Original article

Role of high resolution ultrasonography and colour doppler in thyroid swelling

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Abstract

Introduction: The purpose of this study was to evaluate role of duplex Ultrasound in diagnosis of thyroid swellings and determining their benign and malignant nature.

Material and methods: In this prospective study 100 patients of clinically enlarged thyroid were examined by high frequency grey scale ultrasound and colour Doppler after brief history and clinical examination. Lesions were characterized on the basis of location, shape, echotexture, halo, vascularity and other associated imaging findings and classified in diffuse or nodular pattern and benign or malignant lesions. Final diagnoses were obtained from cytological and/or histological evaluation.

Results: Color assisted duplex sonography was able to identify malignant lesions within the thyroid gland with a sensitivity of 71.4%, specificity of 92.3%, positive predictive value of 83.3% and negative predictive value of 85.7%. Ill-defined margins, taller than wide nodule, hypoechoic echotexture, micro-calcification, thick incomplete peripheral halo, internal vascularity and lymph node metastases favored malignant etiology. Diffuse enlarged hypoechoic gland (100%) with multiple, discrete hypoechoic micronodules (81%) and coarse septation (56%) were found in Hashimoto's thyroiditis. Thyroid inferno (100%) favored Grave's disease.

Conclusion: Ultrasonography is a safe, fast, inexpensive, cost effective and repeatable non-invasive procedure for investigating thyroid gland. With the aid of colour doppler, ultrasound is valuable imaging tool to valuable for identifying many malignant or potentially malignant thyroid nodules. Hence we recommend the use of ultrasonography for the evaluation of thyroid pathologies.

Key words: Thyroid nodule, Color Doppler.

Introduction

Thyroid disorders are common clinical problem in India. Autopsy studies have demonstrated that the thyroid nodularity is present in approximately 37% of the general population, 12 % of which have solitary thyroid nodules. The incidence of clinically apparent thyroid nodules in general population is 4-5%. The overall incidence of malignancy in solitary thyroid nodules is 10-25%.[1]

Before the advent of high resolution ultrasound imaging, radionuclide scintigraphy was the chief method to evaluate the thyroid gland both functionally and morphologically. Along with being much safer and non-ionising, ultrasound is also a much cheaper alternative. C.T and M.R.I are used in the evaluation of thyroid masses, but are not as sensitive as ultrasound in the detection of intra-thyroidal lesions but are used for the

evaluation of mediastinal extension of thyroid masses.

The management of thyroid nodules is multi-disciplinary and involves surgeons, pathologists and radiologists. The current approach to thyroid swellings has been revolutionized with the introduction of thyroid ultrasonography (USG). Because of superficial location and good vascularisation of thyroid gland high resolution real time grey scale and colour Doppler sonography can delineate and demonstrate the normal thyroid anatomy and pathological conditions with remarkable clarity. In addition, following thyroid surgery, ultrasonography provides a safe tool for disease surveillance.

Aims and Objective

The purpose of this study is to assess the spectrum of diseases affecting thyroid gland by colour assisted duplex sonography and evaluate the accuracy of sonological features of benign and malignant nodules, there by establishing efficacy of thyroid ultrasound as important imaging tool in assessment of thyroid swellings.

Material and methods

The ethical committee of our institute approved this prospective study. Informed consent was taken from all patients undergoing this study. We prospectively studied 100 patients over a period of 18 months starting from May 2014 in Department of Radio-diagnosis and imaging of NIMS Medical College & Hospital, Jaipur (Rajasthan). Patients of all age groups and with clinically suspected thyroid diseases were included in the study. Patients excluded from the study were those, who did not give consent for ultrasonography and fine needle aspiration cytology/biopsy/thyroid surgery.

Findings of clinical examination were recorded in detail and a clinical diagnosis was established in all the cases. Initial clinical evaluation was done by respective department from where patients were referred to our department and their probable diagnoses were also recorded.

