inferior poles of the thyroid gland. Their most common location is the anterior or the posterolateral surfaces of the lower pole of the thyroid, which can be anywhere between the lower pole of thyroid and thyroid isthmus (44%); within the thyro-thymic ligament in the lower neck which is in proximity to the thymus (39%), within the carotid sheath (15%) or inferiorly as the superior mediastinum (2%).

The relative position of the parathyroids in relation to the recurrent laryngeal nerve is of more importance compared to relation of the glands to the inferior thyroid artery. The inferior parathyroids are usually found in a plane which is more ventral to that of the superior glands, i.e. the Superior parathyroids lies behind the plane of recurrent laryngeal nerve, while the Inferior parathyroids lies in front of this plane.

The parathyroids can easily be confused with Lymph nodes, surrounding fat tissue and thyroid tissue, so during thyroid surgeries the following aspects should be taken care of, like

parathyroid glands have a distinct, encapsulated, smooth surface that differs from the thyroid gland, which comparatively has a more lobular surface.

The inferior parathyroid gland is supplied by the inferior thyroid artery, a branch of the thyrocervical trunk. In approximately 10% of patients, the inferior thyroid artery were absent, most commonly on the left side. In these cases, a branch from the superior thyroid artery basically supplies the inferior parathyroid gland.

Lymphatics:

The Lymphatic vessels of the parathyroid glands drains along with the thyroid gland into the deep cervical lymph nodes and paratracheal lymph nodes.

Nerve Supply:

The parathyroid glands has an extensive supply of nerves, derived from thyroid branches of the cervical (sympathetic) ganglia. These nerves are vasomotor but not secretomotor as the endocrine secretion of parathyroid hormone is controlled hormonally.

Vascular Supply:

Inferior parathyroid glands that descends into the anterior mediastinum are usually vascularized by the inferior thyroid artery. If a parathyroid is positioned lower in the mediastinum, it may be supplied by a thymic branch of the internal thoracic artery or even a direct branch of the aortic arch. The superior parathyroid gland is also supplied by the inferior thyroid artery or by an anastomotic branch between the inferior thyroid and the superior thyroid artery.

Several studies have indicated that in 20-45% of cases, the superior parathyroid glands

receives significant vascularity from the superior thyroid artery. This is mainly in the form of a posterior branch of the superior thyroid artery which is formed at the level of the superior pole of the thyroid. The parathyroid veins then drain into the thyroid plexus of veins.[56,57]

Histology of the parathyroids The parathyroid glands are mainly made up of two types of cell :

- **Chief cells** - These are the cells which secretes the parathyroid hormone (PTH)
- **Oxyphil cells** – They have a secretory function, and tends to become more common with age, but their precise role is not clear.

Rest of the gland is composed of adipose tissue which adds bulk to the gland and increases with age and obesity; and fibrous tissue stroma which gives form to the gland as well as it contains the capillaries to the glands.[58,59,60]

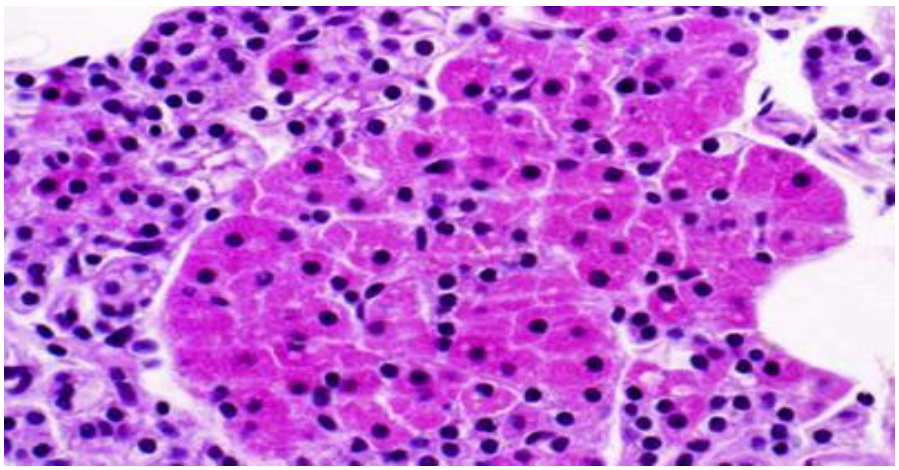


FIG:8 Histology slide of normal parathyroid showing Chief cells & Oxyphil cells.

MATERIAL & METHODS

MATERIALS AND METHODS

SOURCE OF DATA:

60 patients aged between 25 to 65 years who were planned for total thyroidectomy or hemi thyroidectomy in the Department of Otorhinolaryngology were included in the study at R.L.Jalappa Hospital & Research Centre, Tamaka, Kolar from December 2019 to July 2021 were taken up for the study after fulfilling the inclusion criteria and signing an informed consent.

STUDY DESIGN: This was a Cross-sectional Analytical study.

A detailed clinical history, with regard to thyroid disease, pressure symptoms, thyrotoxicosis, features suggestive of hypothyroidism or hyperthyroidism, was evaluated and a detailed clinical examination was done along with Thyroid function tests, blood, urine & Biochemical investigations required for thyroidectomies along with ECG, Chest X-ray, Ultrasonography of neck, FNAC of thyroid nodule was performed.

Exclusion Criteria:

1. Patients having parathyroid adenoma or hyperplasia.
2. Patients having past h/o neck surgeries
3. Patients with history of h/o radioiodine ablation

SAMPLING PROCEDURE:

SAMPLE SIZE ESTIMATION:

Sample size has been estimated according to a recent study "Zuckerkandl tubercle in thyroid surgery: Is it a reality or a myth? published in Annals of Medicine Surgery, in the year 2016 showing incidence of tubercle of Zuckerkandl as 73.41% i.e. tubercle of Zuckerkandl was found in 127 of 173 lobectomies done.

Patients undergoing total or hemi thyroidectomy with 95% confidence interval and with absolute error of 10% the required sample size will be 60 as calculated by the formula given below.

Statistical analysis:

Data was entered into Microsoft excel data sheet and was analyzed using SPSS 22 version software. Categorical data was represented in the form of Frequencies and proportions. **Chi-square test** was used as test of significance for qualitative data.

Continuous data was represented as mean and standard deviation.

Graphical representation of data: MS Excel and MS word was used to obtain various types of graphs such as bar diagram, Pie diagram.

p value (Probability that the result is true) of <0.05 was considered as statistically significant after assuming all the rules of statistical tests.

Statistical software: MS Excel**,** SPSS version 22 **(**IBM SPSS Statistics, Somers NY, USA) was used to analyze data.

METHODOLOGY

In all patients undergoing hemi or total thyroidectomies, the size and shape of the tubercle of Zuckerkandl was measured using a sterile caliper intra operatively.

The distance between tip of tubercle of Zuckerkandl and recurrent laryngeal nerve was measured in millimeters using the tip of the sterile caliper and documented It was documented whether the tubercle of Zuckerkandl was overlying the recurrent laryngeal nerve or not.

The relationship of branches of inferior thyroid artery with recurrent laryngeal nerve adjoining the tubercle of Zuckerkandl was documented.

Distance between tip of Zuckerkandl tubercle with superior parathyroid gland was measured using sterile caliper and documented.

The difficulty in separating Zuckerkandl tubercle from adjacent structures like recurrent laryngeal nerve, branches of inferior thyroid artery & Berry's ligament was documented by noting the time taken for dissection & bleeding at this site.

RESULTS

RESULTS:

Proportion of TZN identified in patients undergoing Thyroid Surgeries was 100% (102/102)

Table 2: Age distribution of subjects

		Count	%
Age	<30 years	9	8.8%
	31 to 40 years	16	15.7%
	41 to 50 years	44	43.1%
	>50 years	33	32.4%
	Total	102	100.0%

Mean age of subjects was 45.20 ± 9.118 years. Majority of subjects were in the age group 41 to 50 years (43.1%).

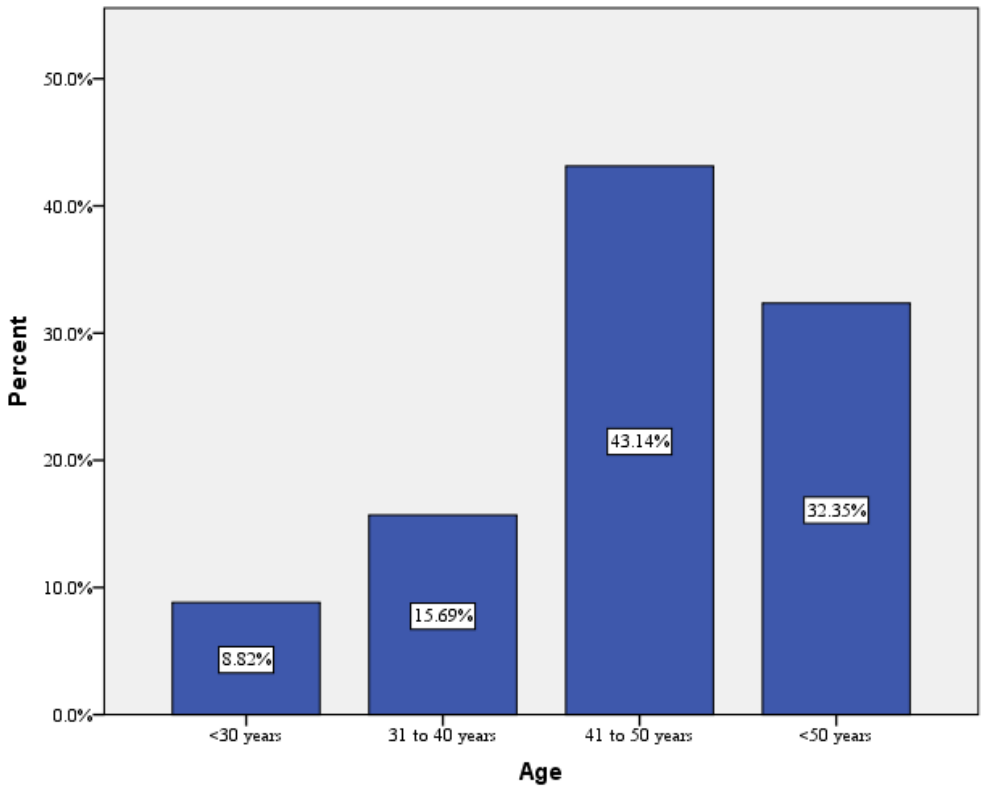


Figure 9: Age distribution of subjects

Table 3: Gender distribution of subjects

		Count	%
Gender	Male	18	17.6%
	Female	84	82.4%

In the study 82.4% were females and 17.6% were males.

