SIMULTANEOUS MEASUREMENT OF THYROIDAL TRAPPING ($^{99m}TcO_4^-$) AND BINDING ($^{131}I^-$): CLINICAL AND EXPERIMENTAL STUDIES IN MAN*

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Thyroidal uptake was measured repeatedly after simultaneous intravenous administration of $^{99m}TcO_4^-$ and $^{131}I^-$ to assess the thyroidal trapping mechanism ($^{99m}TcO_4^-$) as well as combined trapping and binding ($^{131}I^-$). Standard thyroid uptake equipment was used. Studies in controls (n = 43) showed a mean thyroidal (neck minus thigh) $^{99m}TcO_4^-$ uptake of 3.5% reached within 10–20 min, followed by a gradual decrease. Iodine-131$^-$ uptake curves were normal. In hyperthyroidism (n = 9), uptake of both radionuclides was increased. In untreated hypothyroidism and in goiter with low $^{131}I^-$ uptake (n = 7), $^{99m}TcO_4^-$ uptake appears by this technique to be greater than the $^{131}I^-$ uptake.

In a series of normal volunteers, thyroid space (from T/S ratio) as well as thyroidal uptake were determined. TSH administration (n = 7) stimulated the thyroidal uptake and the thyroid space of both radionuclides. Triiodothyronine (n = 7), while markedly reducing $^{131}I^-$ thyroidal uptake and space, had no effect on measurements of thyroidal $^{99m}TcO_4^-$ concentration by this technique although suppression could be demonstrated by a more specific technique. Propylthiouracil (n = 5) also reduced $^{131}I^-$ thyroidal uptake and the ^{131}I space. It did not affect $^{99m}TcO_4^-$ uptake but increased the ^{99m}Tc space. Lugol's solution (n = 6) virtually obliterated both thyroidal uptake and space for both radionuclides.

Validating studies comparing this technique with a scanning technique which identifies specific thyroidal $^{99m}TcO_4^-$ showed that the thigh correction is inadequate and that failure to demonstrate suppression after triiodothyronine was due to technical limitations. In seven control $^{99m}TcO_4^-$ studies over a 3-month interval on a single subject, the coefficient of variation for the technique used in these studies was 18.3%. For the scanning technique, it was 28.3%.

This method uses generally available equipment and is useful in detecting the stimulation of trapping seen in hyperthyroidism and after TSH stimulation. It should also be valuable in the study of iodine-deficient populations. However, caution is advised when uptake levels are low because of the large, variable concentration of pertechnetate in nonthyroidal neck tissues. To study low $^{99m}TcO_4^-$ uptakes, techniques which specifically identify thyroidal radioactivity must be used.

The first step in manufacture of thyroid hormone, the extraction of iodide from the blood by the thyroid gland over a large concentration gradient, has proven elusive to investigation. This so-called thyroidal "trapping" mechanism typically creates a 30-fold concentration of iodide in the thyroid cell (*3*). This concentrated iodide is rapidly incorporated into tyrosine moieties of the thyroglobulin, leading ultimately to production of active hormone. Because of the amount of this "bound" iodine compared with the the amount of trapped iodide present in the normal thyroid gland, studies using radioactive iodine inevitably measure both "trapped" and "bound" iodine. Separate measurement of the trapping mechanism

Received Sept. 11, 1972, revision accepted May 23, 1973.

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* Presented in part at the American Thyroid Association, 1967 and the Third International Congress of Endocrinology, 1968 (*1,2*).

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itself has been approached by suppression of binding by pharmacologic agents (*3,4*), by abrupt elimination of the trapping mechanism, with the amount of radioiodide discharged subsequently taken as indicative of the quantity of trapped iodide within the thyroid gland (i.e., the "perchlorate test"), and by direct analysis of excised animal thyroids for relative iodide and bound iodine (*5*). These approaches have yielded interesting results but can be criticized on methodologic grounds.

