

Research Article

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## Surgical anatomy of thyroid and incidence of malignancy in solitary nodule of thyroid

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### ABSTRACT

**Background:** Thyroid diseases are the commonest endocrine disorders worldwide and India it about 42 million suffering from thyroid disease. Thyroid nodules are up to 8% of the adult population having palpable nodules. With the use of ultrasound, up to 10 times more nodules are likely to be detected. Fine-needle aspiration biopsy is crucial in the investigation of a thyroid nodule since the frequency of malignancy is estimated to be 15-25%. These may be subject to surgical intervention than is required because histological examination is the only way in which malignancy can be excluded. Early diagnosis and treatment remains the cornerstone of management. A thorough understanding of thyroid anatomy is central to the performance of safe thyroid surgery and reduces the incidence of post-operative morbidity and mortality.

**Methods:** Fifty nodular patients were studied prospectively in department of surgery, Rajarajeswari Medical College Bangalore for a period of 2 years with prior approval of Ethical Committee. Aim of the study was to know the incidence of malignancy in solitary nodule thyroid in our institute.

**Results:** Out of 50 patients, 4 (8%) were males and 46 were females (96%) with female to male ratio of 11.5:1. Maximum age of presentation was 60 years and minimum age was 16 years with an average age incidence of 36.14 years. Histopathological examination proved to be papillary carcinoma in 6 cases, Hashimotos thyroiditis in 3 cases and 1 each showed follicular adenoma and follicular carcinoma and total incidence of malignancy in this study is 14%.

**Conclusions:** Solitary nodule thyroid commonest disease of thyroid with high prevalence in females. Malignancy is around 14% and can come as surprise on post-operative HPE even when no suspicion by FNAC, which is comparable with others study. The main indication for surgery in STN are cosmetic or pressure symptoms or suspicious of malignancy. Near total thyroidectomy or lobectomy are the known surgeries for STN. Thorough surgical anatomy is must to prevent post-operative complications.

**Keywords:** Solitary nodule thyroid (STN), Fine-needle aspiration cytology (FNAC), Histopathological examination (HPE), Near total thyroidectomy, Total thyroidectomy, Malignancy

### INTRODUCTION

India has the world's biggest goitre belt in sub-Himalayan. Even though national goitre control

programme is reducing the prevalence of goitre but there is significant increase in incidence of solitary thyroid nodules (STN) in India so also in the worldwide.<sup>1</sup>

The corner stone of safe and effective thyroid surgery is thorough training, understanding of thyroid anatomy and pathology. The current evolution of thyroid surgery as day care procedure or short stay and endoscopic thyroidectomy emphasizes the need to avoid complications by utilizing meticulous surgical technique.<sup>2</sup> With perfect anatomy and appropriate techniques, thyroid surgeries can reduce the post-operative complications. Indications for thyroid surgery changed from life threatening conditions to deformity and discomfort since the mortality rate reduced from 20% to less than 1% by Theodor Kocher.

The importance of solitary thyroid nodule lies in the increased risk of malignancy compared with other thyroid swellings. The incidence of malignancy varies from 5% to 38% in different studies. Clinical diagnosis of solitary nodule may not be perfect always, only 56.8%<sup>3</sup> were really solitary at operation and histopathology.

Thus this study is about surgical anatomy of thyroid and the clinic pathological correlation and the percentage of malignancy in solitary thyroid nodule.

Study of "Incidence of malignancy in Solitary Thyroid Nodule" has been conducted by utilizing the cases diagnosed clinically as STN and treated on inpatient basis. All these cases were studied in detail clinically and conducted relevant investigations whatever indicated. The investigations included haemoglobin, urine analysis, blood sugar, blood urea, blood grouping and Rh typing, thyroid profile, X-ray of the neck-AP & lateral views and chest X-ray and examination of vocal cords movements. All the patients were subjected to FNAC. All patients underwent surgery and all the excised thyroid specimen were sent for Histopathological examination. Patients were discharged after couple of days and advised for regular follow up with HPE reports.

#### *Surgical anatomy of thyroid gland<sup>4-10</sup>*

Thyroid gland weighs about 20-25 gms and larger in females than in males. Gland occupies the important position in the central compartment of the neck, lying astride the trachea just above the thoracic inlet.

