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### RESEARCH ARTICLE

#### ROLE OF RADIOLOGICAL INVESTIGATIONS IN SURGICAL MANAGEMENT OF THYROID SWELLING

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#### Abstract

**Background:** Thyroid nodules are most common clinical entity we come across in HEAD & NECK surgery. Evaluation of the extent of a big thyroid swelling is always a challenge. The clinical examination of thyroid swelling has limitations in its deeper and inferior extensions like retrosternal, retro esophageal, tracheal compression and also subclinical swelling. There are various investigatory modalities to assess the extent of swelling.

**Study Design:** Prospective observational study done on 200 patients who underwent surgery for thyroid swelling in whom preoperative investigatory findings were cross checked intra operatively and compared.

**Materials and Methods:** Total of 200 patients included in study, who were diagnosed clinically with thyroid swelling further investigated with Ultrasonography (USG), Computed Tomography (CT) scan, Magnetic Resonance Imaging (MRI) scan whenever necessary and their findings are compared with that of intraoperative findings.

**Results:** CT was supposed to be the best investigatory modality for assessing 3-dimensional view of thyroid swelling, the nature and vascularity of thyroid swelling is well documented by the Ultrasound(U/S), relationship to the surrounding structures when in doubt MRI proved to be advantageous.

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#### Introduction:

Thyroidectomy is the only treatment option for thyroid swellings. The first thyroidectomy was performed way back in 952AD by Albucasis and after some point of time, surgeons stopped performing the surgery because of its complications which eventually led to mortality<sup>[1]</sup>. In the 1860s Theodor Billroth undertook thyroid surgery but due to sepsis there was a high rate of mortality, he did thyroid surgeries until 1877 when antisepsis had become entrenched. Only then mortality was reduced to about 8%. In 1872 Theodor Kocher performed surgery with the precise dissection within the capsule, the mortality for his landmark surgery of simple goiter had fallen to less than 1%<sup>[2]</sup>. Kocher was awarded with Nobel Prize in 1909 for his remarkable work. From performing thyroid surgeries with an unpredictable outcome to performing minimally invasive thyroid surgeries, we have come a long way in improving our surgical skills and minimizing perioperative morbidity. The ease of the surgery depends upon the prior knowledge about size, extent, vascularity, relationship to surrounding structures, histopathological nature of

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the lesion, and surgeon's expertise. In clinical examination we can assess the type of lesion i.e., solid or cystic, and the extent of the lesion by height and width but not the depth. To an extent, ultrasound can assess the probable size, nature of swelling, and its vascularity. In radiological investigations for example, Ultrasound with all the recent advances and documentation like TIRADS score may give some idea regarding the nature of the swelling, vascularity, solitary or dominant in a multinodular and probability of benign or malignant nature by microcalcifications but it has limitations in assessing complete deeper extensions and the true pathological nature has to be confirmed only by FNAC. Patients with pressure symptoms, with suspicion of deeper extensions, infiltrations and not having complete information about extension in ultrasound were further investigated with CT and MRI. So prior knowledge about the three-dimensional extension of bigger swellings and its relationship to the surrounding vital structures will always be helpful in successful surgical execution.

The purpose of the study is to evaluate the efficacy of investigations in assessing the thyroid swelling so that surgical management can be less treacherous.

### Aim of the Study

To know the accuracy of radiological investigations in determining the size, nature, vascularity, type of swelling, extension, and relation to the surrounding structures.

### Materials and Methods:

This study was a prospective observational study undertaken in a tertiary health care center. Patients with thyroid swelling and willing for surgery were included in this study. After a clinical examination confirming thyroid swelling, ultrasound evaluation was done in all 200 patients. Patients with pressure symptoms, swelling size more than 5 cm on clinical and ultrasound examination, and patients with suspicion of infiltration and retrosternal extension were further evaluated with a CT scan if needed with contrast. A total of 70 out of 200 patients underwent CT scan. Further suspicion of adhesions and infiltration in CT were evaluated by MRI in 05 patients. These findings were crosschecked with intraoperative findings and HPE report.

### Observations and Results:

We compared the findings of clinical examination, USG, CT scan findings, and MRI with those of the intraoperative findings like the type of the lesion (cystic or solid), size of the lesion, vascularity, extension, adhesion to the surrounding structures, retrosternal or not, tracheal compression vs infiltration. Finally, conclusion is drawn accordingly.