Shortly after ^{99m}Tc-pertechnetate became readily available, Andros, et al (*6*) suggested that this would be a useful radionuclide for measurement of the thyroidal trapping mechanism. Subsequently, a number of centers have reported studies of thyroidal function with pertechnetate in man (*7–9*). In general, these have been clinically oriented studies, directed toward decreasing radiation exposure to the patient, and have shown thyroidal pertechnetate uptake to be increased in hyperthyroidism but of no value in the diagnosis of hypothyroidism. A number of reports have taken advantage of methodology for specifically identifying the radioactivity within the thyroid, directly measuring and subtracting away the neck background radioactivity (scanning techniques). These studies suggest that measurements made with simple uptake probes (uptake techniques) give consistently elevated values for pertechnetate uptake by the thyroid. However, many interested clinicians will not have available the more sophisticated equipment necessary for practical use of the scanning techniques and will wish to continue to use uptake techniques. In this paper we evaluate data collected with uptake equipment under a variety of conditions. We also compare results of this type of data collection with that using a scanning technique in low uptake situations.

MATERIALS AND METHODS

Subjects. Studies were performed on patients with and without thyroid disease drawn from the patient populations of the University of California, Los Angeles, Hospital (UCLA) and the Veterans Administration Hospital, Los Angeles (VA), and on normal volunteer subjects who were paid for their services.

Uptake techniques. Subjects were studied in the supine position with their necks slightly hyperextended in the posture ordinarily used for thyroid uptake studies. Two scintillation detectors were used in these studies, one placed over the thyroid and the other over the thigh with its field of view centered 10 cm above the upper border of the patella. Tracer doses of $^{99m}TcO_4^-$, 10–60 μCi, and $^{131}I^-$, 5–15 μCi, were injected intravenously. Subsequently, measurement of the radioactivity in the neck and the thigh was obtained by gamma-ray spectroscopy with separate counting of the radioactivity centering on the 365-keV peak of ^{131}I and the 140-keV peak of ^{99m}Tc. At each counting time, counts were recorded for each of the two radiopharmaceuticals for the neck and thigh. Counts were regularly made 10 min, 30 min, 60 min, 2 hr, 3 hr, and 6 hr after the isotope injection. In most cases a 24-hr count was also recorded. In the UCLA series, counts were also made at 45 min, whereas in the VA series, counts were made at 20 min. Careful attention was given to placement of the detectors in precisely the same position for each count. In most cases, the subjects remained stationary under the counter for the first hour.

A standard containing an aliquot of the administered dose was prepared for each of the two radiopharmaceuticals. This was made up to 25 ml in saline solution and placed in a large test tube which was then inserted into an AEC Lucite phantom. The phantom was then counted in precisely the same manner as the thyroid and thigh. When use of this phantom was not feasible, the standard was made up to 25-ml volume in a 50-ml beaker. Counting was then performed with the top surface of the beaker in the position of the surface of the skin. This method of standard preparation was carefully cross-calibrated on the gamma detectors used at both institutions with that of the Lucite phantom. A correction factor (0.95) was used. Standard counts were made with each probe used, and counts from each probe were related to the standard relevant to that probe. To assure ourselves that the gamma detection instruments available at the two hospitals gave comparable results, several patients were transported between the two institutions and portions of their study were performed on both instruments.

Although the lower energy gamma rays from ^{99m}Tc contributed virtually nothing to the counts made when the gamma detectors were adjusted to the ^{131}I channel, it was necessary to correct our ^{99m}Tc counts for ^{131}I crossover. We observed, as has been pointed out by others, that the shape of the gamma spectrum from ^{131}I in our phantom differed from that emanating from the patient's neck because of the greater degree of attenuation and scatter in the patient's neck. For this reason, the ^{131}I crossover onto the ^{99m}Tc counts represented a greater portion of the ^{131}I present when counting a patient than was the case when the phantom was counted. We found that it was necessary to determine this "crossover factor" for each individual subject. This was done in one of two ways: (A) In almost all subjects, ^{99m}Tc counts in the neck and thigh had become unmeasurably low

