Original Research Article

Ultrasonography (USG) and multi-detector computerized tomography (MDCT) evaluation of thyroid swellings

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International Archives of Integrated Medicine, Vol. 4, Issue 9, September, 2017.

Available online at http://iaimjournal.com/
ISSN: 2394-0026 (P) **ISSN: 2394-0034 (O)**
Received on: 05-09-2017 **Accepted on:** 13-09-2017
Source of support: Nil **Conflict of interest:** None declared.
How to cite this article: Naveen Kumar S, Vidyadhara Rani P. Ultrasonography (USG) and multi-detector computerized tomography (MDCT) evaluation of thyroid swellings. IAIM, 2017; 4(9): 145-155.

Abstract

Background: Thyroid ultrasound has undergone a dramatic transformation from the cryptic deflections on an oscilloscope produced in A-mode scanning, to barely recognizable B-mode images, followed by initial low resolution gray scale, and now modern high resolution images.

Aim: The aim of the present study was to evaluate the diagnostic role of ultrasonography (USG) and multi-detector computed tomography (MDCT) in thyroid swellings, compare the ultrasonographic findings with multi-detector computed tomographic findings and to correlate the radiological findings with histopathological examination (HPE).

Materials and methods: The present study was carried out in the Department of Radiology, Kamineni Institute of Medical Sciences, Narketpally. In this study, 50 patients with thyroid gland swellings diagnosed clinically, referred to Radiology Department were selected during the period from October 2008 to September 2010. Histopathological examination was acquired in 35 cases. The study was carried out to observe the sensitivity, specificity and diagnostic accuracy of USG and MDCT in thyroid gland swellings.

Results: Maximum number of patients belonged to the age group of 21-40 years that was 27 cases (54.00%) and maximum number of patients were females – 41 cases (82.00%). Most common diagnosis was multi-nodular goitre on USG-16 cases (32.00%) and MDCT- 14 cases (28.00%), solitary thyroid nodule is common in the right lobe of thyroid by USG -5 cases (62.50%) and MDCT-5 cases (62.50%). Most common malignancy was papillary carcinoma of thyroid -5 cases (62.50%) and most common inflammatory disorder was hashimoto's thyroiditis -5 cases (10.00%).

Conclusion: The present study has concluded that USG is the fast and cost-effective modality of imaging investigation of choice in thyroid diseases and for differential diagnosis of thyroid nodules. MDCT is superior to ultrasound in evaluating retrosternal extension, relations and infiltrations in large lesions. It is also very helpful in evaluating extra-capsular, mediastinal, vascular invasion, lymph nodal involvement and metastasis. MDCT is very crucial in preoperative planning in malignancies of thyroid and large benign lesions.

Key words

Ultrasonography (USG), Multi-detector computed tomography (MDCT), Throid swellings and histopathological examination (HPE).

Introduction

USG

The potential of ultrasound as an imaging modality was realized as early as the late 1940's when utilizing sonar and radar technology developed during World War II. Several groups of investigators around the world started exploring diagnostic capabilities of ultrasound like Goldberg and Kimmelman [1].

In the early1950s, John Wild and John Reid in minnesota developed a prototype B-mode ultrasonic imaging instrument and were able to demonstrate the capability of ultrasound for imaging and characterization of cancerous tissues at frequencies as high as 15 MHz [1]. Thus, the thyroid was among the first organs to be well studied by ultrasound. The first reports of thyroid ultrasound appeared in the late 1960's [1]. Between 1965 and 1970 there were seven articles published specific to thyroid ultrasound. In the last five years there have been over 1,300 published [1].

Thyroid ultrasound has undergone a dramatic transformation from the cryptic deflections on an oscilloscope produced in A-mode scanning, to barely recognizable B-mode images, followed by initial low resolution gray scale, and now modern high resolution images [1].

MDCT

Godfrey Hounsfield developed the first CT scanner in 1972 with the help of a company called Electric and Musical Industries Ltd, CT has developed and modified enormously from first generation to sixth generation and to recent seventh generation (MDCT) in 2002.

