Diagnostic imaging of the thyroid gland – CT and MRI features

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Learning Objectives

The prevalence of incidental thyroid lesions in the general population seems to be high. Approximately 10 % to 40 % in ultrasonography (US) studies and 36% to 50% in autopsy series [1]. Most of these lesions are benign. However, the risk of malignancy ranges from 1.5 % to 17 % in incidentally detected lesions.

The goal in evaluating a thyroid nodule is to determine whether it is benign or malignant and therefore requires further diagnostic workup.
Background

There have been few reports on prevalence and specific characteristics of thyroid abnormalities incidentally detected on CT. CT is not a sensitive technique for demonstrating intrathyroid lesions. However, CT is useful in evaluating lymphadenopathy, local tumor extension, and extension into the mediastinum or retrotracheal region.

Therefore, US is used for primary detection of intrathyroid lesions, and CT or MRI is used for staging. Attempts to differentiate benign from malignant nodules by measuring the iodine content and enhancement characteristics of the nodules on CT scans have been unsuccessful.

MRI is not as sensitive as US in depicting intrathyroid lesions. Early optimism regarding the use of MRI in the diagnosis of intrathyroid lesions is fading. However, MRI is helpful in the evaluation of local extension of thyroid neoplasms or the spread of disease into the mediastinum or retrotracheal region. In addition, MRI is useful in assessing lymphadenopathy. High-tesla-scanners and specially configured coils have improved the resolution of MRI.
**Imaging Findings OR Procedure Details**

**CT**

The gland is generally hyperdense compared with muscle because of its iodine content on non-contrast images and it dramatically enhances due to its vascularity post-contrast administration. The CT attenuation may be diminished in patients on thyroid replacement therapy. See Fig. 1 on page 6 and Fig. 2 on page 6 for CT characteristics of the thyroid gland.

CT of the thyroid is neither sensitive enough nor specific enough to allow the characterization of thyroid nodules. But thyroid cancer is suggested when certain patterns of calcification are seen in a thyroid mass and when extension to the surrounding soft tissues is visualized. Regional lymphadenopathy in association with a thyroid mass also is suggestive of thyroid malignancy.

Thyroid cancers may be missed on CT scans in the presence of a multinodular goiter. An intrathyroidal parathyroid gland and/or adenoma may lead to a false-positive diagnosis of thyroid cancer.

**MRI**

On MRI, thyroid tissue has a shorter T1 than muscle and therefore a relatively increased signal intensity compared with the adjacent "strap muscles" and sternocleidomastoid (Fig. 3 on page 7). Signal intensity is relatively higher on T2 weighted sequences (Fig. 4 on page 8).

**Calcified nodule**

Thyroid nodules with nodular or rim calcifications in CT are more likely to be malignant, with a sensitivity of 46.7%, a specificity of 86.7%, and a positive predictive value of 33.3%. These calcifications on CT correlate with coarse calcification or microcalcifications on US [1;2]. Calcifications found on CT scan tend to be of the coarse variety more associated with benign than malignant changes while microcalcifications are frequently associated with malignancy. But it can be expected that that most microcalcifications cannot be identified at CT owing to their very small size [1]. When found within a solid nodule in ultrasound, they have shown to predict a threefold increase in cancer risk [3]. See Fig. 5 on page 9, Fig. 6 on page 10 and Fig. 7 on page 11 for CT examples of calcified thyroid nodes.
**Primary malignancies**

*Follicular thyroid carcinoma* (FTC) is a well-differentiated tumor and may resemble an adenoma. It is the most common thyroid tumor developing after exposure to radiation. Patients that present with thyroid cancer following radiation to the head and neck may present with more extensive disease. Despite its well-differentiated characteristics FTC may be invasive and in fact easily spread to other organs. See Fig. 8 on page 12 for CT image of FTC.

*Anaplastic thyroid carcinoma* (ATC) is usually large and classically shows local invasion into a variety of the adjacent structures including the great vessels, trachea and the larynx. The greater soft tissue contrast provided by MRI seems to make MRI more reliable than CT for detecting invasion. Especially muscle oedema and effacement of fat planes are better seen on MRI. The tumor is heterogeneous and substantial cystic necrosis and hemorrhage often can be depicted. See Fig. 9 on page 13 for CT image demonstrating anaplastic carcinoma.

Typically small and localised, *Papillary thyroid carcinoma* (PTC) is usually reasonably well defined. Just a minority is ill-defined and invasive. In fact these tumors may spread easily to other organs or adjacent structures, including the larynx and trachea and, less often the esophagus.

*Medullary thyroid carcinoma* (MTC) is usually a solid tumor, well circumscribed and may show areas of coarse of psammomatous/ cloudy calcification.
Fig. 1: non-enhanced CT demonstrating slightly hyperdense thyroid gland compared to muscle tissue.

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Fig. 2: contrast enhanced CT demonstrating enhancement of thyroid tissue compared to muscle.

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Fig. 3: T1w TSE image showing slight hyperintensity of thyroid gland compared to muscle tissue.

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Fig. 4: T2w TSE image showing hyperintensity of thyroid gland compared to muscle tissue.

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Fig. 5: non-enhanced CT showing coarse calcarifications in a multinodular goiter, representing degenerative regressive calcifications.

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**Fig. 6:** contrast enhanced CT showing mostly eggshell-like calcified hypodense nodules in a multinodular goiter.

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Fig. 7: non-enhanced CT showing eggshell calcification of a thyroid adenoma in the right thyroid lobe.

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Fig. 8: contrast-enhanced CT showing heterogeneous nodule of the left thyroid gland, histologically proven follicular carcinoma.

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Fig. 9: non-enhanced CT demonstrating diffuse hypodensity of the thyroid gland reflecting areas of cystic necrosis of anaplastic carcinoma.

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Conclusion

CT and MRI cannot replace US in the differential diagnosis of thyroid nodules.

But typical imaging features of malignancies should be known in order to direct further workup of incidentally detected lesions.
Personal Information

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References

