USE OF THE ANGER SCINTILLATION CAMERA FOR DETERMINING THYROID UPTAKE

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Nineteen patients, representing a spectrum of thyroid function, were studied. The mean 24-hr thyroid ^{131}I uptakes determined by a standard counting procedure and by our scintillation camera counting method were 15.0% and 16.4%, respectively, for the entire patient population. The 24-hr ^{131}I uptakes from these two methods correlated with a coefficient of 0.99. A high degree of correlation between the two methods was found in evaluating euthyroid and hypothyroid patients and a similar finding was noted in the one hyperthyroid patient studied.

The use of ^{131}I-NaI to determine iodine uptake and incorporation into the thyroid at various times has become a conventional and widely utilized means of evaluating patients with all types of thyroid abnormalities. The 24-hr thyroid uptake as performed with the standard techniques on modern equipment is a well-established, reliable, reproducible, and useful procedure (*1*). The Anger scintillation camera, which was developed for imaging procedures, can be modified for use as a whole-body counter for determining nuclide retention. Using results from a series of selected patients with various levels of thyroid function, we compare thyroid ^{131}I uptake measurements using the conventional method with those using the scintillation camera.

MATERIALS AND METHODS

Nineteen outpatients were studied with conventional ^{131}I uptake methods and with a modified scintillation camera method. The subjects were 12 women and 7 men, ranging over 20–54 years in age. Twelve patients were determined to be eumetabolic with no thyroid disease; six patients were determined to be hypothyroid as a result of idiopathic hypothyroidism, Hashimoto's thyroiditis, or thyroid surgery; one patient was hyperthyroid. All patients were studied 24 hr after 10–100 μCi of ^{131}I was administered; four patients were also studied at 4 hr.

Both counting procedures were performed within 1 hr of each other. Conventional counting for the thyroid uptake was performed with a single probe using a 2-in. NaI crystal and flat-field collimation (*2*). The patients were then studied with a Searle Radiographics Pho/Gamma scintillation camera (Fig. 1). The collimator core was removed from the detector, leaving the 11.5-in.-diam by 0.5-in.-thick crystal uncollimated. This makes "chair" geometry possible. The patient was seated 6 ft from the detector. The height and level of the detector and the patient-to-detector distance were standardized. The instrument was set for an energy of 364 keV with a 35% window width. The whole-body count was made 45 min after oral administration of the ^{131}I to

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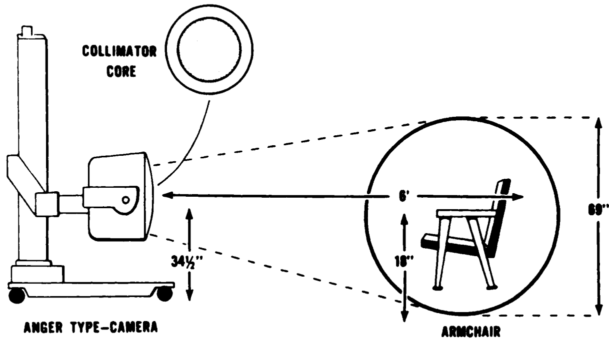

FIG. 1. Chair geometry for determining whole-body uptakes. After removal of collimator, counts are determined with only housing in place. Camera is set at predetermined height and level for detection, and patient is placed in armchair about 6 ft from detector.

allow for equilibration of the radionuclide throughout the body; this measurement was taken as 100% of the administered activity. The patient did not void before the initial counting. Net counts per minute averaged about 480,000 on Day 1 and 25,200 on Day 7. Whole-body counts were performed both with and without a 2-cm-thick lead shield between the patient's thyroid and the detector. The difference between the unshielded and shielded activity counts was taken to represent the thyroid uptake.

Whole-body scanning with ^{131}I was done to image the nonthyroid uptakes. The scans were performed with the Donner Laboratory Mark-II whole-body scanner, developed by Hal O. Anger. The machine consists of a stationary detector head which houses sixty-four 1.5-in.-diam by 1.5-in.-thick crystals, each with its own photomultiplier tube. The patient is placed on a bed that moves over the detector. Scanning time is adjusted for the amount of activity administered to the patient and can be from 45 sec to 88 min. The method allows for transmission, emission, and combined transmission–emission whole-body scans.

RESULTS

The comparison of the two methods for determining thyroid ^{131}I uptake in all patients is shown in Table 1. The correlation coefficient between the two methods is 0.99 and the regression equation is $Y = 0.99X + 1.51$, where X denotes the conventional values and Y denotes the values obtained by whole-body scanning (Fig. 2). The mean 24-hr uptake for all patients undergoing the conventional measurement is 15.0% ± 2.3% (mean ± s.e.m.); that for the measurements using the whole-body counting method is 16.4% ± 2.3%. When these two sets of data are compared, the p value is greater than 0.05, indicating no statistically significant difference between the results from the two methods.

TABLE 1. COMPARISON OF 24-HR ^{131}I UPTAKES USING THE STANDARD AND WHOLE-BODY METHODS*

Patient No.	Standard method 4 hr	Standard method 24 hr	Whole-body 4 hr	Whole-body 24 hr	Deviation 4 hr	Deviation 24 hr
1		51.0		49.6		−1.4
2		1.0		0.6		−0.4
3		3.0		3.0		None
4		4.0		4.0		None
5		2.0		2.2		+0.2
6		32.0		32.4		+0.4
7		23.5		24.4		+0.9
8		21.5		22.6		+1.1
9	7.7	18.8	7.9	20.0	+0.2	+1.2
10		21.0		22.4		+1.4
11		21.0		22.8		+1.8
12		17.0		18.9		+1.9
13		10.0		12.2		+2.2
14	5.0	10.0	5.2	12.4	+0.2	+2.4
15		26.7		29.3		+2.6
16	7.0	14.0	8.0	16.6	+1.0	+2.6
17		13.3		16.2		+2.9
18	8.0	14.0	8.0	17.2	None	+3.2
19		14.0		17.2		+3.2
19†		14.0		20.0		+6.0
Mean ± s.e.m.		15.0 ± 2.3		16.4 ± 2.3		

* Results expressed as percent of uptake.
† Patient No. 19 was imaged on two occasions.