Advantages of MDCT are efficient use of x-ray beam with increasing slices, reduction of radiation dose, faster acquisition, thinner slices for better z-axis resolution, isotropic imaging and improved spatial and temporal resolution [2-5].

Materials and methods

The present study was a retrospective study carried out in the Department of Radiology, Kamineni Institute of Medical Sciences (KIMS), Narketpally. In this study, 50 patients with thyroid gland swellings diagnosed clinically, referred to radiology department were selected during the period from October 2008 to September 2010. Histopathological examination was acquired in 35 cases. Histopathological diagnosis was considered as gold standard for confirmation .The study was carried out to observe the sensitivity, specificity and diagnostic accuracy of USG and MDCT in thyroid gland swellings.

Inclusion criteria

- All the patients of various age groups presenting with thyroid swellings were included.
- Patients with derangement of T3/T4/TSH values referred from outpatient departments were included.

Exclusion criteria

- Known malignancies.
- Trauma cases.

- Established cases of thyroid diseases under treatment.

Procedure

USG

All Ultrasound examinations were performed on ESAOTE MY LAB XVISION 50 AND PHILIPS ENVISOR ultrasound machines. Patient is examined in the supine position with an extended neck. A pillow is placed under the shoulders to provide better exposure of the neck. Since the gland is situated superficially, 7.5-10 MHz linear array transducer is used. Blood flow can be studied using duplex sonography, in which gray scale 2D sonography is combined with pulsed doppler.

With color Doppler imaging (CDI), the pulsed doppler information is encoded for flow direction and (mean) flow velocity and displayed in the 2D image. CDI is generally used to examine intravascular flow, while the more sensitive power doppler is used to detect parenchymal flow.

The entire thyroid from upper to the lower pole and the isthmus are examined in the longitudinal and transverse planes. The region of the carotid arteries and jugular veins laterally and supra clavicular fossa are also examined for any lymphadenopathy.

MDCT

All cases were performed on MDCT SIEMENS SOMATOM EMOTION (6 SLICE MDCT). Patients were typically scanned in the supine position with the neck mildly hyperextended so that the hard palate is roughly perpendicular to the tabletop. When possible, the patient is scanned with quiet breathing and swallowing suspended.

Contiguous 5 mm thick axial sections are obtained from the level of the cavernous sinuses (upper level of the external auditory canal) to the superior mediastinum, including the aortic arch. In cases where small lesions are being evaluated, thinner sections (1.25 to 2 mm) reconstructions are obtained Sagittal and coronal reconstructions are made. Contrast enhanced MDCT is performed after injecting 100ml of iv non-ionic contrast (ioversol/ iohexol) at the rate of 4-5ml/ sec. Arterial, venous and delayed phases are obtained**.**5mm axial sections are obtained with 1.25 to 2 mm reconstructions.

Results

In the present study, 50 patients with thyroid gland swellings diagnosed clinically, referred to radiology department were selected. Histopathological examination were acquired in 35 cases. The lesions were classified into nodular, diffuse thyroid and malignant. Maximum number of patients belong to the age group of 21-40 years-27(54.00%) and maximum number of patients were females - 41(82.00%) as shown in (**Table - 1**). Benign lesions were the commonest (84.00%) among all the thyroid swellings, with 21-40 year age group being predominantly involved (54.00%).

Malignant lesions (18.00%) were affected most commonly in the age group of 41-60 years. The predominant lesions were papillary carcinoma (62.50%) followed by follicular carcinoma (38.50%) of thyroid gland (**Table – 2**).

Most common diagnosis was multi-nodular goitre in USG-16 (32.00%) and MDCT-14 (28.00%). Solitary thyroid nodule was common in the right lobe of thyroid by USG - 5 (62.50%) and MDCT-5 (62.50%). Most common malignancy was papillary carcinoma of thyroid - 5 (62.50%) and most common inflammatory disorder was hashimoto’s thyroiditis - 5 (10.00%) (**Figure – 1, 2, Table - 3**).

Discussion

The role of Ultrasonography in the diagnosis of thyroid diseases is becoming increasingly important as it allows detection of cystic lesions as small as 2 mm in size and solid nodules as small as 4 mm, as quoted by Caroll BA (1982) [6] and reiterated by Luigi Solbiati, et al. (1985) [7].