Our study was conducted in 200 cases and we had done USG in all 200 cases and, out of 200 cases we had done CT for 70 cases and MRI for 05 cases.

### Type of Swelling

Clinical examination findings were compared with those of ultrasound and cross-verified with intraoperative findings (**Table-1**). The type of thyroid swelling in ultrasound findings does match with intraoperative findings.

**Table 1:-** Patients categorized into cystic and solid thyroid swelling.

MODALITY	Cystic (No. of patients with %)	Solid (No. of patients with %)
CLINICAL	40(20%)	160(80%)
ULTRASOUND	48(24%)	152(76%)
SURGICAL	48(24%)	152(76%)

### Size Grading

Clinical examination findings of the size of swelling were compared with that of Ultrasound, and CT scan and cross-checked with intraoperative findings (**Table-2**). Swelling with size less than 5 cm in clinical, ultrasound evaluation and size more than 5cm in CT evaluation do match with intraoperative findings.

**Table 2:-** Showing grading of size of thyroid swelling in different modalities.

SIZE GRADING (length in cms)	CLINICALLY (200cases)	ULTRASOUND (200 cases)	CT (70 cases)	SURGICALLY (200 cases)
3-5	120(60%)	120(60%)	0	120(60%)
5.1-7	54(27%)	58(29%)	42(60%)	46(23%)

>7.1	26(13%)	22(11%)	28(40%)	34(17%)
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### Type of Calcifications

Out of 200 patients, 20 patients had microcalcifications in ultrasonography and 08 patients had macrocalcifications in CT out of 70 patients.

Microcalcifications (punctate calcifications) in thyroid swelling have a high possibility of malignancy. Patients with microcalcifications in ultrasound mostly turned out to be malignant lesions on histopathological examination.

### Patients With Positive Lymph Nodes

Out of 200 patients, 10 patients had clinically palpable lymph nodes including 4 occult papillary lesions and ultrasonographically 22 patients had sub centimetric lymph nodes in FNAC-proven malignant cases. CT scan picked up clinically palpable lymph nodes but has not been able to pick up subcentimetric lymph nodes. Whereas all 22 patients had positive lymph nodes intraoperatively as picked up in ultrasound.

### Retrosternal Variation

Clinical examination findings with huge swellings were compared with those of ultrasound, and CT scan findings and cross-verified with intraoperative findings (**Table-3**)

**Table 3:-** Showing patients with retrosternal variation compared in various modalities.

MODALITY	Patients with retrosternal variation
CLINICAL	14
ULTRASOUND	14
CT	14
SURGICAL	14

### Retroesophageal Variation

Clinical findings with suspicion of deeper extension were compared with CT scan findings and were cross-checked with intraoperative findings (**Table-4**)

**Table 4:-** Showing patients with retro esophageal extension compared in various modalities.

MODALITY	Patients with retro esophageal variation
CLINICAL	10 (symptomatic)
ULTRASOUND	0
CT	20
SURGICAL	20

### Cases With Tracheal Compression

Clinical findings with suspicion of pressure symptoms were compared with CT scan findings and cross-checked with intraoperative findings (**Table-5**)

**Table 5:-** Showing patients with tracheal compression compared in various modalities.

MODALITY	Patients with tracheal compression
CLINICAL	12 (symptomatic)
ULTRASOUND	0
CT	20
SURGICAL	20

### Swelling Going Above Thyroid Cartilage

Clinical examination findings with swelling going above thyroid cartilage are compared with that of ultrasound, CT scan, and cross-verified with surgical findings (**Table-6**)

**Table 6:-** Patients with swelling above thyroid cartilage compared in various modalities.

MODALITY	Patients with swelling going above thyroid cartilage
CLINICAL	15
ULTRASOUND	16
CT	16
SURGICAL	16

