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Characterization of Thyroid Lesions with High Resolution Ultrasonography and Colour Doppler: A Case Series.

Dhaval K. Thakkar, Sanjay M. Khaladkar, Dolly K. Thakkar, Mansi N. Jantre, Vilas M. Kulkarni, Amarjit Singh.

Abstract:
BACKGROUND: *Diffuse and focal thyroid disease is common thyroid disorder. Incidence of nodularity within thyroid is high (50-70%).Ultrasound is the most sensitive imaging test available for the examination of the thyroid gland. It confirms presence of a thyroid nodule when the physical examination is equivocal and differentiate between thyroid nodules and cervical masses from other origin. Incidence of thyroid cancer is low (<1% of all malignancies). The dilemma for the radiologist is how to identify the few thyroid cancers present within a multitude of benign thyroid nodules.**AIM AND OBJECTIVES:** To evaluate the role of high resolution Ultrasonography and Doppler in thyroid lesions (diffuse& nodular thyroid disease);in differentiating benign and malignant thyroid nodules &to correlate with FNAC in relevant cases.**MATERIAL AND METHODS:** Prospective analysis of 100 patients of clinically enlarged thyroid was done on USG (Gray scale and color doppler).* ***RESULTS:*** *30% were male and 70% were females with high incidence in 3rd decade. 67% cases had diffuse thyroid disease while 33% cases had nodular thyroid disease. Out of 67 cases of diffuse thyroid disease, 46 (68.65%) were multinodulargoiter, 10(14.92%) were Grave's disease and 11(16.41%) were Hashimoto's thyroiditis. Out of 33 cases of nodular thyroid disease, 10(30.30%) were colloid cyst& hyperplastic nodule each, 8(24.24%) had solitary benign adenoma, 4(12.12%) were carcinoma& 1(3.03%) was of focal thyroiditis. Thin complete peripheral halo(48.48%), well defined margins(84.84%), egg shell calcification(3.03%), hyperechoic(33.33%) nodules, peripheral and internal vascularity(33.33%) favored benign etiology. Thyroid inferno(100% cases) favored Graves disease, micronodular pattern(58.33%) in diffuse thyroid disease favored Hashimotos' thyroiditis.* ***CONCLUSION:*** *B-Mode and Color Doppler helps in characterization and differentiation of various thyroid lesions.*

Keywords : *Thyroid; nodule; ultrasonography (US), Color Doppler.*

I. Introduction

Due to its superficial location it is the only endocrine gland accessible for direct physical and Ultrasonography (USG) examination.Thyroid disorders are the most common amongst all the endocrine diseases in India.[1]

Thyroid abnormalities are relatively common in general population. The clinical spectrum of thyroid diseases varies from a simple benign goitre to a profound malignancy.

Before the advent of high resolution ultrasound, scintigraphy was the chief means to evaluate the thyroid gland both functionally and morphologically. But it was found to be nonspecific and needed supplementation by other imaging modalities, especially for evaluation of isotopically cold nodules.

Ultrasonography is safe, simple, radiation free, non-invasive, economically affordable and yet effective method for detection of abnormalities of the thyroid gland. Moreover, due to the superficial location of the gland, it is ideally situated for sonographic examination with high frequency probes. The most useful way to image the thyroid gland and its pathology was by using ultrasonography, as recognized in the guidelines for managing thyroid disorders published by the American Thyroid Association.[2] Besides facilitating the diagnosis, it also covers the multitudes of clinically unapparent thyroid nodules, most of which are benign.

Thyroid ultrasound differentiates solid from cystic lesions, solitary nodules from multinodular and diffuse enlargement, and extra thyroidal lesions. Transducers of frequencies higher than 10 MHz make possible visualization of nodules as small as 1 millimetre. Nearly 50% of patients with a clinically suspected solitary thyroid nodule had avoided surgery by thyroid scanning.[3]

Sonography is used to determine the character and number of lesions, to differentiate thyroidal from extra-thyroidal masses, to follow the response of drugs in patients on thyroid suppression therapy, to monitor those with increased risk for thyroid cancer and to guide fine needle aspiration.

The newly developed high resolution ultrasonography with Color Doppler flow mapping reveals fine details of the thyroid gland and the hemodynamic features of thyroid neoplasm. [4] Thus, a combination of

conventional sonography and color flow Doppler increases the screening sensitivity and accuracy in distinguishing benign and malignant thyroid nodules. [5]

With this background, this study was carried out to assess the role of high resolution ultrasonography in evaluation of enlarged thyroid gland.

II. Material And Methods

A prospective study was carried out on 100 patients in the Department of Radio-diagnosis, in a tertiary care teaching hospital, over a period of 2 years from December 2011 to December 2013. Institute Ethics Committee Clearance was obtained before the start of the study.

Patients from all age groups including both men and women with clinically enlarged thyroid gland were included. Patients with history of any thyroid surgery or radiation therapy were excluded. Patients with physiological causes of thyroid enlargement were also excluded.

The study was carried with either ACUSON X300 PE (Premium Edition) or ACUSON Antares (Siemens co. Ltd. Munich, Germany). A high frequency linear transducer (7.5 to 12 MHz) was used to image the superficially located thyroid gland as it provided high definition images with a spatial resolution of 0.7-1.0mm. However, a 3.5–5 MHz convex probe was sometimes more convenient for measurements of large thyroids.

The proforma was designed based on the objective of the study and it was pretested and used after modification. Detailed clinical history, physical and systemic examination findings were noted in addition to the laboratory investigations.