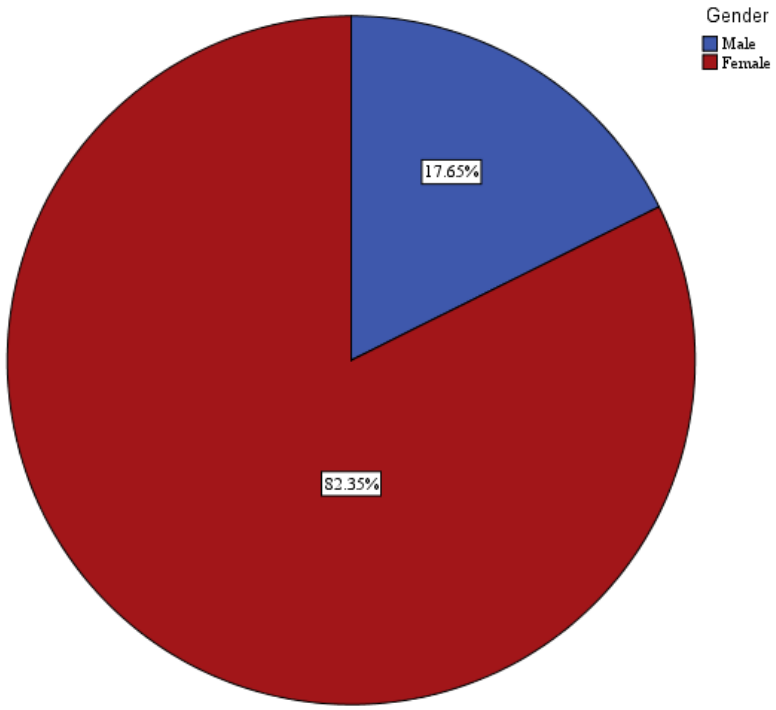


Figure 10: Pie diagram showing Gender distribution of subjects

Table 4: Diagnosis among subjects

		Count	%
Diagnosis	PTC	51	50.0%
	MTC	4	3.9%
	FTC	17	16.7%
	BENIGN MNG	21	20.6%
	BENIGN Solitary Nodule/ Nodular Hyperplasia	4	3.9%
	THYROIDITIS	5	4.9%

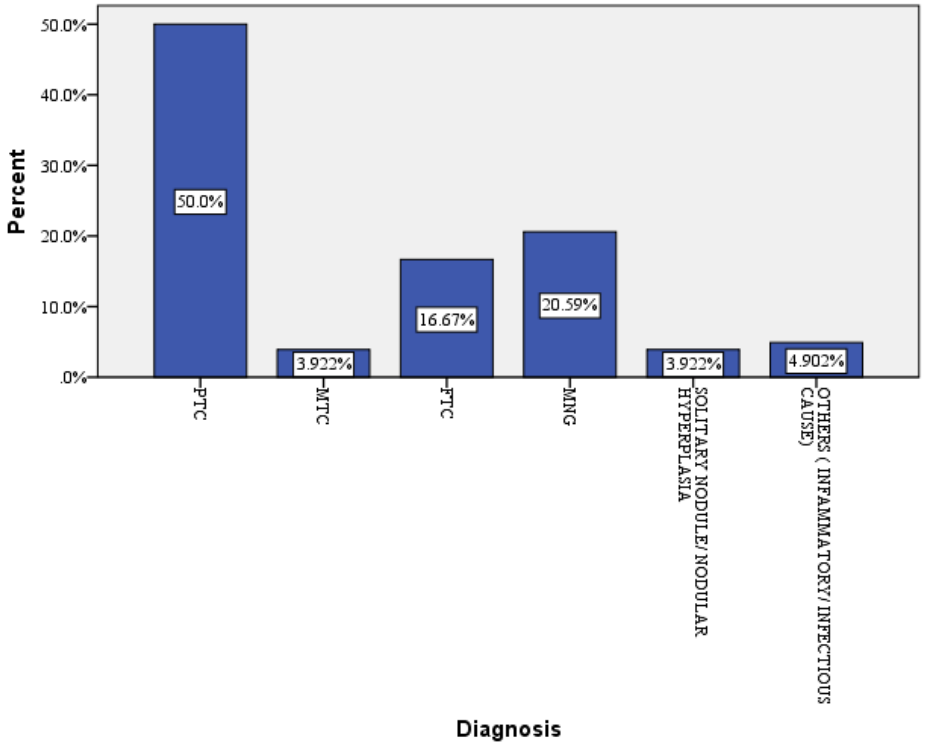


Figure 11: Bar diagram showing Diagnosis among subjects

Table 5: Type of Thyroidectomy distribution

		Count	%
Type of Thyroidectomy	Total Thyroidectomy	84	82.4%
	Hemi Thyroidectomy	18	17.6%

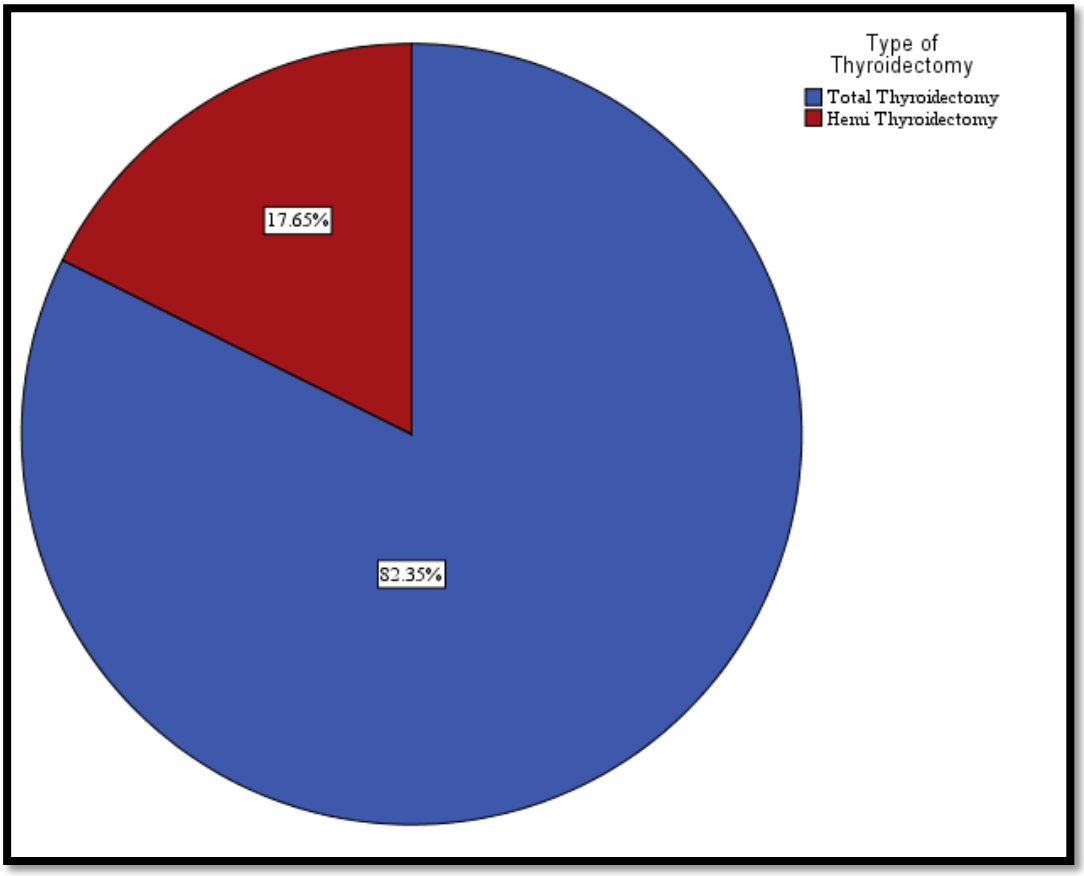


Figure 12: Pie diagram showing Type of Thyroidectomy distribution

Table 6: PTG Visualized

		Count	%
PTG Visualized	≤2	30	29.4%
	>2	72	70.6%

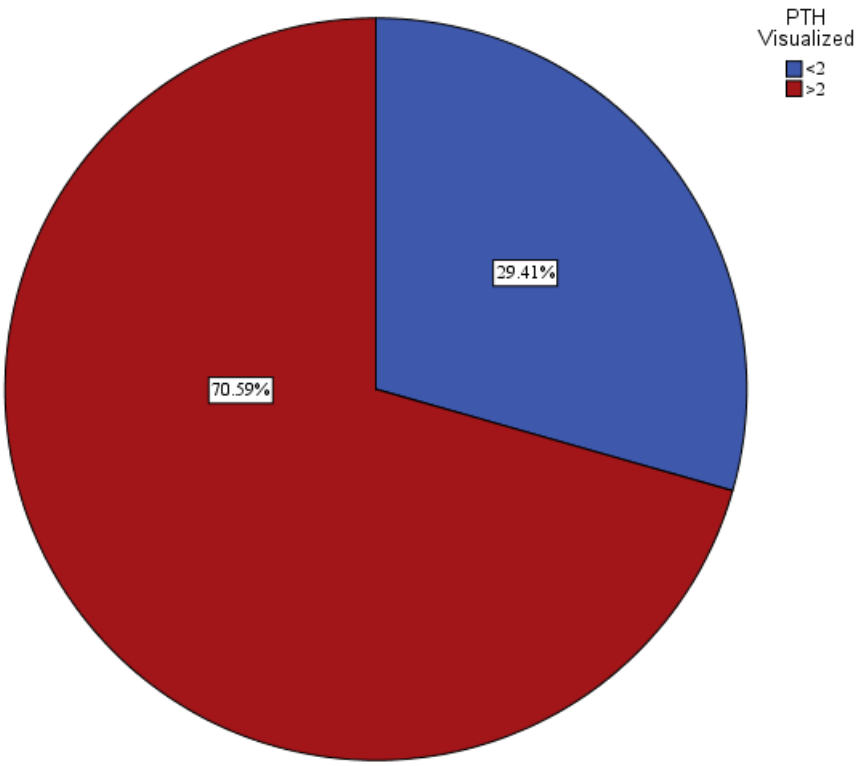


Figure 13: Pie diagram showing PTG Visualized

Table 7: PTG Saved

		Count	%
PTG Saved	>2	68	66.7%
	≤2	34	33.3%

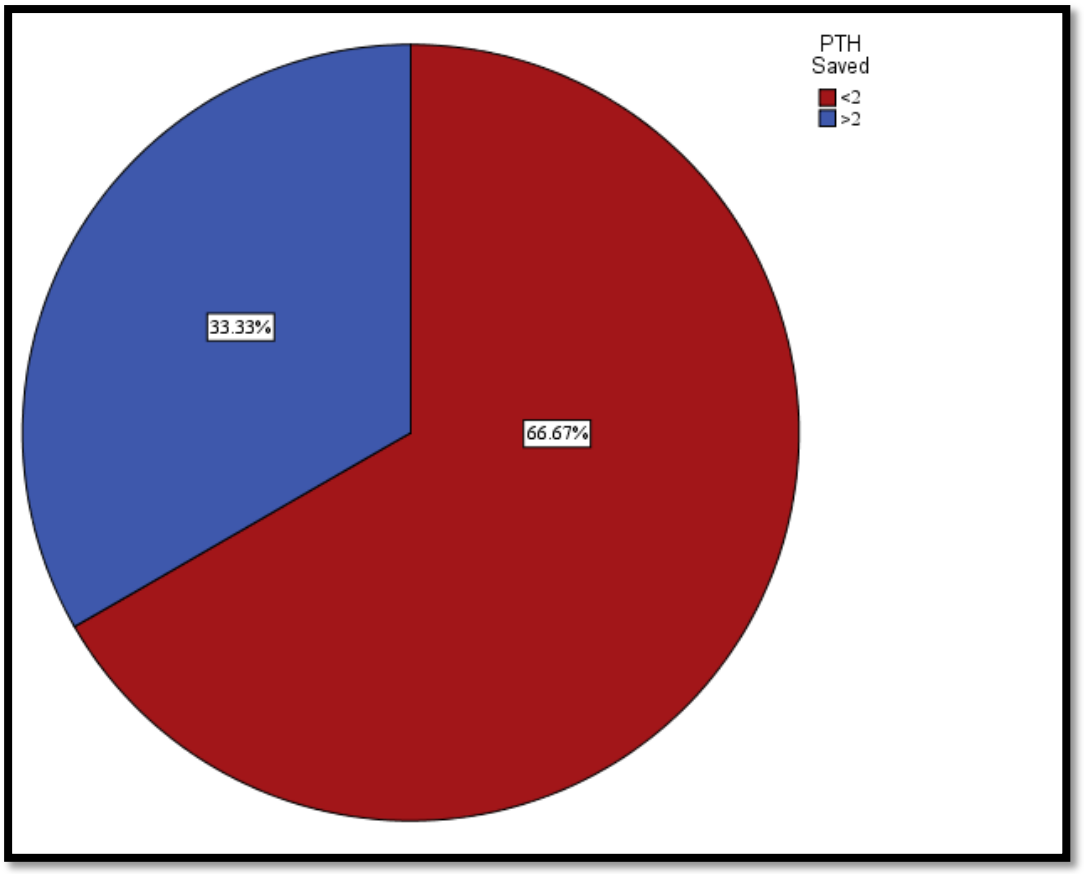


Figure 14: Pie diagram showing PTG Saved

Table 8: Association between PTG visualized and PTG Saved

		PTH Visualized			
		≤2		>2	
		Count	%	Count	%
PTH Saved	≤2	30	100.0%	38	52.8%
	>2	0	0.0%	34	47.2%

