

2022-11-06

---

# Anatomical Variations of Recurrent Laryngeal Nerve and Outcome in Thyroid Surgeries Performed in Tibebe Ghion Specialised Hospital, Bahir Dar, North West Ethiopia

---

Abel, Gashaw

---

<http://ir.bdu.edu.et/handle/123456789/14699>

*Downloaded from DSpace Repository, DSpace Institution's institutional repository*



**BAHIR DAR UNIVERSITY**  
**COLLEGE OF MEDICINE AND HEALTH SCIENCES**  
**DEPARTMENT OF Surgery**

---

**Anatomical Variations of Recurrent Laryngeal Nerve and Outcome in Thyroid Surgeries  
Performed in Tibebe Ghion Specialised Hospital, Bahir Dar, North West Ethiopia**

---

**A Research Thesis To Be Submitted To Bahirdar University, College Of Medicine And  
Health Sciences, Department Of Surgery For The Partial Fulfillment Of The Requirements  
For Speciality Certificate In General Surgery**

**By: Abel Gashaw (Md, General Surgery Resident)**

**November, 2022 G.C**

**BAHIR DAR, ETHIOPIA**

ANATOMICAL VARIATIONS OF RECURRENT LARYNGEAL NERVES AND OUTCOME  
IN THYROID SURGERY PERFORMED IN TIBEBE GHION SPECIALISED HOSPITAL,  
BAHIR DAR, NORTH WEST ETHIOPIA FROM JUNE 2021 TO AUGUST 2022 G.C

BY: ABEL GASHAW (MD, GENERAL SURGERY RESIDENT)

Tel: +251920762909

E-mail: [abigash@gmail.com](mailto:abigash@gmail.com)



ADVISORS:

1. Dr. MELESSE GEBEYEHU (MD, HEAD AND NECK SURGEON)

Tel: +25153599231

E-mail: [gbmelesse@gmail.com](mailto:gbmelesse@gmail.com)

SIGNATURE: 

2. Pro. NETSANET FENTAHUN

Tel: +251913516677

E-mail: [netsanetfentahun01@gmail.com](mailto:netsanetfentahun01@gmail.com)

SIGNATURE: 



## **ACKNOWLEDGEMENT**

First and foremost, I would like to thank Bahir Dar University, Department of Surgery for giving me this opportunity to practice the development of health-related research.

I am deeply indebted to my advisors Dr. Melesse Gebeyehu and Pro. Netsanet Fentahun for all their guidance, advice, material support, and valuable comments for developing this proposal.

I would like to thank my beloved friends for their valued comments and support along the way.

**Table of Contents**

**ACKNOWLEDGEMENT..... ii**

**Table of Contents ..... iv**

**LIST OF TABLES AND FIGURES..... vi**

**ABRRIVIATIONS..... vii**

**ABSTRACT..... viii**

**1. INTRODUCTION..... 1**

**1.1 Background..... 1**

**1.2 Statement of the Problem. .... 3**

**1.3 Significance of the Study ..... 4**

**2. LITERATURE REVIEW ..... 5**

**2.1 Anatomical Variations of RLNs..... 5**

**2.2 Magnitude of Recurrent Laryngeal Nerve Injury ..... 6**

**3. OBJECTIVES ..... 8**

**3.1 General Objective..... 8**

**3.2 Specific Objectives..... 8**

**4. METHODS AND MATERIALS ..... 8**

**4.1 Study Area and Period..... 9**

**4.2 Study Design ..... 9**

**4.3 Population ..... 9**

**4.3.1 Source Population ..... 9**

**4.6 Study Variables ..... 11**

**4.6.1 Dependent Variable ..... 11**

**4.6.2 Independent Variables..... 11**

**5. RESULTS ..... 15**

**5.1 Sociodemographic Characteristics ..... 15**

**5.2 Branching Patterns of RLN..... 17**

5.3 Relation of RLN with ITA and TEG .....	17
5.4 Early Postoperative Outcome .....	18
6. Discussion.....	19
7. Conclusion and Recommendations .....	20
7.1 Conclusion.....	20
7.2 Limitations of the Study .....	21
7.3 Recommendations .....	21
8. REFERENCES.....	22
9. ANNEXES .....	24
9.1 Informed Consent.....	24
9.2 Checklist.....	25

## LIST OF TABLES AND FIGURES

	Page
Figure 1-conceptual frame work .....	7
Table 1- Patients' information .....	15
Table 2-Sociodemographic characteristics of patients .....	16
Table 3-Frequency distribution RLN branching pattern .....	17
Table 4-Frequency of relationship of RLN to the ITA .....	18
Table 5-Early postop outcome and comorbidities .....	19

## **ABRRIVIATIONS**

ARHB	Amhara Regional Health Bureau
BDU	Bahir Dar University
CMHS	College of Medical and Health Sciences
ELB	Extralaryngeal branching
GC	Gregorian calendar
HTN	Hypertension
ITA	Inferior thyroid artery
MD	Medical Doctor
MPH	Master of public health
NRLN	Nonrecurrent laryngeal nerve
PHD	Doctor of philosophy
PI	Principal Investigator
RLN	Recurrent laryngeal nerve
RLNI	Recurrent laryngeal nerve injury
SPSS	Statistical Package for Social Sciences
SRP	Student Research Program
SSE	Surgical Society of Ethiopia
SSI	Surgical site infection
TEG	Tracheoesophageal groove
TGSH	Tibebe Ghion Specialized Hospital



## **ABSTRACT**

**Background:** Thyroid surgery requires a thorough knowledge of the neck anatomy and its anatomical variations. This is of utmost importance, since it is well known that variations of the recurrent laryngeal nerve are prone to iatrogenic injuries. Injury to the recurrent laryngeal nerve is one of the most severe complications of thyroid surgery. Surgeons must have a comprehensive understanding of the anatomy of the recurrent laryngeal nerve during thyroid operation..