Table- 1: Age and sex distribution of cases (n=50).

Age group (years)	Females n(%)	Males n(%)	Total n(%)
0-10	--	--	--
11-20	2(4.00)	--	2(4.00)
21-30	12(24.00)	2(4.00)	14(28.00)
31-40	11(22.00)	2(4.00)	13(26.00)
41-50	3(6.00)	4(8.00)	7(14.00)
51-60	8(16.00)	1(2.00)	9(18.00)
61-70	2(4.00)	--	2(4.00)
71-80	3(6.00)	--	3 (6.00)
Total	41(82.00)	9(18.00)	50(100.00)

Table – 2: Categorization of USG and MDCT diagnosis of thyroid swellings (n=50).

Categorization of thyroid swellings	USG diagnosis n (%)	MDCT diagnosis n (%)
Nodular thyroid diseases	27(54.00)	25(50.00)
Diffuse thyroid diseases	11(22.00)	11(22.00)
Malignant	12(24.00)	14(28.00)
Total	50(100.00)	50(100.00)

Figure - 1: USG diagnosis of thyroid swellings (n=50).

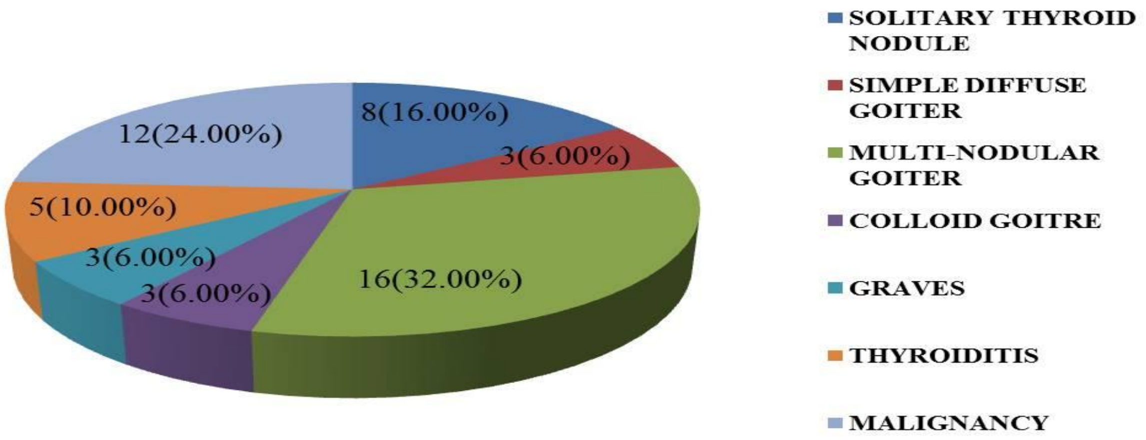


Figure – 2: MDCT diagnosis of thyroid swellings (n=50).

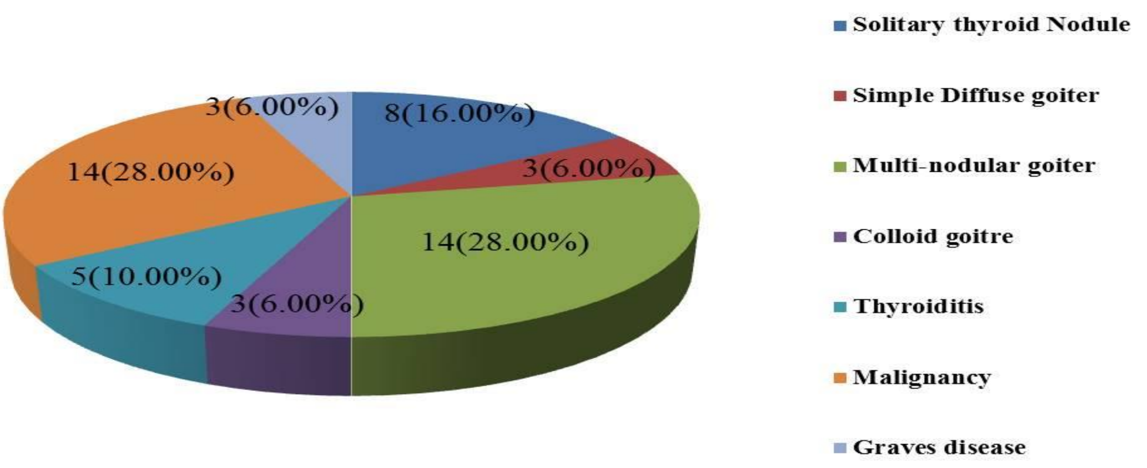


Table - 3: Histopathological diagnosis of thyroid swellings (n=35).