χ 2 =21/25, df =1, p <0.001*

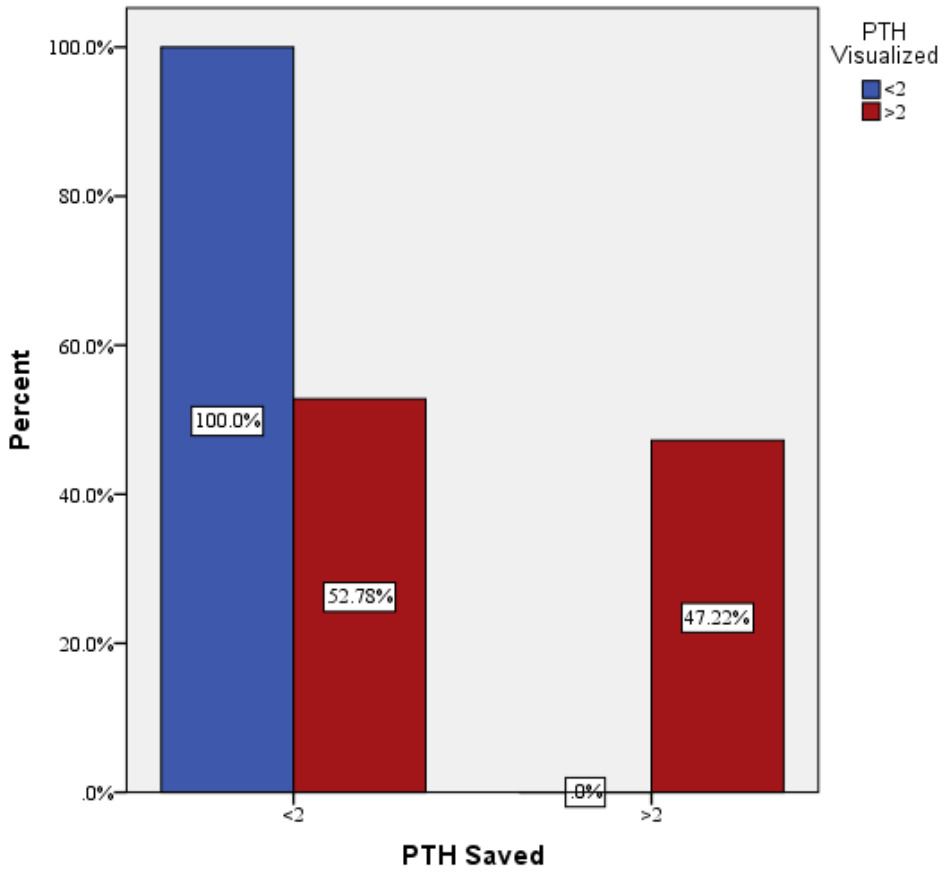


Figure 15: Bar diagram showing Association between PTG visualized and PTG Saved

Table 9: RLN Saved distribution

		Count	%
RLN Saved	Saved	102	100.0%

Table 10: Size of TZN distribution

		Count	%
Size	Grade 1	78	76.5%
	Grade 2	20	19.6%
	Grade 3	4	3.9%

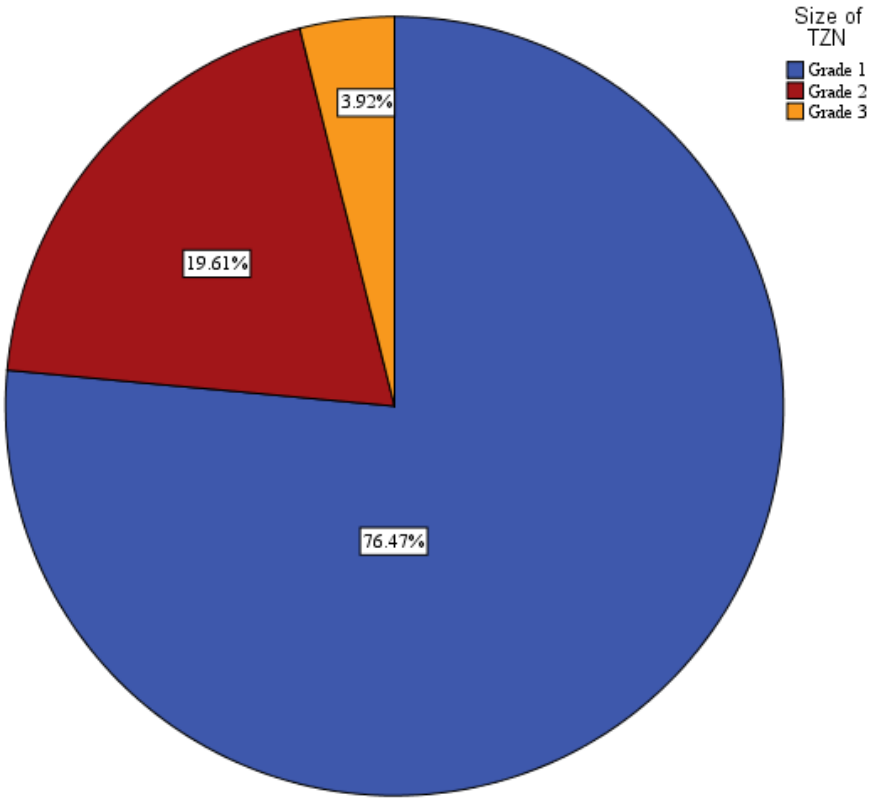


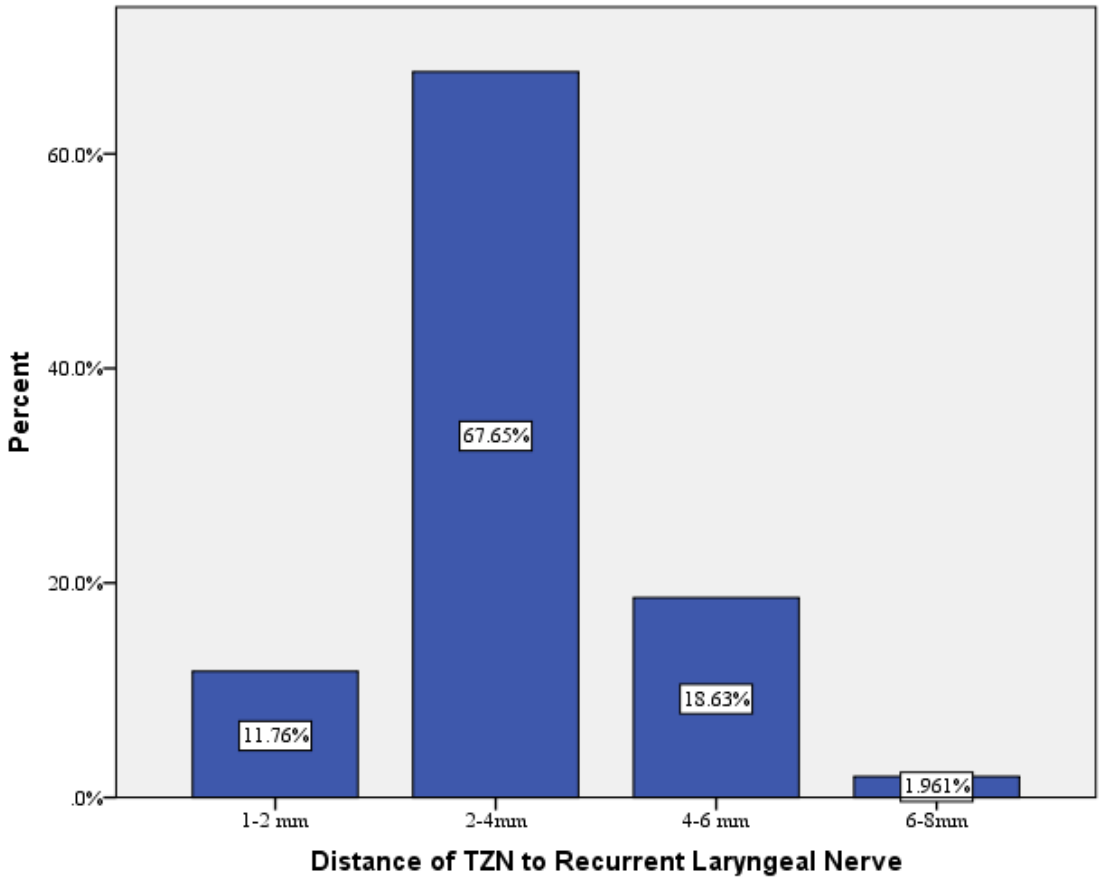
Table 11: Shape TZN distribution

		Count	%
Shape TZN	Pyramidal	102	100.0%

Table 12: Distance of TZN to Recurrent Laryngeal Nerve distribution

		Count	%
Distance FROM TIP OF TZN to RLN	1-2 mm	12	11.8%
	2-4mm	69	67.6%
	4-6 mm	19	18.6%
	6-8mm	2	2.0%

Figure 17: Bar diagram showing Distance of TZN to Recurrent Laryngeal Nerve distribution