**Objective:** To assess the anatomical variations of recurrent laryngeal nerves and outcome in patients who had undergone thyroid surgery in Tibebe Ghion Specialised hospital, Bahir Dar, Ethiopia.

**Method:** Institutional based cross sectional study was conducted on 102 patients from June, 2021 to August, 2022 G.C in Tibebe Ghion Specialised hospital, Bahir Dar, Ethiopia using nonprobability consecutive sampling technique. Data were analyzed with descriptive data analysis using SPSS 25 version.

**Results:** The findings indicated that several extra laryngeal branches coming off of the recurrent laryngeal nerve on both right and left sides. On the right side, 24.1% (18.4% bifurcations and 5.7% trifurcations) demonstrated branching of the nerve and 10.2% demonstrated branching (bifurcations) on the left side. In relation to inferior thyroid artery, 68.9% of right nerves were related posteriorly, while 27.7% were related anteriorly. On the left side, 91.3% of the nerves were posterior to the artery whereas 7.3% were related anteriorly. The anatomical variation of RLN which interdigitate between branches of the artery were demonstrated in 3.4% and 1.4% on the right and left sides respectively. The relation of recurrent laryngeal nerve with tracheoesophageal groove, was also examined and on the right side, in 93.1% of the cases the nerve was in the groove and it was lateral to trachea in 6.9% of the cases. Of all the patients included in this study 92.2% had uneventful early postoperative period with hoarseness and hypocalcemia occurred in 2% of the cases each.

**Conclusion:** Anatomical consideration of the variations in the course, branching pattern, and relation of recurrent laryngeal nerve with inferior thyroid artery and tracheoesophageal groove is essential to minimize complications associated with surgical procedures of the neck, especially thyroidectomy.

**Key words:** Thyroidectomy, Recurrent Laryngeal Nerve

# 1. INTRODUCTION

## 1.1 Background

The thyroid gland is a butterfly-shaped endocrine organ located in the anterior compartment of the neck at the level 5<sup>th</sup> cervical to 1<sup>st</sup> thoracic vertebrae(1)(2)(3). It consists of two lateral lobes connected by a narrow bridge known as the isthmus(4)(5). The thyroid gland is one of the most important endocrine organs and plays a significant role in regulating metabolism, blood calcium levels, growth, and development(6).

The recurrent laryngeal nerve (RLN) is a branch of the vagus nerve, which carries motor, sensory and parasympathetic fibers to the larynx. The RLN is consistently present superior to the inferior thyroid artery before it ascends behind the inferior constrictor to the nerve's entry point into the larynx. This relationship is a major landmark for its identification during thyroid surgery(7)(8).

Thyroidectomy is a quite common daily operation in general surgery. Thyroid surgery is a specific surgery that requires detailed anatomical information. The recurrent laryngeal nerve (RLN) is the major structure at risk during thyroid and parathyroid surgery(9). However, the anatomical structures of the region, mainly the relationship of recurrent laryngeal nerve (RLN) and inferior thyroid artery (ITA) makes the procedure challenging(10).

Thus, consideration and recognition of every variation is essential to minimizing the rate of RLN injury during thyroid surgery. The American Association of Endocrine Surgeons and ATA Guidelines for the definitive surgical management of thyroid disease recommended that RLNs should be identified and preserved during dissection in thyroid operation(11).

One factor increasing the risk of RLN paralysis is anatomical variation of the RLN. Variations in the RLN can be produced by changes in the course of the nerve due to previous surgery or the impaction of a mass, the relationship between the RLN and inferior thyroid artery (ITA), the nonrecurrent laryngeal nerve course, and extralaryngeal branching. Nonrecurrent laryngeal nerve course is a rare anatomic specialty. It is usually seen on the right side and arises during embryological development. Extralaryngeal branching of the RLN is a frequently seen anatomical specialty. The risk of developing nerve paralysis is higher in extralaryngeal branching of the RLN. The nerve may be vulnerable to compression, traction, and transection due to the diminished caliber of the nerve due to the branching(9).

Bifurcation, a well known variation in RLN, should be fully identified and preserved integral by surgical dissection for preventing this complication. The 3 main identification approaches for RLN dissection include the lateral, inferior, and superior approaches. There are many descriptions of variations of the RLN. The RLN usually runs in the tracheoesophageal groove (50–77%), the paratracheal area (17–40%), and the paraesophageal area (6%) or within thyroid parenchyma (4%) and it can divide into 2 or 3 branches before entering the larynx(12).

