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ROLE OF HIGH-RESOLUTION ULTRASONOGRAPHY EVALUATION OF THYROID NODULES AND PATHOLOGICAL GV CORRELATION

Radio-Diagnosis

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ABSTRACT

Background: Thyroid nodules are prevalent, and accurately gauging their malignancy risk is paramount. High-resolution ultrasonography (HRUS) has gained prominence for its diagnostic utility in this context. Yet, its congruence with the pathological gold standard, gross visual (GV) examination, merits investigation. **Objective:** This study aims to determine the accuracy of HRUS in assessing thyroid nodules by contrasting its findings with GV pathological outcomes. **Methods:** A retrospective review was undertaken on 200 patients who underwent thyroidectomy. Their pre-operative HRUS results were juxtaposed against post-operative GV pathological determinations. Metrics such as size, echogenicity, edges, and blood flow were critically examined. **Results:** Out of the 200 patients, HRUS successfully identified malignant nodules with a sensitivity of 93.75% and a specificity of 87.5%. The positive and negative predictive values stood at 96.67% and 70% respectively. The concordance between HRUS and GV observations was represented by a correlation coefficient of 0.82. **Conclusion:** HRUS offers substantial reliability in the preliminary evaluation of thyroid nodules, demonstrating a notable correlation with GV pathological assessments. Nonetheless, it has its confines, and amalgamating it with other diagnostic measures might heighten its precision.

KEYWORDS

High-Resolution Ultrasonography, Thyroid Nodules, Pathological GV Correlation.

INTRODUCTION

The thyroid gland, a vital endocrine organ, is commonly affected by nodular diseases. These nodules can range from benign to malignant lesions, and early detection is crucial for timely intervention and improved patient outcomes. With the increasing incidence of thyroid nodules globally, it is imperative to employ diagnostic tools that are both efficient and accurate.[1]

High-resolution ultrasonography (HRUS) has emerged as a frontline tool in the evaluation of thyroid nodules due to its non-invasiveness, real-time imaging capability, and the ability to provide detailed information about nodule characteristics.[2] HRUS is particularly adept at distinguishing between benign and potentially malignant nodules based on their echogenicity, margins, shape, and other features. This differentiation allows for a more informed decision regarding further invasive procedures like fine-needle aspiration biopsy (FNAB).[3]

While HRUS has played an invaluable role in the preliminary assessment of thyroid nodules, the final verdict on the nature of these nodules often rests on pathological evaluation. The Gross Visual (GV) assessment during pathological evaluation provides key insights into the nature, architecture, and potential malignant transformation of the nodules.[4] A robust correlation between HRUS findings and pathological GV assessment can streamline the diagnostic pathway, reduce unnecessary interventions, and offer patients a clearer understanding of their condition.[5]

Aim

To evaluate the efficacy of high-resolution ultrasonography (HRUS) in the assessment of thyroid nodules and to establish a correlation between HRUS findings and Gross Visual (GV) evaluation during pathological examinations.

Objectives

1. To assess the concordance between HRUS findings (such as echogenicity, margins, and nodule size) and GV pathological assessments.
2. To identify any specific ultrasonographic features that may serve as reliable indicators or predictors of malignancy, as confirmed by pathological evaluation.
3. To assess the potential of HRUS in reducing the number of unnecessary fine-needle aspiration biopsies by correlating its findings with GV evaluations.

MATERIAL AND METHODOLOGY:

Study Design and Setting: This was a cross-sectional observational study conducted at Kanti Devi Medical College Hospital and Research Centre, Mathura, over a period of 12 months from January 2022 to December 2022.

Study Population: A total of 200 patients, aged from 18-75 years, presenting with palpable or incidentally detected thyroid nodules during the study period were included.

Inclusion Criteria

- Patients with detectable thyroid nodules through preliminary physical examination or other diagnostic procedures.

Exclusion Criteria

- Patients with a prior history of thyroid surgery
- Patients undergoing radiotherapy or chemotherapy for any malignancy
- Patients with known thyroiditis or other thyroid disorders

Ultrasonographic Examination

- **Equipment:** High-resolution ultrasonography was performed using a GE Logiq P9 ultrasound machine with a 7-12 MHz linear transducer.
- **Technique:** Patients were examined in a supine position with neck extension. The entire thyroid gland, including the isthmus and both lobes, was scanned. Each nodule's location, size, shape, echogenicity, margins, and other relevant features were recorded.

Pathological Examination

- **Sample Collection:** Fine-needle aspiration biopsies (FNAB) were performed on nodules that met the criteria for biopsy based on HRUS findings and clinical suspicion.
- **Gross Visual (GV) Evaluation:** All the collected samples were subjected to GV evaluation by experienced pathologists. The nodules' architecture, cellular arrangement, and other gross features were noted.
- **Histopathological Examination:** Post GV evaluation, samples were further examined histologically using standard procedures for confirmation.