by 24 hr. Assuming no residual ^{99m}Tc, the ratio of the net counts (with room background subtracted) with the machine set for measurement of ^{99m}Tc divided by the net counts with the machine set to measure ^{131}I, yielded the proportion of the ^{131}I counts contaminating ^{99m}Tc measurements. This method of calculation was very satisfactory for the neck counts, but the thigh ^{131}I counts at 24 hr were usually so low that this ratio was statistically unreliable. For this reason in the later studies the injection routine was modified in the following manner: at the beginning of the study, the $^{131}I^-$ injection was made, and the needle left in the vein. After 1 min for circulation of the isotope, 1-min counts were performed over the thigh with the two channels of the instrument set to record ^{99m}Tc and ^{131}I, respectively. Immediately afterward, a 1-min count of the neck with the instrument similarly set was performed. At the end of these counts (3 min after the $^{131}I^-$ injection) the $^{99m}TcO_4^-$ was injected through the same needle. (When the injection was performed in this split fashion, the time of injection was arbitrarily taken to be the time of the $^{99m}TcO_4^-$ injection so that in these studies the $^{131}I^-$ had actually been injected for 3 min longer than would otherwise have been the case. We found that this 3-min differential had no significant effects on our results, and it is not taken into account in the analysis of the data.) In those subjects in whom the crossover factor was calculated by both of these techniques, the ratio was virtually identical. Neck and thigh counts were corrected for room background, isotopic crossover, and radioactive decay, divided by appropriately corrected standard counts, and expressed as the percent of the dose present. For the time intervals less than 1 hr, correction factors empirically derived from earlier work (*10*) were multiplied by the thigh counts. These were 1.31 for the 10-min observation, 1.23 for 20 min, 1.12 for 30 min, and 1.05 for 45 min. The percent of the dose seen in the thigh was then subtracted from the percent of the dose in the neck for an arbitrary measurement of the "thyroid" uptake.

Comparison of uptake technique with scanning technique. Five normal subjects were studied in multiple sessions by the uptake technique, except that 1 mCi of $^{99m}TcO_4^-$ was administered without ^{131}I, and a single set of measurements was made 20 min after intravenous injection. In each case, immediately after this measurement, the subject was placed under a rectilinear scanner (Ohio-Nuclear) and a rapid scan of the neck was made ("scanning" technique). The standard for these studies was 10% of the dose which was placed in a Lucite phantom resembling a normal thyroid gland in size, shape, and location within scattering material. This phantom was scanned using a technique identical to that with which the subject's neck was scanned. The scans were then analyzed by dot counting in a circle encompassing the visible thyroidal radioactivity and in a semicircle of like radius in the nearby neck region (*11*). Net thyroidal activity on the scans was calculated as (counts in thyroid circle) —2X (counts in background semicircle). Similar calculations were made for the scan of the phantom, and thyroidal $^{99m}TcO_4^-$ uptake was calculated from the patient-to-phantom ratio.

All of these subjects were studied in three control sessions and in two sessions after suppression with 7 or 8 days of 25 μg every 8 hr of triiodothyronine. The first control session is not reported here (to remove novelty effect). Results obtained in the other two control sessions and in the two suppression sessions were averaged. One of these subjects underwent a total of seven control studies for assessment of day-to-day and random variability in these techniques.

Thyroidal "space" measurements. In those studies in which serum radioactivity was measured, blood was obtained either through an indwelling needle or by repeated venipuncture. Samples were counted in a well scintillation counter and the counts were divided by counts from a standard prepared from the injected material. Radioactivity in the serum was expressed as the percent of the dose per milliliter. The thyroidal space or volume of distribution for a radiopharmaceutical was calculated as (% of dose in thyroid)/(% of dose in 1-ml serum).

RESULTS

Thyroidal uptake of $^{131}I^-$ and $^{99m}TcO_4^-$ were measured using the uptake technique in 43 control studies (Fig. 1). Thirteen of these were "hospital control" patients. Thirty were normal volunteers. The $^{131}I^-$ uptake rose in these normal subjects in the fashion usually observed when studies are performed with $^{131}I^-$ alone. Technetium-99m-pertechnetate uptake, on the other hand, achieved a maximum averaging approximately 3.5% of the dose which remained relatively constant from 10 min to 1 hr and subsequently fell gradually.

