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Analysis of Causes of Misdiagnosis in Thyroid Nodules by Ultrasonographic Diagnosis

Lina Shang

The Affiliated Hospital of Hebei University, Baoding, Hebei, China

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Abstract: The Objective is to analyze the causes of misdiagnosis in thyroid nodules during ultrasonographic diagnosis. Thirty cases of thyroid nodules, initially diagnosed by ultrasonography but subsequently confirmed as misdiagnosed by postoperative pathology between January 2024 and December 2024, were included. Ultrasonographic features, pathological findings, and clinical information were analyzed to classify types of misdiagnosis and summarize the underlying causes. Among the 30 misdiagnosed cases, 15 (50%) were benign nodules misdiagnosed as malignant, with adenomas being the most frequently misdiagnosed as papillary carcinoma (8 cases). Ten cases (33.3%) were malignant nodules misdiagnosed as benign, predominantly involving missed diagnoses of micropapillary carcinoma (6 cases). Three cases (10%) involved misjudgment of nodule nature, and 2 cases (6.7%) were missed diagnoses of multiple nodules. The primary underlying causes of misdiagnosis included atypical ultrasonographic features, inadequate equipment resolution, insufficient operator expertise, and poor integration of clinical information. Misdiagnosis of thyroid nodules in ultrasonographic diagnosis is associated with the complex characteristics of nodules, technical limitations, and operators' subjective judgment. Improving diagnostic accuracy requires the application of high-resolution ultrasound technology, enhanced operator training, integration of multidisciplinary clinical information, and dynamic follow-up of suspicious nodules.

1. Introduction

Thyroid nodules are common clinical thyroid disorders, whose incidence has been increasing annually with the widespread adoption of imaging modalities. Ultrasonography, characterized by non-invasiveness, convenience, and high reproducibility, stands as the first-line method for screening and diagnosing thyroid nodules[1]. However, the diversity of pathological types of thyroid nodules, the complexity of ultrasonographic features, and variability in operators' expertise and technical proficiency result in a certain rate of misdiagnosis. Misdiagnosis may not only delay patients' treatment but also cause unnecessary surgeries or overtreatment, thereby increasing their psychological and economic burdens[2]. The present study aims to analyze the underlying causes of misdiagnosis in the ultrasonographic diagnosis of thyroid nodules, thereby providing references for enhancing diagnostic accuracy and reducing the incidence of clinical misdiagnosis.

2. Materials and Methods

2.1. General Data

Thirty cases of thyroid nodules that were initially diagnosed by ultrasonography but subsequently confirmed as misdiagnosed via postoperative pathology between January 2024 and December 2024 were included. Among them, 12 were male and 18 were female, aged 25–68 years (mean, 46.3±11.2 years), with disease duration ranging from 3 months to 12 years (mean, 2.8±2.3 years). The inclusion criteria were as follows: (1) Ultrasonographic identification of thyroid nodules with subsequent surgical treatment; (2) Definitive postoperative pathological findings inconsistent with preoperative ultrasonographic diagnoses; (3) Clear ultrasonographic images; and (4) Complete clinical data. The exclusion criteria were as follows: (1) Poor-quality ultrasonographic images that precluded accurate assessment of nodule features; and (2) Comorbidities of other severe diseases that might affect diagnostic analysis. All patients gave written informed consent, and the study was approved by the hospital's Ethics Committee.

2.2. Methods

Data pertaining to the 30 cases of ultrasonographically misdiagnosed thyroid nodules were collected and analyzed. The nodule characteristics, including size, boundary clarity, internal echo patterns, calcification status, and blood flow distribution, were extracted from ultrasonographic reports. The final diagnoses (benign or malignant) and specific pathological subtypes were confirmed based on postoperative pathological reports. Clinical data, including symptoms, thyroid function test results, findings from other imaging examinations, and disease duration, were also collected.

2.3. Observation Indicators and Evaluation Criteria

Types of misdiagnosis were categorized according to discrepancies between pathological findings and ultrasonographic diagnoses: (1) Benign nodules misdiagnosed as malignant; (2) Malignant nodules misdiagnosed as benign; (3) Misjudgment of nodule nature; and (4) Incorrect identification of primary versus secondary nodules in multiple nodules, with secondary nodules missed.

2.4. Statistical Analysis

Statistical analyses were performed using SPSS 22.0 software. Categorical data were expressed as percentages and subjected to the chi-square (χ^2) test, whereas continuous data were presented as (mean ± standard deviation) and analyzed using the t-test. A P-value < 0.05 was considered a statistically significant difference

3. Results

Types of misdiagnosis in the 30 ultrasonographically misdiagnosed thyroid nodules were as follows: Of the 15 cases (50%) where benign nodules were misdiagnosed as malignant, adenomas misclassified as papillary carcinoma accounted for the highest proportion (8 cases), primarily due to overlapping ultrasonographic features—specifically, heterogeneous internal echoes and localized increased blood flow signals—with those of papillary carcinoma. Five cases of nodular goiter were misdiagnosed as carcinoma, attributable to indistinct boundaries secondary to internal fibrosis or

hemorrhage. Ten cases (33.3%) involved malignant nodules misdiagnosed as benign, among which 6 were missed diagnoses of micropapillary carcinoma (diameter ≤ 5mm). These nodules typically exhibited ultrasonographic features of indistinct boundaries, slightly hypoechoic signals, and the absence of obvious calcification, rendering them easily overlooked. Four cases of follicular carcinoma were misidentified as adenomas, attributable to homogeneous blood flow signal distribution and lack of typical microcalcifications. Misjudgment of nodule nature occurred in 3 cases (10%), where colloid cysts were misdiagnosed as solid nodules due to echo enhancement caused by colloid concentration. Missed diagnoses of multiple nodules were noted in 2 cases (6.7%), primarily stemming from incomplete glandular scanning by operators or inadequate focus on secondary nodules.

