Ultrasound and Thyroid Nodules: Use of Artificial Intelligence in Thyroid Nodule Ultrasonography

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Intro and Background

Ultrasonography is the most common imaging modality used in the detection of thyroid nodules, which affect nearly 50% of the general population. While ultrasound provides an effective method of thyroid nodule assessment, the interpretation of imaging findings relies on radiologist/sonographer interpretation and lacks inter- and intra-observer consistency.

As the finding of thyroid nodules on imaging continues to increase, there is a need for improvement in assessment modalities to reduce the workload of radiologists and increase the efficiency of diagnosis and management.

In this literature review, we aim to outline the theory and integration of artificial intelligence models in ultrasonography, as well as the limitations and future directions of AI in thyroid nodule assessment. We will pay special attention to the point-of-care ultrasound (POCUS) modality.

Methods

We conducted a comprehensive literature search using the NIH PubMed database. Relevant search terms included various combinations of the following: "thyroid", "nodules", "ultrasound", "POCUS", "bedside", "artificial intelligence", "deep learning", "machine learning", "convoluted neural networks", and "computer assisted diagnostics". Studies were included if they were randomized controlled trials (RCTs), retrospective and/or prospective, focused on the theory and use of artificial intelligence in the diagnosis and clinical management of thyroid nodules, peer-reviewed, available in a full-text format, and published in English within the past 10 years. Select review articles were also included.

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Integration of AI in Thyroid Nodule Detection

The stand-alone use of artificial intelligence is not feasible for clinical use. The most promising role of deep learning models is an adjunctive one, aimed at assisting clinicians in treatment decisions and improving diagnostic accuracy. Peng et al. developed an artificial intelligence model (ThyNet) and compared its diagnostic performance to that of 12 radiologists individually and with the use of AI. They concluded that ThyNet was significantly better than radiologists at differentiating between malignant tumors and benign thyroid nodules.

Additionally, when radiologists used ThyNet, their diagnostic performance improved markedly. Specifically, the use of ThyNet in adjunct with physicians decreased the number of fine needle aspirations from 61.9% to 35.2%, while the number of malignancies that were missed decreased from 18.9% to 17%. These findings suggest that incorporating a deep learning AI model into thyroid nodule management protocols can greatly enhance diagnostic accuracy and reduce unnecessary medical procedures. The effectiveness of AI assistance also varies depending on the radiologists' level of experience. For senior radiologists, an optimized AI strategy can reduce diagnostic time and costs without compromising accuracy. In contrast, a traditional all-AI approach may be more beneficial for junior radiologists, significantly improving their diagnostic capabilities.

Human physicians remain essential for validating AI-generated diagnostic results, as the accuracy of AI depends on the quality of its training datasets. Human expertise will continue to be crucial in interpreting ultrasound findings for thyroid nodule diagnosis, regardless of advancements in AI technology.