Nine standard uptake studies on eight patients with hyperthyroidism due to Graves' disease are presented in Fig. 2. (One patient was studied on two occasions, before his initial ^{131}I therapy and 4 months later while still hyperthyroid by all criteria.) The 1 s.d. limits for the control series are reproduced as shaded areas for comparison. Iodine-131-iodide uptake in these hyperthyroid patients was more rapid

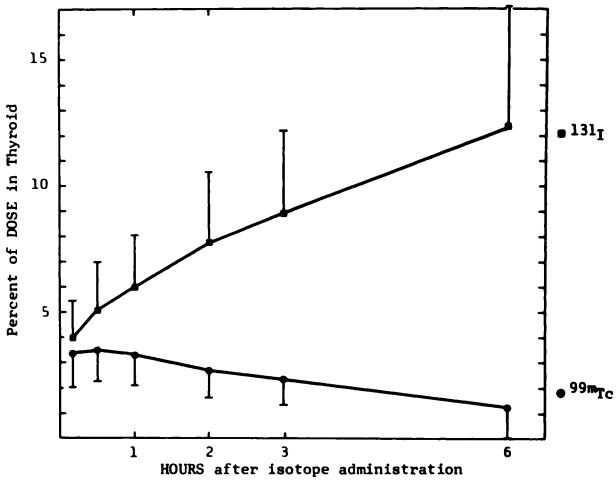

FIG. 1. Combined control series (n = 43). Mean ± s.d.

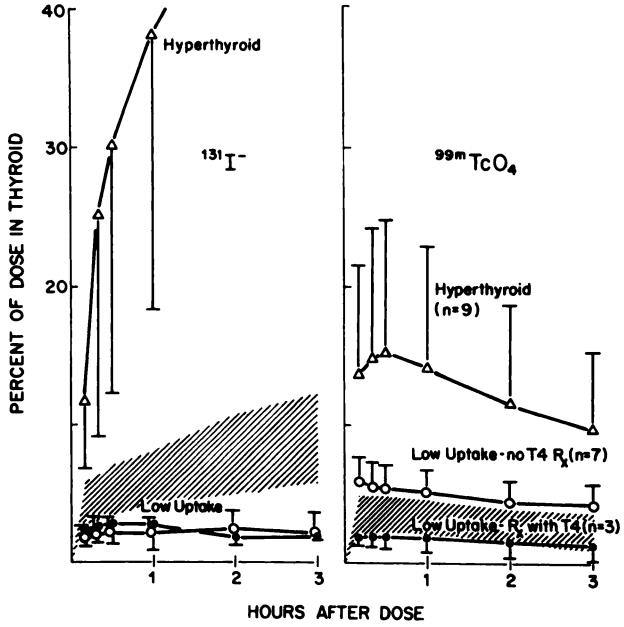

FIG. 2. Hyperthyroid studies (n = 9) and studies in patients with 24-hr ^{131}I uptake less than 7%. (n = 3 with thyroid medication; n = 7 without thyroid medication.) Mean ± s.d. 1 s.d. limits of control series shown as shaded areas.

and greater in degree than in any of the control subjects. Technetium-99m-pertechnetate uptake was also stimulated, with a mean during the first hour of approximately 14%. Between 30 min and 3 hr, none of the hyperthyroid ^{99m}Tc-pertechnetate uptakes fell within 2 s.d. of the control mean. However, the configuration of the ^{99m}Tc curve was comparable in the hyperthyroid patients to that observed in the control studies.

Also presented in Fig. 2 are the $^{131}I^-$ and $^{99m}TcO_4^-$ uptake in all patients in the uptake series with 24-hr $^{131}I^-$ uptakes of 7% or less (referred to as "low uptake" patients). Included in this group are patients with spontaneous hypothyroidism, hypothyroidism secondary to thyroid surgery or radiation, and two patients clinically euthyroid but with large goiters. Seven of these patients had not received thyroid medication, and three were currently on suppressive levels of thyroid medication. The $^{131}I^-$ uptake curve was similar whether the patient's low uptake was spontaneous or associated with suppression of endogenous TSH. Patients on suppressive medication also had low $^{99m}TcO_4^-$ uptakes. On the other hand in those patients who were not receiving thyroid medication, the $^{99m}TcO_4^-$ uptake was elevated significantly above the control level ($p < 0.001$ for all time intervals studied). Technetium-99m-pertechnetate uptake in these patients was also significantly greater than their ^{131}I uptake.