The RLN typically branches superior to the inferior thyroid artery and posterolaterally to the ligament of Berry, and this is the location where the nerve is most susceptible to injury. If the posterior branch is identified and believed to be the sole RLN, the anterior branch is particularly vulnerable to injury when the capsular dissection approach to thyroidectomy is used. If the anterior branch is identified first, it is more likely that the surgeon will find the posterior branch during capsular dissection, thereby preventing injury. The likelihood of lesion to the anterior branch is particularly important because there is a high risk of vocal cord palsy and long-term complications from its injury(13)

Surgeons should know the variations in RLN topography and the technique for preserving trunk and terminal branches of RLN, so as to decrease the risk and enhance the safety of thyroid surgery(14).

## **1.2 Statement of the Problem.**

Transient post-operative RLN paralysis occurs in approximately 3–8% of cases whereas permanent paralysis occurs in 0.3–3% of cases. Therefore, identifying the anatomical variant of RLN does have significant importance to preserve the nerve and its function during surgery. Although recent monitoring advances have allowed intraoperative neuromonitoring to reduce the incidence of RLN injury, visual identification of the RLN remains the gold standard for RLN injury prevention(15).

Fully understanding the anatomical variations of the RLN may help surgeons dissect the RLN in a safe, fast, and correct way. Therefore, it is vital to determine the anatomical position of the RLN in thyroid surgery. In addition to the hoarseness that occurs with unilateral RLNI, bilateral RLNI leads to dyspnea and often life-threatening glottal obstruction. The incidence of RLNI has been found to be higher during re-explorations, Graves disease and thyroid carcinoma procedures(15).

Knowledge of the anatomical relationships of the RLN to the tracheoesophageal groove, ligament of Berry, and ITA is essential. The course of the RLN with respect to the ITA is quite variable. Most commonly it crosses behind the branches of the artery, more predictably so on the left. However, the nerve may pass deep to, superficial to, or between the terminal branches of the ITA. Up to twenty anatomical variations have been described(16).

However, the overall incidence rate of nonrecurrent laryngeal nerve (NRLN) is between 0.28% and 0.52%, whereas the incidence rate of the right-sided NRLN is 0.3% to 0.8%, and that of the left-sided NRLN is 0.004% to 0.04%. Despite the incidence rate of NRLN being rare, the probability of intraoperative injury can reach 12.9%(17).

Being the first study in our country, this study will reveal the real anatomical variations of RLN in our set up and lay the ground work for future studies.

### **1.3 Significance of the Study**

During thyroidectomy, the RLN is at risk of iatrogenic injury which is one of the major complications of thyroid surgery resulting in significant postoperative patient morbidity. Even though thyroidectomy is one of the most common procedure performed by General Surgeons, in the presence of several anatomical variations, there is little known regarding the anatomical variations of RLNs encountered in our country, Ethiopia.

This study is aimed at determining the proportions of the anatomic variations of the novel recurrent laryngeal nerves in patients who undergone thyroidectomy between June, 2021 to August 2022 G.C in Tibebe Ghion Specialised Hospital, Bahir Dar, Ethiopia. We will attempt to dissect the recurrent laryngeal nerves during thyroidectomy procedures to identify, preserve the nerves and document the anatomical variations encountered in the above mentioned time period.

Being the first study to be performed in Tibebe Ghion Specialized Hospital under Bahir Dar University and in our country in general this study will give an insight on the common anatomical variations of the recurrent laryngeal nerves encountered during thyroidectomy in our set up for the surgical residents as well as general surgeons to increase the safety of the procedure and decrease the postoperative unwanted patient outcomes. Moreover, this study will provide baseline information to other researchers in conducting further detailed investigations on related issues.

## **2. LITERATURE REVIEW**

### **2.1 Anatomical Variations of RLNs**

A prospective study done in China showed that anatomical variations were identified in 690 RLNs, including 305 left- and 385 right-side nerves. As many as seven RLN anatomical variations were identified and these findings indicate that anatomical variations of the RLN are common, and the identification of these anatomical variations of the RLN can help to minimize the risk of post-operative RLN paralysis(18).

In another prospective study about 30.9% of the RLNs gave off multiple branches into the larynx. Two and 3 branches of RLNs into the larynx were found in 25.5% and 5.4% of the cases, respectively. Nonrecurrent laryngeal nerve appeared in 2 cases. On the left side, 68.0%, 25.6%, and 6.4% of cases were found with 1, 2, and 3 bifurcations of RLN to larynx entry, respectively. On the right side, 69.8%, 25.8%, and 4.4% cases were identified with 1, 2, and 3 bifurcations of RLN to larynx entry, respectively. The combining dissection approach was proved as successful and safe for protecting the RLN with no permanent RLN paresis(14).

A study done on 55 cadavers at Oakland University showed that branches coming off of the RLN on both the right and left sides, innervating both the esophagus and trachea in some instances. On the right side, 89.1% demonstrated anywhere between 2-5 extra-laryngeal branches, and 74.6% demonstrated branching on the left side(19).

RLN is observed as either related anteriorly, posteriorly, or in between the ITA. The right RLN demonstrated 67.9% anterior to the ITA, and 32.1% posterior to it. The left RLN demonstrated the exact opposite results with 32.1% anterior, and 67.9% posterior to the ITA(19).

## 2.2 Magnitude of Recurrent Laryngeal Nerve Injury

Vocal cord paralysis caused by recurrent laryngeal nerve (RLN) injury is a not uncommon occurrence after thyroid surgeries, with recent series quoting rates of transient paralysis up to 5% to 10%. Thus, consideration and recognition of every variation is essential to minimizing the rate of RLN injury during thyroid surgery. Surgeons should know the variations in RLN topography and the technique for preserving trunk and terminal branches of RLN, so as to decrease the risk and enhance the safety of thyroid surgery(14).

