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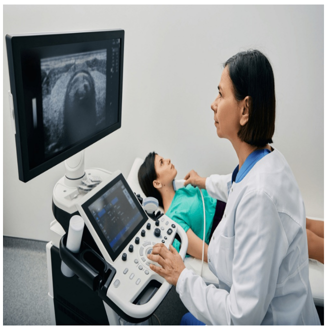
SMI TI-RADS for Enhancing Thyroid Nodule Risk Stratification



The incidence of thyroid cancer has been on the rise, making the need for accurate and non-invasive diagnostic tools more critical than ever. Thyroid nodules are quite prevalent, with a majority being benign. Only a small percentage demonstrate malignant potential. Although fine-needle aspiration (FNA) remains a reliable diagnostic method, unnecessary biopsies are often performed on benign nodules, highlighting the need for better stratification tools. Current risk stratification systems (RSSs) use conventional ultrasound (US) features to classify the likelihood of malignancy in thyroid nodules. However, they often overlook vascular characteristics crucial in tumour biology. A recent review published in Insights into Imaging explores the study that aimed to establish a new risk stratification system called SMI TI-RADS (Superb Microvascular Imaging Thyroid Imaging Reporting and Data System), which integrates both conventional US and advanced microvascular imaging to improve the diagnosis and management of thyroid nodules.

The Role of Microvascular Ultrasound in Thyroid Nodule Diagnosis

Conventional US is a widely used tool for detecting thyroid nodules, but it has limitations, particularly in its ability to evaluate blood flow and vascular patterns. Vascular characteristics of nodules are closely linked to their malignant potential, but standard colour Doppler flow imaging (CDFI) is limited in detecting small vessels or slow blood flow. Microvascular ultrasound (MVUS), specifically Superb Microvascular Imaging (SMI), provides a detailed analysis of low-speed blood flow without the need for contrast agents, thereby offering more accurate imaging of nodule vasculature than CDFI. SMI achieves higher sensitivity, specificity, and diagnostic efficiency for distinguishing malignant from benign nodules.

The study used conventional US and SMI to develop a comprehensive and practical risk stratification system—SMI TI-RADS. The system aimed to enhance the current diagnostic criteria by integrating SMI features, leading to improved thyroid nodule risk classification and reduced unnecessary biopsies.

Development and Validation of SMI TI-RADS

The study involved 643 thyroid nodules from 471 patients who underwent conventional US, SMI, and either FNA or surgical assessment. Univariable and multivariable logistic regression analyses were conducted on various US and SMI features such as nodule shape, margins, echogenicity, echogenic foci, vascularity patterns, ring-SMI patterns, penetrating vascularity, and flow-signal enlargement. Based on these features, a point-based system was constructed to predict the malignancy risk of thyroid nodules, with each feature assigned a specific score according to its likelihood of indicating malignancy.

The SMI TI-RADS model categorises nodules from TR1 (benign) to TR5 (highly suspicious for malignancy), providing clear guidance for when FNA should be performed. Nodules with greater hypoechogenicity, irregular margins, punctate echogenic foci, and extensive vascular patterns on SMI received higher scores. The system was tested for its diagnostic performance against eight other widely used classification systems, demonstrating superior sensitivity (87%), specificity (87%), and overall diagnostic efficiency. Internal and external validation cohorts confirmed the accuracy of SMI TI-RADS, with area under the receiver operating characteristic curve (AUC) values of 0.88 and 0.91, respectively.

Comparison with Other Risk Stratification Systems

SMI TI-RADS was found to outperform existing thyroid nodule RSSs, such as the American College of Radiology (ACR) TI-RADS, European Thyroid Association (EU) TI-RADS, and Korean Society of Thyroid Radiology (KSThR) TI-RADS. It demonstrated higher diagnostic accuracy, with an AUC of 0.94, significantly greater than competing systems. Furthermore, SMI TI-RADS showed a higher biopsy yield of malignancy (BYM) of 79%, indicating that most of the biopsied nodules were malignant. The unnecessary biopsy rate (UBR) was also reduced to 21%, showcasing the potential of SMI TI-RADS to decrease the number of benign nodules subjected to FNA.

This performance underscores the value of incorporating vascular patterns and flow dynamics in thyroid nodule assessment. SMI's advanced imaging capabilities allow for better visualisation of blood flow characteristics, such as the presence of a cloud-like rim of vessels around the nodule, penetrating vascularity, and abnormal enlargement of flow signals, which are indicative of malignancy. These features were integrated into SMI TI-RADS to provide a more nuanced and accurate classification system, improving the guidance for clinical decision-making regarding the need for biopsy and further treatment.

The SMI TI-RADS system significantly advances thyroid nodule risk stratification by integrating both conventional US and superb microvascular imaging features. It demonstrates superior diagnostic accuracy, efficiency, and specificity in identifying malignant nodules compared to existing classification systems. The improved stratification and risk assessment reduce the rate of unnecessary biopsies and provide better guidance for the clinical management of thyroid nodules. Future multicentre prospective studies are recommended to validate the effectiveness and applicability of SMI TI-RADS in diverse clinical settings. This system can potentially refine the approach to thyroid nodule diagnosis and enhance patient care by minimising invasive procedures.

Source: **Insights into Imaging**

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