Histopathological diagnosis	**n(%)**
Multinodular goitre	12(34.28)
Malignancy	8(22.85)
Solitary thyroid Nodule-benign (Follicular adenoma)	6(17.14)
Colloid goitre	3(8.58)
Hashimoto's thyroiditis	3(8.58)
Simple diffuse goitre	2(5.72)
Graves disease	1(2.85%)
Total	35(100.00)

Table - 4: Correlation of USG diagnosis with MDCT diagnosis (n=50).

MDCT **USG**	**Positive for malignancy**	**Negative for malignancy**	**Total**
Positive for malignancy	10(TP)	1(FP)	11
Negative for malignancy	2(FN)	37(TN)	39
Total	12	38	50

TP-true positive; FN-false negative; FP-false positive; TN-true negative

2 False negatives were large goiter mimicking malignancy on MDCT

1 False positive was cystic nodule with solid component which was misdiagnosed as malignancy on USG

- Sensitivity (TP / TP + FN)X100 = 83.33 %
- Specificity (TN / TN + FP)X100 = 97.36 %
- Positive predictive value (TP / TP + FP)X100 = 90.90 %
- Negative predictive value (TN / TN + FN)X100 = 94.87 %
- False positive rate (FP / TN + FP)X100 = 2.63 %
- False negative rate (FN / TP + FN)X100 = 16.66 %
- Overall efficacy (TP+ TN / Total no of cases) = 94.00%

Table – 5: Correlation of USG diagnosis with histopathological diagnosis (n=35).

HPE **USG**	**Positive for malignany**	**Negative for malignany**	**Total**
Positive for malignancy	7(TP)	1(FP)	8
Negative for malignancy	1(FN)	26(TN)	27
Total	8	27	35

TP-true positive; FN-false negative; FP-false positive; TN-true negative

1 False negative was malignant nodule which was misdiagnosed as benign nodule.

1 False positive was cystic nodule with solid component diagnosed as malignancy on USG but HPE confirmed as benign nodule

- Sensitivity (TP / TP + FN)X100 = 87.50 %
- Specificity (TN / TN + FP)X100 = 96.29 %
- Positive predictive value (TP / TP + FP)X100 = 87.50 %
- Negative predictive value (TN / TN + FN)X100 = 96.29 %
- False positive rate (FP / TN + FP)X100 = 3.70%
- False negative rate (FN / TP + FN)X100 = 12.50%
- Overall efficacy (TP+ TN / Total no of cases) = 94.28%

Table – 6: Correlation of MDCT diagnosis with histopathological diagnosis (n=35).

MDCT HPE	Positive for malignancy	Negative for malignancy	Total
Positive for malignancy	6(TP)	2(FP)	8
Negative for malignancy	2(FN)	25(TN)	27
Total	8	27	35

TP-true positive; FN-false negative; FP-false positive; TN-true negative

2 False negatives were Follicular ca and papillary ca which were misdiagnosed as benign lesions on MDCT. 2 False positives were large goitre mimicking malignancy on MDCT.

- Sensitivity (TP / TP + FN)X100 = 75.00 %
- Specificity (TN / TN + FP)X100 = 92.59 %
- Positive predictive value (TP / TP + FP)X100 = 75.00 %
- Negative predictive value (TN / TN + FN)X100 = 92.59 %
- False positive rate (FP / TN + FP)X100 = 7.40%
- False negative rate (FN / TP + FN)X100 = 25.00%
- Overall efficacy (TP+ TN / Total no of cases) = 88.57%

USG when compared with MDCT has a better sensitivity of 83.33 % and specificity of 97.36%.