Hypoparathyroidism and Recurrent Laryngeal Nerve Injury (RLNI) represent nearly half of all the complications of thyroid surgery. The latter complication after thyroidectomy, although infrequently encountered, can jeopardize the quality of life. In addition to the hoarseness that occurs with unilateral RLNI, dyspnea and life-threatening glottal obstruction may occur following bilateral nerve injury(15).

A study performed in the Kingdom of Saudi Arabia, transient unilateral vocal cord paresis developed in 3.2% cases, and 0.3% it became permanent (post Rt. Hemithyroidectomy). Whereas, bilateral vocal cord paralysis developed in 0.58% but none became permanent. One of the most important risk factor identified in this study is nonidentification and sparing of RLN during the procedure(15).

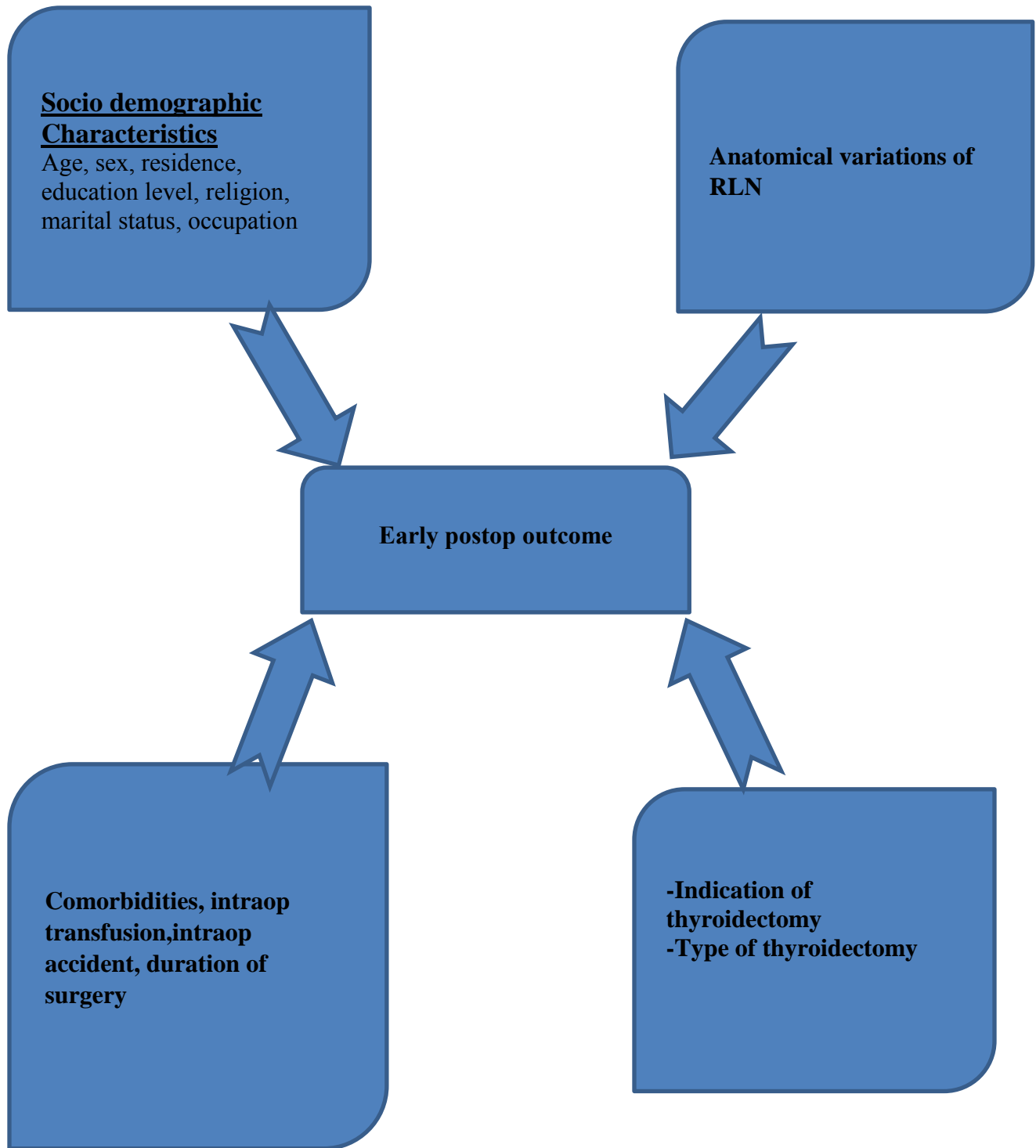


Figure 1-conceptual frame work



### **3. OBJECTIVES**

#### **3.1 General Objective**

-To determine the anatomical variations of recurrent laryngeal nerve and outcome in patients who underwent thyroid surgery in Tibebe Ghion Specialized hospital, Bahir Dar, Ethiopia

#### **3.2 Specific Objectives**

-To determine the anatomical variations of recurrent laryngeal nerves in patients who underwent thyroid surgery in Tibebe Ghion Specialized hospital, Bahir Dar, Ethiopia.