In this study a standard Ultrasonography machine GE voluson 730 pro, equipped with a linear probe of high-frequency (7-10MHz) is used.

Scanning Technique:-

The patient is examined in the supine position with neck hyperextended to identify the inferior margin of the gland, which may extend to the clavicle in some patients. A small pad is placed under the shoulders to provide better exposure of the neck particularly in patient with a short, stocky habitus.

Thyroid lesions were assessed by the following USG criteria:

1. Number of nodules
2. Location Diffuse/Right/Left lobe/Isthmus
3. Dimensions and Shape (roundish, oval, irregular)
4. Borders (smooth, rough)
5. Contours (well defined, indistinct)
6. Echotexture (hyperechoic, isoechoic and hypochoic)
7. Echostructure (the degree heterogeneity)
8. Calcifications
9. Peripheral halo
10. Vascularity on Colour and Power Doppler

In addition, surrounding structures were studied for any pathology especially lymphadenopathy.

Diagnosis & Follow up:

After the history, physical examination, duplex scanning, thyroidal hormonal array, a diagnosis is made. Color Doppler was applied in order to study the vascularity of the thyroid gland. Power Doppler was applied to detect intranodal vascularity.

Final diagnosis is made based on fine needle aspiration biopsy/cytology/histopathological findings obtained from the resected thyroid specimens as applicable.

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Observations and Results

Out of the total 100 cases in our study, 85 patients were female and 15 patients were males. Hence females were more commonly affected than males. 3rd decade showed the highest incidence followed by 4th decade. The incidence among females was also highest in this decade. Out of the 100 patients, 39 patients were thought to have solitary nodule by palpation out of which 11(28%) cases were detected as multiple nodules.

60(60%) cases had diffuse thyroid disease while 40(40%) cases had nodular thyroid disease. Out of 60 cases of diffuse thyroid disease, 29(48.3%) were multinodular goitre, 15(25%) were Grave's disease and 16(26.7%) were Hashimoto's thyroiditis.

Out of 40 cases of nodular thyroid disease, 18(45%) were solitary colloid goitre, 8(20%) were benign adenoma, 14(35%) were carcinoma. The most common type of cancer was papillary thyroid cancer (11 cases). In our study ultrasonography with colour doppler showed 71% sensitivity, 92.3% specificity, 83.3% positive predictive value, 85.7% negative predictive value and 85% diagnostic efficiency for the differentiation of benign from malignant thyroid nodules.

Discussion

Ultrasound is a useful modality in the work up of thyroid abnormalities. It can easily differentiate between thyroid nodules and other cervical masses. Alternatively, Sonography may help to confirm the presence of a thyroid nodule when the findings of physical examinations are equivocal. This has added a new dimension to the management of solitary nodule of the thyroid.

In our Study, Females were more commonly affected than males. 3rddecade showed the highest incidence followed by 4th decade. On clinical examination, 39 patients diagnosed as solitary thyroid nodule. Out of 39, 11(28%) patients diagnosed as multinodular goitre on Sonography. So Sonography has been helpful in identifying additional thyroid nodules when one of them is palpable.

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.

Sonographic Patterns of Thyroid Lesions

Hyperplastic/Adenomatous/Colloid Goitre:

It is the most frequent solid lesion. Most of the nodules are hyperechoic, echogenic or mixed echogenic. Few of them are hypoechoic. Colloid nodules have well defined margins with intact capsule. Long standing nodules may show peripheral or egg shell calcification. Less frequently, hypoehoic honeycombing pattern can be seen. Peripheral hypoechoic halo is typically seen, caused by perinodular blood vessels and compression of the adjacent normal parenchyma.