The thyroid gland has two lobes connected by isthmus. Each lobe is pear shaped consists of narrow upper pole and broader lower pole. The lobes occupy the anterolateral surface of trachea extending from the middle of thyroid cartilage superiorly up to 6<sup>th</sup> tracheal ring inferiorly. The isthmus lies in the front of 2<sup>nd</sup> and 3<sup>rd</sup> tracheal rings and attached quite firmly to trachea. The lobes lie under cover of the sternohyoid, sternothyroid and between anterior borders of two sternomastoid muscles. The gland possesses its own delicate capsule and fascia propria. It lies within the envelope of pretracheal fascia.

The superficial surface of the gland is covered by the infrahyoid and sternomastoid muscles with its fascial coverings. The medial surface is related to the trachea and oesophagus, two nerves Recurrent and external laryngeal nerves, two muscles inferior constrictor and cricothyroid. The posterior surface overlaps the common carotid artery and covers the terminal part of inferior thyroid artery.

Isthmus joins the anterior surface of lobes towards their lower poles. The posterior surface of isthmus is firmly adherent to the 2<sup>nd</sup> and 3<sup>rd</sup> tracheal rings. A small portion of the gland projects upward from the upper border of isthmus, named as pyramidal lobe. It represents the distal most part of the thyroglossal duct. Sometimes few muscle fibres are attached to it, called levator glandulae thyroidea and it is innervated by external laryngeal nerve.

#### *Blood supply*

The thyroid gland is supplied by a pair of superior thyroid arteries, inferior thyroid arteries, and solitary thyroidea ima artery and accessory thyroid arteries.

#### *Superior thyroid artery*

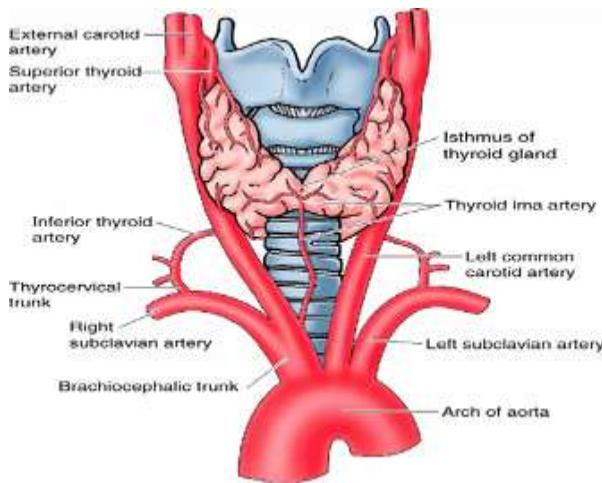
First branch from the anterior surface of the external carotid artery. After giving off sternomastoid and superior laryngeal branches, it pierces the pretracheal fascia as a single branch and reaches the tip of the upper pole and enters the gland superficially. It breaks up into branches in the anterior surface of the gland. It gives a branch to the back of the gland and a branch to anastomose with its fellow opposite on the upper border of isthmus. This vessel gives off a branch to supply the pyramidal lobe. The superior artery supplies upper 1/3<sup>rd</sup> of lobe and upper 1/2 of isthmus.

#### *Inferior thyroid artery*

Branch of thyrocervical trunk which arises from the first part of the subclavian artery. In the neck, it passes behind the carotid artery. Before entering the pretracheal fascia, it divides into 4 or 5 branches that pierce the fascia separately to reach the lower pole of the gland. The inferior thyroid artery gives off oesophageal and tracheal branches before its terminal distribution into the gland. Inferior thyroid artery may be absent congenitally in 35% of the patients. The inferior thyroid artery supplies the lower 2/3<sup>rd</sup> of the lobe and the lower 1/2 of isthmus with parotid glands. This makes a major share in thyroid blood supply.

#### *Thyroidea ima artery*

It enters the lower part of the isthmus in 3% of the individuals. It arises from the arch of aorta or innominate artery.