-To assess outcome of patients who underwent thyroid surgery in Tibebe Ghion Specialized hospital, Bahir Dar, Ethiopia.

### **4. METHODS AND MATERIALS**

Patients admitted for thyroid pathologies for thyroidectomy were admitted, thorough preoperative evaluation and investigations were performed, and an informed consent for the participation of the study was taken in addition to a written informed consent for the surgery. Those patients who fulfill inclusion criteria and willing to participate in the study were prepared for the planned type of thyroidectomy and thyroidectomy was performed with dissection, identification, and preservation of the RLNs. The informed operating team about the study appropriately filled the questions on the specific checklist prepared for this study after the completion of the procedure and took a clear and visible intraoperative pictures of the RLNs which were dissected from the inferior pole of the thyroid gland to the cricothyroid membrane. Data from the checklist attached to the patient's chart and intraoperative pictures were used for the analysis of the study.

## **4.1 Study Area and Period**

The study was conducted in TGSH, Bahir Dar, Ethiopia. Tibebe Ghion Specialized Hospital, located in Bahir Dar, is one of the largest specialized referral hospitals in the Amhara region and the country at large. It is a specialized public hospital and one of the university hospitals in the country. The hospital is a new referral teaching hospital in the Amhara region, and it is established by Bahir Dar University in 2018 G.C.

Bahir Dar city administration is located in West Gojjam, North West Ethiopia at 550km far from Addis Ababa (capital city of Ethiopia). TGSH, currently runs residency programs in seven specialties and fellowship in three sub-speciality programs. The hospital provides a tertiary level health care service and it is administered by Bahir Dar University. The hospital has more than 500 beds, all over 105 beds are dedicated to General Surgery cases.

The study was conducted from June, 2021 to August, 2022 G.C.

## **4.2 Study Design**

Institutional based cross sectional study design was applied

## **4.3 Population**

### **4.3.1 Source Population**

All patients who were hospitalized for thyroidectomy in TGSH from June 2021 to August 2022 G.C.

### **4.3.2 Study Population**

Those patients who fulfilled the illegibility criterias and underwent thyroidectomy with dissection, identification and preservation of RLNs in TGSH from June 2021 to August 2022 G.C were included in the study.

## **4.4 Inclusion and Exclusion Criteria**

### **4.4.1 Inclusion Criteria**

- Patients who underwent thyroidectomy with dissection, identification and preservation of RLNs.

### **4.4.2 Exclusion Criteria**

- patients who underwent a repeat anterior neck surgery
- patients who were not willing to participate in the study
- patients who already had RLN palsy before the surgery
- patients who underwent completion thyroidectomy or previous neck dissection
- those with unclear intraoperative pictures of RLN

## **4.5 Sample Size**

-All patients who underwent thyroidectomy with dissection and identification of RLNs in the research's time period were included.

## **4.6 Study Variables**

### **4.6.1 Dependent Variable**

- Early postoperative outcome, in the first 7 days

### **4.6.2 Independent Variables**

- Anatomical variations of RLN variables
- Sociodemographic variables
- Indications of thyroidectomy
- Type of Thyroidectomy
- Intraoperative transfusion
- Comorbidities
- Duration of surgery
- Early postop outcome
- Intraop accident

## **4.7 Definition of terms**

- Thyroidectomy:** is surgical removal of all or part of the thyroid gland

**-Recurrent laryngeal nerve:** is a nerve that supplies the larynx, part of the airway which is responsible for passage of air

**-Inferior thyroid artery:** is arterial blood vessel with supplies thyroid and parathyroid glands

**-Tracheoesophageal groove:** anatomical space between trachea and esophagus which is used as an anatomical landmark for the classification of variations of RLN

#### **4.8 Data Collection Tool and Procedures**

Checklist developed after revision of similar articles written in English will be used as data collection tools and using sort of modifications based on local resource(14,18). The checklist will be composed of sociodemographic characteristics, type of thyroidectomy, laterality, early postop outcome, intraop transfusion, intraop accident, comorbidities, duration of surgery, indications and anatomic variations encountered.

During data collection resident physician and ward nurses were involved. Supervision of the data collection process was made by the principal investigator. The supervisor crosschecked for completeness and consistency of collected data daily.

#### **4.9 Data Quality Control**

Data collection formats were properly designed and data collectors were trained well and supervised by the investigator. Tool pre-testing were done to ensure that data collectors are clear with the content and techniques of gathering the data. Every data sheets were checked and evaluated by the investigator after collection for its completeness in order to ensure quality of data before, during, and after data collection.

#### **4.10 Data Processing and Analysis**

The data were entered into and analyzed using SPSS Windows Version 25 for analysis. Descriptive statistics like frequency and percentage were computed for categorical data and presented by the use of text, tables, graphs and charts.

#### **4.11 Ethical Consideration**

Ethical clearance was obtained from institutional review board of BDU, College of Medicine and Health Sciences. Then this ethical clearance and cooperation letter was sent for TGSH to obtain permission to perform data collection. Confidentiality of patient information was maintained by taking the data anonymously. The data extracted from questioners was only used for the study and every data was kept confidential by securing personal information in passwords. In addition, a written informed consent was obtained from patients before operation.