In our study, we found colloid goitre the commonest lesion with 44 cases out of 100 cases (44%).Out of 44 cases, 18 cases were of solitary colloid goitre and rest 26 cases were of multinodular goitre. In solitary goitre cases, 8(44%) of these lesions were hyperechoic, 3(16%) cases were isoechoic, 1(6%) were hypoechoic and 6(34%) cases were cystic in nature which correlated with the previous study done by **Scheible W et al.**[2]

James GM, Charbeneu mentioned that peripheral or egg shell calcification is the most reliable sign of benign nature of the thyroid nodule.[3] Our study

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revealed 8 cases showing such peripheral or egg shell calcification. On colour doppler out of 18, 16(88%) cases showed perinodular vascularity or no vascularity.

Thyroid Cyst:

Cysts in the thyroid gland can be easily diagnosed by sonography. These cysts are rarely true epithelial cysts. Most of the reported cystic lesions represent degenerative changes in adenomatous nodular goiter or adenoma. Comet tail artifacts are caused bright echogenic foci due to micro-crystals or aggregates of colloid substance. In the series of **Simeone J et al**, 16% of follicular adenomas had greater than half of the lesion containing fluid.[4]

Amongst 6 cases of colloid cysts were noted. They were anechoic lesions with well defined walls showing posterior acoustic enhancement. 4 cases(66%) showed comet tail artifact, 2(10%) cases case showed spongiform nature and 1 case showed egg shell calcification and solid component each. Solid component within the cyst was echogenic. Ultrasound guided fine needle aspiration biopsy was done which showed benign nature.

Multinodular Goitre:

Multinodular 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. USG shows well defined multiple hyperechoic, isoechoic or mixed echoic nodules with cystic degeneration. 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.[5]

In our study, we found 29 cases of Multinodular goitre. On USG, Nodules were wider than tall in 29(100%) cases, margins were well defined in 29(100%) cases, thin complete regular peripheral halo was seen in 20(69%) cases. 16(55%) cases were solid, 6(21%) were predominantly solid, 7(24%) cases were predominantly cystic. Calcification was present in 17(59%) cases. On color Doppler, peripheral flow was seen in 15(52%) cases, peripheral and internal flow was seen in 8(28%) cases. Our findings corroborate with findings of **BrKljacic B et al**.[6]

Follicular Neoplasm:

Follicular adenoma can be clearly distinguished from the adenomatous nodules which are the results of hypertrophy of the glandular tissue. The follicular adenoma is a functional autonomous nodule or a precursor of follicular thyroid neoplasm. The echogenicity of thyroid adenomas vary considerably but the majorities are more echogenic than normal thyroid parenchyma and are solitary where as adenomatous nodules are usually multilocular.

Adenomas often have a thick, smooth peripheral hypoechoic halo resulting from the fibrous capsule and blood vessels. Sometimes “spoke and wheel” pattern can be visualised on colour doppler. Adenomas can undergo degeneration with cystic or hemorrhagic changes. Hypoechoic areas in adenomas are a consequence of hemorrhages into the nodule.

In our study, 8(8%) out of the 100 cases were found to be thyroid adenomas. On ultrasound 5(62%) cases were hyperechoic while 2(25%) were hypoechoic and 1(13%) was of mixed echotexture each. They were wider than tall with well defined margins. Thin complete peripheral halo was seen in 5(62%) cases. Calcification was noted in one case. Both peripheral and central vascularity was seen in

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all 8 cases, which correlated with the previous studies done by **Sillery N et al.**[7]

Thyroid Malignancy:

Most of the primary thyroid cancers are epithelial in origin and most of them are well differentiated and papillary carcinoma accounts for 75-90% of all cases. Follicular carcinoma accounts for 5-15% of all thyroid cancers and is second subtype of well differentiated thyroid cancer.

Ultrasound is valuable for identifying many malignant or potentially malignant thyroid nodules. Although there is some overlap between the ultrasound appearance of benign nodules and that of malignant nodules, certain ultrasound features are helpful in differentiating between these two. These features include micro-calcifications, local invasion, lymph node metastases, a nodule that is taller than it is wide, and markedly reduced echogenicity. Metastatic cervical lymph nodes showing foci of micro-calcification may be seen which may show cystic degeneration. Other features, such as absence of halo, ill-defined irregular margins, solid composition, and vascularity are less specific but may be useful ancillary signs.

