

COMPARATIVE STUDY OF GRAY SCALE AND COLOUR DOPPLER ULTRASOUND IN ASSESSMENT OF THYROID NODULE AND CORRELATION WITH FINE NEEDLE ASPIRATION CYTOLOGY

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ABSTRACT

Background: Nodular thyroid disease is detected in 3–7% of the adult population worldwide. Although less than 7% of thyroid nodules are malignant, accurate differentiation between benign and malignant nodules is critical for appropriate clinical management. High-resolution ultrasonography (USG) is the imaging modality of choice for evaluating thyroid nodules, and fine needle aspiration cytology (FNAC) remains the gold standard for pathological diagnosis.

Aim: To evaluate the role of Gray Scale ultrasound and Color Doppler in the assessment of thyroid nodules and to correlate the findings with FNAC results.

Materials and Methods: A hospital-based comparative study was conducted over 18 months in the Department of Radio Diagnosis, SSSMC&RI, Chennai. A total of 59 patients presenting with thyroid nodules were evaluated using Gray Scale ultrasound and Color Doppler. Various sonographic parameters including margins, peripheral halo, echogenicity, composition, calcification, shape, and vascular pattern were assessed. The dominant or most suspicious nodule was considered for each patient. Ultrasound findings were correlated with FNAC cytological results.

Results: The study included patients of both sexes across all age groups presenting with thyroid swellings. Gray Scale ultrasound features including hypoechogenicity, irregular margins, microcalcifications, taller-than-wide shape, and absence or irregular peripheral halo showed significant association with malignancy. Color Doppler evaluation revealed that intranodular vascularity was a significant predictor of malignancy. The combination of Gray Scale and Color Doppler findings demonstrated higher diagnostic accuracy compared to either modality alone.

Conclusion: Gray Scale ultrasound and Color Doppler are complementary modalities in the evaluation of thyroid nodules. Combined use of these techniques improves the diagnostic accuracy in differentiating benign from malignant thyroid nodules and helps in reducing unnecessary FNAC procedures.

KEYWORDS: Thyroid nodule, Gray Scale ultrasound, Color Doppler, Fine needle aspiration cytology, Thyroid malignancy

INTRODUCTION

Nodular thyroid disease is detected in 3–7% of the adult population worldwide. Thyroid cancer is rare and accounts for <1% of all malignant neoplasms. It has a good long-term prognosis after surgical excision. The high prevalence of thyroid nodules in the general population calls for a clear strategy to identify patients in whom surgical excision is genuinely indicated as opposed to those who can be managed conservatively.

Current management guidelines (American Thyroid Association) state that diagnostic USG should be performed in all patients with thyroid nodules and fine needle aspiration (FNA) in potentially malignant nodules.

Nodular hyperplasia is the most common cause of benign thyroid nodules. Although less than 7% of thyroid nodules are malignant, it is critical that they be accurately identified. High-resolution US is the imaging modality

of choice to investigate thyroid nodules. When multiple signs of thyroid malignancy appear in combination, USG helps to make an accurate prediction.

Fine-needle aspiration (FNA) may help in further assessment of the nodule. Recognition of specific morphologic patterns is an appropriate method for the identification of benign thyroid nodules that do not require cytological evaluation and may substantially decrease the number of unnecessary biopsy procedures. Horvath et al. proposed the Thyroid Imaging Reporting and Data System (TIRADS) to develop a standardized US characterization and data reporting system for thyroid lesions. There are various sonographic features which predict malignancy, including irregular margin, echogenicity, calcification, halo characteristics, and internal composition.

The current indications for fine-needle aspiration (FNA) of thyroid nodules <10 mm are highly selective. FNA is also not necessary in the case of autonomous or cystic nodules ≥10 mm. In the remaining cases, ultra-sonographic characteristics of the nodule (composition, echogenicity, shape, margins, halo, and calcifications) are important for the indication of FNA and for estimating the risk of malignancy.

In addition to the controversy regarding the use of Doppler US for the differentiation of benign and malignant nodules, there is no consensus on which type of vascularity would be considered suspicious of malignancy. Some organizations such as the American Thyroid Association consider "increased intranodular vascularity" as suspicious, without requiring that vascularity is predominantly or exclusively intranodal. Others such as the Society of Radiologists in Ultrasound propose only "predominantly or exclusively central" blood flow to be defined as suspicious.