No special preparation of patient for thyroid US was required. The patient was positioned supine, with the neck extended. A small pad was placed under the shoulders to exaggerate the neck extension for better exposure of the neck. The examiner operates from the head end on patient's right. The transducer was steadied by resting the wrist and proximal forearm on the patient's chest. The Ultrasound (US) probe was positioned on the front surface of the neck and moved from the suprasternal notch to the hyoid bone. The thyroid gland was examined in transverse, longitudinal and oblique planes in order to visualize the entire gland including upper and lower poles. In case of suspected retrosternal extension, imaging of lower poles was enhanced by asking the patient to swallow, as it momentarily raised the thyroid gland. The entire gland including the isthmus was examined.

The examination was conducted in two parts as grey scale and Doppler imaging. Initially the examination was performed using grey scale imaging for location, dimensions, margins (regular, irregular), shape, echo density (normal, increase and decrease), echo structure (homogeneous, heterogeneous) of the thyroid gland. Thyroid abnormalities were observed with respect to character of changes (diffuse, focal and mixed), location (in right or left lobe, both lobes, isthmus), number of lesions, contours (sharpness), borders (smoothness), dimensions (in three perpendicular planes), echo density and echo structure. Following this, relations of the thyroid with surrounding structures was noted. Finally, the status of regional cervical lymph nodes was evaluated.

Sonography was performed with both low and high gain sensitivity settings particularly at points of interest or where differentiation of solid and cystic lesions was necessary. The scan was extended superiorly from the level of submandibular gland upto the level of clavicles. The examination was extended laterally to include the region of carotid artery and internal jugular vein so as to visualize enlarged lymph nodes. [6]

Second part of the examination was carried out by using Doppler in order to assess the vascularity. Vascularity of the thyroid parenchyma was observed and categorized as one of these – (a) avascular: no colour spots; (b) hypo-vascularity: 2-3 colour spots; (c) moderate vascularity: 5-6 colour spots and (d) hyper vascularity: peripheral rim as well as multiple arterial and venous vessels appear.

In case of a lesion – presence of central or peripheral flow was noted. The peak systolic velocity (PSV) of inferior thyroid artery and or superior thyroid artery was assessed. The normal PSV is 15-19 cm/sec.

III. Results

Ultrasonography was done in hundred patients having clinically enlarged thyroid gland. Out of which, thirty patients were males (30%) and seventy patients were females (70%). Hence females were more commonly affected than males. The age of patients ranged from 11 years to 60 years. It is clear from the table that the 3rd decade showed highest incidence followed by 4th decade. The incidence amongst females was also highest in 3rd decade. The youngest case in the study was a 15 years old boy and oldest case was of 60 year old lady (Table 1).

Every patient in the study had come with chief complaint of a swelling in front of the neck (100%). Other various symptoms with which patients presented are listed in the table (Table 2). Some patients presented with more than one complaint.The duration of swelling ranged from 6 months to 10 years (Table 3). The longest

history was that of a woman aged 60 years with duration of swelling of 10 years. The shortest duration was that of 6 months in 8 patients.

Out of 100 cases, clinical examination showed diffuse thyroid disease in 67 cases and nodular thyroid disease in 33 cases. Of which maximum were suspected to have multinodular goiter. The size of the nodules varied in our study from 1cm to 6cm. Ultrasonography showed diffuse thyroid 67 cases (67%) and nodular thyroid disease in 33 (33%) cases. (Table 4)

Out of 67 cases of diffuse thyroid disease, Multi Nodular Goiter (MNG) were detected in 46/67 cases (68.65%), Graves disease in 10/67 (14.92%) cases and Hashimoto's thyroiditis in 11/67 (16.41%) cases (Table 5A). Out of 33 cases of nodular thyroid disease on USG, 10 cases (30.30%) were detected to have hyperplastic nodule, 10 cases (30.30%) were of colloid cyst, 8 cases (24.24%) had solitary benign adenoma, 4 cases (12.12%) were carcinoma of thyroid and 1 case (3.03%) was of focal thyroiditis (Table 5B). FNAC was done in cases of nodular thyroid disease and in Hashimoto's thyroiditis and the findings of USG examination were corroborated with histo-pathological examination (Table 6).

In 46 cases of MNG, nodules were wider than tall in 46 (100%) cases, margins were well defined in 46 (100%) cases, thin complete regular peripheral halo was seen in 36 (78.26%) cases, 26 (56.52%) cases were solid, 10 (21.74%) were predominantly solid, 5 (10.86%) cases were predominantly cystic, while 5 (10.86%) were cystic. 18 (39.13%) were hyperechoic, 8 (17.39%) cases were isoechoic, 10 (21.74%) were mixed echoic and 10 (21.74%) were anechoic. Macro-calcification was present in 28 (60.86%) cases. On color Doppler, peripheral flow was seen in 27 (58.69%) cases, peripheral and internal flow was seen in 10 (21.74%) cases (Table 7). [Figure 1]

12 cases were detected to have Hashimoto's thyroiditis, of which 11 (91.66%) cases were diffuse where as 1 (8.33%) case was focal (Table 8A). 4/12 (33.33%) cases were heterogeneously hypoechoic, 7/12 (58.33%) cases showed, micro-nodular pattern while 1 (8.33%) case of focal thyroiditis appeared hypoechoic. On Color Doppler, vascularity was increased in 10 (83.33%) cases. Reactive sub centimeter sized lymph nodes were detected to lower pole of thyroid lobes in 11/12 (91.66%) cases (Table 8B)[Figure 2]. Grave's disease was detected in 10 cases. In all 10 (100%) cases, thyroid echotexture was diffusely hypoechoic with marked increase in vascularity (thyroid inferno) (Table 9)[Figure 3 (A) and (B)].