2 false negatives were large goiter mimicking malignancy on MDCT and 1 false positive was cystic nodule with solid component which was misdiagnosed as malignancy on USG.

USG when compared with Histopathological examination (HPE) has a better sensitivity of 87.50 % and specificity of 96.29%.1 false negative was malignant nodule which was misdiagnosed as benign nodule and 1 False positive was cystic nodule with solid component diagnosed as malignancy on USG but Histopathological examination confirmed as benign nodule (**Table – 4, 5, 6**).

MDCT when compared with HPE has a sensitivity of 75.00% and specificity of 92.59%.2 False negatives were follicular carcinoma and papillary carcinoma which were misdiagnosed as benign lesions on MDCT and 2 false positives were large goitre mimicking malignancy on MDCT.

Table – 7: Comparative study of differential diagnosis of thyroid nodules by USG (n=27).

Author	Sensitivity	Specificity
IShigaki, et al. [16] (2004) N=30	85.7%	93.8%
Present study N=27	87.50 %	96.29%

Table – 8: Comparative study of differential diagnosis of thyroid nodules by MDCT (n=25).

Author	Sensitivity	Specificity
IShigaki, et al. [16] (2004) N=30	78.6%	81.3%
Present study N=25	75.00%	92.59%

Table – 9: Comparative study of sonographic features of malignant lesions (n=10).

Sonographic Characteristics	Kim, et al. (2002) [17] N=49	Present study N=10
Microcalcification	29 (59.18)	6(60.00)
Irregular or microlobulated margin	27 (55.10)	4(40.00)
Marked hypoechogenicity	13 (26.53)	4(40.00)
More tall than wide	16 (32.65)	3(30.00)

Table – 10: Comparison of hypoechogenicity in malignancies by USG (n=12).

Author	Hypoehcogenecity with adjacent normal thyroid tissue- n(%)
Lin JD, et al. (1997) [18] N=21	16 (76.19)
Present study N=12	9 (75.00)

Table – 11: Categorization of MDCT diagnosis of thyroid swellings (n=30).

Author	Multi nodular goitre N (%)	Graves disease N (%)	Hashimoto's thyroiditis n (%)	Adenoma N (%)	Carcinoma N (%)
Paul M. Silverman, et al. (1984) [19] N=18	12(66.66)	2(11.11)	1(5.5)	1(5.5)	2(11.11)
Present study N=50	14(28.00)	3(6.00)	5(10.00)	--	11(22.00)

Table - 12: Comparison of retrosternal extension in thyroid swellings.

Author	Retrosteral extension N(%)
Paul M. Silverman, et al. (1984) [19] N=18	6 (33.33)
Present study N=50	15(30.00)

Figure – 3: USG and MDCT Enlarged gland with multiple nodules suggestive of Multi nodular goiter.