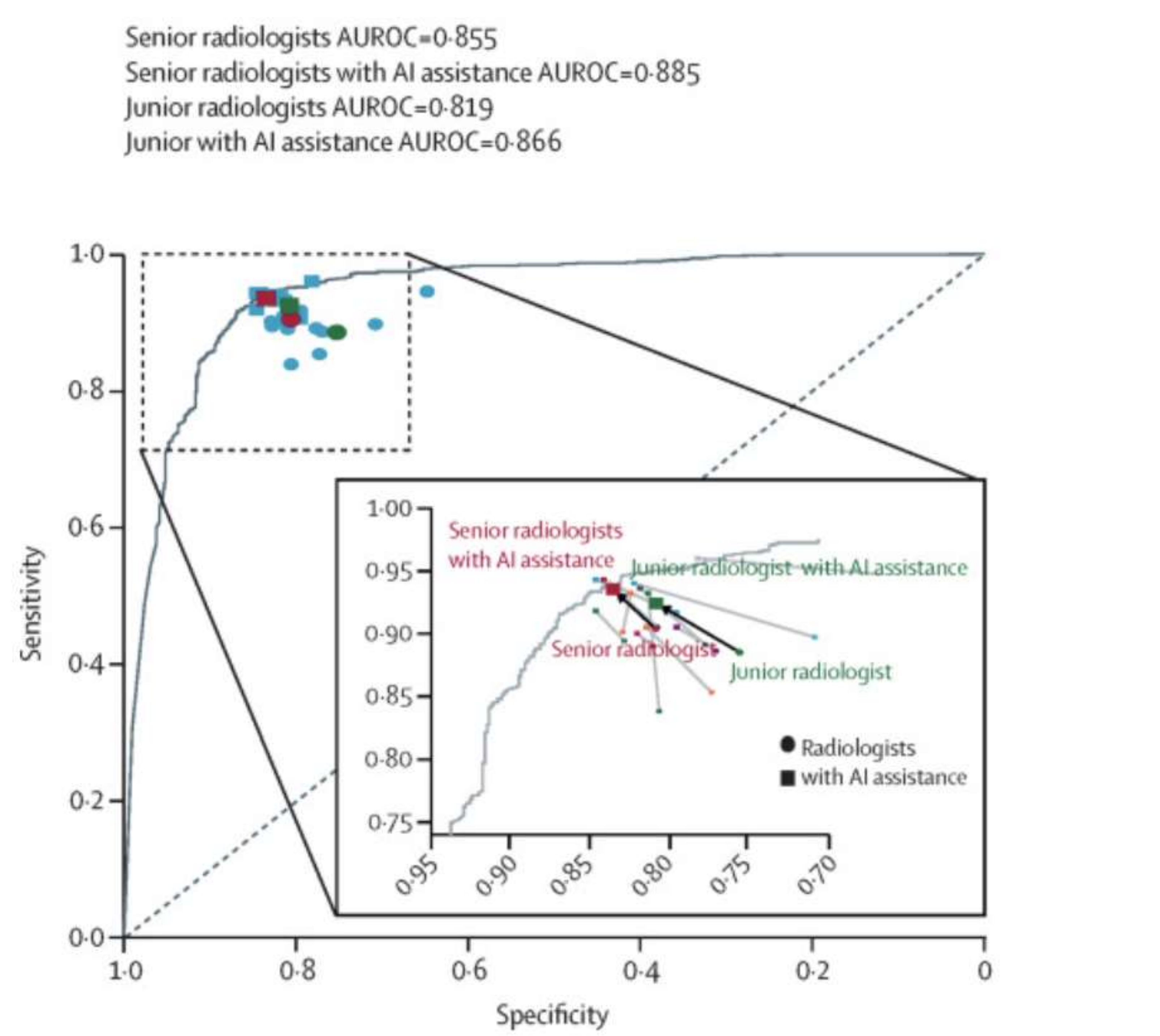
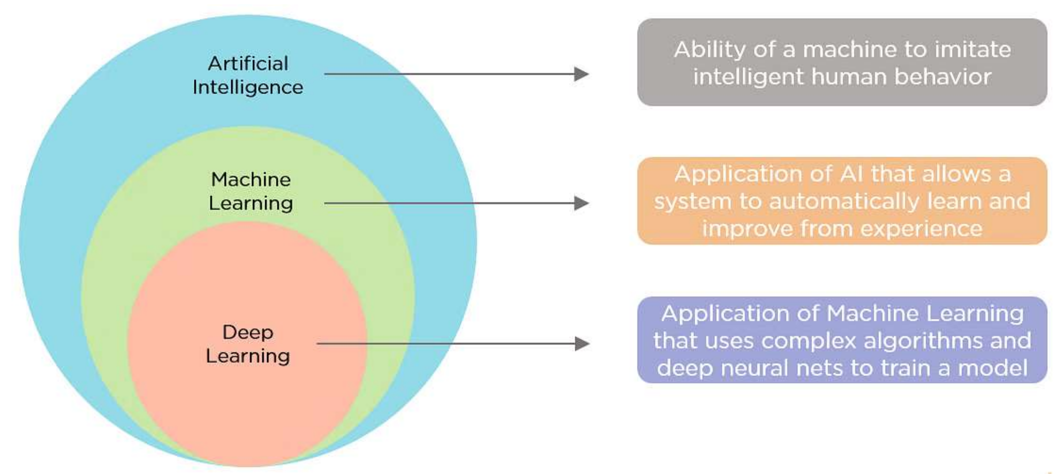


Figure 2 Diagnostic performance of ThyNet and radiologists in serial test for discrimination of malignant from benign thyroid nodules

Theoretical Basis & AI Modalities

Primary AI modalities are Deep Learning and Machine Learning. They are distinguished by the complexity of their neural networks and ability to recognize pathological patterns on diagnostic imaging. Machine learning shows the most promise as a mode of AI integration into existing computer-assisted diagnostics. ML assisted CAD demonstrates promise as an adjunctive tool for trained radiologists, as it displays higher sensitivity but lower specificity for thyroid pathology detection.



Conclusions

AI deep learning and machine learning modalities differ by accuracy and number of neural networks and have potential for diagnostic integration. Successful application of artificial intelligence in thyroid ultrasonography can reduce patient harms, like unnecessary biopsies, and can help improve healthcare equality by providing access to diagnostic tools in community hospitals and rural regions. While there is scarce literature available on the specific use of deep learning technologies in combination with POCUS for thyroid nodule diagnosis, we are certain that current deep learning models can be adapted from traditional ultrasound to bedside ultrasound systems, further improving the accessibility of a powerful and dynamic technology, especially in resource-limited regions.

Contact & references

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