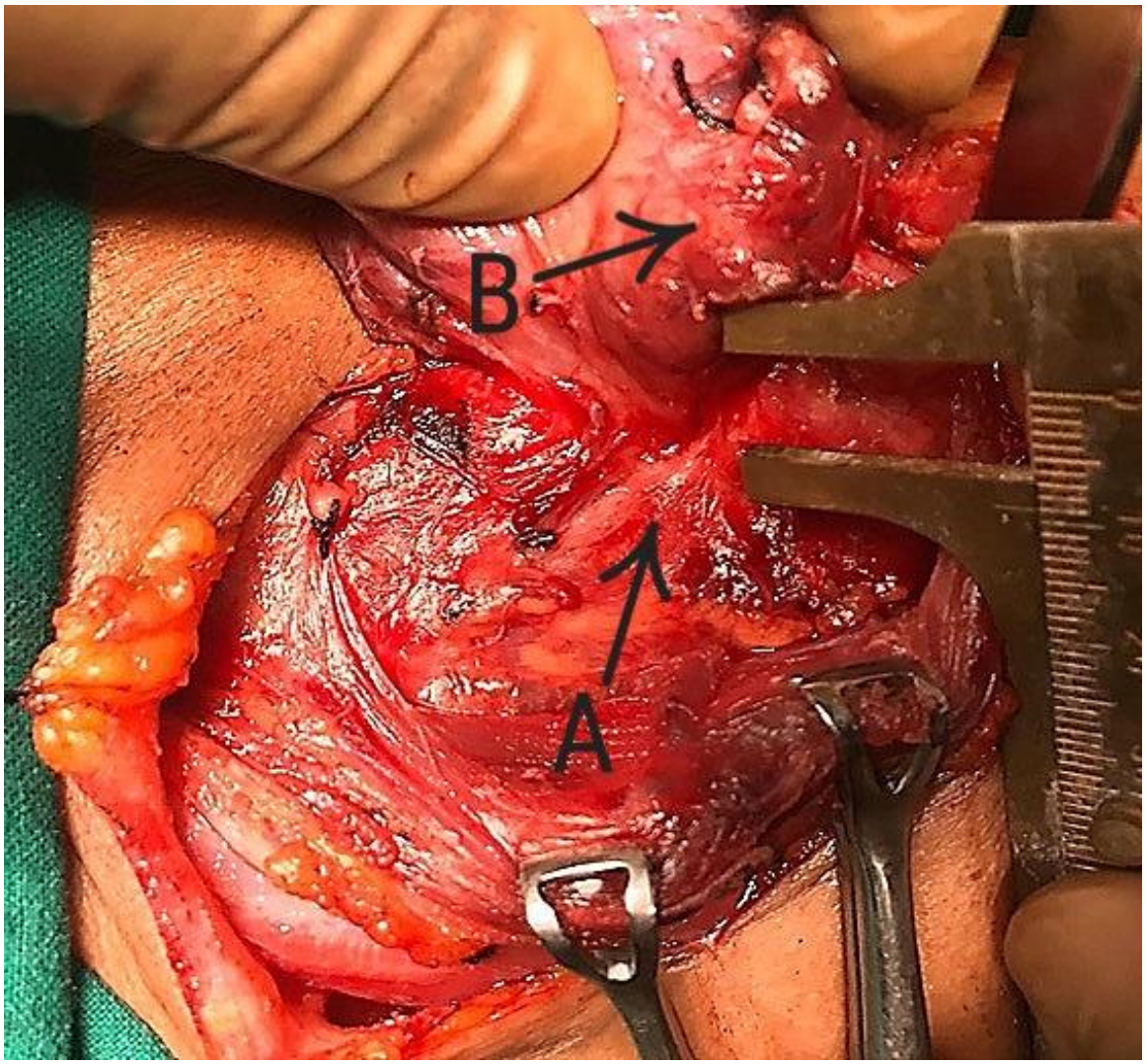


FIG: 18 MEASURING DISTANCE BETWEEN (A) RECURRENT LARYNGEAL NERVE AND (B) TUBERCLE OF ZUCKERKANDL

Table 14: Relation of TZN to Recurrent Laryngeal Nerve distribution

		Count	%
Relation of TZN to Recurrent Laryngeal Nerve	Anterior	7	6.9%
	Medial	95	93.1%

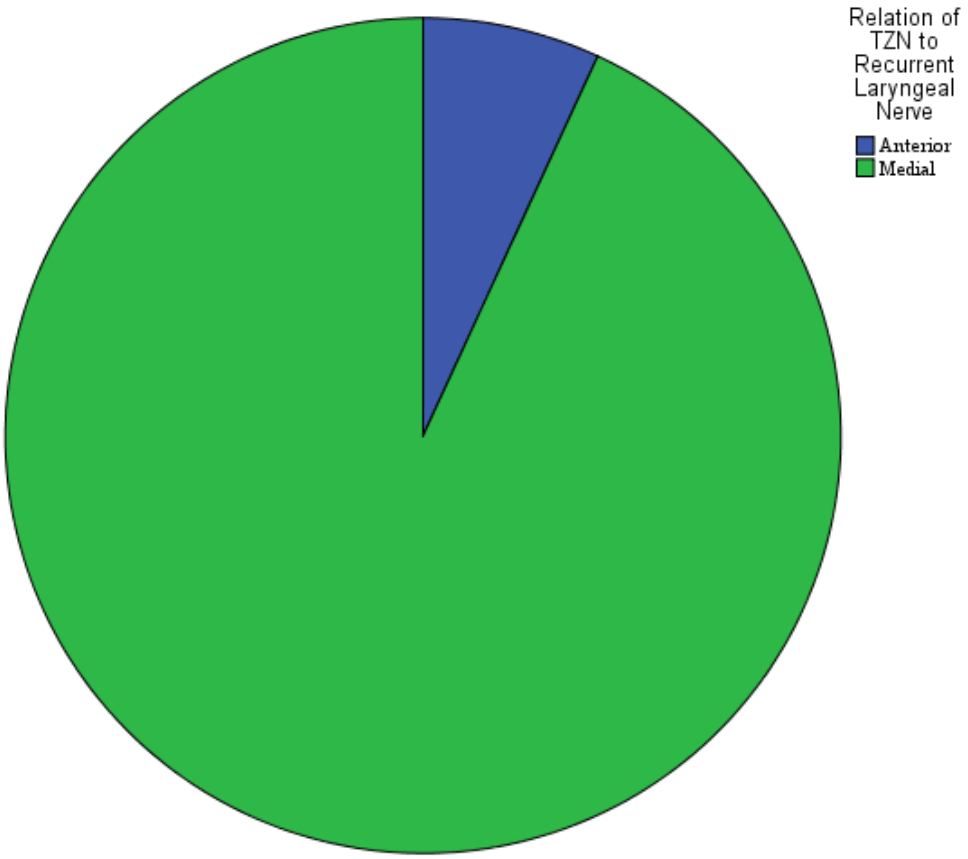


Figure 19: Pie diagram showing Relation of TZN to Recurrent Laryngeal Nerve distribution

Table 15: Distance of TZN to SUPERIOR PTG distribution

		Count	%
Distance of TZN to SUPERIOR PTG	1-2mm	8	7.8%
	2-4mm	67	65.7%
	4-6mm	27	26.5%
	6-8mm	0	0.0%

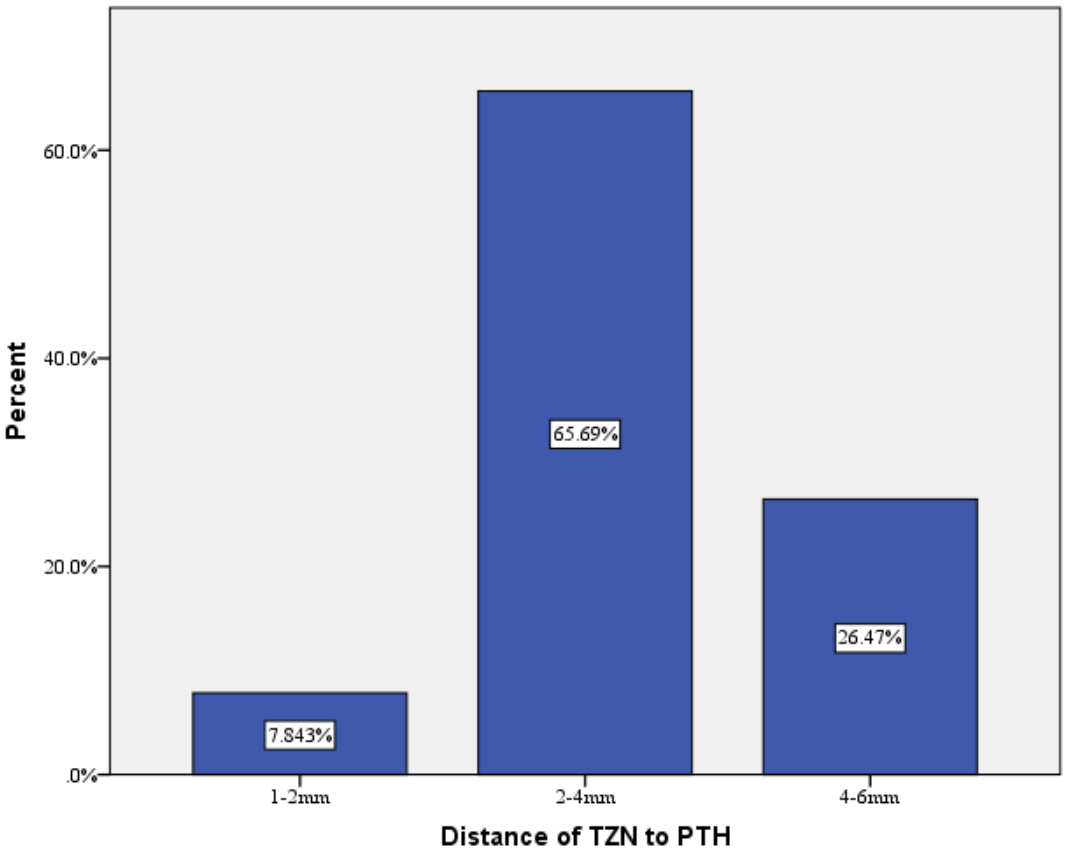


Figure 20: Bar diagram showing Distance of TZN to PTG distribution

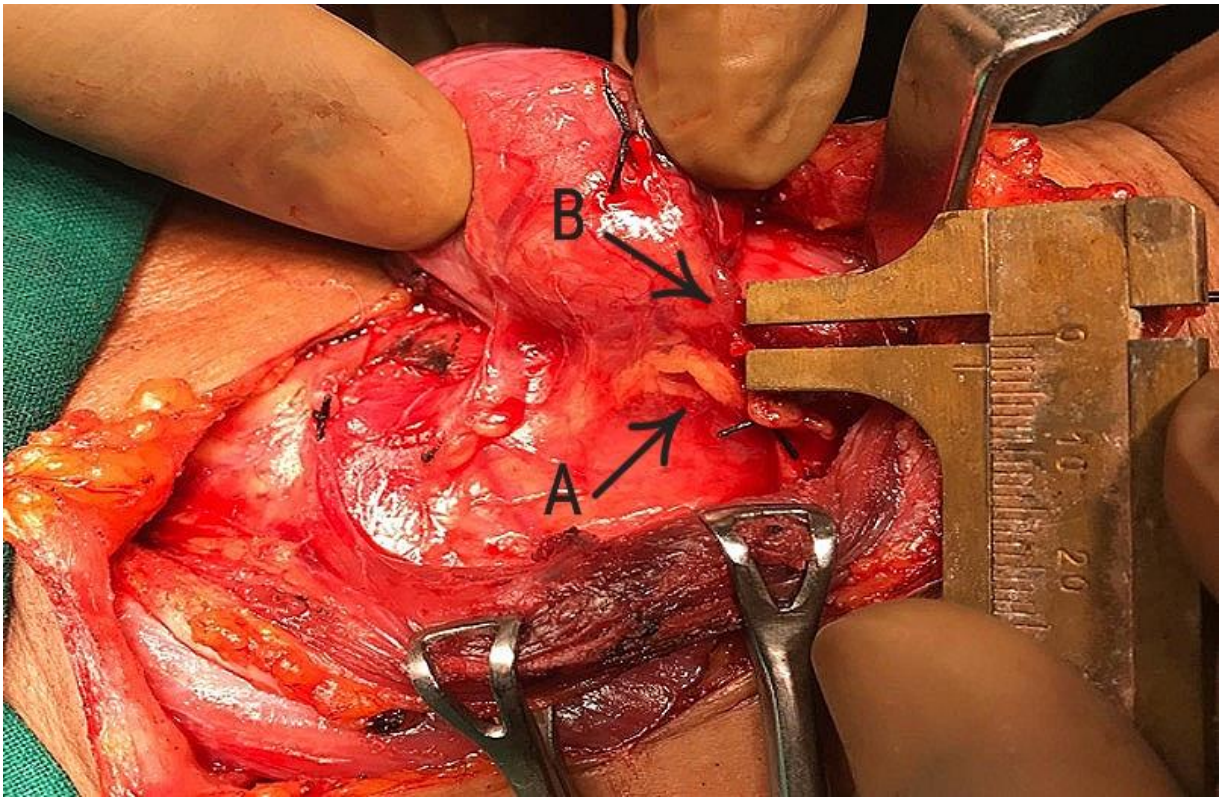


FIG:21 MEASURING THE DISTANCE BETWEEN (A) SUPERIOR PARATHYROID GLAND AND (B) TUBERCLE OF ZUCKERKANDL

Table 16: Time Taken to dissect distribution

		Count	%
Time Taken to dissect	1 to 5 min	2	2.0%
	5 to 8 min	1	1.0%
	8 to 10 min	52	51.0%
	10 to 15 min	36	35.3%
	15 to 20 min	11	10.8%