Nine normal subjects, six male and three female, between the ages of 20 and 30 years, were studied on repeated occasions by the uptake technique. In these subjects, a control experiment, performed at a time when the subject was living his normal life, in good health, and taking no medications, was coupled with one or more experimental sessions associated with administration of a drug. The $^{131}I^-$ and $^{99m}TcO_4^-$ uptakes for these nine normal subjects did not differ significantly from the overall control series although they tended to be somewhat lower. Mean ± 1 s.d. for the control studies in these subjects is shown as shaded areas in the two halves of Fig. 3. Figure 3 presents the results of stimulation with TSH, of suppression of endogenous TSH by

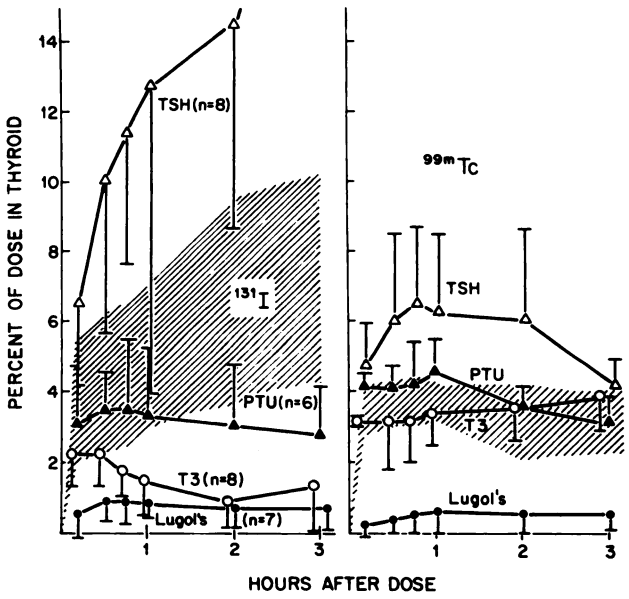

FIG. 3. Experimental studies on normal subjects. Mean ± s.d. 1 s.d. limits for control studies in these subjects (n = 9) shown as shaded areas.

administration of triiodothyronine, of propylthiouracil, and of Lugol's solution.

As would be expected, $^{131}I^-$ uptake was stimulated by TSH and suppressed by triiodothyronine medication. Technetium-99m-pertechnetate uptake was also stimulated by TSH administration. However, after 8 days of triiodothyronine in suppressive doses, there was no significant alteration in the $^{99m}TcO_4^-$ uptake compared with the control values. This observation was unexpected in view of the stimulation of $^{99m}TcO_4^-$ uptake observed after TSH administration. As shown below, it is probably artifactual due to the relatively large role of neck radioactivity at these low uptake levels. It is of interest that in these normal subjects on triiodothyronine suppression, $^{99m}TcO_4^-$ uptake was greater than $^{131}I^-$ uptake as was also observed for the untreated group of low uptake patients mentioned above.

Propylthiouracil, in doses of 200 mg every 8 hr for 3 days (a dose which might be expected effectively to block organification of newly trapped iodine) caused suppression of $^{131}I^-$ uptake with no change in the $^{99m}TcO_4^-$ uptake. Unlike the case of triiodothyronine suppression with propylthiouracil treatment, the ^{131}I and ^{99m}Tc curves are virtually superimposed upon each other and upon the control ^{99m}Tc curve. These results suggest that organification of the ^{131}I was effectively blocked by the propylthiouracil treatment.

Five drops of Lugol's solution three times daily for 3 days brought about suppression of both $^{131}I^-$ and $^{99m}TcO_4^-$ uptakes to below 1% on the average. This virtual obliteration of the uptake of both isotopes after iodide suggests that, at least at this dose, iodide administration is an equally good technique for blocking trapping of either ^{131}I or ^{99m}Tc. It is of interest that iodides also appear to inhibit the background uptake of both nuclides.