Causes of misdiagnosis: Atypical ultrasonographic features constituted the primary factor. Microcarcinomas were frequently underdiagnosed, attributable to their small size, indistinct boundaries, and absence of typical malignant characteristics. Both adenomas and papillary carcinomas may present with hypervascular blood flow signal distribution, which in turn complicates their differentiation. Instrument-related factors were non-negligible: low-resolution ultrasonographic devices had limited capacity to visualize microcalcifications, while color Doppler flow imaging exhibited insufficient sensitivity to low-velocity blood flow, thereby masking the vascular features of malignant nodules. Operator inexperience was manifested by excessively subjective judgment of nodule boundary clarity and echo patterns—for instance, misinterpreting the halo sign in nodular goiter as malignant infiltration—and failure to adequately assess the relationship between primary and secondary nodules in multiple nodules. Coexisting Hashimoto's thyroiditis caused uneven glandular background echoes, leading to blurred nodule boundaries and misdiagnosis as malignant. Image artifacts arising from improper patient positioning or respiratory motion also interfered with the accurate assessment of nodule characteristics.

4. Discussion

Thyroid nodules refer to abnormal masses occurring within the thyroid gland, which can move up and down with swallowing movements and constitute one of the most prevalent thyroid disorders in clinical practice. The majority of thyroid nodules are benign, and patients may be asymptomatic, often detected incidentally during physical examinations or examinations for other diseases. A minority of nodules may be accompanied by abnormal thyroid function, manifesting as symptoms of hyperthyroidism or hypothyroidism. Malignant nodules, during their growth, may compress surrounding tissues, resulting in manifestations such as neck masses, hoarseness, or dysphagia. With the widespread adoption of ultrasonographic examination techniques, the detection rate of thyroid nodules has significantly increased[3]. The results of this study indicated that the misdiagnosis rate of thyroid nodules in ultrasonographic diagnosis was 100% (30/30). Of these, misdiagnosis of benign nodules as malignant was the most common (50%), followed by misdiagnosis of malignant nodules as benign (33.3%), alongside misjudgment of nodule nature and missed diagnoses of multiple nodules. While ultrasonographic examination is of great value in the diagnosis of thyroid nodules, it still has certain limitations, and the occurrence of misdiagnosis is associated with multiple factors. In terms of misdiagnosis types, the misdiagnosis of benign nodules as malignant was relatively common (15 cases), particularly the misdiagnosis of adenomas as papillary carcinoma (8 cases). This is related to the similarity in ultrasonographic features between adenomas and certain papillary carcinomas. Especially when the nodules are small or accompanied by calcification, the diagnostic discriminability of ultrasonographic images decreases, which can easily lead to misjudgment. Malignant nodules were misdiagnosed as benign (10 cases), particularly micropapillary carcinoma (6 cases). Due to their small size, slow growth, and lack of typical

malignant signs on ultrasonographic images, such nodules are prone to missed diagnosis. In terms of the causes of misdiagnosis, atypical ultrasonographic features are the primary factor. Some nodules lack clear benign or malignant signs on ultrasonographic images, such as indistinct boundaries, uneven echoes, and atypical blood flow signals, which increase the difficulty of diagnosis. Insufficient instrument resolution also affects diagnostic accuracy, particularly in primary hospitals where some outdated equipment has a limited ability to distinguish small nodules or hypoechoic nodules. Insufficient experience of operators is also a key factor. Different operators may have differences in their understanding and judgment of the same image, especially their insufficient ability to identify atypical nodules, which makes them prone to being affected by subjective factors[4]. Insufficient integration of clinical information also cannot be ignored. The diagnosis of thyroid nodules cannot rely solely on ultrasonographic images but also needs to be comprehensively judged in combination with patients' clinical symptoms, laboratory tests, family history, etc. Incomplete provision of clinical information may result in discrepancies in ultrasonographic diagnosis. Enhancing the accuracy of ultrasonographic diagnosis for thyroid nodules necessitates multi-faceted improvements. High-resolution ultrasonographic equipment—particularly advanced devices with capabilities like elastography and contrast-enhanced ultrasonography—should be promoted to improve diagnostic capabilities for small and hypoechoic nodules. Professional training for ultrasonographic physicians should be strengthened, particularly in the differential diagnosis of atypical nodules and special cases, to improve operators' comprehensive judgment capabilities. A multidisciplinary collaboration mechanism should be established to encourage close collaboration between ultrasonographic diagnosis, clinical practice, and pathology, among other disciplines, thereby avoiding the limitations of single-discipline diagnosis. For suspicious nodules, dynamic follow-up or further examinations are recommended to reduce the incidence of misdiagnosis and missed diagnoses[5].

In conclusion, the misdiagnosis of thyroid nodules in ultrasonographic diagnosis stems from a confluence of the complex nature of nodule characteristics, technical limitations, and operators' subjective judgment. Clinically, efforts should focus on employing high-resolution ultrasonographic technology, enhancing operator training, and integrating multi-disciplinary clinical information, with a view to improving diagnostic accuracy.

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