

## The Utility of Color-Flow Doppler Sonography in the Evaluation of Hyperthyroidism

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Rec date: January 9, 2015; Acc date: January 9, 2015; Pub date: January 18, 2015

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### Editorial

As with all facets of medicine, the key to uncovering the etiology of an illness lies in performing a careful history and physical examination. Such is also the case when dealing with patients who manifest with hyperthyroidism. Aside from the clinical encounter, physicians have a myriad of diagnostic tools at their disposal. A host of investigations, ranging from a simple blood test to a nuclear thyroid uptake and scan, can be ordered. In recent years, thyroid ultrasonography has established itself as a useful and popular medium for the evaluation of various forms of thyroid dysfunction. One aspect of performing a thyroid ultrasound involves assessing the intra-thyroidal blood flow using color-flow Doppler sonography (CFDS). This editorial explores the utility and appropriate use of CFDS in the management of patients with hyperthyroidism.

As mentioned above, a good history and physical exam are key in working through the differential diagnoses of hyperthyroidism. A personal history of autoimmunity, physical signs such as that of orbitopathy or thyroid acropachy, or a family history of hyperthyroidism, would lead more so down the road of an autoimmune entity like Graves' disease. On the other hand, a prior bout of a fever, a sore throat or a recent viral illness may be suggestive of subacute thyroiditis. Recent drug use may point towards drug-induced hyperthyroidism or iatrogenic hyperthyroidism i.e. excessive intake of levothyroxine. Indeed, autoimmune markers (i.e. thyroid stimulating immunoglobulin or thyroid peroxidase antibody) provide additional information. However, one should not base a diagnosis solely on an antibody titer. For instance, elevated TPO levels can be found in silent thyroiditis, Hashimoto's thyroiditis as well as in Graves' disease.

A reasonable next step in the management algorithm of a patient with hyperthyroidism would be to perform a thyroid uptake and scan. A destructive process such as subacute thyroiditis will have decreased uptake, whereas an autoimmune process like Graves' disease will have increased uptake. The uptake component of the test helps quantify the percentage of radioactive iodine uptake by the gland, thus giving information about the hyperactivity of the gland. This in turn helps to calculate the dose of radioactive iodine needed for treatment. The benefit of the scan portion of this test lies with its ability to delineate the structure of the gland and outline areas of decreased versus increased uptake i.e. a hot versus cold nodule.

So, given the information that can be gleaned from a thyroid uptake and scan, when should one consider performing a thyroid ultrasound? Recently, the American Association of Clinical Endocrinologists (AACE) and the Endocrine Society have expressed concern with regards to an increasing trend amongst physicians to order ultrasounds. It is felt that the overzealous use of this imaging modality

diverts the attention of a physician, from the biochemical abnormality at hand, to the work up of an incidentally found entity such as a thyroid nodule. Both societies advocate employing the use of a thyroid scan to investigate the possibility of an autonomous nodule, in the setting of hyperthyroidism. A thyroid ultrasound should be considered only if one is dealing with a multinodular goiter or palpable nodule [1].

This practice guideline seems perfectly reasonable. However, in certain clinical scenarios such as in pregnancy, nuclear scans are contraindicated. In this limited setting, CFDS may provide a cost effective and less invasive method of confirming the underlying etiology of a patient's hyperthyroid state. For example, in the setting of Graves' disease, CFDS of the thyroid demonstrates a pulsatile pattern of intra-thyroidal flow in multiple areas, both in diastole and in systole. Ralls et al. first described this pattern in 1988 and coined the term *inferno* [2]. A larger prospective study by Cappelli et al. reported Doppler ultrasound as having a 95% sensitivity and 95% specificity for the diagnosis of Graves' disease, vis-à-vis a nuclear scan which had a 97% sensitivity and 99% specificity. Doppler ultrasonography was also more cost effective [3].

Other etiologies of thyrotoxicosis, such as subacute thyroiditis, will also have distinguishing characteristics. For instance, in subacute thyroiditis, inflamed areas of the thyroid appear hypoechoic on ultrasound and demonstrate absent to reduced blood flow on Doppler [4]. In a small study, Kumar et al. further evaluated the role of thyroid blood flow assessment by CFDS in working up the differential diagnosis of thyrotoxicosis. It was found that the peak systolic velocity of the inferior thyroid artery was much higher in patients with Graves' disease, as opposed to those with destructive thyroiditis. Patients with destructive thyroiditis were in fact noted to have a low peak systolic velocity. CFDS parameters, when correlated with Technetium Tc 99m pertechnetate scan results, demonstrated a comparable specificity of 95% and sensitivity of 96% [5]. An older paper by Vitti et al., further assessing the thyroid blood flow pattern in patients with Graves' disease versus those with Hashimoto's thyroiditis, also confirmed increased thyroid blood flow in patients with Graves' disease. Interestingly, the authors concluded that in patients with a similar echographic pattern on plain ultrasound, CFDS can help distinguish those with Graves' disease and those with Hashimoto's thyroiditis [6].

Some data also indicates that CFDS may serve as a quick tool to help differentiate between the different forms of iatrogenic hyperthyroidism. For example, amiodarone-induced thyrotoxicosis (AIT) occurs in two forms. AIT 1 develops in patients with an underlying thyroid disease such as latent Graves' disease, whereby the iodine load exacerbates the autonomous function of the thyroid gland. AIT 2 happens in individuals with relatively normal thyroid glands, and is thought to be more of a drug-induced destructive

thyroiditis [7]. It is crucial to ascertain which form a patient has due to the fact that one type responds well to anti thyroid drugs, and the other to glucocorticoids. Bogazzi et al. used CFDS to successfully differentiate between AIT 1 and AIT 2 [8]. Lastly, the surreptitious ingestion of excess thyroid hormone causes thyroiditis factitia. In study on 5 women with this condition, Bogazzi et al. demonstrated normal thyroid volume and echogenicity on conventional ultrasound, with absent hypervascularity on CFDS. This is in keeping with the suppression of the native thyroid gland secondary to excessive exogenous thyroid hormone. In comparison, again a group of women with untreated Graves' disease was found to have increased mean peak systolic velocity readings [9].

In conclusion, requesting CFDS in a hyperthyroid patient unable to undergo a nuclear uptake and scan, may be a practical and cost effective next best step in management. By recognizing the clinical information obtained from a Doppler of the thyroid, clinicians can avoid additional invasive workup and initiate timely and effective therapy. Lastly, a quick Doppler study should be performed as part of a regular ultrasound examination of the thyroid, as the information gained is well worth the little bit of extra time taken to carry out the measurements.

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