**Figure 1: Arterial supply of the thyroid veins.**

The thyroid gland is drained by following veins

1. *Superior thyroid vein*: It leaves the upper part of the gland, crosses the common carotid artery and terminates into the internal jugular vein or common facial vein.
2. *Middle thyroid vein*: It leaves the gland at the middle of the lateral part of the lobe, follows the inner border of the omohyoid muscle across the carotid vessels to end in internal jugular vein. It is thick, short and directly enters the jugular vein. It is present only in 30% of individuals.
3. *Inferior thyroid vein*: It leaves the Isthmus at the inferior border and runs down in front of the trachea to end in innominate vein of the same side.
4. *Fourth thyroid vein*: KOCHER drew attention to the frequent existence of this vein which passes outward between middle and inferior thyroid vein.

#### *Nerves related to the gland*

The external laryngeal nerve and the recurrent laryngeal nerve are in close relationship with the gland.

1. *External laryngeal nerve*: It is a branch of superior laryngeal nerve, descends on the fascia of the inferior pharyngeal constrictor to supply the cricothyroid muscle which is tensor of vocal cords. The nerve lies close to the superior pedicle with nerve medial, vein lateral and superior thyroid artery between them. The nerve can be separated from the vessel by blunt dissection as it lies outside the false capsule of the gland. However in some instances the nerve may lie adhered to artery (15%) or may lie between the branches of the artery (6%) and thus the nerve then be injured during ligation of vessels. This can be avoided by ligation of superior thyroid vessels below superior pole. Injury to external laryngeal nerve results in

decrease range of pitch and fatigue in speaking. It may or may not cause change in voice. Laryngoscopy reveals normal movement of vocal cord but it is irregular and wavy and the cord lies at the lower level and has lack of the tone resulting in bulge on expiration and retraction on inspiration.

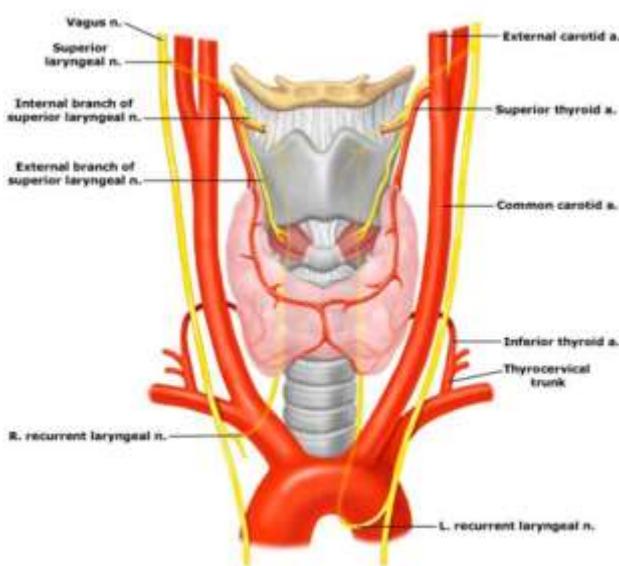
2. *Recurrent laryngeal nerve*: The nerve is branch of vagus nerve embryo logically related to 4<sup>th</sup> aortic arch vessels. The nerve lies in the tracheo-oesophageal groove and posterior to the inferior thyroid artery. The nerve may be lateral (28%) or anterolateral (10%) to trachea. In 30% of cases, it passes anterior to inferior thyroid artery or may even lie within its branches. In some cases, the nerve will be embedded in the ligament of Berry and thus it will be drawn forward with the gland traction. Injury to this nerve results in partial (abductor) or total paralysis of the cord resulting in hoarseness and respiratory difficulty.

3. *Non-recurrent laryngeal nerve*: In 0.63% cases the recurrent laryngeal nerve may not recur. The recurrent laryngeal nerve arises from the vagus nerve in the neck in the proximity to the 4<sup>th</sup> primitive aortic arch vessels which form the subclavian artery on the right side and aortic arch on the left side. The recurrent laryngeal nerve passes caudal to these vessels to larynx and is therefore dragged caudally when vessels descend. Occasionally the right aortic arch fails to develop and right subclavian artery arises from the aorta behind the left subclavian artery and passes behind the oesophagus. In these cases, the right side nerve is not drawn down and passes directly to the larynx as a non-recurrent laryngeal nerve. On left side it occurs in 0.04% of the cases.