#### **4.12 Dissemination of the Study**

The finding of the study will be presented and submitted to BDU, CMHS, school of medicine, department of Surgery as one of the partial fulfillments of specialty certificate. The finding of the study will be shared with ARHB, SSE, and other concerned bodies. For broader dissemination, the manuscript will be submitted to one of the peer-reviewed journals for publication.

## 5. RESULTS

### 5.1 Sociodemographic Characteristics

There were 102 patients included in this study. The tested population in this prospective study consisted of 92 women and 10 men with 53.9 % between 18 and 39 years of age. A total of 156 laryngeal nerve dissections, including 69 on the left side and 87 on the right side, were performed with unilateral exposure in 48 patients and bilateral exposure in 54 patients. The most common type of thyroidectomy performed was subtotal thyroidectomy, 80.4%, followed by total thyroidectomy (14.7%) and near total thyroidectomy (4.9%) with controlled toxic multinodular goiter being the most common indication, 64.7%, followed by simple nodular goiter with compressive symptoms (15.7%), thyroid cancer (13.7%) and thyroid neoplasm (5.9%). Most of the patients were from rural part of the country, 83.3% and 95.1% were orthodox Christianity followers [Table 1, 2, and Figure 2].

Table 1- Patients' information

	Total patients	102
Gender	Males	10 (9.8%)
	Females	92 (90.2%)
Indications of thyroidectomy	CTMNG	66 (64.7%)
	SNG with compressive symptoms	16 (15.7%)
	Thyroid cancer	14 (13.7%)
	Thyroid neoplasms	6 (5.9%)
Type of thyroidectomy	Subtotal thyroidectomy	82 (80.4%)
	Total thyroidectomy	15 (14.7%)
	Near total thyroidectomy	5 (4.9%)



Table 2-Sociodemographic characteristics of patients

		<b>Frequency</b>	<b>Percentage</b>
<b>Age (in years)</b>	18-39	55	53.9
	40-60	43	42.2
	61-80	4	3.9
<b>Religion</b>	Orthodox	97	95.9
	Muslim	4	3.1
	Protestant	1	1
<b>Marital status</b>	Single	20	19.6
	Married	77	75.5
	Divorced	1	1
	Widowed	4	3.9
<b>Residency</b>	Rural	85	83.3
	Urban	17	16.7
<b>Level of education</b>	Unable to read and write	34	33.3
	Grade 1-6	26	25.5
	Grade 7-12	8	7.8
	Diploma and above	34	33.3
<b>Occupation</b>	Farmer	21	20.6
	Civil servant	20	19.6
	Merchant	9	8.8
	House wife	41	40.2
	Student	11	10.8

## 5.2 Branching Patterns of RLN

The findings indicated that RLN has several variations based on the branches it gives and relation with ITA and TEG. On the right side, 24.1% (18.4% bifurcations and 5.7% trifurcations) demonstrated branching of the RLN and 10.2% demonstrated branching (bifurcations) on the left side [Table 3]. Using the Fisher's Exact Test, and following data analysis, it was determined that there is a statistically significant difference in the branching pattern between the two sides.

Table 3-Frequency distribution RLN branching pattern

	Right side		Left side	
	Frequency	%	Frequency	%
Single trunk	66	75.9	62	89.8
Branches	21	24.1	7	10.2
Two branches	16	18.4	7	10.2
≥3 branches	5	5.75	-	-

## 5.3 Relation of RLN with ITA and TEG

The relationship between RLN and ITA, a common landmark used by surgeons to locate RLN during thyroidectomy, was also examined. In relation to ITA, 68.9% of right RLN's were related posteriorly, while 27.7% were related anteriorly. On the left side, 91.3% of RLNs were posterior to ITA whereas 7.3% were related anteriorly. The anatomical variation of RLN which interdigitate between branches of ITA were demonstrated in 3.4% and 1.4% on the right and left sides respectively [Table 4]. There is statistically significant difference between the two sides, as determined by  $P < 0.05$  (Fischer's Exact Test).

Table 4-Frequency of relationship of RLN to the ITA

	Right side		Left side	
	Frequency	%	Frequency	%
Anterior	24	27.7	5	7.3
Posterior	60	68.9	63	91.3
In-between	3	3.4	1	1.4

The relation of RLN with another important landmark during thyroidectomy, TEG, was also examined. On the right side, in 93.1% of the cases RLN was in the TEG and it was lateral to trachea in 6.9% of the cases, no such variation was demonstrated on the left side.

#### **5.4 Early Postoperative Outcome**

Of all the patients included in this study 92.2% had uneventful early postoperative period, in the first seven days after thyroidectomy, with hoarseness and hypocalcemia occurred in 2% of the cases each and there was one death with immediate cause of death of upper airway obstruction.

Associated comorbidities were identified in 13.7% of the patients with hypertension being the most common, 12.7%, which could be due to the fact that most, 54%, of the patients were less than 40 years of age [Table 5]. Intraoperative transfusions were required only in two patients with intraoperative accident, vascular, occurred only in a single case and 73.5% of thyroidectomies were completed within two hours.