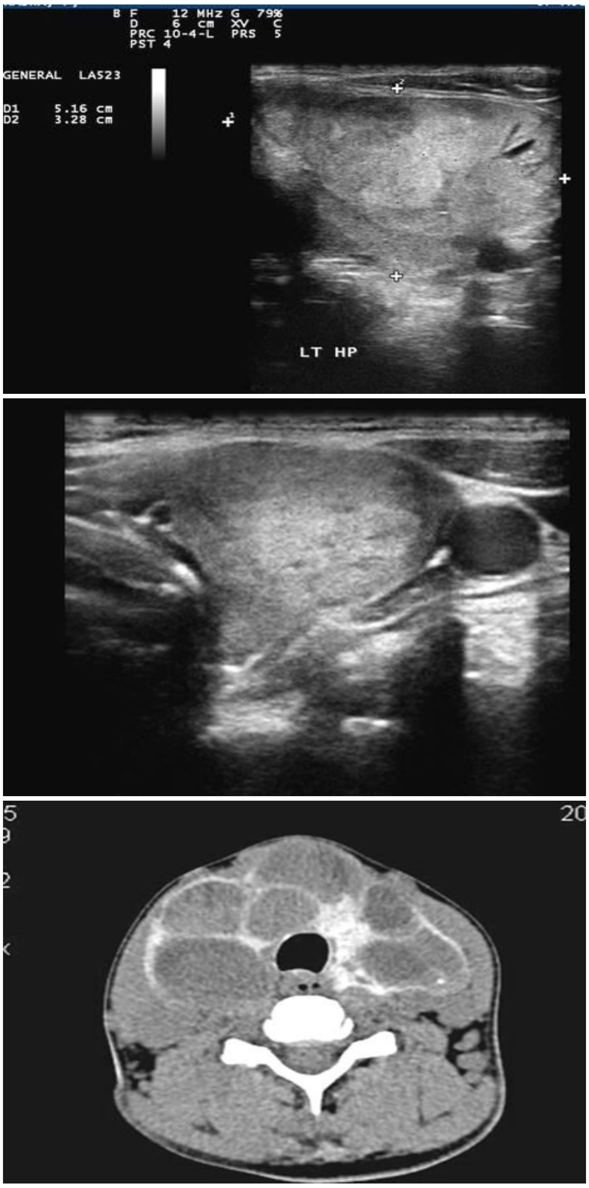
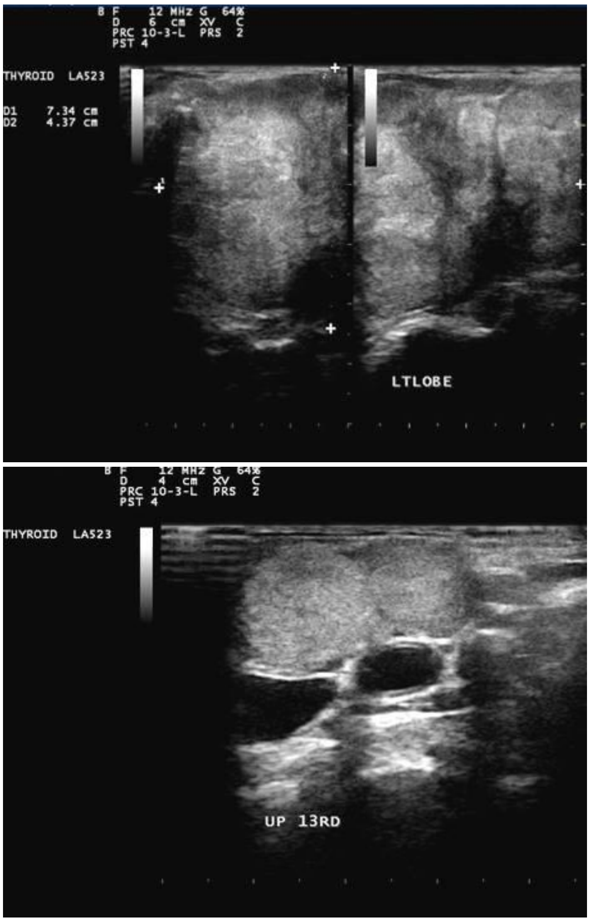


Figure – 4: USG and MDCT showing large adenomatous goitre with retrosternal extension.

Figure – 5: USG and MDCT showing thyroid Malignancy with soft tissue infiltration, vascular invasion, destruction of cricoid cartilage with vocal cord infiltration, multiple enhancing metastatic cervical lymph nodes with expansile lytic bony metastasis and lung metastasis.