Solitary nodule were detected in 33/100 (33%) cases. Of which, 18 (54.5%) cases were solid, 10 (30.3%) cases were cystic, 1 (3%) case was of focal thyroiditis and 4 (12.1%) cases were of thyroid carcinoma (Table 10A).Nodule characterization was done in all the 33 cases. 28 (84.84%) cases were wider than tall, 5 (15.15%) were taller than wide. 28 (84.84%) were well defined, 5 (15.15%) had ill defined margins. 16 (48.48%) had thin complete peripheral halo [Figure 4A], 2 (6.06%) had thick incomplete irregular halo while peripheral halo was absent in 15 (45.45%) cases. 23 (69.69%) cases were solid, 1 (3.03%) was predominantly solid, 2 (6.06%) were predominantly cystic and 7 (21.21%) were cystic. 11 (33.33%) were hyperechoic, 3 (9.09%) were isoechoic and hypoechoic, 2 (6.06%) were markedly hypoechoic while 7 (21.21%) were mixed and anechoic each. Calcification was absent in 30 (90.90%) cases. Egg shell/ peripheral calcification was seen in 1 (3.03%) case where as micro-calcification was seen in 2 (6.06%) cases. On Color Doppler study, 10 (30.3%) cases showed peripheral flow [Figure 4B], 11 (33.3%) showed peripheral and internal flow, 3 (9.09%) showed internal chaotic flow patter while 9 (27.27%) showed no flow. Cervical lymphadenopathy was seen in 1 case of papillary carcinoma (Table 10B).

Amongst 10 cases of hyperplastic nodule, 7 (70%) were hyperechoic whereas 3 (30%) were isoechoic (Table 11A). Amongst 8 cases of follicular adenoma, 4 (50%) were hyperechoic while 2 (25%) were hypoechoic and of mixed echotexture each (Table 11B) [Figure 5 A andB]. Amongst 10 cases of colloid cyst [Figure 6], 4 (40%) showed comet tail artifact, 2 (20%) showed internal echos. 1 (10%) case showed septations, solid component, spongiform nature and egg shell calcification each (Table 11C).

IV. Discussion

Ultrasound is a useful imaging modality in the work up of thyroid abnormalities. It can easily differentiate thyroid nodules from other cervical masses. Alternatively, sonography helps to confirm the presence of thyroid nodule when the findings of physical examinations are equivocal. This has added new dimension to the management of solitary nodule of the thyroid. The major use of thyroid scanning as stated by Rodney J Butch et al in 1985 is to identify additional thyroid nodules when only one of them is clinically palpable. [7]

Asymptomatic thyroid nodules are common in the general population especially in the middle aged. Virtually any thyroid disease can manifest as one or more nodules. If a solitary nodule has sonographic features suspicious of malignancy and cytology reveals malignant cells only then the decision of surgical excision should be undertaken, as a complication of surgery, morbidity and at times mortality can be a real problem. [8,9]
Nirad Mehta et al in 1994 stated that ultrasound of thyroid is a reliable method for evaluation of solitary thyroid nodules when combined with FNAC. [10]
Nodule on USG shows different echotexture than surrounding parenchyma. Most of them are detected incidentally and are not true tumors but hyperplastic regions of thyroid. Ultrasound can detect nodules which may not be clinically palpable. Also characterization of thyroid nodule on gray scale and color Doppler can help in differentiating between benign and malignant nodules. It also aids in deciding which nodules should undergo FNAC. The present series of study consisted of 100 cases who presented with clinically palpable thyroid diseases. FNAC was done in relevant cases.

Mulitnodular goiter is commonest pathological condition of thyroid. USG shows multiple nodules in an enlarged thyroid. It occurs due to hyperplasia with subsequent formation of nodules with associated fibrosis and calcification within nodules. Vascular compression due to follicular hyperplasia causes focal ischaemia with resultant necrosis and inflammatory changes. Microscopically it shows hyperplastic foci of thyroid tissue, colloid, hemorrhage, fibrosis and calcification. USG shows well defined multiple hyperechoic, isoechoic or mixed echoic nodules with cystic degeration. Colloid component may show comet tail artifact. Dystrophic central or peripheral curvilinear calcification may be seen. Well defined peripheral halo due to compressed adjacent tissue is noted. Color Doppler may show peripheral and/or central vascularity.[11]In 46 cases of MNG, nodules were wider than tall in 46 (100%) cases, margins were well defined in 46 (100%) cases, thin complete regular peripheral halo was seen in 36 (78.26%) cases, 26 (56.52%) cases were solid, 10 (21.74%) were predominantly solid, 5 (10.86%) cases were predominantly cystic, while 5 (10.86%) were cystic. 18 (39.13%) were hyperechoic, 8 (17.39%) cases were isoechoic, 10 (21.74%) were mixed echoic and 10 (21.74%) were anechoic. Macro-calcification was present in 28 (60.86%) cases. On color Doppler, peripheral flow was seen in 27 (58.69%) cases, peripheral and internal flow was seen in 10 (21.74%) cases. Our findings corroborate with findings of BrKljacic B et al.[12]

Graves' disease (Thyrotoxicosis) is commonly seen In females between 20-50years. It is characterized by thyrotoxicosis and is an autoimmune disease. USG shows diffusely enlarged thyroid which is hypoechoic and heterogenous. Color Doppler shows marked hypervascularitycausing spectacular thyroid inferno. Extensive intra-thyroid flow is seen in both systole and diastole.[13]Spectral Doppler will often demonstrate peak systolic velocities exceeding 70 cm/s which were the highest velocity found in thyroid disease. In our study, Grave's disease was detected in 10 cases. In all 10 (100%) cases, thyroid echotexture was diffusely hypoechoic with marked increase in vascularity (thyroid inferno). Erdogan MF, Anil C et al had studied 55 patients with hyperthyroidism, 29 patients were diagnosed as Grave's disease.[14] Gray scale patterns of both Grave's disease and Hashimoto's thyroiditis were found to be similar there by precluding the possibility to differentiate one from the other. The only way to differentiate the two was on basis of vascular pattern. Vascular patterns were significantly higher in the Graves disease rather than Hashimoto's thyroiditis.