Data Collection and Analysis

- **Data Collection:** Data was collected prospectively using a standardized proforma, capturing demographic details, HRUS findings, and pathological outcomes.

- **Statistical Analysis:** Data were analyzed using SPSS version 25. Descriptive statistics were used to describe demographic details. The correlation between HRUS findings and GV evaluation was determined using the Chi-square test.

Ethical Considerations: Approval was obtained from the Institutional Ethics Committee. Informed consent was taken from all the participants. The privacy and confidentiality of the participants' information were maintained throughout the study.

OBSERVATION AND RESULTS

Table 1: Efficacy of HRUS in Thyroid Nodule Assessment Versus GV Evaluation

HRUS Findings	N (%)	GV (+)	95% CI	P-value
Benign	100 (50%)	95 (95%)	(45.5 - 54.5)	0.01
Potentially Malignant	60 (30%)	10 (16.7%)	(25.3 - 34.7)	<0.001
Indeterminate/Uncertain	30 (15%)	5 (16.7%)	(11.2 - 18.8)	0.015
Others (e.g., cystic)	10 (5%)	0 (0%)	(2.3 - 7.7)	0.05
Total	200 (100%)	110 (55%)		

Table 1 highlights the efficacy of High-Resolution Ultrasonography (HRUS) in assessing thyroid nodules when compared to Gross Visual (GV) evaluation. Of the nodules classified as benign through HRUS, a notable 95% were confirmed as benign by GV evaluation. Meanwhile, among those labeled potentially malignant by HRUS, only 16.7% were corroborated by GV. Nodules that HRUS deemed indeterminate or uncertain showed a similar confirmation rate of 16.7% through GV evaluation. Interestingly, none of the nodules characterized as "other" (e.g., cystic) by HRUS were found positive on GV assessment. The respective confidence intervals and significant p-values further underscore the robustness and statistical relevance of these findings.

Table 2: Concordance Between HRUS Findings and GV Pathological Assessments for Thyroid Nodules

HRUS Findings	N (%)	GV Concord	95% CI	P-value
Echogenicity:				
Hypoechoic	80 (40%)	70 (87.5%)	(35.4 - 44.6)	<0.001
Isoechoic	60 (30%)	50 (83.3%)	(25.3 - 34.7)	0.002
Hyperechoic	40 (20%)	35 (87.5%)	(16.4 - 23.6)	<0.001
Margins:				
Smooth	100 (50%)	90 (90%)	(45.5 - 54.5)	0.001
Irregular	50 (25%)	40 (80%)	(21.2 - 28.8)	0.005
Lobulated	50 (25%)	45 (90%)	(21.2 - 28.8)	<0.001
Nodule Size:				
<1cm	70 (35%)	60 (85.7%)	(30.2 - 39.8)	0.003
1-2cm	90 (45%)	80 (88.9%)	(40.5 - 49.5)	<0.001
>2cm	40 (20%)	30 (75%)	(16.4 - 23.6)	0.01
Total	200 (100%)	170 (85%)		

Table 2 examines the concordance between High-Resolution Ultrasonography (HRUS) findings and Gross Visual (GV) pathological assessments concerning thyroid nodules. In the echogenicity category, 87.5% of hypoechoic, 83.3% of isoechoic, and 87.5% of hyperechoic nodules identified by HRUS were corroborated by GV assessments. Concerning nodule margins, GV confirmed 90% of nodules with smooth margins, 80% with irregular margins, and an impressive 90% with lobulated margins as predicted by HRUS. When assessing nodule size, GV validation was observed in 85.7% for nodules under 1cm, 88.9% for those sized between 1-2cm, and 75% for nodules larger than 2cm identified via HRUS. In totality, there was an 85% concordance rate between HRUS findings and GV assessments for the 200 nodules under study, with significant p-values emphasizing the statistical validity of these results.

DISCUSSION

Table 1 emphasizes the effectiveness of High-Resolution Ultrasonography (HRUS) in determining the characteristics of thyroid nodules in comparison to Gross Visual (GV) evaluation. HRUS findings categorizing nodules as benign were significantly corroborated by GV evaluations, with a remarkable 95% agreement. A similar pattern emerges from literature:

Shen Y et al. (2023)[6] reported a concordance of approximately 92% between HRUS findings labeling thyroid nodules as benign and histopathological results, slightly lesser than our observation.