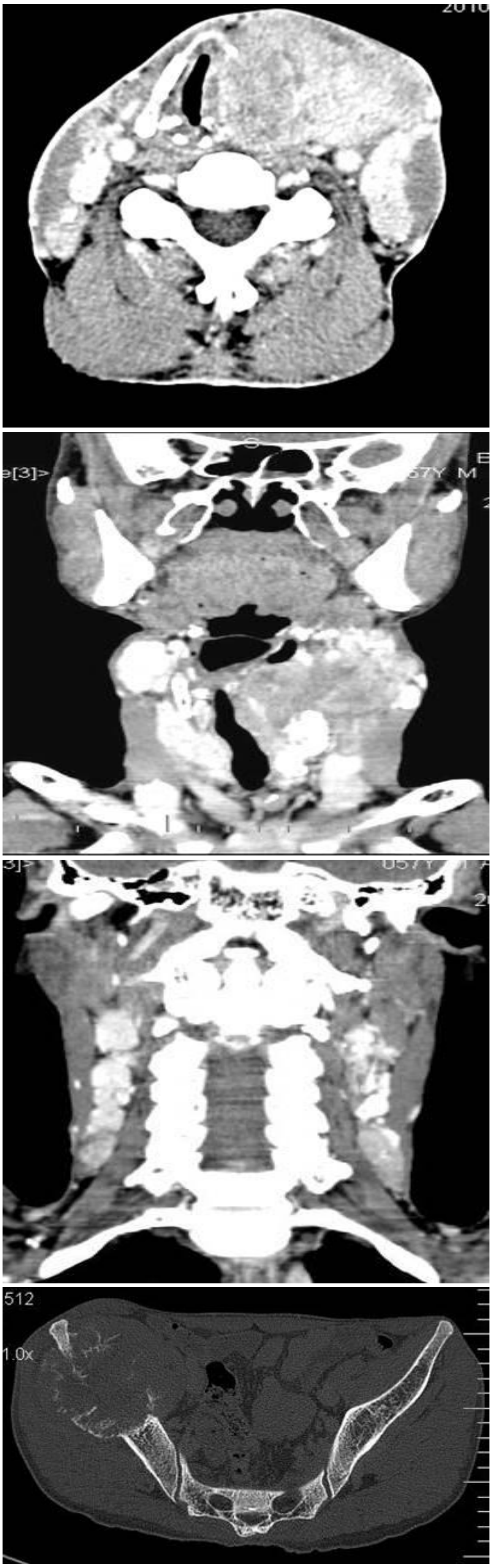
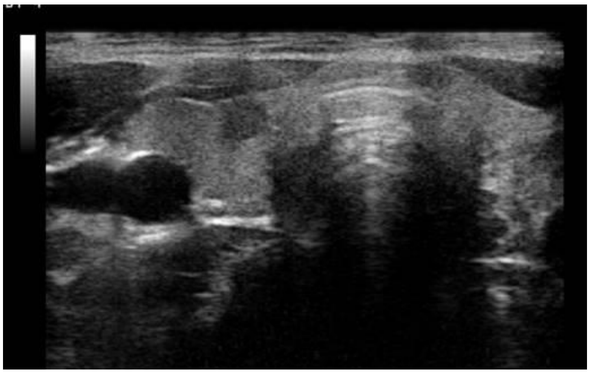
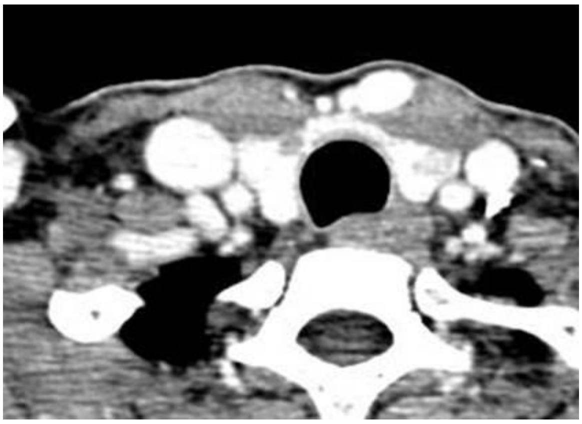
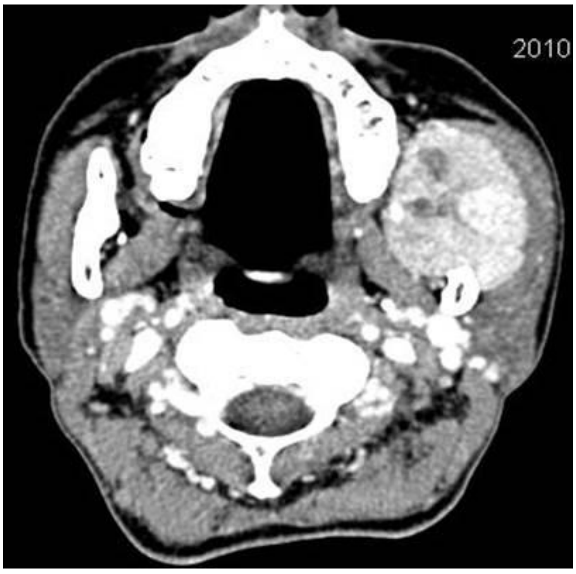
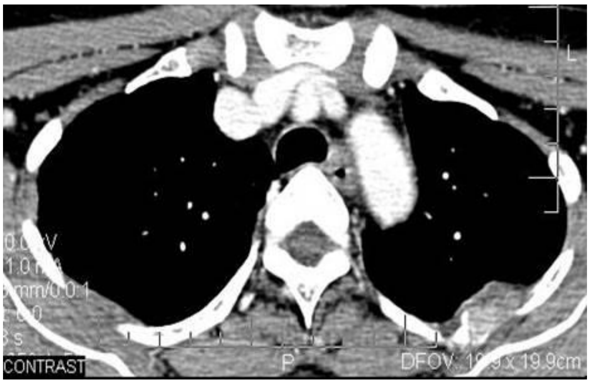