Table 5-Early postop outcome and comorbidities

		<b>Frequency</b>	<b>Percentage</b>
<b>Early postop outcome</b>	Uneventful	94	92
	Hoarseness	2	2
	Hypocalcemia	2	2
	Hematoma and SSI	1	1
	Air way obstruction	1	1
	Tracheal injury	1	1
	Death	1	1
<b>Comorbidities</b>	HTN	13	12.7
	Cardiac disease	1	1
	No comorbidities identified	88	86.3

## 6. Discussion

In this cross sectional study, the anatomical variations of RLNs on living patients who underwent thyroid surgery were examined. The traditional course of RLNs is as follows: the left RLN Separates from the vagus nerve hooking around the aortic arch and returns into the larynx in the TEG. In comparison, the right RLN originating from the vagus nerve travels below the subclavian artery before entering the larynx within the TEG. The nerve passes posterior to ITA before it ascends in the neck. However, not every RLN follows the same above course. Many Publications have described various arrangements of RLNs and techniques for identifying and protecting RLN during thyroid surgery.

In this study several anatomical variations of RLN were identified based on branching pattern and it's relation with important anatomical landmarks during thyroid surgery, ITA and TEG. Extralaryngeal branching of the RLN is the most common anatomical variation encountered during thyroidectomy. We have observed branching of the RLN in 24.1% on the right side compared to 10.2% on the left side which is within the range of figures reported from studies done in Chinese patients whereas it is lower than those studies done on cadaver dissection from US (14,18,19). It was suggested that observing branching of RLN is underestimated in

intraoperative studies on live patients. In addition, it was determined that there's a statistically significant difference in the branching pattern between the two sides.

In addition to the branching, RLN has variations based on the course it takes in relation to ITA and it was observed that more anterior course of the nerve occurred on the right side, with a more anterolateral course, compared to the left side which is similar to the results reported in studies done in China and US, even if the magnitude is lower in this study. Similarly, we have observed a more lateral course of the RLN on the right side compared with the left side, which has a more consistent course in the TEG, similar to the results reported in the previous studies.

In addition to the greater number of branches, the relationship of the right RLN to the ITA and TEG may potentially make it more vulnerable to injury as well compared to the typical relation between RLN and ITA/TEG, where the RLN passes posterior to ITA in the TEG(19). It was observed that a significantly higher rate of anatomical variations of the right RLN compared with the left RLN.

Most of the patients who underwent thyroidectomy had uneventful early postoperative period, 92.2%, and hoarseness and hypocalcemia were the most common morbidities observed in this study, 2% each. It was also demonstrated that these morbidities occurred in patients who underwent total thyroidectomy with the duration of surgery being greater than 2 hours.

## **7. Conclusion and Recommendations**

### **7.1 Conclusion**

The anatomical variations of RLN are frequently encountered in patients who undergo thyroid surgery. The large anatomical variability of RLN may increase the risk of vocal cord paralysis caused by RLN injury. The awareness of these anatomical variations of RLN by surgeons may be helpful in the dissection, identification and preservation of the nerve with its terminal branches for a safe thyroidectomy. The American Association of Endocrine Surgeons and ATA Guidelines for the definitive surgical management of thyroid disease recommended that RLNs should be identified and preserved during dissection in thyroid operation(11) and this should be the routine practice in our setup..

## **7.2 Limitations of the Study**

There are some limitations to this study:-

- the study population were those who underwent thyroid surgery, and thus, the ratio of male to female patients was 1:9. Therefore, the observed variations of the RLN was more on the female individuals.
- the study period was relatively short and the sample size was small.
- information regarding the increased risk of injury associated with the anatomical variation of the RLN is sparse.

## **7.3 Recommendations**

- Surgeons should be aware of the possible anatomical variations of RLN that could be encountered during thyroid surgery
- Dissection, identification and sparing of the RLN should be a routine practice during thyroidectomy.
- Future multi-institutional studies including more male patients should be conducted with long term follow up to determine the likelihood that having variations of the nerve increases iatrogenic nerve injury
- Further comparative prospective studies comparing the outcomes of thyroid surgeries between procedures done with and without identification and preservation of the nerve is warranted

## 8. REFERENCES

1. Maneenin C, Maneenin N, Iamsaard S. Anatomical Variations of Thyroid Glands in Northeastern-Thai Embalmed Cadavers. 2019;37(1):136–40.
2. Ranade A V, Rai R, Pai MM, Nayak SR, Krisnamurthy A, Narayana S. Anatomical variations of the thyroid gland : possible surgical implications. 2008;49(10):831–4.
3. ANATOMICAL VARIATIONS OF THYROID GLAND AND ITS CLINICAL. 2013;2(2):12–6.
4. Possible Variations of Thyroid Gland : A Detailed Cadaveric Study. file:///C:/Users/user/Desktop/proposal/anatomical-variations-of-thyroid-gland-and-its-clinical-significance-in-nor.pdf. 2018;7(2):9–13.
5. Rao GHMS. Anatomical Variations of Thyroid Gland & Its Clinical Significance. 2018;17(9):22–4.
6. Velasco-nieves NM, Omotuyi A, Fakoya J, Mathew S, Zafar M, Milla KA, et al. Anatomical variation of the thyroid gland – Levator glandulae thyroideae. 2020;10(2):173–5.
7. Al-azzawi A. Journal Pre-proof. Ann Med Surg [Internet]. 2021;102823. Available from: <https://doi.org/10.1016/j.amsu.2021.102823>
8. Hamid SS. Surgical Aspects of Recurrent Laryngeal Nerve Handling during Thyroid Surgery : A Case Series Study. 2021;274–84.
9. Uludağ M, Yetkin G, Oran EŞ, Aygün N, Celayir F, İşgör A. Extralaryngeal division of the recurrent laryngeal nerve : A common and asymmetric anatomical variant. 2017;164–8.
10. Noussios G, Chatzis I, Konstantinidis S, Filo E, Spyrou A. The Anatomical Relationship of Inferior Thyroid Artery and Recurrent Laryngeal Nerve : A Review of the Literature and Its Clinical Importance. 2020;12(10):640–6.
11. Patel KN, Yip AYL, Lubitz CC, Grubbs EG, Miller BS, Shen W, et al. The American Association of Endocrine Surgeons Guidelines for the Definitive Surgical Management of Thyroid Disease in Adults. Vol. 271. 2020.
12. Morais M, Luís JC. Nonrecurrent Laryngeal Nerve and Associated Anatomical Variations : The Art of Prediction. 2015;234–8.
13. Henry BM, Vikse J, Graves MJ, Sanna S, Sanna B, Tomaszewska IM, et al. Extralaryngeal branching of the recurrent laryngeal nerve : a meta-analysis of 28 , 387 nerves. Langenbeck's Arch Surg. 2016;913–23.