Finally, even when vascularity is taken into consideration, other ultra-sonographic characteristics of the nodule continue to be important; i.e., Doppler US does not replace gray-scale ultrasound (GSUS). It is therefore important to know whether (i) an apparently benign nodule on GSUS becomes suspicious when Doppler US reveals suspicious vascularity and the probability of the nodule being benign increases when Doppler US is also not suspicious; (ii) a suspicious nodule on GSUS is no longer suspicious when Doppler US is not suspicious and its risk of malignancy increases when Doppler US is also suspicious.

AIM AND OBJECTIVES

Aim

To correlate the Gray Scale ultrasound and Color Doppler evaluation of thyroid nodules with Fine needle aspiration findings.

Objectives

1. To evaluate the Gray Scale features of thyroid nodules on Ultrasonography and to evaluate the vascular pattern of thyroid nodules on Color Doppler.
2. To differentiate benign nodules from malignant nodules on Ultrasonography.
3. To correlate ultrasound features with the cytological and histopathological findings.

MATERIALS AND METHODS

Type of Study-A hospital-based comparative study was undertaken to assess the role of Gray Scale Ultrasound and Color Doppler in evaluation of thyroid nodules with pathological correlation.

Duration of Study-18 months

Source of Data-All cases referred to the Department of Radio Diagnosis and Imaging, SSSMC&RI, Ammapettai, Chennai.

Study Population-59 patients

Sample Size Calculation-Based on the previous study, the prevalence value is 26%.

$$n = 4pq/l^2$$

where $p = 26\%$, $q = 100 - 26 = 74$, $l = \text{absolute error} - 12\%$

$$n = 4 \times 26 \times 74 / 12^2$$

$$n = 58.78 \approx 59$$

Inclusion Criteria

- Both sexes
- All age groups

- Any neck swelling in the region of the thyroid

Exclusion Criteria

- Neck swelling other than thyroid nodule

Equipment-Ultrasound machine Mindray with both curvilinear transducer, high frequency linear array transducer and Doppler probe.

Methodology-Patients were examined in the supine position with a pillow underneath the shoulders to slightly extend the neck.

The diagnosis based on Gray Scale features on Ultrasonography and findings on Color Doppler of thyroid lesions were evaluated and correlated with the cytological features and histopathological features. Gray Scale sonographic characteristics for each nodule were described followed by the Colour Doppler.

On Gray Scale, the following parameters were assessed for each nodule:

- Margins
- Peripheral halo
- Echogenicity
- Composition
- Calcification
- Shape
- Lymph nodes

If a patient had several thyroid nodules, the dominant/most suspicious nodule was considered and assessed for this study.

All nodules underwent Color Doppler to describe the vascular patterns. Nodules were classified as nonvascular, peripheral, central, or mixed (both peripheral and central vascularity). Nodules with vascularity were categorized as peripheral, central, or mixed vascular.

REVIEW OF LITERATURE

Historical Aspects-In 1656, English anatomist Thomas Wharton named the gland thyroid, meaning "shield," as its shape resembled the shields commonly used in Ancient Greece. In 1811, Paris discovered iodine in the burnt ashes of seaweed and proposed that this was the main ingredient in treatments prescribed for goitre. Around ten years later, British physician-chemist Dr. William Prout was the first to suggest iodine in the treatment of goitre.

Previous Studies-

Popli MB et al. (2012) assessed the utility of gray-scale USG to identify patterns of thyroid nodules and to correlate the characteristics of benign and malignant nodules with pathological diagnosis.

Wesley RP et al. (2015) evaluated whether Doppler ultrasound (DUS) is of additional value to gray-scale ultrasound (GSUS) in predicting the benign or malignant nature of thyroid nodules.

Palaniappan MK et al. (2016) determined the specific gray scale characteristics, angioarchitecture and cut-off values of Doppler indices of malignant and benign thyroid nodules.

Shekappa C et al. (2017) determined that FNAC and USG examinations are complementary to each other in predicting malignancy and avoid unnecessary or inadequate surgery.

Wang M et al. (2020) compared the diagnostic performance of grayscale ultrasound, subjective color Doppler ultrasound, and combined features in predicting thyroid carcinoma, using FNAC as the reference standard. They found that combined gray-scale with subjective color Doppler ultrasound-guided FNAC is recommended for the diagnosis of thyroid carcinoma.