The non-recurrent laryngeal nerve may be mistaken for inferior thyroid artery or middle thyroid vein and ligated during thyroidectomy.

4. *Internal laryngeal nerve*: It is the branch of the superior laryngeal nerve and penetrates the larynx through thyrohyoid membrane. Injury to this nerve is exceptional and occurs only when the superior pole is very much enlarged. It results in loss of sensation of laryngeal inlet with post deglutition coughing, chocking, or aspiration pneumonia.

The thyroid gland is surrounded by two capsules, the true capsule and a false capsule. The true capsule is made up of condensation of connective tissues around the gland while the false capsule is formed by pre-tracheal fascia. The blood vessels pierce both these capsules and thus firmly ramify to form a dense vascular plexus beneath the inner or true capsule of the gland. The space between the two capsules is traversed by the arterial and venous trunks. During operations on thyroid utmost care is taken not to injure the true capsule as under it lies the numerous fragile vessels.



**Figure 2: Shows the nerves in relation of thyroid capsules.**

#### *Suspensory ligament of berry*

This is the thickening of pre-tracheo fascial investment of thyroid. It passes from inner and posterior surface of the gland to cricoid cartilage. The two ligaments left and right form a sling, anchoring the gland to the larynx. They increase in size in large goitres, thus preventing the gland falling away from larynx. The recurrent laryngeal nerve is in immediate contact with the back of the ligament.

#### *Lymphatics of thyroid*

The gland is drained by two sets of lymphatics

##### *1. Ascending lymphatics:*

Medial: leave the upper border of the gland and drain into nodes situated on the cricothyroid membrane, the prelaryngeal gland.

Lateral: leave the upper pole of the gland and run along the superior thyroid artery to the deep cervical nodes situated at the bifurcation of common carotid artery.

##### *2. Descending lymphatics:*

Medial: pass to the gland on the trachea, pre-tracheal lymph nodes.

Lateral: pass from the deep surface of the gland to small nodes placed on recurrent nerve, the nodes of recurrent chain.

The lymph vessels run in the interlobular connective tissue and connect with the network within the capsule of

the gland. The ascending lymphatic channels drain the upper border of isthmus and surface of the lobes.

The descending channels drain the major part of isthmus and lower part of lateral lobes. The median lymph node near the isthmus is often involved in thyroid cancer, which is called Delphian node.

#### *Nerve supply of the gland*

The bulk of the sympathetic supply is derived from the middle cervical ganglion and enters the gland on the inferior thyroid artery. Some fibres from the superior ganglions travel with the superior thyroid artery. The sympathetic fibres are vaso-constrictor. Vagus nerve also supplies the gland. Its purpose is unknown.

#### *Aetiopathogenesis of solitary nodule of thyroid*

A discrete swelling in an otherwise impalpable gland is termed solitary nodule. A discrete swelling in a gland with palpable contralateral lobe or generalized mild nodularity is called dominant nodule of thyroid. This differentiation is subjective. Establishing such minor abnormality is unnecessary because the management of discrete swellings; be they isolated or dominant is similar. The incidence of isolated thyroid nodule is 1-2% in the general population. Any thyroid disease can present as a solitary nodule. 11-20% of isolated swellings are malignant. In addition 30-40% is follicular adenomas. The remainder is non-neoplastic consisting largely of areas of colloid degeneration. Rates of malignancy as low as 3-5% is also reported.

Causes of isolated or dominant thyroid swelling are the following,

##### *A) Non neoplastic*

1. Adenomatous (colloid) generation
2. Localised chronic lymphocytic thyroiditis
3. Hyper functioning adenoma
4. Cyst

*B) Neoplasms of thyroid:* Neoplasms of thyroid can be divided into benign and malignant.