If $^{99m}TcO_4^-$ uptake were due exclusively to the thyroidal trapping mechanism, it would be expected that the ^{99m}Tc-pertechnetate thyroid space would become constant in the later portions of the experiment. Figure 4 shows that, as expected, there is a rapid rise of thyroidal radioiodine space. The $^{99m}TcO_4^-$ space also rises rapidly early after injection but then continues to rise more slowly. Taking the control thyroid ^{99m}Tc space from Fig. 4 for each time interval as 100%, relative changes in thyroidal ^{99m}Tc trapping were inferred from changes in the thyroidal ^{99m}Tc space after the various experimental manipulations. Figure 5 presents the thyroidal ^{99m}Tc space in the four experimental conditions expressed as percentage of the control thyroidal ^{99m}Tc space. It can be seen that, by this criterion, trapping is stimulated after TSH and also after propylthiouracil. Triiodothronine suppression appears not to affect the trap but Lugol's solution obliterates it.

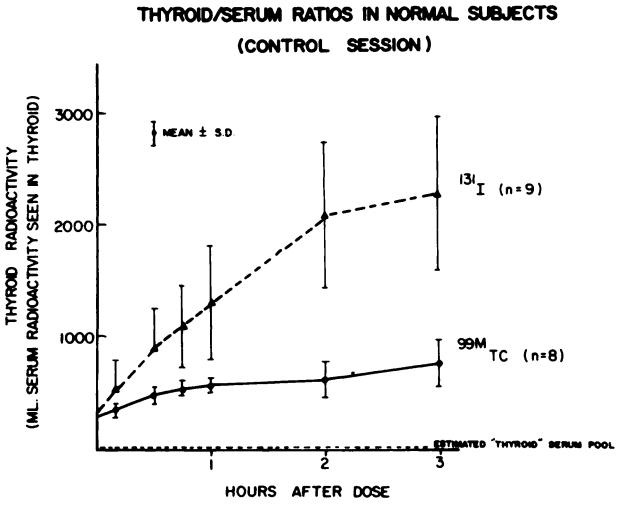

FIG. 4. Thyroidal $^{131}I^-$ and $^{99m}TcO_4^-$ "space" or "volume of distribution" (% of dose in thyroid)/(% of dose in 1-ml serum) in normal control series. (Mean ± s.d.)

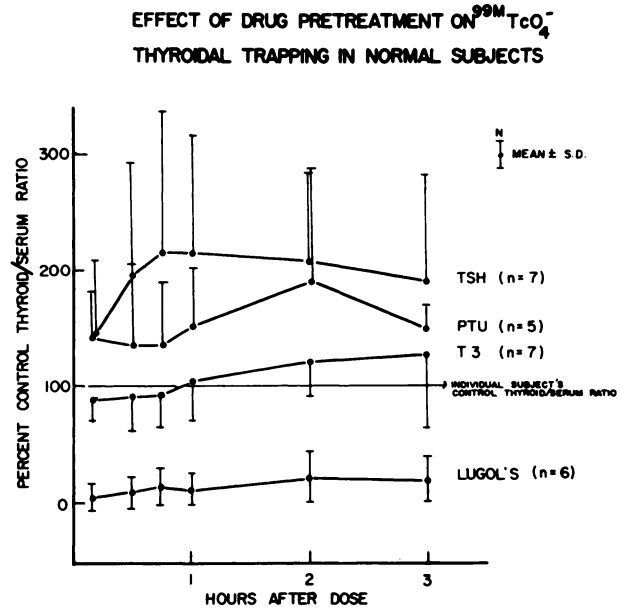

FIG. 5. Thyroidal $^{99m}TcO_4^-$ "space" in normal control subjects after drug pretreatment, expressed as percent of subject's control (Mean ± s.d.)

Comparative validating studies. The results of the validating experiments are reported in Tables 1 and 2. Table 1 shows control studies performed on a single subject on seven occasions during a 3-month period. Coefficient of variation for the standard uptake used above is 18.3%. For the more precise "scanning" technique, the coefficient of variation was 28.3%.