Hashimoto's thyroiditis is and autoimmune condition leading to destruction of and is the most common chronic thyroiditides. It occurs predominantly in females over 40 years of age. It usually presents as hypothyroidism which may subsequently develop in 50% cases. In acute initial phase it may cause hyperthyroidism. Typically it starts in anterior portion and isthmus of thyroid. It has acute, subacute and chronic phase. In acute phase, focal nodular thyroiditis with small hypoechoic nodules with illdefined margins are seen. In subacute phase entire thyroid gland is enlarged with increased vascularity. The characteristic USG appearance is focal or diffuse glandular enlargement with coarse heterogenous and hypoechoic parenchymal echo pattern. Presence of multiple hypoechoic micro-nodules (1-6mm size) – micro-nodular pattern with fine echogenic fibrous septa is diagnostic. Color Doppler shows slight to marked increase in vascularity associated with hypothyrdoidism. Demonstration of serum thyroid antibodies and antithyroglobulin is diagnostic. End stage thyroiditis presents with atrophic thyroid gland. Reactive lymph nodes and perithyroidal satellite lymph node especially "Delphian" node cephalad to isthmus are usually seen.[13]12 cases were detected to have Hashimoto's thyroiditis, of which 11 (91.66%) cases were diffuse where as 1 (8.33%) case was focal. 4/12 (33.33%) cases were heterogeneously hypoechoic, 7/12 (58.33%) cases showed, micro-nodular pattern while 1 (8.33%) case of focal thyroiditis appeared hypoechoic. On Color Doppler, vascularity was increased in 10 (83.33%) cases. Reactive sub centimeter sized lymph nodes were detected to lower pole of thyroid lobes in 11/12 (91.66%) cases. Micro-nodulation is a highly sensitive sign of chronic thyroiditis with positive predictive value of 94.7%.[15]Erdogan MF, Anil C, Cesur M et al found 24 cases of Hashimoto's thyroiditis while evaluating 55 patients with

hyperthyroidism.[14] In their study, ultrasonic patterns of were of diffusely enlarged gland with diffuse hypoechogenecity. Micro-nodulation was seen within.

Hyperplastic nodules form 80% of nodular thyroid disease. It is caused by hyperplasia of gland and occurs in 5% of population. Peak age is 35-50years, women affecting three times more than men. They can be isoechoic compared to normal thyroid tissue, hyperechoic due to numerous interfaces between cells and colloid substance and may undergo cystic degeneration. Hyperechoic and isoechoic nodules show hypoechoic peripheral halo due to perinodular blood vessels, mild edema or compression of adjacent parenchyma. Less frequently honey comb or sponge like pattern may be seen.[16] Amongst 10 cases of hyperplastic nodule, 7 (70%) were hyperechoic whereas 3 (30%) were isoechoic. None of the lesions were hypoechoic or of mixed echogenicity. Thin complete regular peripheral halo was seen in all 10 cases. Margins were well defined. They were wider than tall. No calcification or cervical lymphadenopathy was seen. Peripheral flow pattern was seen on color Doppler study in all cases. Nirad Mehta et al in 1993 found colloid goitre in 119 patients with thyroid swellings.[10] The sonographic patterns of 119 patients were as follows: 13 (10.9%) were hyperechoic, 25 (21%) isoechoic, 30 (25.2%) hypoechoic, 5 (4.2%) were heterogeneous in echo texture.

Colloid cyst is due to degenerative changes in goitrous nodules. Purely anechoic areas are due to colloid fluid. Comet tail artifacts are caused bright echogenic foci due to micro-crystals or aggregates of colloid substance. Thin intracystic avascular septation correspond to attenuated strands of thyroid tissue. Internal echos are due to hemorrhage. Thin peripheral egg shell calcification or course egg shell calcification may be seen.[16]Amongst 10 cases of colloid cyst, 4 (40%) showed comet tail artifact, 2 (20%) showed internal echoes. 1 (10%) case showed septations, solid component, spongiform nature and egg shell calcification each. James and Charbeneau mentioned that peripheral or egg shell calcification as the most reliable sign of benign nature of the thyroid nodule.[17] Our study revealed 1 case showing such peripheral or egg shell calcification.

Follicular adenoma represents 5-10% nodular disease of thyroid and seven times more common in females.[16] They arise from follicular cells and are often indistinguishable from follicular carcinoma. They are solid masses which can be hyperechoic, isoechoic or hypoechoic. They have peripheral hypoechoic complete halo resulting from fibrous capsule and blood vessels seen on color Doppler. Spoke and wheel appearance (vessels passing from periphery to centre) is also seen.[16]Amongst 8 cases of follicular adenoma, 4 (50%) were hyperechoic while 2 (25%) were hypoechoic and of mixed echotexture each. They were wider than tall with well defined margins. Thin complete peripheral halo was seen in 6 cases. No calcification was noted. Both peripheral and central vascularity was seen in all 8 cases. In 52 cases of follicular adenoma Sillery et al.stated echotexture was heterogeneous in 19 (36.5%) cases, predominantly homogenous in 20(38.5%) cases and homogenous in 13 (25%). Peripheral halo was seen in 30 (57.7%) cases. Type 3 vascularity was seen in 26 (54.2%) cases with no lymphadenopathy.[18] Richard A et al in his study on 28 patients with solitary solid thyroid masses found 10 (36%) cases demonstrating the halo sign.[19] Eight (80%) of these lesions were benign, being either adenomas or benign nodules; however, two (20%) of them proved to be carcinomas.