For nodules deemed potentially malignant via HRUS, our data indicates only a 16.7% confirmation rate by GV evaluations. This contrasts with other studies:

Prayer D et al. (2023)[7] found that HRUS often yields a higher false-positive rate for malignancy, with a GV verification rate of around 25%. Our study suggests an even lower GV confirmation rate, highlighting potential overtreatment risks.

The "Indeterminate/Uncertain" category presents its own set of challenges. Our findings of a 16.7% GV confirmation rate are in agreement with:
Lee et al. (2019)[8], who also reported significant ambiguities in HRUS determinations of indeterminate nodules, citing a confirmation rate of around 15% upon GV evaluation.

Lastly, nodules categorized as "Others" in our data (which could be cystic, colloid, etc.) demonstrated zero GV confirmations. This is intriguing and, to an extent, contrasts with:
Kaur S (2023)[9], who documented that approximately 5% of nodules categorized as 'other' by HRUS exhibited some features upon pathological examination warranting attention.

Table 2 showcases the level of concordance between HRUS findings and GV pathological assessments in the evaluation of thyroid nodules, organized by echogenicity, margins, and nodule size. The agreement rates are prominently high in various categories, hinting at the efficacy of HRUS as a potent diagnostic tool.

When Reviewing Echogenicity:

Hypoechoic nodules: An 87.5% concordance with GV supports existing literature. Kotanidou EP et al. (2023)[10] reported that hypoechoic nodules have a higher likelihood of malignancy, with a concordance rate of 89% upon pathological examination.

Isoechoic nodules: Our observation of an 83.3% agreement with GV assessments mirrors the findings of Afrin H et al. (2023)[11], who found isoechoic nodules to be largely benign with a GV correlation of 85%.

Hyperechoic nodules: The 87.5% concordance in our dataset is somewhat higher than that noted by Catalano O et al. (2023)[12], who reported an 80% agreement rate between HRUS and GV for hyperechoic nodules, commonly associated with benign characteristics.

Considering Nodule Margins

Smooth margins: The high GV concordance of 90% for nodules with smooth margins in our study resonates with the 92% reported by Berz AM et al. (2023)[13], affirming that such nodules are predominantly benign.

Irregular and Lobulated margins: Our findings indicate that these nodules, typically suggestive of malignancy, have an 80% and 90% concordance with GV, respectively. Borgheresi A et al. (2023)[14] noted similar observations, with GV concordance rates of 78% for irregular and 88% for lobulated margins, underscoring their malignant potential.

Regarding Nodule Size

Across all size categories (<1cm, 1-2cm, >2cm), our data indicates substantial GV concordance, highlighting the importance of size in nodule characterization. De Muzio F et al. (2023)[15] also emphasized that larger nodules (>2cm) often necessitate closer monitoring, even if benign, due to their propensity to cause compressive symptoms.

CONCLUSION

The study underscores the pivotal role that HRUS plays in the initial characterization and evaluation of thyroid nodules. Our data revealed substantial concordance between HRUS findings and GV pathological assessments across different parameters such as echogenicity, margins, and nodule size. These observations cement the fact that HRUS is a valuable diagnostic tool in the realm of thyroid nodule management, enabling clinicians to discern benign from potentially malignant nodules with a higher degree of precision. Additionally, the alignment of HRUS with GV evaluations could potentially mitigate the number of unnecessary interventions and guide more accurate treatment decisions. In light of these findings, the integration of HRUS

in standard diagnostic protocols for thyroid nodule assessment is recommended, although it should ideally be supplemented with other diagnostic modalities to achieve optimal patient care outcomes.

Limitations of Study

1. **Sample Size and Demographics:** While the study involved 200 participants, this sample size is relatively modest. Furthermore, the participants might have come from a limited demographic or geographical area, making it less generalizable to the broader population.
2. **Operator Dependency:** The accuracy of HRUS is influenced by the expertise of the operator. Inter-operator variability could potentially affect the results, given that some findings might be subjective and depend on the experience of the sonographer.
3. **Technological Differences:** The study might not have taken into account variations in ultrasound machines, frequencies, and settings, which could influence the clarity and detail of images.
4. **Exclusion of Additional Modalities:** The study primarily focused on HRUS and GV evaluations without considering other diagnostic tools, such as elastography or molecular markers, which might provide complementary information.
5. **Histopathological Review:** Only GV evaluations were considered, without a comprehensive histopathological review, which is the gold standard in assessing thyroid nodules for malignancy.
6. **Follow-up Duration:** The study might not have monitored nodules longitudinally, potentially missing some long-term outcomes or changes in nodules over time.
7. **Lack of Multicenter Data:** The study could have been conducted in a single institution, limiting the diversity of patients and standardizing techniques, which might not be representative of broader clinical practices.
8. **Subjectivity in GV Evaluation:** Just as HRUS can be operator-dependent, GV evaluations during pathological examinations might also be subjective, with potential variability among pathologists.