Table 2 shows the averages of two control studies

TABLE 1. REPEATED 20–30-MIN $^{99m}TcO_4^-$ UPTAKES ON A SINGLE SUBJECT

Date	"Uptake technique"	"Scan technique"
6/11	2.96	1.72
6/12	3.14	1.53
6/19	2.41	0.87
8/24	3.30	1.40
8/25	3.34	0.89
9/1	2.07	1.87
9/2	3.58	1.73
Mean	2.97	1.43
s.d.	0.543	0.405
Coefficient of variation	18.3%	28.3%

TABLE 2. $^{99m}TcO_4^-$ 20–30-MIN UPTAKES BEFORE AND AFTER 7–8 DAYS SUPPRESSION WITH TRIIODOTHYRONINE*

	"Uptake technique"		"Scan technique"	
Subject	Control	After suppression	Control	After suppression
ST	3.25	2.61	1.42	0.31
BU	1.95	1.93	0.58	0.01
DA	2.20	2.28	1.20	0.13
CO	2.72	2.48	1.20	0.68
DV	2.42	1.14	0.92	0.06
Mean	2.51	2.12	1.06	0.24
s.d.	0.50	0.53	0.32	0.27
P for (control-suppression)	NS		<<0.001	

* Each entry is mean of two studies.

and of two studies after triiodothyronine suppression in five subjects studied 20–30 min after $^{99m}TcO_4^-$ injection by the two techniques. These data clearly demonstrate that, by the scanning technique, $^{99m}TcO_4^-$ thyroidal uptake is markedly reduced after suppression of endogenous TSH. Using the uptake technique, some decrease in $^{99m}TcO_4^-$ uptake occurs in three of the five subjects but it is not statistically significant in degree. This independent series of observations confirms the data presented in Fig. 3. The uptake technique fails to demonstrate suppression of $^{99m}TcO_4^-$ accumulation after triiodothyronine despite the fact that such suppression occurs.

DISCUSSION

In all of the uptake studies presented, while the level of $^{99m}TcO_4^-$ uptake varied widely from person to person, the configuration of the curve showing thyroidal levels with reference to time followed a consistent pattern. The thyroidal $^{99m}TcO_4^-$ uptake reached a maximum level shortly after administration, plateaued for approximately 1 hr, and subsequently fell gradually. The drop in thyroidal ^{99m}Tc levels roughly parallels the decrease in serum ^{99m}Tc concentrations. However, a constant thyroidal ^{99m}Tc space was not reached during the 3 hr of observation. This suggests that ^{99m}Tc reaches its ultimate volume of distribution within the thyroid rather slowly or that distribution into the nonthyroidal neck tissues is continuing to occur and is inadequately corrected for by the thigh correction. This increasing ^{99m}Tc space could be due to formation of irreversible ^{99m}Tc products within the thyroid, with concentration of these products increasing while the "trapped" pertechnetate volume remained constant. [Formation of such products has been shown in the rat (*12,13*) but is probably not significant in man (*14,15*).] This possibility cannot be ruled out from our data but is probably quantitatively unimportant, as by 24 hr the thyroidal pertechnetate levels were universally zero except in a few cases of hyperthyroidism. Other work presented elsewhere (*16*) indicates that the majority of plasma ^{99m}Tc is bound and that equilibration of ^{99m}Tc into its ultimate volume of distribution occurs over a matter of more than 4 hr. Our tentative conclusion from these observations is that the ^{99m}Tc space, as measured in this study, is a semiquantitative measure of the thyroidal trapping mechanism and presumably of the thyroidal iodine trap. The thyroidal $^{99m}TcO_4^-$ *uptake* (without correction for simultaneous plasma levels), is one step removed, but again probably can be taken as a reliable semiquantitative reflection of the thyroidal iodine trap.

Our data confirm the observation reported by others that $^{99m}TcO_4^-$ uptake is increased in hyperthyroidism. Other workers have also reported a failure to observe consistent decreases in $^{99m}TcO_4^-$ uptake in hypothyroidism. Our observations (Fig. 2) suggest that there is actually relative stimulation of $^{99m}TcO_4^-$ uptake in patients with reduced $^{131}I^-$ uptakes. In our series similar $^{99m}TcO_4^-$ uptake curves were observed whether the low uptake was associated with clinical hypothyroidism or with other factors. In patients of this type, replacement therapy with thyroid medication reduced the $^{99m}TcO_4^-$ uptake. This small series of observations suggests that, in patients with hypoformation of thyroid hormone, the trapping mechanism may actually be stimulated. These observations are in keeping with the studies of Hauser, et al (*17*).