Follicular carcinoma accounts for 5-15% of all thyroid cancers and is second subtype of well differentiated thyroid cancer. Women are affected more than men. USG and FNAC may not differentiate it from follicular adenoma. Irregular tumor margin, thick irregular halo, tortuous chaotic arrangement of internal blood vessels on color Doppler is suggestive of follicular carcinoma [Figure 7].

Papillary carcinoma of thyroid peaks in 3rd and 7th decades of life. Women are affected more than men and accounts for 75-90% of thyroid carcinoma. Psammoma bodies (round lamilated calcification) is seen in 35% cases. Most of them are hypoechoic with irregular margins and show micro-calcification (less than 2mm). Hypervascularity is seen in 90% of cases. Metastatic cervical lymph nodes showing foci of micro-calcification may be seen which may show cystic degeneration. In our series 2 cases of papillary carcinoma, proven on biopsy, appeared markedly hypoechoic (with reference to strap muscles), showed ill defined margins with microcalcification and increased vascularity [Figure 8 A and B]. Metastatic cervical lymphadenopathy was seen in one of these cases.

Some authors described carcinoma as exclusively hypoechoic but Solbiati et al found out only 68% of the malignant lesions were hypoechoic.[22] In a study conducted by Jenny K, WaiKit Lee et al showed that micro-calcifications are one of the most specific ultrasound findings of a thyroid malignancy. Micro calcifications were found in 29-59% of all primary thyroid carcinomas.[23]

Three colour flow patterns are described within thyroid nodules:[11]

1. Type I-no flow detected within the nodule
2. Type II- peri-nodular arterial flow pattern
3. Type III- intra-nodular flow with multiple vascular poles, chaotic arrangement, with or without peri-nodular flow.

Benign hyperplastic nodules usually show Type I and Type II color flow pattern while malignant nodules show Type III color flow pattern. Due to high colour sensitivity of modern ultrasound machines, vessels are now detected within the majority of thyroid nodules. Predominantly peripheral flow is typical of a benign colour flow pattern, whereas a chaotic intranodular pattern is more indicative of malignancy.[11]

V. Conclusion

Our experience agrees to the fact that high resolution ultrasound is better over the other investigations for the anatomic characterization of thyroid lesions because of the superficial location. It not only differentiates diffuse from nodular thyroid disease, solid and cystic lesions and helps in characterization of benign and malignant thyroid nodule. It also aids in deciding which nodule should undergo FNAC. In selected cases, direction of fine needle aspiration biopsy can be best accomplished with sonography.

Although there is some overlap between the gray scale appearance of benign nodules and that of malignant nodules, although certain features are helpful in differentiating the two. Entirely cystic nodule, spongiform nodule, comet tail artifact within cyst, hyperechoic and isoechoic nodules, thin complete peripheral halo, well defined margins, egg shell calcifications, peripheral flow pattern, wider than tall shape favor benign etiology. Solid, hypoechoic nodule, irregular margins, thick incomplete peripheral halo, micro-calcification, internal chaotic vascularity and cervical lymphadenopathy with calcification favor malignant etiology

Color Doppler sonography is safe, fast, inexpensive, popular, cost effective and repeatable non invasive procedure for investigating thyroid gland. Color Doppler sonography is gaining importance for the functional evaluation of the thyroid disorders. It allows differentiating untreated Grave's disease from Hashimoto's thyroiditis, which present with similar gray scale findings.

Thyroid ultrasound was very efficient in picking up lesions in all 100 cases in our study. In comparison, to other studies, our study gave a similar picture in terms of benign lesion being much more common than malignant lesions. The most common benign lesion determined in our study was adenomatous nodules, just as it was the most common benign lesion accounted in many other studies.

Chronic thyroiditis cases could also be efficiently detected using ultrasound in our study. Color Doppler was effectively used in our study to differentiate Grave's disease and chronic thyroiditis which have similar gray scale findings.

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Tables

AGE (YEARS)	MALES	FEMALES	TOTAL	PERCENTAGE
0.1-10	0	0	0	-
11-20	2	6	8	8
21-30	8	32	40	40
31 – 40	10	14	24	24
41-50	10	2	12	12
51-60	0	16	16	16

Table 1: showing age and sex distribution of patients

SYMPTOMS	NO. OF PATIENTS	PERCENTAGE
Swelling in front of neck	100	100
Difficulty in swallowing	10	10
Difficulty in breathing	8	8
Hoarseness of voice	6	6
Pain in the swelling	8	8
Evidence of hyperthyroidism (palpitation, ↑HR, BP)	20	20
Evidence of hypothyroidism	0	0

Table 2 – showing various clinical manifestations

DURATION	NO. OF PATIENTS	PERCENTAGE
1-6 months	8	8
7-12 months	18	18
1.1 - 5 years	62	62
6 - 12 years	12	12
13 years and above	0	0
Total	100	100

Table 3 – showing the duration of swelling in patients

Thyroid disease on Ultrasonography	No. of cases (n=100)	Percentage (%)
a) Diffuse thyroid disease	67	67
b) Nodular thyroid disease	33	33

Table 4 – showing pattern of thyroid disease on USG.