### Discussion:

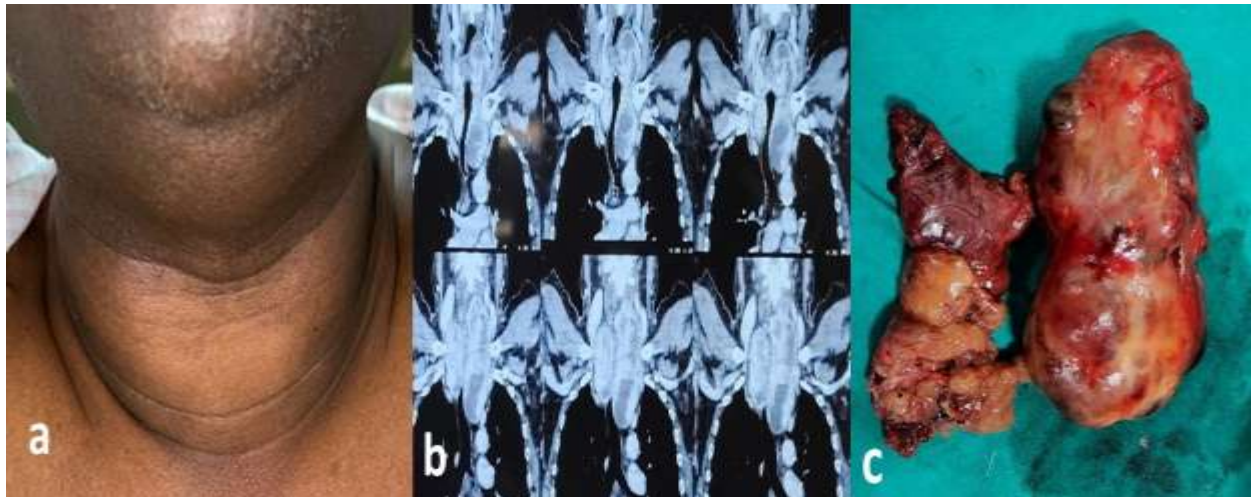
Thyroid surgery has indeed travelled a long and difficult path through the ages. Eventually, thyroidectomy from the dark ages advanced to minimally invasive surgery. In our current study, we tried to evaluate the efficacy and limitations of clinical and radiological examination (ultrasound, CT, MRI scan) in assessing the size, extension, nodularity, nature of the swelling, and its relation to the surrounding structures by cross-checking them with surgical findings.

Ultrasound is the best modality to know the type of thyroid swelling whether it is a cystic or solid, solitary nodule or a dominant nodule in otherwise multinodular goitre with subclinical nodules, multifocality of disease. To know the representative area for FNAC in cystic swelling or small nodules, ultrasound is useful. Ultrasound is an effective method of assessing swelling whether cystic or solid<sup>[3]</sup>.

Clinical and ultrasonographic evaluation was sufficient to evaluate thyroid swelling of small to medium size (up to 5 cm). Ultrasonography can accurately detect non-palpable nodules in the thyroid, estimate the size of nodules and differentiate simple cysts that have a low risk of being malignant from solid nodules<sup>[4]</sup>.

For large swelling (>5 cm) or swellings with pressure symptoms, a CT scan is always a better tool to assess the extension and its relation to the surrounding structures and also helpful in preoperative surgical planning. CT scan provides better information about the three-dimensional extension of the swelling. It provides information about the superior extension, retroesophageal extension, pressure exerted by the mass on the trachea, scabbing trachea, and probability of postoperative tracheomalacia, inferior extension, and even retro-sternal extension accurately. The information can be augmented by contrast study when needed. CT examination plays a crucial role in preoperative evaluation and surgical planning in swelling of large size (> 5 cm)<sup>[5]</sup>.

A retrosternal extension can be identified by clinical and ultrasonography but exact extension cannot be made out. On clinical suspicion and not being able to get below the swelling on palpation, we assessed the patients with a CT scan. CT scan is always a better diagnostic tool than other modalities to confirm the retrosternal component of thyroid swelling, assessing the extension and its relation to mediastinal structures. CT often aids in the preoperative assessment of the location and extent of intra-thoracic thyroid tissue in relation to major vessels<sup>[6]</sup>. All the findings in the CT are confirmed intraoperatively in our study and showing large gross specimen [Figure 1].