When ^{131}I uptake was low in situations suggesting stimulation of endogenous TSH (Fig. 2), the $^{99m}TcO_4^-$ uptake was often greater than the $^{131}I^-$ uptake. While this could be artifactual or due to the greater plasma $^{99m}TcO_4^-$ levels, it also could indicate that $^{99m}TcO_4^-$ is actually trapped more avidly than is ^{131}I. Supporting this suggestion is the report

of Wolff and Maurey (*18*) showing a lower K_m for TcO_4^- than for I^- in thyroid slices.

In the studies of normal subjects by the uptake technique, TSH was seen to stimulate $^{99m}TcO_4^-$ uptake, but short-term administration of triiodothyronine to suppress endogenous TSH did not reduce $^{99m}TcO_4^-$ uptake. Suppression was, however, demonstrated by the scanning technique. Because, in the unstimulated gland, neck background is quantitatively as important as true thyroid radioactivity, failure to demonstrate suppression by the uptake technique is probably due to technical factors. However, iodide suppression completely obliterated thyroidal $^{99m}TcO_4^-$ uptake even by the uptake technique. The reason for this disparity between the effects of iodide and of triiodothyronine is obscure. We have observed (in studies to be reported elsewhere) that iodine administered after $^{99m}TcO_4^-$ has much less effect, suppressing total neck "uptake" only slightly. Hence, the inhibition exhibited here is related to pretreatment with iodine.

The data indicate that short-term propylthiouracil treatment does not suppress $^{99m}TcO_4^-$ uptake in normal patients. Indeed, thyroidal ^{99m}Tc levels are virtually unchanged when compared with the control studies. The calculated ^{99m}Tc space, shown to be elevated after propylthiouracil therapy in Fig. 5, is associated with decreasing plasma ^{99m}Tc levels. However, it suggests that the thyroidal trap may actually be somewhat stimulated after propylthiouracil administration. This observation, which is of only borderline significance ($p < 0.05$), deserves future scrutiny. Should trapping actually be stimulated by propylthiouracil, it will be necessary to reevaluate studies of the thyroidal iodide trap which have depended upon prior inhibition of organification with propylthiouracil.

Recent work by a number of groups has emphasized the importance of making accurate measurement of extrathyroidal radioactivity when studying the thyroidal $^{99m}TcO_4^-$ uptake. Admittedly, the correction used in the uptake technique observations of this study was insufficient. Attempts by ourselves and by other workers to find a consistent, reliable correction based upon knowledge of the ratio of extrathyroidal neck tissue concentration to that in the thigh have been disappointing. At this point, studies using standard uptake techniques must be considered semiquantitative rather than quantitative in nature with the full understanding that the absolute values presented are undoubtedly in error. Nevertheless, when the thyroid trap is stimulated, when groups of patients are compared, or when a single subject or patient is used as his own control, valid interpretations are possible.

The greater sensitivity of an uptake apparatus over that of a scanning apparatus permits a 100-fold reduction in $^{99m}TcO_4^-$ dose. The trapping study described here requires only 10 μCi of $^{99m}TcO_4^-$, a dose so small that it can be used with impunity even in children and pregnant women. This test is probably as valuable diagnostically as the ^{131}I uptake in hyperthyroidism and can be a useful adjunct in that condition, particularly when radiation dose is a consideration.

Combined $^{131}I^-$ and $^{99m}TcO_4^-$ uptakes are recommended for evaluation of goiter, thyroiditis, and other instances where an organification defect is suspected. They can be used for evaluation of suppression only when the initial $^{99m}TcO_4^-$ uptake is increased. Since the thyroid space of $^{99m}TcO_4^-$ may be increased by propylthiouracil, we advise caution in the use of the $^{99m}TcO_4^-$ uptake to evaluate suppressibility during treatment with antithyroid drugs.

ACKNOWLEDGMENT

Supported in part by Grants 5 R01 AM 13397-01 and 5 R01 AM 13397-02 from USPHS and by Veterans Administration Designated Research Funds RCS 15-4.

We wish to thank D. H. Solomon, L. R. Bennett, D. E. Johnson, and W. H. Blahd for their advice and for the use of their laboratories (Bennett and Blahd). Valuable technical assistance was given by Jeanne Larson, Kenneth Shoaf, and Kim N. Diezeraad.

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