5A. Diffuse thyroid disease (n=67)

ULTRASOUND DIAGNOSIS	No. of cases (n=67)	Percentage(%)
a) Multinodulargoitre	46	68.65
b) Grave's disease	10	14.92
c) Chronic thyroiditis / Hashimotos (Diffuse)	11	16.41
Total	67	100

5B. Nodular thyroid disease (n=33)

ULTRASOUND DIAGNOSIS	No. of cases (n=33)	Percentage(%)
a) Hyperplastic nodule (20) i. Hyperplastic / Adenomatous solid nodule ii. Colloid cyst	 10 10	 30.30 30.30
b) Solitary benign adenoma	08	24.24
c) Carcinoma of thyroid	04	12.12
d) Hashimoto's (Focal)	01	3.03
Total	33	100

Table 5 – showing various causes of Diffuse (A) and Nodular thyroid disease (B) on USG.

SR. NO	DISEASE	USG DETECTED	PATHOLOGICALLY DETECTED
1.	Multinodular goitre	46	46
2.	Solitary nodule	18	18
3.	Thyroid cyst	10	-
4.	Chronic thyroiditis	12	12
5.	Grave's disease	10	-
6.	Carcinoma	4	4

Table 6 – Comparison between duplex sonography and pathological diagnosis

MulitnodularGoitre(MNG) (n=46)

Characteristics of MulitnodularGoitre	No. of cases (n=46)	Percentage (%)
I. Shape		
a) Taller than wide	00	00
b) Wider than tall	46	100
II. Margin		
a) Well defined	46	100
b) Illdefined	00	00
III. Peripheral Halo		
a) Thin, Complete, Regular	36	78.26
b) Absent	10	21.74
IV. Internal contents		
a) Solid	26	56.52
b) Predominantly solid	10	21.74
c) Predominantly cystic	05	10.86
d) Cystic	05	10.86
V. Echogenicity		
a) Hyperechoic	18	39.13
b) Isoechoic	08	17.39
c) Hypoechoic	00	00
d) Marked Hypoechoic	00	00
e) Mixed	10	21.74
f) Anechoic	10	21.74
VI. Calcification		
a) Present	28	60.86
i. Eggshell/Peripheral/curvilinear	00	
ii. Macro calcification	28	
iii. Micro calcification	00	
b) Absent	18	39.13
VII. Color flow		
a) No flow	09	19.56
b) Peripheral flow	27	58.69
c) Peripheral + internal flow	10	21.74
d) Internal chaotic	00	00
VIII. Cervical lymphadenpathy	00	00

Table 7 – showing various characteristics of MulitnodularGoitre (MNG)

8 (A). Hashimoto's thyroiditis (n=12)

	No. of cases (n=12)	Percentage (%)
a) Diffuse	11	91.66
b) Focal	01	08.33

8 (B). Characteristics of Hashimoto's thyroiditis (n=12)

	No. of cases (n=12)	Percentage (%)
I. Echotexture		
a) Heterogeneously hypoechoic	04	33.33
b) Micro nodular pattern	07	58.33
c) Hypoechoic	01	08.33
II. Vascularity		
a) Increased	10	83.33
b) Not increased	02	16.66
III. Reactive lymph nodes	11	91.66

Table 8 – showing pattern (A) and various characteristics (B) of Hashimoto's thyroiditis.

Grave's disease (n=10)

	No. of cases (n=10)	Percentage (%)
Hypoechoic	10	100
Increased vascularity (Thyroid inferno)	10	100

Table 9 – showing various characteristics of Grave's disease.

10 (A) - Solitary Nodule (n=33)

	No. of cases (n=33)	Percentage (%)
a) Solid	18	54.5
b) Cyst	10	30.3
c) Focal thyroiditis	01	3.03
d) Carcinoma	04	12.1
Total	33	100

10 (B) - Characteristics of Solitary Nodule

	No. of cases (n=33)	Percentage(%)
I. Shape		
a) Taller than wide	05	15.15
b) Wider than tall	28	84.84
II. Margin		
a) Well defined	28	84.84
b) Illdefined	05	15.15
III. Peripheral Halo		
a) Thin, Complete, Regular	16	48.48
b) Thick, incomplete, irregular	02	6.06
c) Absent	15	45.45
IV. Internal contents		
a) Solid	23	69.69
b) Predominantly solid (spongiform)	01	3.03
c) Predominantly cystic	02	6.06
d) Cystic	07	21.21
V. Echogenicity		
a) Hyperechoic	11	33.33
b) Isoechoic	03	9.09
c) Hypoechoic	03	9.09
d) Marked Hypoechoic	02	6.06
e) Mixed	07	21.21
f) Anechoic	07	21.21
VI. Calcification		
a) Present		
i. Eggshell/Peripheral/curvilinear	01	3.03
ii. Macro/ central calcification	00	0.00
iii. Micro calcification	02	6.06
b) Absent	30	90.90
VII. Color flow		
a) No flow	09	27.27
b) Peripheral flow	10	30.3
c) Peripheral + internal flow	11	33.33
d) Internal chaotic	03	9.09
VIII. Cervical lymphadenpathy	01	3.03

Table 10 – showing pattern (A) and various characteristics (B) of Solitary Nodule.