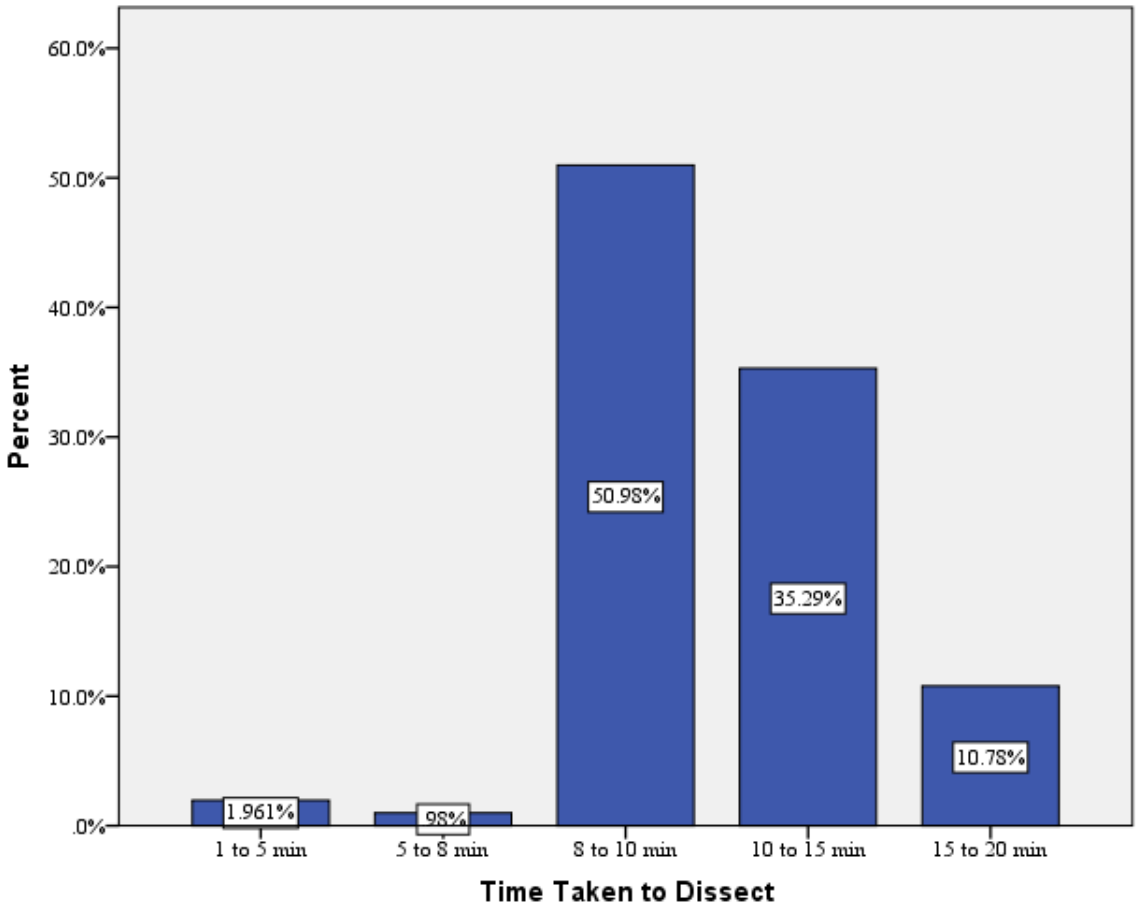


Figure 22: Bar diagram showing Time Taken to dissect distribution

Table 17: Association between Distance of TZN to Recurrent Laryngeal Nerve with respect to Size of TZN

		Size					
		Grade 1		Grade 2		Grade 3	
		Count	%	Count	%	Count	%
Distance of TZN to RN	1-2 mm	9	11.5%	3	15.0%	0	0.0%
	2-4mm	54	69.2%	12	60.0%	3	75.0%
	4-6 mm	13	16.7%	5	25.0%	1	25.0%
	6-8mm	2	2.6%	0	0.0%	0	0.0%

$\chi 2 = 2.185$, df =6, p = 0.902

In the study there was no significant association between Size of TZN and distance to RN.

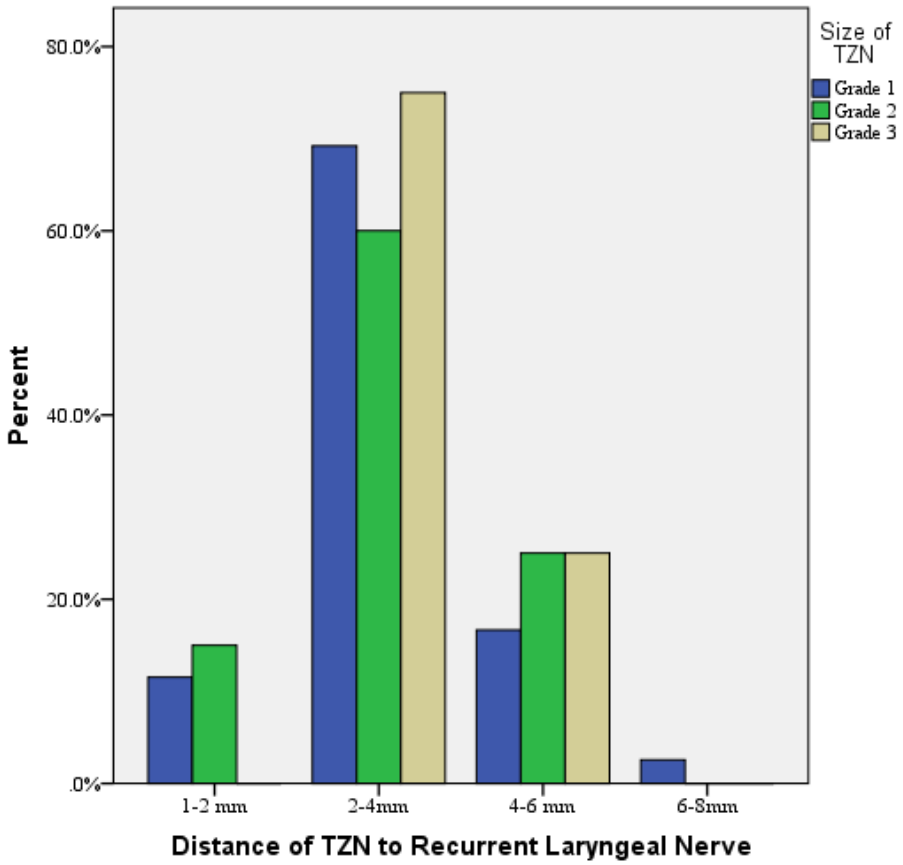


Figure 23: Bar diagram showing Association between Distance of TZN to Recurrent Laryngeal Nerve with respect to Size of TZN

Table 18: Association between Relation of TZN to Recurrent Laryngeal Nerve with respect to Size of TZN

		Size					
		Grade 1		Grade 2		Grade 3	
		Count	%	Count	%	Count	%
Relation of TZN to Recurrent Laryngeal Nerve	Anterior	7	9.0%	0	0.0%	0	0.0%
	Medial	71	91.0%	20	100.0%	4	100.0%

$\chi 2 = 2.313$, df =2, p = 0.315

In the study there was no significant association between Size of TZN and Relation of TZN to Recurrent Laryngeal Nerve.

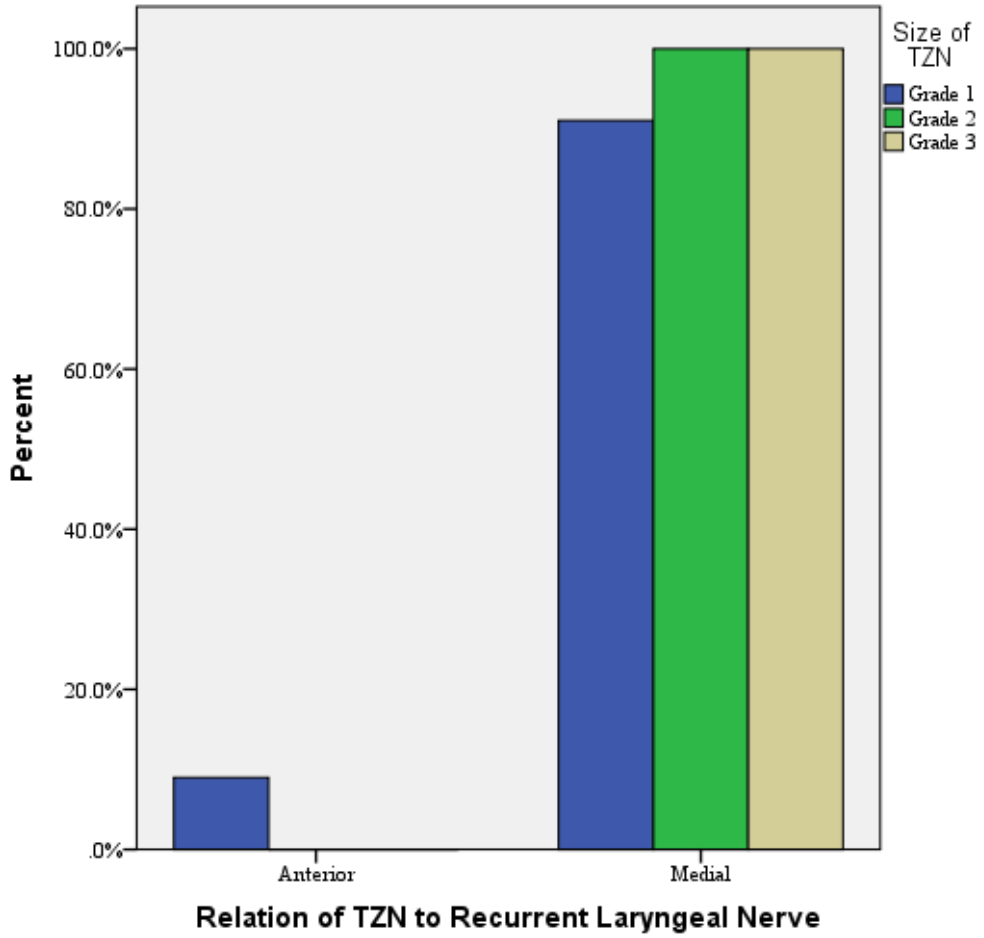


Figure 24: Bar diagram showing Association between Relation of TZN to Recurrent Laryngeal Nerve with respect to Size of TZN

Table 19: Association between Distance of TZN to PTG with respect to Size of TZN

		Size					
		Grade 1		Grade 2		Grade 3	
		Count	%	Count	%	Count	%
Distance of TZN to PTH	1-2mm	6	7.7%	2	10.0%	0	0.0%
	2-4mm	51	65.4%	12	60.0%	4	100.0%
	4-6mm	21	26.9%	6	30.0%	0	0.0%
	6-8mm	0	0.0%	0	0.0%	0	0.0%

$\chi 2 = 2.410$, df =4, p = 0.661

In the study there was no significant association between Size of TZN and Distance of TZN to PTG.

