Imaging and Screening of Thyroid Cancer

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KEYWORDS

• Thyroid cancer • Ultrasonography • Screening • Overdiagnosis

KEY POINTS

- Ultrasound (US) is the first-line diagnostic tool for the diagnosis of thyroid diseases, especially for the differentiation of benign and malignant nodules.
- The relatively low aggressiveness of many thyroid cancers, however, coupled with the high sensitivity of sonography for focal thyroid lesions, can lead to cancer diagnosis and treatment with no effect on outcomes.
- The widespread use of US is recognized as the most important driver of thyroid cancer overdiagnosis.
- To avoid excessive diagnosis and overtreatment, US should not be used as a general community screening tool and should be reserved for patients at high risk of thyroid cancer and in the diagnostic management of incidentally discovered thyroid nodules.
- With integration of prescreening risk stratification and the rigorous application of consensus criteria for nodule biopsy, the value of the diagnostic US in thyroid disease evaluation is likely to be maximized.

INTRODUCTION

Thyroid cancer, with an estimated 64,300 new cases and 1980 deaths in 2016, is the most common endocrine malignancy in the United States.[1] According to the National Institutes of Health Surveillance, Epidemiology, and End Results database, in the past 20 years, thyroid cancer incidence has increased significantly in the United States. Canada, Australia, and Western Europe, and some Asian countries have seen a similar increase in incidence.[2,3] For example, thyroid cancer has become the most common cancer in South Korea, where the 2011 thyroid cancer diagnosis rate was 15 times higher than in 1993.[4]

Despite the rapid increase in diagnosis (>5% per year in both men and women), thyroid cancer death rates only increased slightly from 0.43 (per 100,000 population) in 2003 to 0.51 in 2012.[1] More than 40,000 people in South Korea were diagnosed with thyroid cancer in 2011, but only 400 died of thyroid cancer, a similar mortality to that seen in the prior decade.[4] Increased diagnosis without a corresponding change in mortality is suggestive of overdiagnosis. Several population-

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based studies ascribe this to increasing utilization of sonography, fine-needle aspiration (FNA), and an increase in thyroid nodules found on nonthyroid imaging studies.[5,6] In some countries, thyroid ultrasound (US) is used as a screening tool as part of routine health maintenance.[4] This has led to an epidemic of overdiagnosed thyroid cancer,[7] in which a large number of clinically occult thyroid nodules, which are most papillary thyroid carcinomas (PTCs), are detected and aspirated.[8] Overdiagnosis leads to overtreatment: it is estimated in excess of 90% of thyroid cancer patients have their thyroid glands surgically removed,[4,9] even though the evidence that thyroidectomy alters outcomes in these patients is lacking. In addition to the surgical risks of overtreatment, overdiagnosis of low-risk cancers also leads to psychological morbidity and increases health care costs.[10] For these reasons, the role of thyroid US in thyroid cancer screening is limited.

NORMAL ANATOMY AND IMAGING TECHNIQUES OF THYROID CANCER

Normal Anatomy

The thyroid is a shield-shaped endocrine gland. It locates anteriorly in the neck, composed of left and right lobes, connected by a median isthmus. The weight of thyroid is approximately 25 g in adults, with lobar dimensions approximately 5 cm (length) $\times$ 3 cm (transverse) $\times$ 2 cm (anteroposterior). The isthmus varies from 0.6 cm to 1 cm sonographically. The thyroid hormones secreted by thyroid gland regulate the metabolic rate, protein synthesis, and other aspects, such as development.[11]

Ultrasound Imaging

US can image thyroid structures, internal/surrounding blood flow, and adjacent tissues. It has been widely applied for nodule detection, characterization, risk stratification, treatment monitoring, and post-thyroidectomy cancer surveillance. Compared with other imaging modalities, US has high spatial resolution, uses no ionizing radiation, and is low in cost. For these reasons, US is the first-line imaging tool for evaluation of the thyroid. Despite a lack of evidence for screening efficacy, and the significant harm potential associated with overdiagnosis, US is in common use in some countries as a screening tool for thyroid cancer.

IMAGING PROTOCOLS

Thyroid sonography is not recommended as a screening tool in asymptomatic patients. As a result, there is no published screening imaging or screening work-up protocol. In the absence of evidence, several expert societies have issued recommendations regarding the interpretation of thyroid sonography. Two of the most commonly used systems have been published by the American Thyroid Association (ATA) and Society of Radiologists in Ultrasound (SRU). The ATA guidelines recommend FNA in specific circumstances, including (1) nodule greater than or equal to 1 cm in greatest dimension with a high suspicion sonographic pattern; (2) nodule greater than or equal to 1 cm in greatest dimension with an intermediate suspicion sonographic pattern; (3) nodule greater than or equal to 1.5 cm in greatest dimension with low suspicion sonographic pattern; and (4) nodules greater than or equal to 2 cm in greatest dimension with very low suspicion sonographic pattern (eg, spongiform). Observation without FNA is an option for nodules that do not meet these criteria.[12] The SRU guidelines are also widely used and are somewhat simpler than those published by the ATA. In the SRU criteria, FNA is recommended in: (1) a nodule $\geq$ 1.0 cm in largest diameter if microcalcifications are present, (2) a nodule $\geq$ 1.5 cm in largest diameter with any of the following signs: solid or almost entirely solid, or coarse calcifications within the nodule, (3) a nodule $\geq$ 2.0 cm in largest diameter and mixed solid and cystic, or almost entirely cystic with a solid mural component; or (4) the nodule has shown substantial growth since prior US examination.[13]

IMAGING FINDINGS/PATHOLOGY

On FNA, most thyroid nodules can be divided into benign (colloid) nodules, follicular lesions, and malignant nodules.[14] The role of thyroid sonography is to diagnose, localize, and risk-stratify nodules for potential biopsy. Risk stratification is accomplished through assessment of nodule size and sonographic features. Multiple sonographic characteristics have been proposed to identify malignant nodules (**Table 1**). A system that integrates these signs, the Thyroid Imaging Reporting and Data System (TIRADS) system, has been proposed, and the US patterns, definitions, and corresponding malignancy risks (TIRADS scores) are shown in **Table 1**.[15] The characteristic sonographic features of thyroid nodule malignancy have largely been derived from series of the most common thyroid malignancy, PTC. These sonographic findings are less common in other thyroid cancers, such as follicular variant of PTC and medullary and ATCs. The typical US features in these less common thyroid neoplasm are summarized (**Table 2**),[16] and some characteristic US features of malignant thyroid cancers are depicted (**Fig. 1**).