11(A) - Hyperplastic nodule (n=10)

Echotexture	No. of cases (n=10)	Percentage (%)
a) Hyperechoic	07	70
b) Isoechoic	03	30
c) Hypoechoic	00	00
d) Mixed echoic	00	00

11(B) - Follicular adenoma (n=08)

Echotexture	No. of cases (n=08)	Percentage (%)
a) Hyperechoic	04	50
b) Isoechoic	00	00
c) Hypoechoic	02	25
d) Mixed echoic	02	25

11 (C) - Colloid cyst (n=10)

Characteristics	No. of cases (n=10)	Percentage (%)
a) Comet tail	04	40
b) Internal echos/hemorrhage	02	20
c) Septations	01	10
d) Solid component	01	10
e) Spongiform	01	10
f) Egg shell calcification	01	10

Table 11 – showing various characteristics of Hyperplastic Nodule (A), Follicular adenoma (B) and Colloid cyst (C).

Figure legends

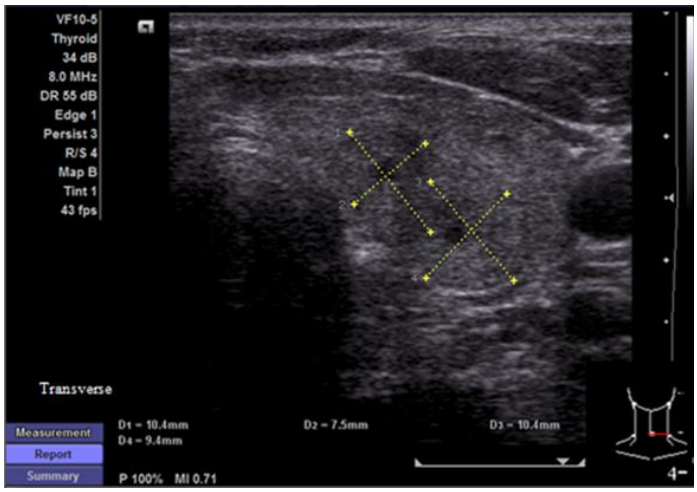

Fig. 1 – Transverse ultrasound of left lobe of thyroid showing two well defined isoechoic lesions measuring 10.4 x 7.5 mm and 10.4 x 9.4 mm. Both the lesions show central hypointense-anechoic areas suggestive of cystic degeneration.

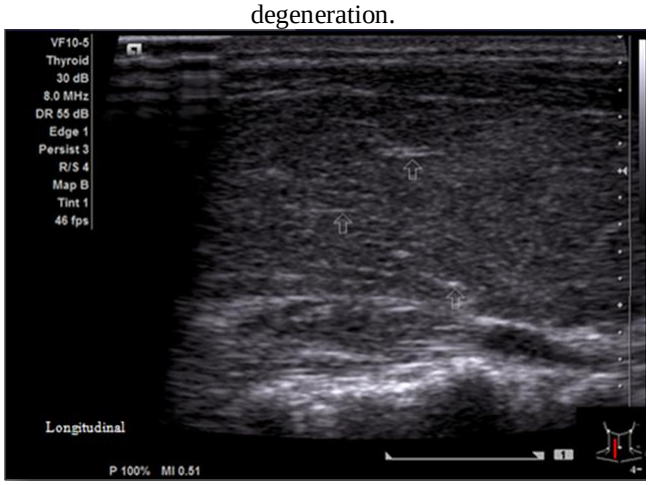

Figure 2 reveals Hashimoto's thyroiditis - Longitudinal sonographic image showing diffusely hypoechoic right lobe of thyroid with multiple thin echogenic septae (micro-nodular pattern).

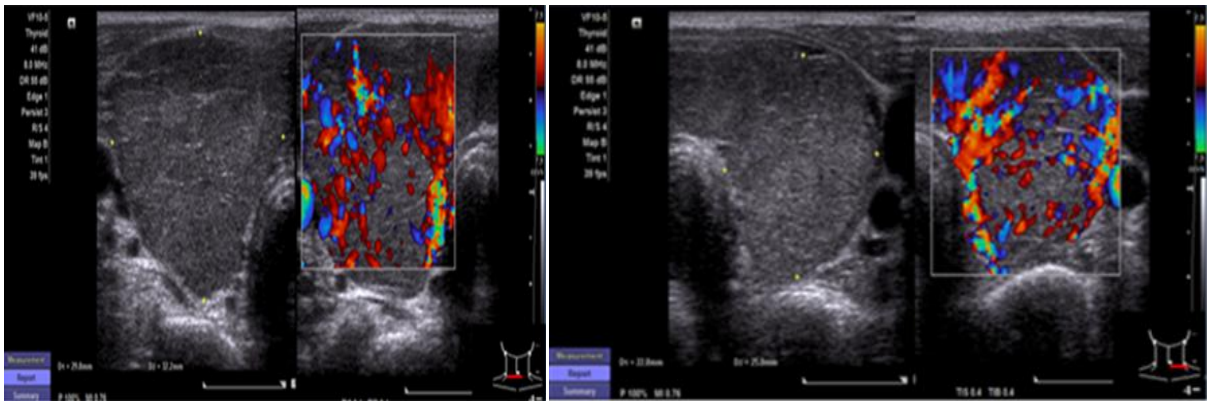

Figure 3: Graves disease – Transverse ultrasound section of left lobe (A) and right lobe (B) showing enlarged and diffusely hypoechoic both lobes of thyroid and isthmus with increased vascularity.