1. Benign: Follicular adenoma
2. Malignant

1. Primary
  - Follicular epithelium:* Differentiated
  - Follicular carcinoma, papillary carcinoma
  - Follicular epithelium:* Undifferentiated
  - Anaplastic carcinoma
  - Para follicular cells:* Medullary carcinoma
  - Others:* Teratoma, Sarcoma
  - Lymphoid cells:* Lymphoma
2. Secondary
  - Metastatic
  - Local infiltration

Differential diagnosis of isolated thyroid nodule includes the following

1. *Cysts*
  - a. Simple cysts
  - b. Mixed cystic-solid (complex)
2. *Thyroid Adenoma*
  - a. Autonomously functioning (hot)
  - b. Non or hypo functional
3. Colloid Nodule
4. Thyroiditis
5. Infection
  - a. Granulomatous disease
  - b. Abscess
6. Developmental abnormalities
  - a. Unilateral lobe agenesis
  - b. Cystic Hygroma
  - c. Dermoid
  - d. Teratoma
7. Carcinomas
  - a. Primary thyroid
  - b. Metastatic to thyroid
8. Lymphoma of thyroid

## METHODS

Fifty nodular patients were studied prospectively in Department of General surgery, Rajarajeswari Medical College and Hospital Bangalore for a period of 2 years with prior approval of institutional Ethical Committee. The aim of study was to know the incidence of malignancy in solitary nodule Thyroid in our institute.

### Inclusion and exclusion criteria

Only those patients with clinical evidence of solitary thyroid nodule were taken up for the study, excluding malignant thyroid with secondary and recurrent thyroid nodule.

### Method of study

Study of "Incidence of malignancy in solitary thyroid Nodule" has been conducted by utilizing the cases diagnosed clinically as STN and treated on inpatient basis. All these cases were studied in detail clinically and conducted relevant investigations whatever indicated.

The investigations included haemoglobin, urine analysis, blood sugar, blood urea, blood grouping and Rh typing, thyroid profile, X-ray of the neck-AP & lateral views and chest x-ray and examination of vocal cords movements. All the patients were subjected to FNAC. All patients underwent surgery and all the excised thyroid specimen were sent for histopathological examination.

Patients were discharged after couple of days and advised for regular follow up with HPE reports.

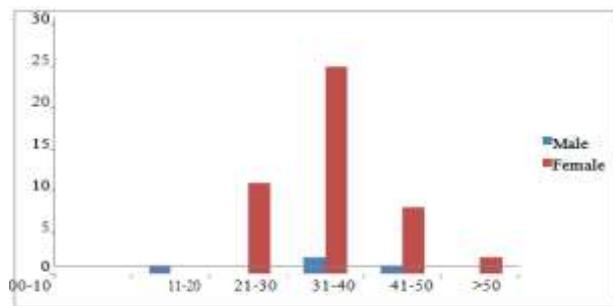
## RESULTS

In our study of 50 patients 4 (8%) were males and 46 were females (96%) with female to male ratio of 11.5:1. Age and Sex distribution of the patients studied 4% (2 cases) of the males presented in the age group of 31-40 years. Whereas majority of the females 72% (36 cases) presented in the age group between 21-40 years. In our study maximum age of presentation was 60 years and minimum age was 16 years with an average age incidence of 36.14 Years.

Histopathological examination proved to be papillary carcinoma in 6 cases, Hashimotos thyroiditis in 3 cases and 1 each showed follicular adenoma and follicular carcinoma and total incidence of malignancy in this study is 14%.

**Table 1: Age and Sex Incidence.**

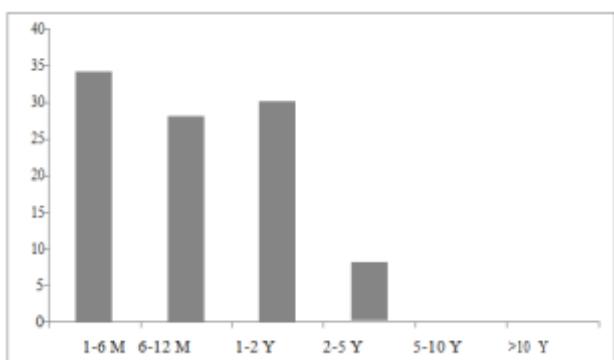
Age in years	Male	Female	Total	Percentage
00-10	0	0	0	0%
11-20	1	0	1	2%
21-30	0	11	11	22%
31-40	2	25	27	54%
41-50	1	8	9	18%
51-60	0	2	2	4%
61-70	0	0	0	0%
71-80	0	0	0	0%
Total	4	46	50	100%