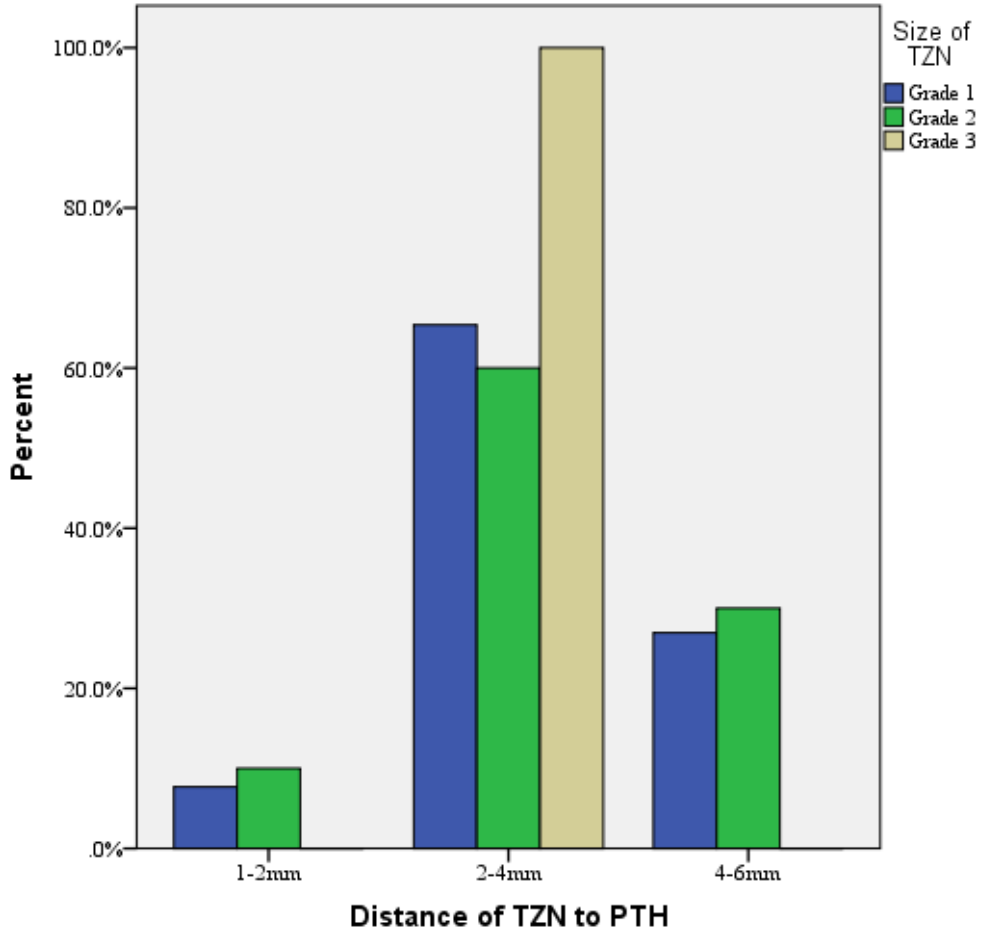


Figure 25: Bar diagram showing Association between Distance of TZN to PTG with respect to Size of TZN

Table 20: Association between Distance of TZN to PTG with respect to Size of TZN

		Size					
		Grade 1		Grade 2		Grade 3	
		Count	%	Count	%	Count	%
Time Taken to dissect	1 to 5 min	2	2.6%	0	0.0%	0	0.0%
	5 to 8 min	0	0.0%	1	5.0%	0	0.0%
	8 to 10 min	41	52.6%	11	55.0%	0	0.0%
	10 to 15 min	27	34.6%	5	25.0%	4	100.0%
	15 to 20 min	8	10.3%	3	15.0%	0	0.0%

$\chi 2 = 12.993$, df =8, p = 0.112

In the study there was no significant association between Size of TZN and Time Taken to dissect.

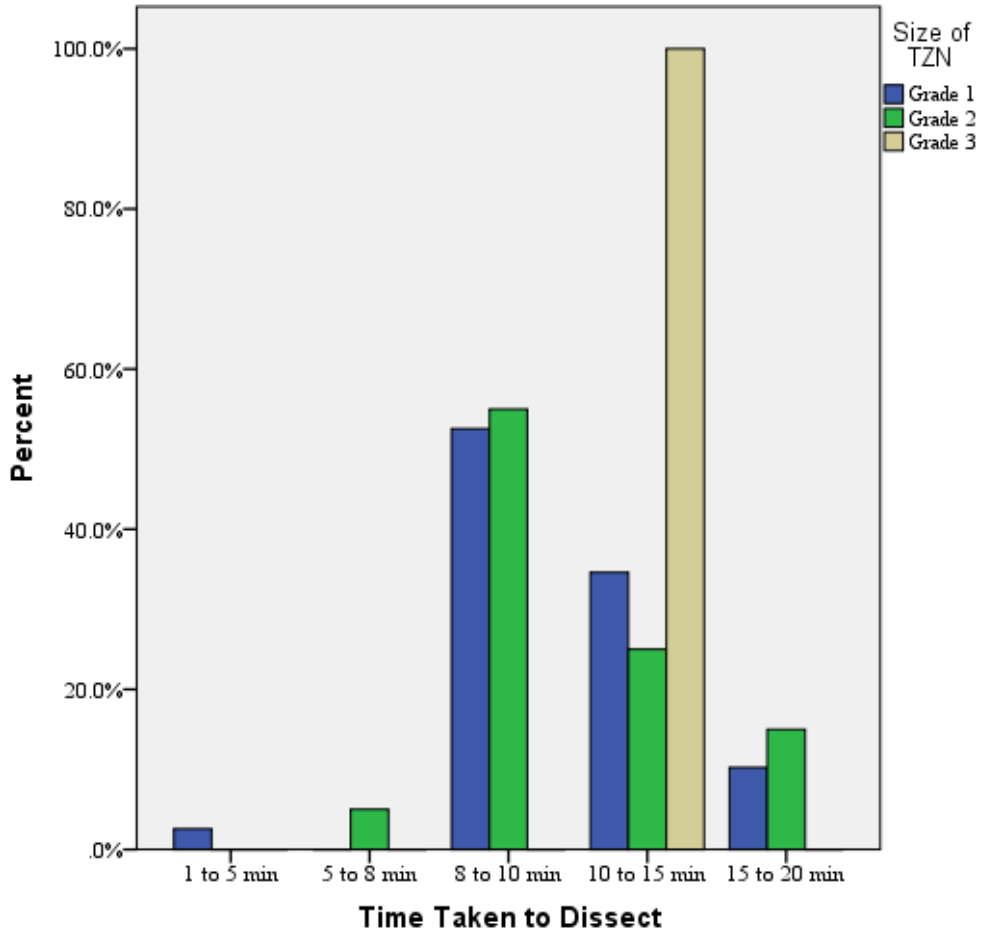


Figure 25: Bar diagram showing Association between Distance of TZN to PTG with respect to Size of TZN

DISCUSSION

DISCUSSION

The incidence of TZN reported in literature varies from 20.1 % to 95 %.[61-64] In our study TZN was identified in all of the cases (100%). There is vast heterogeneity in the incidence which probably can be explained on the basis of geographical, genetic or ethnic factors. However our study shows that it is a constant landmark and if meticulously sought would be seen in majority of patients which can be used to identify RLN. Most investigators have detected the ZT more frequently in the right thyroid lobe.[7,16,17,19,20] In the present study, the ZT was identified in 100% of the specimens, which is consistent with the incidence range reported by most authors. However in few cases of goiter the TZN can be grossly enlarged and can also harbour malignancy in thyroid malignancies.

Grade I and II together constituted about 96.1% of all TZN in our study. In 1998, Pelizzo et al.[65] reported the presence of TZN in 104 Italian patients during thyroid lobectomy and found grade 0 in 24 (23 %), grade I in 9 (8.6 %), grade II in 56 (53.8 %), and grade III in 15 (14.4 %) specimens. Most of the studies have documented grade I and grade II TZN with highest occurrence with an incidence ranging from 18 to 90 % . In previous studies majority of the tubercles are less than 1 cm in size. Therefore an active effort has to be made to identify it while performing the dissection failing which it is likely to be missed. Our results show that Grade III was identified in only 4 % cases. The incidence of grade III was as high as 55 % as reported by Hisham et al.[66] In all probability the reason for low incidence of grade III in our study could be most of our patients were benign thyroid nodules. Grade III probably is more commonly seen in enlarged thyroid glands in case of malignancies or in case of multinodular goiter or ectopic thyroid rests mimicking the TZN.

TZN is like an arrow pointing towards the RLN. Similar description is provided by Pelizzo in literature.[5] If mobilized medially TZN allows easy identification of the nerve before it turns below the inferior cricothyroid joint. In our study TZN in all cases was pyramidal in shape and was like a blunt arrow pointing towards RLN. Various other shapes like bilobed, bifid or rectangular have also been described by other authors which was present in about 5 % of cases.[68,69] The occurrence of these shapes could be mainly due to nodular changes in TZN in setting of multinodular goiter.

In our study, all RLN ran anterior and medial to the TZN. The tubercle of Zuckerkandl was lying anterior to Recurrent laryngeal nerve in 7 cases (6.9%). The tubercle was lying medial to Recurrent laryngeal nerve in 95 cases accounting to 93.1%.

Gauger et al. reported that in 93 % of patients, the nerve was located medially to TZN, while in 7 % cases the RLN passed laterally. In another study by Yun et al. the Recurrent laryngeal nerve was posterior to TZN in 90 % of cases and only in 0.5 % of cases it was anterior to the surface of TZN. The nerve was present lateral to TZN in less than 10 % of cases.[65] Gil-Carcedo E et al. found similar observation. Pradeep et al also reported that the nerve was medial to TZN in 98% of cases, which was similar to our study. Thus, the TZN is a useful guide to locate and protect the RLN as it enters at the region of cricothyroid muscular interval.

Using tubercle of Zuckerkandl as an anatomical landmark to dissect thyroid gland, none of the patients in our study had RLN damage.