Figure – 6: USG and MDCT showing occult thyroid malignancy with mandibular and rib metastasis.









The high prevalence of thyroid disease in the age group between 20-40 years, was quoted by Luigi solbiati, al. (1985) [7].

In present study we found that the age group of 21 to 40 years were the mostly affected people 27/50 patients (54%).

According to Ousehal A, et al. (1994) [8] the characteristics of benign lesions have well defined margin, thin complete peripheral sonoluscent halo, and thick macro-calcifications found in 42/63 (66%). In our series 5/8 (62.50%)

benign thyroid nodule patients showed the above features.

Three cases of graves disease presented with diffuse enlargement of thyroid with thyroid inferno pattern on colour Doppler, similar findings were found by Ralls, et al. (1988) [9].

Three cases of colloid goitre showed comet tail artifact on USG (100%), similar findings were found by Ahuja A (1996) [10].

Three out of five cases of hashimotos thyroiditis showed micronodulation (60.00%). Yeh, et al. (2003) [11] found serologic evidence of Hashimotos thyroiditis in 54 of 57(94.73%) patients who had diffuse micronodulation pattern on sonography and Bhatia, et al. [12] has found similar pattern in 48 out of 76 patients.(63.00 %).

Total malignancies proved by HPE are eight cases, among them five cases were papillary carcinoma, two cases were follicular carcinoma, one case was hurthle cell carcinoma.

Five cases of malignancies presented with metastasis, three cases of papillary carcinoma presented with lymph nodal metastasis, one case of papillary carcinoma with lymph nodal, lung and bone metastasis, one case of follicular carcinoma with bone and soft tissue metastasis.
Among five cases of papillary carcinoma, three cases showed lymph nodal metastasis which are hypoechoic with loss of hilum, minimal axial diameter varied between 6 to 15mm,similar findings were quoted by Rosario PW, et al. (2005) [13].

Three cases of papillary carcinoma presented with lymph nodal metastasis, three cases of metastatic nodes in papillary carcinoma showed marked enhancement (hypervascular) on MDCT, similar findings were found by Weber AL (2010) [14].

Among five cases of biopsy proved papillary carcinoma, four cases showed microcalcifications on USG (80%), similarly 10 out of 11 cases (90%) were found to have microcalcifications on USG by kwak YJ, et al. (2007) [15]. Comparison with other studies [16-19] were as per **Table – 7 to 12**.

Conclusion

USG is a reliable modality in the investigation of thyroid swellings. It helps to differentiate focal from diffuse, solitary or multiple, cystic or solid thyroid swellings. Hashimoto's thyroiditis, graves disease and colloid goiter were successfully differentiated from solitary, multinodular and diffuse goiters entirely on the basis of ultrasound and color doppler sonography findings. USG has better sensitivity and specificity when compared with MDCT in the differentiation of benign from malignant nodules. MDCT is superior to ultrasound in evaluating retrosternal extension, relations and infiltrations in large lesions, extra-capsular and vascular invasion, lymph nodal involvement and metastasis. MDCT is very crucial in preoperative planning in malignancies of thyroid and large benign lesion.

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