Computer tomography is not suited for thyroid volume measurements in patients with Graves' disease before radioiodine therapy

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Chapter Seven

Summary

A pilot study was done to investigate the feasibility of native CT for thyroid volume measurements in patients with Graves' disease. In 4 out of 5 patient studies, the interface between the thyroid and its surroundings could not be adequately defined in a majority of the cross-sections, due to a lack of soft-tissue contrast. Contrast enhanced CT is no option in the work up for $^{131}$I treatment because iodinated contrast agents may block the thyroid's radioiodine uptake capacity for several weeks. It was concluded that CT is not suited for thyroid volume measurements in patients with Graves' disease who are referred for radioiodine therapy.
7.1 Introduction

Accurate thyroid volume data are indispensable for individualized dosage calculations in patients who are referred for radioiodine therapy.¹⁻⁴ In clinical circumstances, the thyroid volume is usually measured with planar scintigraphy or with ultrasonography.⁵,⁶ A good correlation has been demonstrated between scintigraphic or ultrasonographic data and surgical thyroid specimens.⁷,⁸ For these comparisons, however, equipment had been used (viz., rectilinear scanners for scintigraphy, and static B-scanners for ultrasonography) that is no longer regarded as state of the art. In individual patients, the accuracy of modern gamma cameras or real-time ultrasound scanners for thyroid volume measurements has not been assessed with a gold standard.

The aim of the present study was to assess the feasibility of thyroid volume measurements with native computer tomography (CT) in patients with Graves’ disease. Radiographic contrast media are contra-indicated in patients who are scheduled for radioiodine therapy, as the relatively small content of free iodine (contamination) in these agents is enough to block the thyroidal radioiodine uptake for weeks or even months.¹,⁴,⁹,¹⁰ Generally speaking, CT is a reliable standard for organ volumetry.¹¹,¹² The value of native CT for thyroid volume measurements has earlier been demonstrated in patients with nontoxic nodular goiter.¹³

7.2 Patients and methods

Native CT-scanning was performed in addition to the standard pretherapeutic work up (¹³¹I uptake test and ⁹⁹ᵐTc-pertechnetate thyroid scintigraphy) in 5 patients with Graves’ disease who had been referred for radioiodine therapy. Written informed consent had been obtained from all patients. The study was approved by the hospital’s ethics committee.

Acquisition

Spiral CT without contrast enhancement was performed with a commercially available scanner (Tomoscan SR 7000, Philips Medical Systems, Best, The Netherlands). A volume acquisition was performed with the following protocol: 120 kV at 250 mA (± 40 seconds continuous exposure); 5 mm collimation (slice thickness); 5 mm/s table speed with a reconstruction index of 3 mm. Patients were in a supine position and were requested not to swallow. Scanning was performed in descending order over approximately 20 cm (mandibular angle to aortic root) with a field of view of 200 mm, a 512×512 matrix, and the plane of
section perpendicular to the cervical spine. All studies were reviewed independently by two readers.

Image processing

For analysis of thyroid volumes the summation-of-areas technique was used, a method of volume calculation from sequential CT images. This method required manual outlining of the thyroid gland with a mouse on all thyroid-containing CT cross-sections on screen, using the volume measurement function on an Easyvision® workstation (Philips Medical Systems). For each cross-section this function calculates the volume in cubic centimeters within the region of interest, taking into account magnification factor, slice thickness and reconstruction index. The thyroid volume was determined by adding up the volumes calculated from the separate slices.

7.3 Results

In 4 out of 5 studies, accurate manual segmentation of the entire thyroid gland was not feasible. In a majority of the cross-sections, the interface between the thyroid gland and the surrounding tissues (dermal structures, fat, muscles) could only partially be identified. This is illustrated in figures 7.1a-d. In the one remaining study (figure 7.1e) the thyroid contour could be identified in most cross-sections, enabling a reliable volume measurement of the thyroid gland.

7.4 Discussion

In patients with Graves’ disease, the delineation and manual segmentation of the thyroid gland was not feasible with native CT. This is contrary to findings in patients with nontoxic nodular goiter. The discordant results with CT-scanning in different thyroid disorders lead to some speculation.

Iodine is stored in the thyroid gland in the form of colloidal tri- and tetraiodothyronine. In euthyroid subjects the iodine content approximates 500 μg per gram thyroid tissue. In hyperthyroid patients the iodine turnover is increased, which is reflected in a reduction of the thyroidal iodine pool. We argue that the lower (endogenous) thyroidal iodide content in Graves’ disease patients causes a lower signal intensity on CT, which in turn leads to a diminished contrast between the thyroid gland and the surrounding tissues in comparison with euthyroid subjects.

With concern to contrast, the properties of newer developments such as multi-array CT are no different from standard or spiral CT.
CT not suited for thyroid volume measurements in Graves’ disease

With native CT, proper segmentation of the thyroid gland is problematic in most patients with Graves’ disease. Contrast enhancement with radiographic contrast media is contraindicated if radioiodine treatment is considered. In conclusion, CT-scanning is not suited for thyroid volume measurements in patients with Graves’ disease who are referred for radioiodine therapy.

Figure 7.1 CT images of 5 patients (a-e), at the level of the thyroid gland. Four cross-sections with interslice gaps of approximately 1.5 cm are shown for each patient study.
7.5 References


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