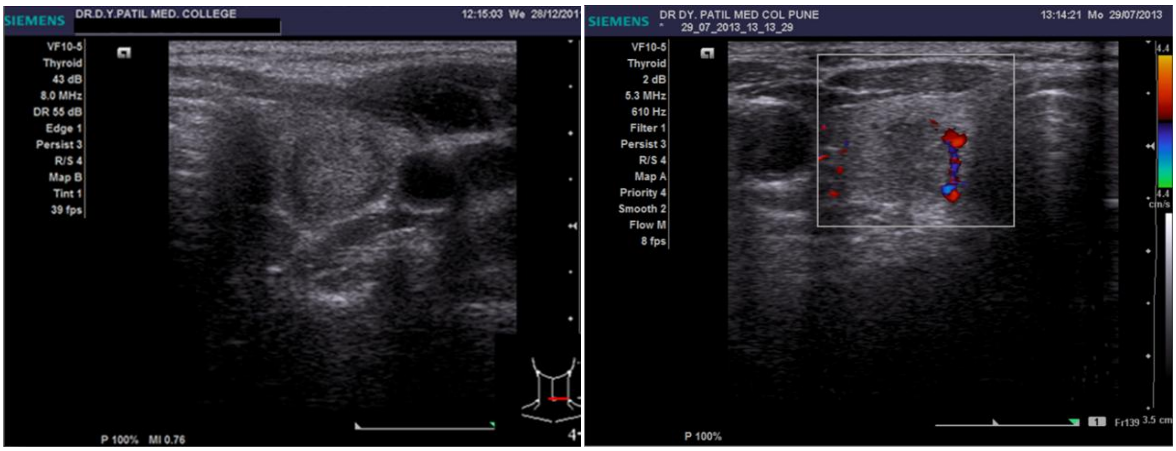

Fig. 4 (A) – Transverse US image of left lobe of thyroid demonstrating isoechoic nodule (1.1 x 1.4 cm) with peripheral thin hypoechoic rim – "halo sign".Figure 4 (B) – Showing adenomatous nodule with peripheral vascularity.

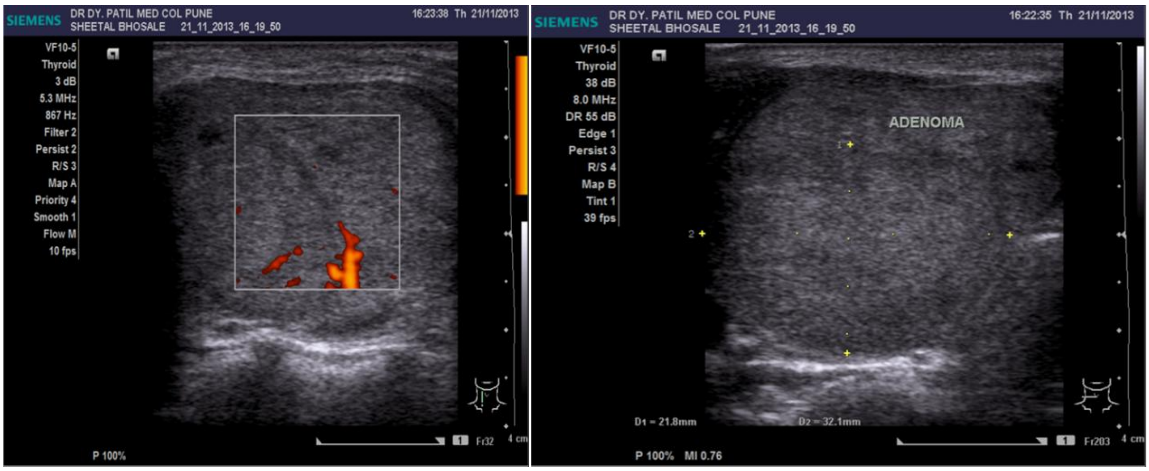

Figure 5 (A) – Transverse US section of right lobe of thyroid reveals nearly iso-echoic follicular adenoma.Figure 5 (B) – Follicular adenoma showing central and peripheral vascularity.

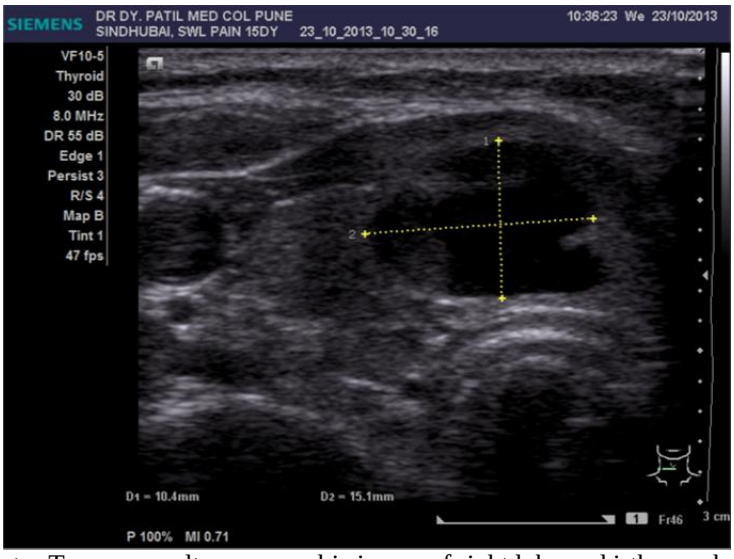

Figure 6: Colloid cyst – Transverse ultrasonographic image of right lobe and isthmus showing anechoic cyst with small solid component.

Fig. 7 – Transverse and longitudinal ultrasound scan showing follicular carcinoma as a well defined solitary round heterogeneous lesion in right lobe of thyroid with intra nodal vascularity. Peak Systolic Velocity measured 22 cm/s. (Normal = 15-19cm/s)

Figure 8 – Papillary carcinoma - (A) longitudinal section and (B) transverse section of left lobe: showing hypoechoic solid lesion with slight irregular margins.