OBSERVATIONS AND RESULTS

Demographic Profile

The study included 59 patients presenting with thyroid nodules. Patients of both sexes across all age groups were included. The majority of patients presented with swelling in the anterior region of the neck.

Gray Scale Ultrasound Findings

Various Gray Scale parameters were assessed for each nodule:

Parameter Benign Nodules Malignant Nodules

Margins (Well-defined) Present Absent/Irregular

Peripheral Halo Thin, regular Absent or irregular

Echogenicity Isoechoic/Hyperechoic Hypoechoic

Composition Solid/Mixed/Cystic Predominantly Solid

Calcification Coarse Microcalcifications

Shape Not taller than wide Taller than wide

Lymph nodes Not enlarged Enlarged

Color Doppler Findings

Vascular Pattern Benign Nodules Malignant Nodules

Absent blood flow Common Rare

Perinodular only Common Uncommon

Intranodular $\pm$ Perinodular Uncommon Common

Correlation with FNAC-

FNAC results served as the reference standard for diagnosis. Ultrasound findings were correlated with cytological results to determine the diagnostic accuracy of Gray Scale and Color Doppler in differentiating benign from malignant thyroid nodules.

DISCUSSION

The present study evaluated the role of Gray Scale ultrasound and Color Doppler in the assessment of thyroid nodules with correlation to FNAC findings. Thyroid nodules are a common clinical entity, and their accurate characterization is essential for appropriate management.

High-resolution ultrasound is the most sensitive imaging test available for examination of the thyroid gland. With the increasing use of ultrasound, more incidental thyroid nodules are being diagnosed. The challenge lies in distinguishing benign nodules that can be managed conservatively from malignant nodules that require surgical intervention.

Gray Scale Features

In our study, several Gray Scale features showed significant association with malignancy. Hypoechogenicity has been consistently reported as a suspicious feature in malignant thyroid nodules. Irregular margins and the absence of a thin regular halo were also more commonly seen in malignant nodules. Microcalcifications were a specific finding associated with malignancy, while coarse calcifications were more frequently seen in benign nodules. The "taller-than-wide" shape on transverse imaging was another important predictor of malignancy, as previously described in the literature.

Color Doppler Features

Color Doppler evaluation revealed that intranodular vascularity was a significant criterion suggesting malignancy. Malignant nodules tended to demonstrate predominantly or exclusively central blood flow, while benign nodules more commonly showed peripheral or absent vascularity. These findings are consistent with previous studies that have reported increased intranodular vascularity as a suspicious feature.

Combined Modality Approach

The accuracy of detecting malignant thyroid nodules by combining Gray Scale and Doppler is higher than either modality alone. Gray Scale and Doppler have their own strengths and weaknesses; they are complementary rather than competitive modalities in diagnosing benign from malignant thyroid nodules.

Several previous studies have demonstrated similar findings. Palaniappan et al. (2016) found that significant relationships were observed between malignancy and hypoechogenicity, irregular margins, taller-than-wide shape, thick incomplete halo, microcalcifications, lymph node enlargement, and local infiltration. Intranodular vascularity was a significant criterion to suggest malignancy on color Doppler.

Wang et al. (2020) reported that combined gray-scale with subjective color Doppler ultrasound demonstrated improved sensitivity and accuracy compared to either modality alone in predicting thyroid carcinoma.

CONCLUSION

Gray Scale ultrasound and Color Doppler are valuable, non-invasive imaging modalities for the evaluation of thyroid nodules. Specific morphological features on Gray Scale including hypoechogenicity, irregular margins, microcalcifications, taller-than-wide shape, and absent or irregular peripheral halo are helpful in differentiating malignant from benign nodules. Color Doppler evaluation, particularly the presence of intranodular vascularity, adds valuable information in the assessment of thyroid nodules.

The combination of Gray Scale and Color Doppler findings improves diagnostic accuracy compared to either modality alone. These imaging techniques are complementary and, when used together, can help in reducing unnecessary FNAC procedures and guide appropriate clinical management.

FNAC remains the gold standard for pathological diagnosis, and ultrasound findings should be correlated with cytological results for optimal patient care.

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