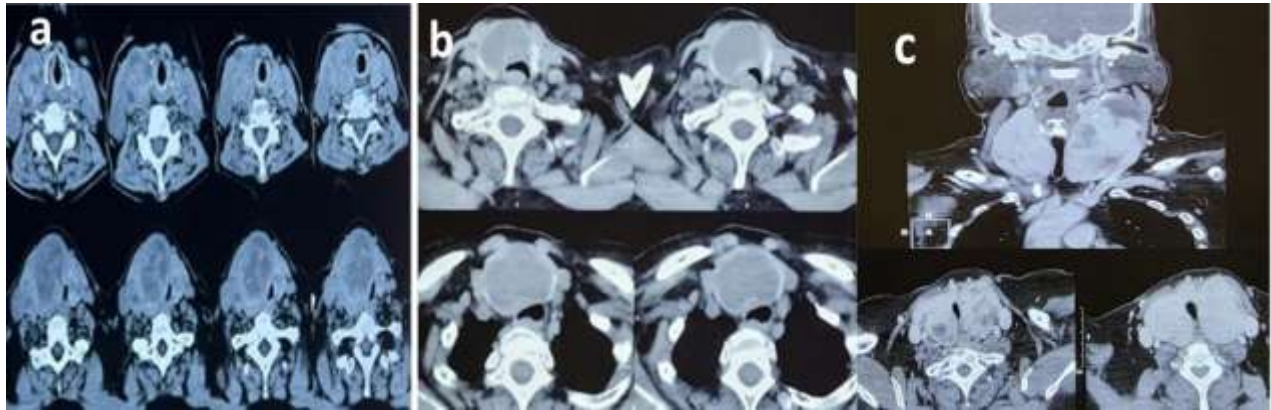
[Figure-1]:(a) preoperative image showing thyroid swelling of a symptomatic patient.

(b) on suspicious clinical & u/s examination pt was evaluated with CT which is showing retrosternal extension.

(c) gross specimen of the same patient with retrosternal extension.

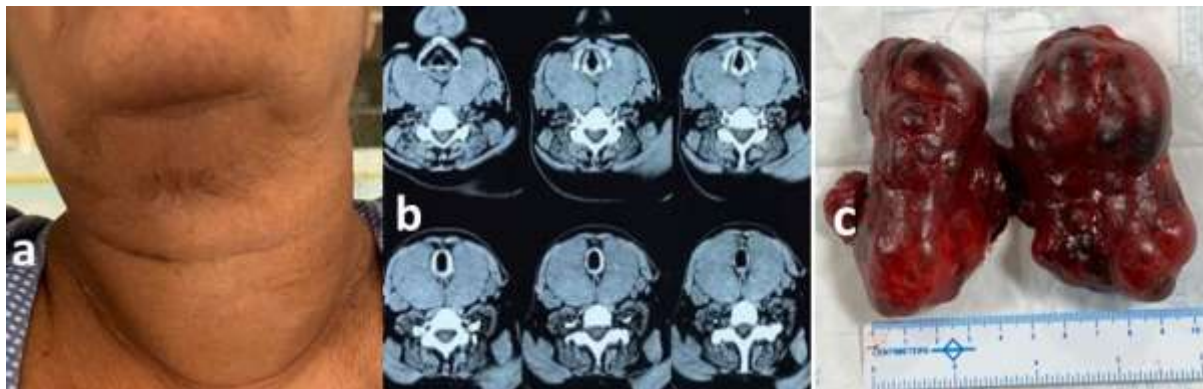
Three-dimensional volume may vary a bit when the CT scan findings were compared to that of intraoperative one, as swelling may be a bit compressed by the surrounding strap muscles, this is the only variation we came across with CT scan in our study.

Patients with complaints of difficulty in breathing were evaluated with ultrasound(U/S) and CT scan. In comparison to U/S, CT has the advantage of a better demonstration of the compression exerted by the mass on the trachea which narrows the tracheal lumen<sup>[6]</sup>. CT scan is always a better modality for assessing the airway compromise by exactly showing the mode of pressure exerted. Like a unidirectional swelling compressing the trachea on one side or anterior compression in the midline, or all around as seen in the scabbing trachea or even infiltration of the trachea by the mass.[Figure 2]



**Figure 2:-**(a) showing trachea compressed by thyroid swelling on the unilateral side.  
 (b)anterior compression of the trachea by thyroid swelling.  
 (c)compression of the trachea all around by thyroid swelling(scabbing trachea).

Retro esophageal extensions are better seen in CT, this is one extension that usually troubles the surgeon during the surgery and even poses a risk to the RLN. We usually miss that extension on clinical examination & ultrasonography. Diffuse thyroid swelling involving both lobes is the type of lesion that is usually associated with retroesophageal extension. Large thyroid swelling involving both the lobes of the thyroid gland is always better to be examined with CT scan to rule out the retroesophageal extension as they can present without any presenting complaints of dysphagia and no evidence in ultrasonography[Figure 3]. Our intraoperative findings confirm the CT scan findings totally in regards to retro esophageal extension. Despite the relationship between gland size and compressive symptoms, not all patients with an enlarged thyroid gland develop compressive symptoms. So, 15% of patients with large goiters are asymptomatic.<sup>[6]</sup>



**[Figure-3]:-**(a) clinical image of a symptomatic patient with thyroid swelling.  
 (b)CT image showing retro esophageal extension.  
 (c)postoperative gross specimen of retroesophageal extension patient.