14. Yin C, Song B, Wang X. Anatomical Variations in Recurrent Laryngeal Nerves in Thyroid Surgery. 2020;(1).
15. Zakaria HM, Awad NA Al, Kreedes AS Al, Al-mulhim AMA, Al-sharway MA, Hadi MA, et al. Recurrent Laryngeal Nerve Injury in Thyroid Surgery. 2011;26(1):34–8.
16. Panieri E, Fagan J. OPEN ACCESS ATLAS OF OTOLARYNGOLOGY , HEAD & NECK OPERATIVE SURGERY.
17. Le VQ, Ngo QD. Nonrecurrent laryngeal nerve in thyroid surgery : Frequency , anatomical variations according to a new classification and surgery consideration. 2019;(January):1–7.
18. Shao T. Anatomical variations of the recurrent laryngeal nerve in Chinese patients : a prospective study of. Nat Publ Gr. 2016;(March):1–4.
19. Fahim DK, Thomas AM, Gemechu JM, Dk F, Am T, Jm G. Anatomical Variations of the Recurrent Laryngeal Nerve and Implications for Injury Prevention During Surgical Procedures of the Neck. 2020;13(3):5–8.



## 9. ANNEXES

### 9.1 Informed Consent

**Bahir Dar University**  
**College of Medicine and Health Sciences**  
**Department of Surgery**  
**A Research Consent Form**

In undersigning this document, I am giving my consent to participate in the study entitled as **‘ANATOMICAL VARIATIONS OF RECURRENT LARYNGEAL NERVE IN THYROID SURGERY PERFORMED IN TIBEBE GHION SPECIALISED HOSPITAL, BAHIR DAR, NORTH WEST ETHIOPIA FROM DECEMBER 2021 TO AUGUST 2022 G.C.’** I have been informed about the purpose of this study and understood that participation in this study is entirely voluntarily. I have been told that my findings during the surgery will not be given to anyone else and no reports of this study ever identify me in any way. I have also been informed that my participation or non-participation or my refusal to answer questions or take pictures of my findings during surgery will have no effect on me. I understood that participation in this study does not involve any risks.

Respondent’s signature \_\_\_\_\_

Investigator’s Name \_\_\_\_\_ Signature \_\_\_\_\_ Date \_\_\_\_\_

## 9.2 Checklist

### Questions to be filled from the Patient's chart

1. Socio-demographic characteristics			Response
	101	Age of the patient (years)	_____
	102	Sex-	1. Male      2. Female
	103	Residency-	1. Urban      2. Rural
	104	Patient's religion	1. Orthodox      2. Muslim      3. Protestant      4. others
	105	Marital status	1. Single      2. Married 3. Divorced      4. Widowed
	106	Patient's Level of education	1. unable to read and write 2. grade 1-6 3. grade 7-12 4. diploma and above
	107	Patient's occupation	1. Farmer      2. Civil servant 3. Merchant      3. House wife 4. Student      5. others
2. Anatomical variations of RLN, Indication and Type of thyroidectomy	201	Laterality	1. Right      2. Left
	202	Indication of thyroidectomy	1. CTMNG      2. Thyroid cancer      3. Thyroid neoplasm 4. SNG with compressive symptoms 5. Cosmetics
	203	Type of thyroidectomy	1. Subtotal      2. Near total      3. Total
	204	Number of branches of RLN	1. Single trunk      2. Two branches 2. Three or more      4. NRLN
	205	Relation of RLN with ITA	1. Anterior      2. Posterior      3. Interdigitate
	206	Relation of RLN with TEG	1. In the TEG      2. Anterior to trachea      3. Lateral to trachea
3. Early postop outcome and variables which affect outcome	301	Early postop outcome	1. uneventful 2. Hoarseness 3. Hypocalcemia 4. Hematoma and SSI 5. Air way obstruction  6. Tracheal injury 7. .Death      8. others
	302	Comorbidities	1. No      2. HTN      3. DM      4. Bleeding diathesis 5. Anemia      6. Cardiac disease      7. others
	303	Transfusion	1. Yes      2. No
	304	Intraop accident	1. Yes      2. No
	305	Duration of surgery	1. <=2 hrs      2. >2 hrs