**Figure 3: Age and sex incidence.**

**Table 2: Duration of swelling.**

Duration of swelling	Total no. of cases	Percentage
1-6 Months	17	34%
6-12 Months	14	28%
1-2 Years	15	30%
2-5 Years	4	8%
5-10 Years	0	0%
>10 Years	0	0%
Total	50	100%

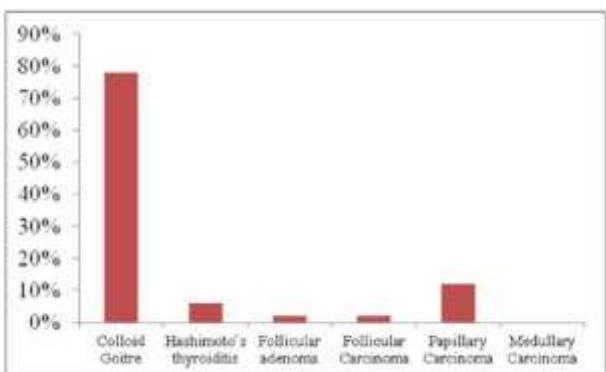
**Figure 4: Duration of swelling.**

Above figures shows maximum duration of swelling is less than 6 months and second most common duration is between 1-2 years.

**Table 3: Shows the incidence of malignancy.**

HPE report	Total No. of cases	Percentage
Colloid goitre	39	78%
Hashimoto's Thyroiditis	3	6%
Follicular adenoma	1	2%
Follicular carcinoma	1	2%
Papillary carcinoma	6	12%
Medullary carcinoma	0	0
<b>Total</b>	<b>50</b>	<b>100%</b>

This figures shows incidence of colloid goitre, Hashimoto's thyroiditis, follicular adenoma and carcinoma and papillary carcinoma.

**Figure 5: Shows percentage of malignancy.**

## DISCUSSION

Of the fifty cases studied, 4 were males (8%) and 46 were females (92%) with a female to male ratio of 11.5:1. In C.F. Nagori series the male to female ratio was 1:3.5.<sup>11</sup>

Table 1 and Figure 3 show the age and sex distribution of the patients studied. 4% (2 cases) of the males presented in the age group of 31-41 years. Whereas majority of the females 72% (36 cases) presented in the age group between 21-40 years. In Fenn<sup>12</sup> et al study the peak age incidence is 4<sup>th</sup> decade and in N.R. Anantha Krishnan study it is 3<sup>rd</sup> and 4<sup>th</sup> decade.<sup>13</sup>

In our study maximum age of presentation was 60 years and minimum age was 16 years with an average age incidence of 36.14 Years.

The Chief complaint in our patients was swelling in front of the neck. None of the patients had associated local symptoms like difficulty in swallowing or breathing. Duration of swelling ranged from 3 months to 5 years and 34% (17 cases) were seen in the range of 3months to 6 months. In Bhansali series 17.83% of cases presented between 3-6 months<sup>14</sup> (Table 2 and Figure 4).

Histopathological examination (Table 3 and Figure 5) proved to be papillary carcinoma in 6 cases, Hashimotos thyroiditis in 3 cases and 1 case showed follicular adenoma and follicular carcinoma respectively. Diagnosis of Follicular carcinoma preoperatively by FNAC was not possible as angio invasion and capsular invasion, which are features of follicular carcinoma, were not evident. This shows that FNAC is not 100% accurate in the diagnosis of follicular carcinoma.

Incidence of malignancy in this study was 14%, which corresponds with other studies where the incidence varies between 11-30%.<sup>15</sup>

The main indication for surgery in our series was cosmetic problem.

Of the 50 cases, 38 cases were subjected to Near Total thyroidectomy, 11 cases underwent Total thyroidectomy and 1 case for hemi thyroidectomy.

## CONCLUSION

Solitary nodule thyroid commonest disease of thyroid with high prevalence in females. Malignancy is around 14% and can come as surprise on post-operative HPE even when no suspicion by FNAC, which is comparable with others study. The main indication for surgery in STN are cosmetic or pressure symptoms or suspicious of malignancy. Near total thyroidectomy or lobectomy are the known surgeries for STN. Thorough surgical anatomy is must to prevent post-operative complications.

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*Ethical approval: The study was approved by the institutional ethics committee*

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