In our study we found total 14 cases of thyroid malignancy, out of which 11 cases were of papillary carcinoma and rest 3 cases were of follicular carcinoma. In our study we found 9(65%) cases of malignancy showing predominantly hypoechogenic lesions.

In a study conducted by **Hoang J 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.[8] **Chan BK et al** studies 55 cases of papillary carcinoma. They found 26(47%) cases with no calcifications, 23(42%) cases with micro-calcifications, 5(9%) cases with coarse, flocculated calcifications and 1(2%) case with peripheral calcifications.[9] In our study, we detected 6(43%) cases of malignancy showing micro-calcifications.

Rago T, Vitti P et al showed in their study that the combination of absent halo sign +micro-calcification+intranodal flow pattern achieved 97.2% specificity for the diagnosis of thyroid malignancy.[10] In our study, we obtained a specificity of 100% using these parameters to evaluate malignancy.

Predominantly peripheral flow is typical of a benign colour flow pattern, where as chaotic intra-nodular pattern is more indicative of malignancy. **Chan BK et al** found 38(69%) cases out of 55 showing intrinsic vascularity.[9] Marked intrinsic hypervascularity was noted in 10(71%) cases in our study.

Hashimoto's Thyroiditis:

It is an auto-immune disease where the patient develops antibodies to their own thyroglobulin. The typical sonographic appearance of Hashimoto's thyroiditis is diffuse coarsened parenchymal echotexture generally more hypoechoic than normal thyroid. Micronodulation is a highly sensitive sign of chronic thyroiditis with a positive predictive value of 94.7%.[11]

In our study, we found 16 cases of Hashimoto's thyroiditis. All of them showed diffuse enlarged gland with diffuse hypoechogenicity.

Multiple, discrete hypoechoic micronodules (micronodulation) were seen in 13(81%) cases. Coarse septation with pseudo-lobulated appearance was seen in 9(56%) cases. Reactive sub-centimeter sized lymph nodes were detected to lower pole of thyroid lobes in 7(44%) cases. On colour doppler study, increased vascularity was noted on 8(50%) cases, however PSV were below 70 cm/s in all cases.

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Graves Disease:

Grave's disease was detected in 15(16%) cases. In all 15(100%) cases, thyroid gland was diffusely enlarged with diffusely hypoechoic echotexture. Color Doppler sonography demonstrated a hypervascular pattern referred to as the "thyroid inferno". Spectral Doppler demonstrated peak systolic velocities exceeding 70 cm/s. Gray scale patterns of both Grave's disease and Hashimoto's thyroiditis were found to be similar in few cases. The only way to differentiate the two was on basis of vascular pattern. Vascular patterns (mean PSV) were significantly higher in the Graves disease rather than Hashimoto's thyroiditis. Our findings corroborate with findings of **Erdogan MF et al**.[12]