The TZN is a very useful landmark for identification of the RLN, as it is nearly always lateral to the nerve, based on its embryological development. Thus, identification and careful elevation of the TZN allows for safe identification of the RLN in the vicinity of Berry's

ligament. In the past, it was the usual practice of most surgeons to identify the RLN low in the tracheooesophageal groove early during the course of thyroidectomy. This technique allowed for safe early identification of the RLN; however, it obliges the surgeon to extensively follow the RLN along its cervical course, which may increase the risk of compromising blood supply to the parathyroid glands. Identifying the RLN in Beahr's triangle or Simons triangle is a safe practice. However in malignant disease if lower part of thyroid gland is stuck to surrounding structures, TZN can be an alternate landmark to help identify the RLN. The nerve can be difficult to find in this location due to dense fascia in Ligament of Berry and may be confused with terminal branches of the inferior thyroid artery. In this scenario, we have found the TZN to be very useful in aiding RLN identification, as the nerve is nearly always just medial, and readily apparent once the TZN is freed and reflected medially.

The lateral lobe of the thyroid gland is retracted medially during thyroid surgery to reveal the TZN in the lateral aspect. Thus, the TZN might have been regarded as a lateral projection or a projection from the posterolateral border of the thyroid lobe for a long time. However, its shape and position can differ according to the extent of thyroid lobe retraction and in excised thyroid lobes because of the softness of the thyroid gland. No lateral projection could be seen in previous anatomic studies reporting morphologic variations of the anterior view of the thyroid gland involving 60 white, 105 Indian, and 168 Korean cadavers. Recently, Won et al proposed descriptive terms for more accurate portrayal of the anatomic location and orientation of the TZN. The lateral border of the thyroid gland was defined as the most lateral margin of the anterior aspect of the thyroid in the anatomic position. The posteromedial border was defined as the margin that exhibits the greatest projection toward the trachea or esophagus. In our study also, the TZN was not observed in the anterior view of the thyroid

gland and was located at the posteromedial border of the thyroid lobe or posterior surface near the posteromedial border of the thyroid lobe.

The shape of the TZN was previously described as sessile (56.4%) or pedunculated (23.1%) in 195 dissected thyroid lobes gained from 107 thyroidectomies,[5] and the nodular-shaped TZN having a narrow neck or stalk from the posterior border of the thyroid lobe was reported as the most common, occurring in more than one-third of the 96 patients. In our study all the lobes were found to be pyramidal in shape (100%).

In our study two or more Parathyroid glands were identified and saved in 68 cases (66.7%) and <2 parathyroid glands could be saved in 34 cases (33.3%). TZN can also be confused with a parathyroid adenoma, especially in patients with primary hyperparathyroidism. In a previous report reviewing primary hyperparathyroidism, there were some cases in which the findings of a diagnostic imaging study such as C-11 methionine PET/CT were positive but the surgeon could not locate the adenoma during the operation. We believe that some of these cases might have resulted from confusion of the TZN with parathyroid adenomas. Theoretically, TZN has been described as the anatomic structure that separates the parathyroid glands into the superior and inferior parathyroid.[5] Additionally, a previous report showed that the abnormal inferior parathyroid glands were more common than the abnormal superior glands in 810 parathyroidectomies reviewed. These anatomic characteristics and statistical results should be considered when examining for parathyroid adenoma in patients with primary hyperparathyroidism.

In our study, the superior parathyroid gland was situated from tubercle of zuckerkandl at a distance of 2-4mm in 67 cases (65.7%). The superior parathyroid gland was situated 4-6mm from TZN in 27 cases (26.5%). Gil Carcedo highlighted the importance of the Zuckerkandl tubercle, as it has proven to be a reliable point of reference to locate the superior parathyroid,

the inferior thyroid artery and the RLN.[72] In total, 195 thyroid lobes which he analyzed the Zuckerkandl tubercle was certainly detected in 155 thyroid lobes (79.48%).

In our study, Grade 1 TZN was seen in 78 cases accounting to 76.5%, Grade 2 was seen in 20 cases (19.6%) and Grade 3 was seen in 4 cases (3.9%) based on Pizello's grading of TZN. Yun and Lee studied the distribution of TZNs according to grade as follows: Grade 0, right 10.7% and left 14.4%; Grade I, right 7.9% and left 11.1%; Grade II, right 43.5% and left 38.5%; and Grade III, right 37.9% and left 35.9%. Yun studied the distribution of TZN according to grade as: grade 0, right 10.7% and left 14.7%; Grade I, right 7.9% and left 11.1%; Grade II, right 43.5 and left 38.5%; and Grade III, right 37.9% and left 35.9% Gravante et al. used only recognizable tubercles (grades 2 and 3) to investigate the relationship. It is classified into three grades according to size: I < 0.5 cm, II 0.5–1 cm, III > 1 cm.

Recognition and removal of the TZN 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. Depending on the size of the tubercle, this may result in a variable remnant of thyroid tissue on each side being left in situ. This remnant thyroid tissue may be a source of persistent radioiodine uptake on radioactive iodine scans, or even of recurrent thyroid mass in cases of multinodular goiter, as is seen after subtotal thyroidectomy.[7,8] To avoid this, it is important to look for the TZN, and ensure that the entirety of this is removed with the specimen.

The findings of our studies are consistent with those of other authors: Pelizzo et al. reported the TZN to be present in 78% of right thyroid lobes and 75% of left thyroid lobes. These

authors considered a TZN to be present even when only a thickening of the thyroid lobe was found; however, 68% of lobes had grade 2 or grade 3 TZs. Hisham et al. reported the recurrent laryngeal nerve to be associated with an enlarged TZN's1 in 74% of cases. On the other hand, Page et al. identified the TZ in only 7% of cases. When present, the tubercle always overlay the recurrent laryngeal nerve. The blood loss during the separation of the tubercle from its underlying structures were estimated in our study and was found out to be minimal and not significant.

In our study, we calculated the time taken for dissecting the TZN from its underlying structures. We found out that more than 50% of our cases took an average time between 8 to 10 minutes. The remaining 36% cases took more than 10 minutes. However, none of our cases took more than 20 minutes for dissection of the Tubercle of Zuckerkandl in its entirety from the structures underlying it.

SUMMARY

SUMMARY

Thyroid surgeries are a commonly performed surgery worldwide and preservation of Recurrent laryngeal nerve and parathyroid glands is an important as well as delicate part of the surgery. Tubercle of Zuckerkandl is a small posterior extension of thyroid gland near the ligament of Berry.

Zuckerkandl's tubercle, is an anatomical landmark by which the surrounding important structures such as the recurrent laryngeal nerve can be identified during the surgery.

Various studies have been carried out till date to find the relationship between tubercle of Zuckerkandl and Recurrent laryngeal nerve. However, the relation between TZN and Superior parathyroid gland has not been documented much, and there is paucity of literature about it.

In our study the size and shape of the tubercle of Zuckerkandl were analysed and the distance between tip of tubercle of Zuckerkandl and recurrent laryngeal nerve were measured in millimeters and documented.

It was also documented whether the tubercle of Zuckerkandl was overlying the recurrent laryngeal nerve or not. The distance between tip of Zuckerkandl tubercle with superior parathyroid gland was also measured. The time taken for dissection of the TZN from its underlying structures were documented along with the blood loss at this region during dissection of the tubercle from its underlying structures.

The TZN is a consistently useful guide in locating as well as subsequently protecting the recurrent laryngeal nerve as it enters the cricothyroid muscle.

The TZN was identified in all cases (p value 0.01) (100%) in our study. The TZN was seen to point towards the recurrent laryngeal nerve in ligamentum berry and the nerve was found

anteromedial to the TZN in 93.1% of studied cases. The average time taken for dissection in this area was 8 to 10 minutes and blood loss in this region is was not significant.

Therefore, knowledge of the TZN-RLN relationship can be of valuable use in RLN identification for prevention of iatrogenic nerve injury and is a cheap and reliable landmark.

CONCLUSION

CONCLUSION

- Tubercle of Zuckerkandl is a consistent and reliable structure which is identified in majority of cases. The TZN is a useful guide when it comes to identification of RLN. Surgeons should be well aware about the incidence, shape, grade and its relation to RLN when it comes to thyroidectomies. Thus, it is a very useful landmark in thyroid surgery for saving the Recurrent laryngeal Nerve. This is an alternative landmark to locate RLN in cases where large volume or adherent disease is present over more commonly used landmarks – Beahr's triangle / Simon's triangle.

- Excision of the tubercle requires fine and meticulous dissection with utmost care because of its close relationship between TZN and RLN.

- The TZN was seen to point towards the entry of recurrent laryngeal nerve and the nerve was found anteromedial to the TZN in majority of studied cases.

- The average distance from TZN to RLN was measured to be 2-4mm on an average and the distance from TZN to Superior Parathyroid gland was found to be on an average 4-6mm.

- The RLN could be uncommonly located on anterior surface of the tubercle. The unusual lateral or anterior course increases the risk of injury to the nerve. During resection of the tubercle, the recurrent laryngeal nerve can be dissected and protected by continuing the capsular dissection technique.

- The TZN was identifiable in significant percentage (p value 0.01) (100%) of the studied cases.

- This study was aimed to emphasise the importance of Zuckerkandl tubercle as an important landmark to trace recurrent laryngeal nerve in thyroid surgeries.
- This study also traced the importance of relation of Zuckerkandl tubercle as a landmark to trace superior parathyroid gland in thyroid surgeries.

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ANNEXURE

ANNEXURES

PROFORMA

Particulars of the patients

Name

Age

Gender

Occupation

Date of admission

Date of surgery

Date of discharge

Complaints

PREVIOUS HISTORY

Any thyroid surgery in past
Thyroid medications / drugs

PERSONAL HISTORY

Diet
Appetite
Smoking
Alcohol
Bowel habits
Sleep

GENERAL PHYSICAL EXAMINATION

Appearance
Attitude
Build and Nourishment
Level of consciousness
Temperature
Pulse
Blood pressure
EXAMINATION of THYROID GLAND

Inspection :

Palpation :

SYSTEMIC EXAMINATION

CVS:
CN:S
RS:
ABDOMEN:

INVESTIGATIONS –

USG scan –

FNAC –

SURGERY PERFORMED :

Type of Thyroidectomy –

Parathyroids visualized -

Parathyroids saved –

Recurrent laryngeal nerve saved –

SIZE AND SHAPE OF TZ:

SIZE: Grade 0 / Grade 1 / Grade 2 / Grade 3

SHAPE:

RELATION TO RLN: Anterior / Posterior / Medial / Lateral / Superior / Inferior

DISTANCE FROM RECURRENT LARYNGEAL NERVE:

DISTANCE FROM SUPERIOR PARATHYROID GLAND:

OUTCOME:

CHANGE IN VOICE:

RADIO IODINE SCAN UPTAKE:

Condition of the patient on discharge: -

DATE OF LAST FOLLOW UP:

STATUS OF LAST FOLLOW UP:

PATIENT INFORMATION SHEET

STUDY TITLE: "EVALUATION OF TUBERCLE OF ZUCKERKANDL AS A LANDMARK FOR RECURRENT LARYNGEAL NERVE AND SUPERIOR PARATHYROID GLAND AND ITS IMPLICATIONS ON COMPLETE REMOVAL OF THYROID"

STUDY SITE: R.L Jalappa Hospital and Research Centre, Tamaka, Kolar.

This is to inform you that, you require Total thyroidectomy / Hemithyroidectomy (complete removal of thyroid gland) for the treatment of your condition. One of the complications encountered during the surgery is the damage to the Recurrent laryngeal Nerve, which can lead to loss of voice in your future.

However identifying the Tubercle Of Zuckerkandl(which is a structure situated behind the thyroid gland) will reduce the risk of injury to the Recurrent laryngeal nerve(which is the nerve which allows you to speak).

We are conducting this study to learn the impact of size and relation of Tubercle of Zuckerkandl to Recurrent laryngeal nerve and Parathyroid glands during thyroid surgeries.