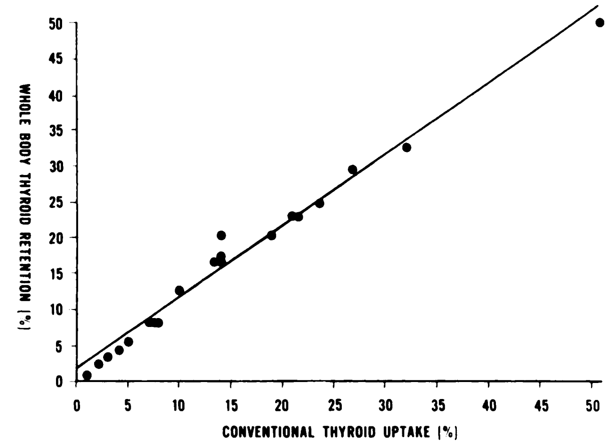

FIG. 2. Linear comparison of data obtained from whole-body retention counts and conventional thyroid uptake counts: correlation coefficient, 0.99; regression equation, $Y = 0.99X + 1.51$.

DISCUSSION

Parker and Wright (*3*) have shown that scintillation cameras can function effectively as whole-body counters for gamma-emitters in the energy range of 60–1500 keV. Our data show a significant positive correlation existing between the scintillation camera method and conventional methods of determining 24-hr thyroidal ^{131}I uptake. Most nuclear medicine clinics have an Anger camera that can be readily adapted to this method of determining thyroid uptakes. Using this method, determination can be made of both thyroidal and nonthyroidal uptakes. This whole-body uptake method also has a distinct advantage in that the patient serves as his own standard. At present the evaluation of whole-body radionuclide retention is conducted with relatively expensive, cumbersome, and time-consuming equipment (*4,5*). Further modifications of this method can be used to determine whole-body uptake of radionuclides.

Data from the present study establish that an excellent correlation exists between both ^{131}I uptake measurements in the evaluation of various clinical thyroid states. The postsurgical hypothyroid patients

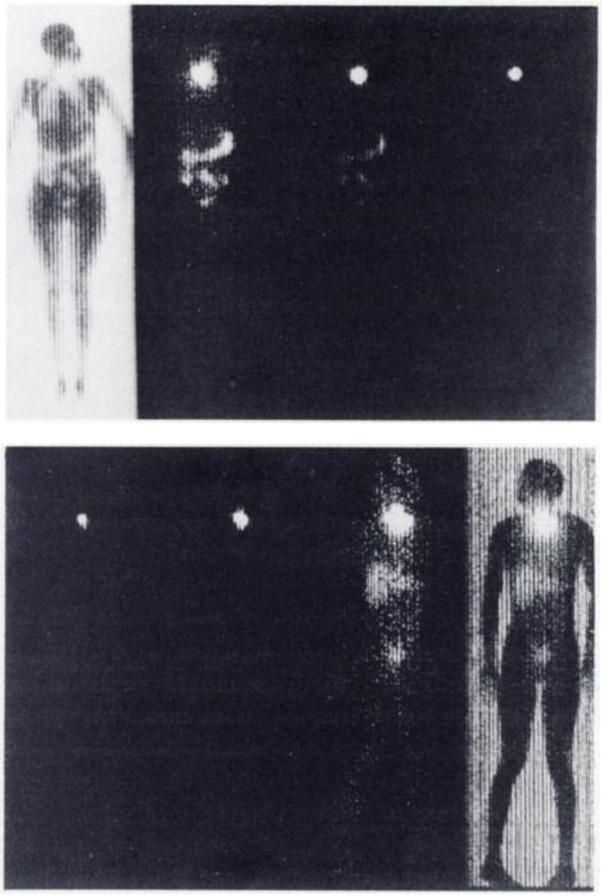

FIG. 3. (Top) Transmissions and combined transmission–emission whole-body scans 3 days after 1-mCi dose of ^{131}I show uptake in thyroid bed, gastrointestinal tract, and bladder. Left-hand figure is combined transmission–emission study showing anatomic localization of uptake. Remaining portions of figure show different photographic exposures of transmission study. (Bottom) Whole-body scan performed 7 days after 30-mCi dose of ^{131}I in patient with functioning tissue in thyroid bed shows uptake in liver and bladder. Liver image reflects hepatic clearance of radioactive thyroid hormone.

in this study had residual uptakes of less than 3% by whole-body counting. When one examines the extrathyroidal sites to account for this residual retention, one finds ^{131}I uptake in the choroid plexus, salivary glands, gastrointestinal mucosa, liver, urinary system, and breast tissue. A representative whole-body image of nonthyroid uptake is presented in Fig. 3. Large doses of 1 and 30 mCi are needed to obtain sufficient imaging capability to show these areas.

Currently we are evaluating the usefulness of this method in determining the extent of residual postoperative thyroid tissue in response to ablative therapy in patients undergoing surgery for cancer of the thyroid (*6*).

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