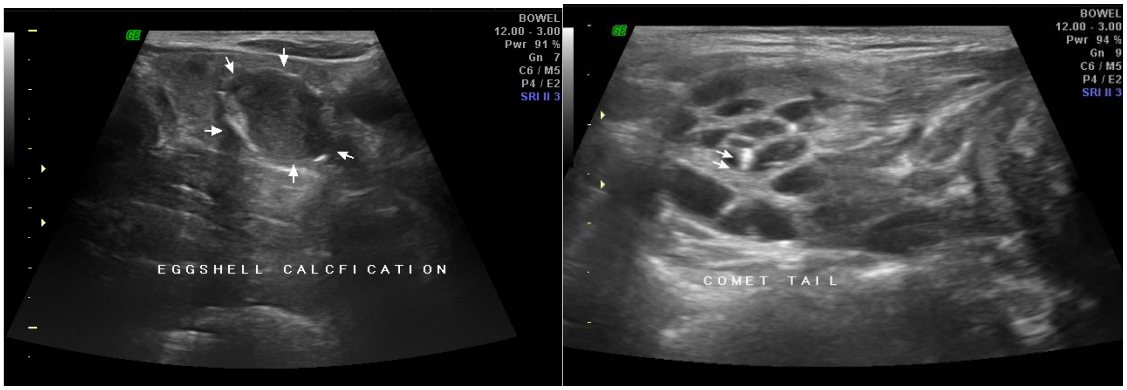

Fig-1 Colloid Nodules **(a)** Well-defined hypoechoic nodule with peripheral egg shell calcification **(b)** Extensive honeycombing or cystic degenerative changes in right lobe of thyroid. Tiny echogenic foci with comet tail artifacts also noted within the nodule.

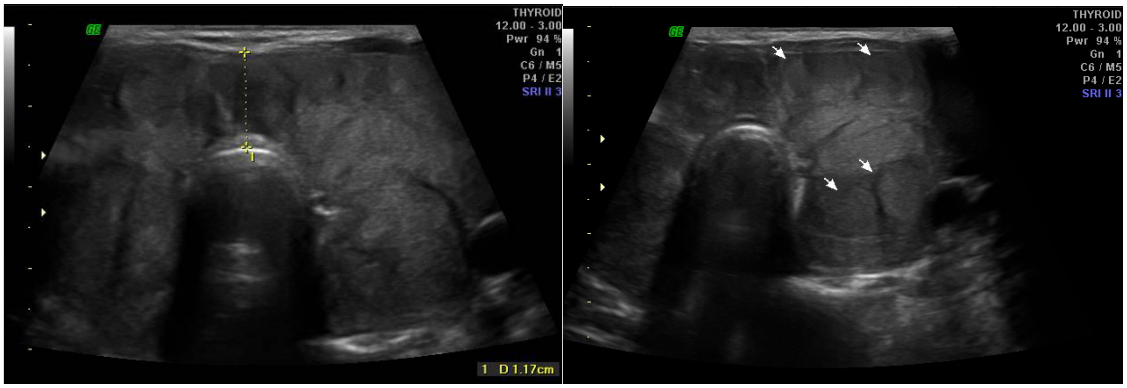

Fig-2: Multinodular Goitre: Diffuse Bulky thyroid with multiple Isoechoic and hypoechoic nodules.

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Fig-3: Follicular Adenoma: Well defined hyperechoic nodule showing peripheral and internal vascularity on PDFI.

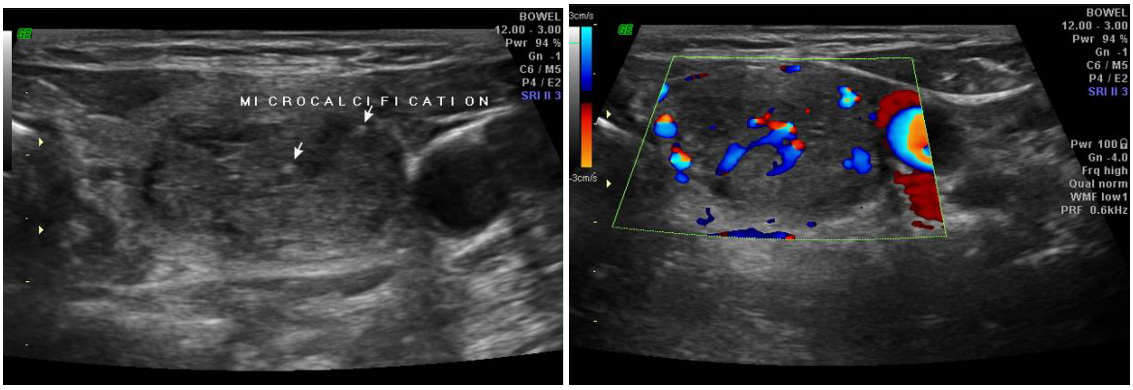

Fig-4: Papillary Carcinoma: Solitary heterogenously hypoechoic nodule with micro-calcification and thick hypoechoic halo showing peripheral and internal vascularity on CDFI.