If you are willing you will be enrolled in this study and we will document the relation of the tubercle of Zuckerkandl and the recurrent laryngeal nerve, by taking intraoperative measurements and photographs.

You will receive the standard care for total thyroidectomy and you will be monitored for any complications.

This will facilitate identifying any impact on thyroid surgeries (if any) if there is a relationship

between the Tubercle of Zuckerkandl and Recurrent laryngeal nerve. It will also benefit other patients undergoing total thyroidectomy or Hemi thyroidectomy in future. You are free to opt-out of the study at any time if you are not satisfied or apprehensive to be a part of the study. Your treatment and care will not be compromised if you refuse to be a part of the study. The study will not add any risk or financial burden to you if you are part of the study.

vv

Your identity and clinical details will be confidential. You will not receive any financial benefit for being part of the study. You are free to contact DR IRFAN AHMED NIWAS or any other member of the above research team for any doubt or clarification you have.

Dr. IRFAN AHMED NIWAS

Mobile no: 97 465 456 07

E-mail id: irfan.niwas@yahoo.com

INFORMED CONSENT FORM

I Mr./Mrs. _____ have been explained in my own understandable language, that I will be included in a study which is **"EVALUATION OF TUBERCLE OF ZUCKERKANDL AS A LANDMARK FOR RECURRENT LARYNGEAL NERVE AND SUPERIOR PARATHYROID GLAND AND ITS IMPLICATIONS ON COMPLETE REMOVAL OF THYROID**"

I have been explained that my clinical findings, investigations, intraoperative findings, post-operative course, will be assessed and documented for study purpose.

I have been explained my participation in this study is entirely voluntary, and I can withdraw from the study any time and this will not affect my relation with my doctor or the treatment for my ailment.

I have been explained about the follow up details and possible benefits and adversities due to interventions, in my own understandable language.

I have understood that all my details found during the study are kept confidential and while publishing or sharing of the findings, my details will be masked.

I have principal investigator mobile number for enquiries.

I in my sound mind give full consent to be added in the part of this study.

Signature of the patient:

Name:

Signature of the witness:

Name:

Relation to patient:

Date:

Place:

MASTER CHART

S.NO	AGE	GENDER	DIAGNOSIS	TYPE OF THYROIDECTOMY	PTH VISUALIZED	PTH SAVED	RLN SAVED	SIZE TZN	SHAPE TZN	DISTANCE TZN RN	RELTN TZN RLN	DISTANCE TZN PTH	TIME TAKEN
1	46	2	1	1	2	2	2	1	1	2	2	2	3
2	40	1	1	1	2	2	2	1	1	3	2	2	4
3	64	2	1	1	2	2	2	2	1	3	2	2	4
4	21	2	1	1	2	2	2	1	1	2	2	2	3
5	54	1	1	1	2	2	2	1	1	2	2	2	3
6	54	2	3	1	2	2	2	2	1	2	2	3	3
7	42	2	1	1	2	1	2	2	1	2	2	2	3
8	45	1	2	2	2	1	2	2	1	3	2	2	3
9	44	2	1	1	2	2	2	1	1	3	2	2	4
10	56	2	3	1	2	2	2	1	1	3	1	2	4
11	41	2	1	1	2	2	2	1	1	2	2	3	4
12	38	2	3	2	1	1	2	1	1	1	1	1	4
13	51	2	1	2	1	1	2	1	1	2	2	1	4
14	30	2	3	1	2	1	2	2	1	2	2	2	4
15	64	2	3	1	2	1	2	2	1	2	2	3	4
16	51	2	4	1	2	1	2	3	1	3	2	2	4
17	45	2	1	1	2	1	2	1	1	3	2	2	5
18	42	2	4	1	1	1	2	1	1	1	2	1	5
19	26	2	4	1	1	1	1	1	1	1	2	1	3
20	36	2	1	1	2	1	2	1	1	3	2	2	3
21	32	2	1	1	2	1	2	1	1	3	2	2	3
22	48	2	4	1	1	1	2	2	1	1	2	1	3
23	53	2	1	1	2	2	2	1	1	2	2	2	3
24	47	2	1	1	1	1	1	1	1	3	2	3	3
25	58	2	4	1	2	2	2	2	1	2	2	2	3
26	32	2	1	2	1	1	2	1	1	2	2	3	3
27	30	2	1	2	1	1	2	1	1	2	2	3	3
28	56	2	1	1	2	1	2	1	1	2	1	2	4
29	48	1	1	1	2	2	2	1	1	2	2	2	4
30	51	2	1	1	1	1	2	1	1	2	2	3	5
31	47	1	5	1	2	1	2	2	1	2	2	2	5
32	43	2	4	1	2	2	2	2	1	2	2	2	5
33	50	1	4	1	2	2	2	2	1	2	2	2	5
34	51	2	3	1	2	2	2	1	1	2	2	2	5
35	42	2	1	1	2	1	2	1	1	2	2	2	5
36	45	1	2	2	2	1	2	1	1	2	2	2	3
37	44	2	1	1	2	1	2	1	1	2	2	2	3
38	56	2	1	1	2	1	2	1	1	2	2	2	3
39	41	2	6	1	2	2	2	6	1	2	2	2	3

S.NO	AGE	GENDER	DIAGNOSIS	TYPE OF THYROIDECTOMY	PTH VISUALIZED	PTH SAVED	RLN SAVED	SIZE TZN	SHAPE TZN	DISTANCE TZN RN	RELTN TZN RLN	DISTANCE TZN PTH	TIME TAKEN
40	38	2	6	2	1	1	2	6	1	2	2	3	3
41	51	2	6	2	1	1	2	6	1	2	2	3	3
42	30	2	3	1	2	1	2	3	1	2	2	2	4
43	64	2	3	1	2	1	2	3	1	2	2	2	4
44	51	2	4	1	2	1	2	1	1	2	2	2	3
45	45	2	6	1	2	1	2	1	1	2	2	2	3
46	42	2	4	1	1	1	2	2	1	3	2	3	3
47	26	2	4	1	1	1	1	2	1	3	2	3	3
48	36	2	1	1	2	1	2	1	1	2	2	2	3
49	32	2	1	1	2	1	2	1	1	2	2	2	4
50	48	2	4	1	1	1	2	2	1	1	2	1	4
51	53	2	1	1	2	2	2	3	1	2	2	2	4
52	47	2	1	1	1	1	1	1	1	1	2	3	3
53	58	2	4	1	2	2	2	1	1	4	2	2	3
54	32	2	1	2	1	1	2	1	1	4	2	3	3
55	30	2	1	2	1	1	2	1	1	2	2	3	3
56	56	2	1	1	2	1	2	1	1	2	2	2	3
57	48	1	1	1	2	2	2	1	1	2	2	2	3
58	51	2	1	1	1	1	2	1	1	3	2	3	4
59	47	1	5	1	2	1	2	1	1	2	2	2	4
60	43	2	4	1	2	2	2	4	1	2	2	2	3
61	50	1	4	1	2	2	2	4	1	2	2	2	4
62	36	2	1	1	2	1	2	1	1	2	2	2	3
63	32	2	1	1	2	1	2	1	1	2	2	2	4
64	48	2	4	1	1	1	2	1	1	2	2	3	4
65	53	2	1	1	2	2	2	1	1	2	2	3	5
66	47	2	1	1	1	1	1	1	1	3	2	3	3
67	58	2	4	1	2	2	2	4	1	2	2	2	3
68	32	2	1	2	1	1	2	1	1	3	2	1	3
69	30	2	1	2	1	1	2	1	1	3	2	1	3
70	56	2	1	1	2	1	2	1	1	2	2	2	3
71	48	1	1	1	2	2	2	1	1	2	2	2	4
72	51	2	1	1	1	1	2	1	1	3	2	3	4
73	47	1	5	1	2	1	2	1	1	2	2	2	4
74	43	2	4	1	2	2	2	4	1	2	2	2	4
75	50	1	4	1	2	2	2	4	1	2	2	2	3
76	51	2	3	1	2	2	2	4	1	2	2	2	4
77	42	2	6	1	2	1	2	1	1	2	2	2	3
78	45	1	2	2	2	1	2	2	1	2	2	2	4

S.NO	AGE	GENDER	DIAGNOSIS	TYPE OF THYROIDECTOMY	PTH VISUALIZED	PTH SAVED	RLN SAVED	SIZE TZN	SHAPE TZN	DISTANCE TZN RN	RELTN TZN RLN	DISTANCE TZN PTH	TIME TAKEN
79	44	2	1	1	2	1	2	1	1	2	2	2	3
80	56	2	1	1	2	1	2	1	1	2	2	2	4
81	41	2	3	1	2	2	2	2	1	2	2	2	3
82	38	2	3	2	1	1	2	1	1	1	2	3	4
83	51	2	3	2	1	1	2	2	1	1	2	3	2
84	36	2	1	1	2	1	2	1	1	2	2	2	5
85	32	2	1	1	2	1	2	1	1	2	2	2	3
86	48	2	3	1	1	1	2	1	1	1	2	3	1
87	53	2	1	1	2	2	2	1	1	2	2	2	3
88	47	2	1	1	1	1	1	1	1	1	1	3	4
89	58	2	4	1	2	2	2	1	1	2	2	2	4
90	32	2	1	2	1	1	2	1	1	1	1	3	3
91	30	2	1	2	1	1	2	1	1	1	1	3	3
92	56	2	1	1	2	1	2	1	1	2	2	2	3
93	48	1	1	1	2	2	2	1	1	2	2	2	4
94	51	2	1	1	1	1	2	1	1	3	2	3	3
95	47	1	5	1	2	1	2	1	1	2	1	2	4
96	43	2	4	1	2	2	2	1	1	2	2	2	4
97	50	1	4	1	2	2	2	1	1	2	2	2	5
98	51	2	3	1	2	2	2	2	1	2	2	2	3
99	42	2	3	1	2	1	2	1	1	2	2	2	4
100	45	1	2	2	2	1	2	2	1	2	2	2	3
101	44	2	3	1	2	1	2	2	1	3	2	3	3
102	56	2	3	1	2	1	2	1	1	2	2	2	1

CODING

GENDER : MALE - 1 ; FEMALE - 2

NODULE/ NODULAR HYPERPLASIA - 5 ; OTHERS (INFAMMATORY/ INFECTIOUS CAUSE) - 6

' : TOTAL THYROIDECTOMY - 1 ; HEMI THYROIDECTOMY - 2

THYROIDS VISUALIZED : ≤ 2 - 1 ; > 2 - 2

S.NO	AGE	GENDER	DIAGNOSIS	TYPE OF THYROIDECTOMY	PTH VISUALIZED	PTH SAVED	RLN SAVED	SIZE TZN	SHAPE TZN	DISTANCE TZN RN	RELTN TZN RLN	DISTANCE TZN PTH	TIME TAKEN
ATHYROIDS SAVED : ≤2 - 1 ; > 2 - 2													
YNGEA NERVE SAVED : SAVED - 1 ; - 2T SAVED													
	SIZE TZN	ADE 1:1; GRADE 2:2; GRADE 3:3											
SHAPE TZN - PYRAMIDAL - 1													
DISTANCE OF TZN TO RLN													
	RELATION OF TZN TO RLN												
	DISTANCE OF TZN TO PTH												
minutes: 2; 8 to 10 minutes: 3; 10 to 15 minutes:4; 15 to 20 minutes: 5													