One of the disastrous complications during thyroid surgeries is bleeding. Prior assessment of vascularity significantly alters the surgical outcomes. For assessing the vascularity of thyroid swelling, Ultrasound Doppler is always helpful whereas a CT scan has a limited role in assessing the vascularity. On Doppler examination, more flow is demonstrated in the central portion of the tumor than in the surrounding thyroid parenchyma and the most common pattern of vascularity in thyroid malignancy is the marked intrinsic hypervascularity<sup>[7]</sup>.

Regarding microcalcifications which can signify papillary carcinoma with specificity up to 95%, calcification if present within nodule has more possibility of malignancy<sup>[3]</sup>. CT can provide information about macrocalcifications alone. Ultrasonography is always a pioneer and is concluded as the better investigation to check for microcalcifications. In our study, almost all the cases that showed microcalcifications were confirmed to be malignant, to be papillary carcinoma in 15 patients, medullary carcinoma in 04 patients, and a follicular variant of papillary carcinoma in 01 patient.

USG is the preferred investigation to pick up small sub-centimetric lymph nodes whereas CT can pick up clinically palpable lymph nodes. USG should always include an evaluation of the neck for abnormal lymph nodes<sup>[8]</sup>. Level 6 lymph nodes may be positive for tumor deposits usually in case of malignant thyroid swelling which can be cleared simultaneously during thyroid surgery provided we have prior information. U/S does provide us with that information.

USG-guided FNAC allows targeting non-palpable nodules and representative sites in larger nodules. Nodules with non-diagnostic FNAC results because of inadequate cellular material or smaller nodules that are difficult to hold during FNAC procedure can be better done under U/S guidance<sup>[9]</sup>. USG-guided FNAC scores over conventional FNAC in cystic swellings as it would be helpful to target the specific area in the cyst wall, from where the representative sample can be obtained for diagnosis. Even in patients with multiple nodules, samples can be obtained from the most representative ones by U/S. USG-guided FNAC has higher sensitivity and specificity in the detection of thyroid neoplasm over conventional FNAC, which were correlated with HPE findings.

Whenever there is a suspicion of malignancy or an FNAC report is positive for malignancy, it is always useful to have a CT scan and MRI scan. For known malignancies, CT is helpful for detecting extra-thyroid invasion<sup>[10]</sup>. Preoperative imaging with CT is indicated if there is a concern for a local invasion that may alter the patient's staging as well as surgical approach.

CT scan gives us an idea about the capsular invasion and infiltration to the surrounding structures but will not be able to demarcate tissue planes. When the relation to the surrounding structures is in doubt MRI is more advantageous to delineate tissue planes and helps to know operability and all those findings were confirmed intraoperatively.

None of the radiological investigations are useful in localizing the normal parathyroid glands in our study. Preserving the parathyroid glands is better done by staying intracapsular as close to the gland as possible. To identify and locate the superior and recurrent laryngeal nerves, none of the radiological investigations were useful. Comprehensive knowledge of the anatomy and knowing all the variations of nerves and their relations to the surrounding structures is mandatory for preserving those structures.

### **Conclusion:-**

Advances in the field of medicine have reduced morbidity and mortality to a great extent. The investigations do let us know what exactly we are dealing with. Ultrasound is superior to a CT scan in differentiating the cystic and solid thyroid swellings. Ultrasound-guided FNAC is always superior to conventional method, especially in cystic lesions. The vascularity of thyroid swelling is well documented by ultrasound over CT. Thyroid swellings with large sizes (> 5 cm), CT plays an important role in three-dimensional assessment. CT scan plays a crucial role in preoperative evaluation and preoperative surgical planning for patients with symptomatic goitre that is with pressure symptoms, as it gives additional information regarding the posterior and retrosternal extension, compression, and mass effect on trachea and vulnerability to tracheomalacia postoperatively. Fixity to surrounding structures is in doubt or when tissue planes are not clear, an MRI scan is always useful. We came to the opinion that it is always better to evaluate larger thyroid swellings with a CT scan.

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