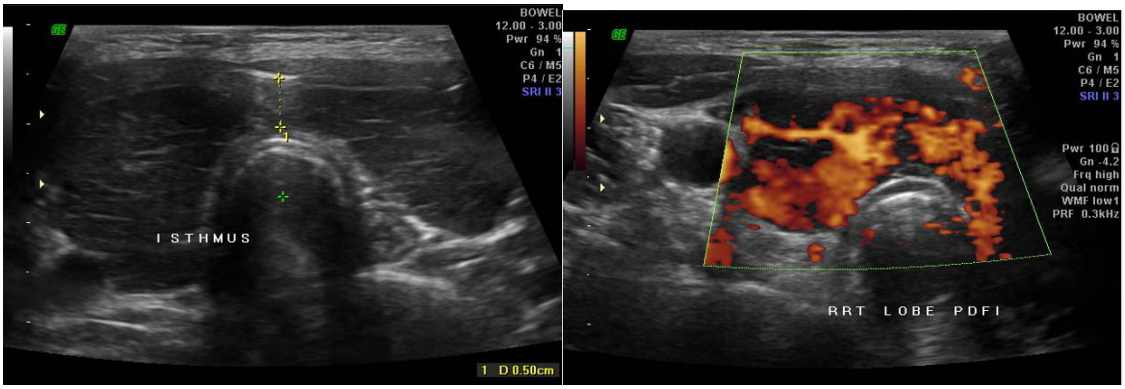

Fig-5: Hashimoto Thyroiditis: Diffuse enlargement of thyroid with multiple linear echogenic septations throughout the hypoechoic parenchyma. Power doppler shows increased vascularity in thyroid.

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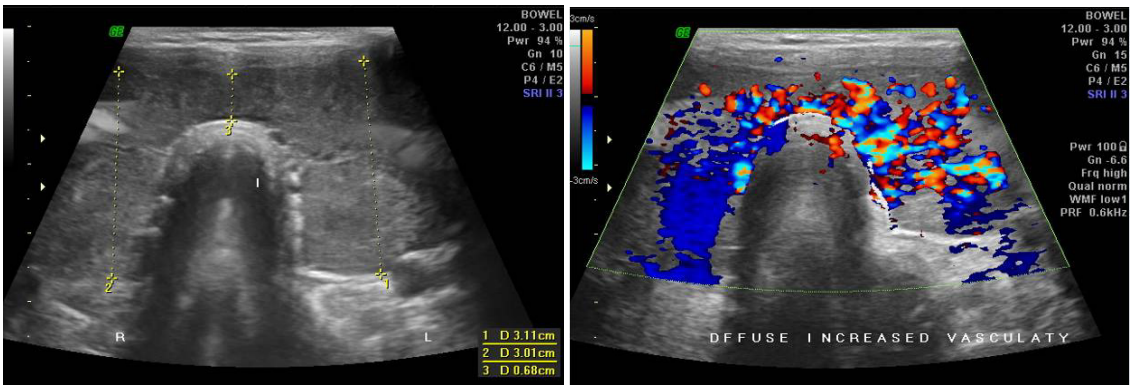

Fig-6: Grave's Disease: Diffusely bulky and hypoechoic echotexture of thyroid with hyper-vascular pattern (thyroid inferno)

Conclusion

Ultrasonography is a safe, fast, inexpensive, popular, cost effective and repeatable non-invasive procedure for investigating thyroid gland. It differentiates solid from cystic lesions, solitary nodules from multinodular and diffuse enlargement, and thyroid lesion from extra-thyroidal lesions. It helps in characterization and differentiation of various thyroid lesions. With the aid of colour doppler, ultrasound is valuable imaging tool to valuable for identifying many malignant or potentially malignant thyroid nodules. Hence the present study, recommends the use of ultrasonography for the evaluation of thyroid pathologies.

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