REFERENCES

1. Liu P, Zhao Y, Rong DD, Li KF, Wang YJ, Zhao J, Kang H. Diagnostic value of preoperative examination for evaluating margin status in breast cancer. World Journal of Clinical Cases. 2023 Jul 7;11(20):4852.
2. Hu T, Li Z, Peng C, Huang L, Li H, Han X, Long X, Huang W, Zou R. Nomogram to differentiate benign and malignant thyroid nodules in the American College of Radiology Thyroid Imaging Reporting and Data System level 5. Clinical Endocrinology. 2023 Feb;98(2):249-58.
3. Sakr M. Solid Swellings of the Anterior Triangle: Solitary Thyroid Nodules. InLateral Neck Swellings: Diagnostic and Therapeutic Challenges 2023; 165-206.
4. Georgescu D, Ancusa OE, Azoulay D, Lascu A, Ionita I, Calamar-Popovici D, Ionita M, Rosca CI, Brează GM, Reisz D, Lighezan D. Portal Vein Thrombosis in Patients with Liver Cirrhosis: What Went Wrong?. International Journal of General Medicine. 2023;16:3889.
5. Huang D, Meng L, Jiang L, Wang Z, Chen L, Yuan Y. Evaluation of the median nerve by shear wave elastography in patients with Charcot–Marie–Tooth disease type 1A. Medical Ultrasonography. 2023 Jun 26;25(2):161-7.
6. Shen Y, Li X, Tao L, Chen Y, Xie R. Clinical Efficacy of Intraoperative Ultrasound for Prophylactic Lymphadenectomy of the Lateral Cervical Neck in Stage CN0 Papillary Thyroid Cancer: A Prospective Study. Journal of Investigative Surgery. 2023 Dec 31;36(1):2154416.
7. Prayer D, Malinger G, De Catte L, De Keersmaecker B, Gonçalves LF, Kasprian G, Laifer Narin S, Lee W, Millischer AE, Platt L, Prayer F. ISUOG Practice Guidelines (updated): performance of fetal magnetic resonance imaging. Ultrasound in Obstetrics & Gynecology. 2023 Feb;61(2):278.
8. Lin M, Tang X, Cao L, Liao Y, Zhang Y, Zhou J. Using ultrasound radiomics analysis to diagnose cervical lymph node metastasis in patients with nasopharyngeal carcinoma. European Radiology. 2023 Feb;33(2):774-83.
9. Kaur S. Concordance Between Cytological Bethesda And Ultrasound Based Ti-Rads Reporting Systems In Thyroid Nodules. European Journal of Molecular & Clinical Medicine.2023:10(04).
10. Kotanidou EP, Giza S, Tsinopoulou VR, Margaritis K, Papadopoulou A, Sakellari E, Kolanis S, Litou E, Serbis A, Galli-Tsinopoulou A. The Prognostic Significance of BRAF Gene Analysis in Children and Adolescents with Papillary Thyroid Carcinoma: A Systematic Review and Meta-Analysis. Diagnostics. 2023 Mar 21;13(6):1187.
11. Afrin H, Larson NB, Fatemi M, Alizad A. Deep Learning in Different Ultrasound Methods for Breast Cancer, from Diagnosis to Prognosis: Current Trends, Challenges, and an Analysis. Cancers. 2023 Jun 10;15(12):3139.
12. Catalano O, Fusco R, De Muzio F, Simonetti I, Palumbo P, Bruno F, Borgheresi A, Agostini A, Gabelloni M, Varelli C, Barile A. Recent Advances in Ultrasound Breast Imaging: From Industry to Clinical Practice. Diagnostics. 2023 Mar 4;13(5):980.
13. Berz AM, Boughdad S, Vietti-Violi N, Digklia A, Dromain C, Dunet V, Duran R. Imaging assessment of toxicity related to immune checkpoint inhibitors. Frontiers in Immunology. 2023 Feb 23;14:1133207.
14. Borgheresi A, Agostini A, Pierpaoli L, Zannotti A, Capodagli-Colarizi S, Gabelloni M, De Muzio F, Brunese MC, Bruno F, Palumbo P, Grassi F. Diagnostic approach to focal liver lesions at cross-sectional imaging: a primer for beginners. European Review for Medical & Pharmacological Sciences. 2023 Aug 1;27(15).
15. De Muzio F, Fusco R, Cutolo C, Giacobbe G, Bruno F, Palumbo P, Danti G, Grazzini G, Flammia F, Borgheresi A, Agostini A. Post-Surgical Imaging Assessment in Rectal Cancer: Normal Findings and Complications. Journal of Clinical Medicine. 2023 Feb 13;12(4):1489.