

PRELIMINARY NOTE

**The Study of Thyroid Physiology Utilizing
Intravenous Sodium Pertechnetate**

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It has been mentioned by McAfee (1) that the gastrointestinal absorption and tissue distribution of Technetium-99m-Pertechnetate is similar in many respects to iodine-131. Following oral administration of pertechnetate the thyroid uptake was found to be maximal at one-to-two hours after administration. It was also mentioned that higher thyroid uptake levels occurred in one-to-two hours in hyperthyroidism.

This preliminary report will assess the efficacy of utilizing pertechnetate in establishing the physiologic status of the thyroid.

PROPERTIES OF TECHNETIUM AND THE PHYSIOLOGY OF
SODIUM PERTECHNETATE

Technetium-99m is the decay product of Molybdenum-99. Technetium's main gamma energy is 0.140 MeV (98.4%). Technetium-99m half-life is 6.04 hours. This study was performed utilizing the sodium pertechnetate form ($\text{NaTc}^{99\text{m}}\text{O}_4$). The pertechnetate form, in turn, is obtained from the Technetium-99m generator. Our sodium pertechnetate was prepared utilizing a Technetium Generator (Nuclear Consultants Corporation TechneKow^R) The Generator is operated per instruction booklet prepared by Nuclear Consultants Corporation.

On intravenous administration, the first effective half-time in the blood stream is 1.5 hours. One hour after injection 30% of the technetium pertechnetate is found in the red cell. In the physiology of sodium pertechnetate, it was found that the stomach receives the highest level of technetium-99m-pertechnetate of all the organs in the body. It was found that the thyroid also selectively concentrates sodium pertechnetate at the level of the thyroid trapping mechanism (2).

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METHODOLOGY

Isotope Dosage. Fifty microcuries of ^{131}I was given orally and the iodine portion of the study completed. For the Technetium uptakes and scans, one millicurie of Technetium was administered intravenously. Neck-thigh ratios were then performed.

Ancillary Studies. On all patients, T 3 Resin *in vitro* tests were performed.

RESULTS

Normal ^{131}I Values. The normal ^{131}I uptake value at 24 hours is 15-to-45 per cent. The T 3 Resin *in vitro* test's normal value is plus or minus five per cent from the control. For uptake studies, neck-thigh ratios were utilized.

Hyperthyroidism (Table I). Two hyperthyroid patients were studied who had not received any therapy. These patients, in the Technetium study, had marked elevations of Technetium concentration throughout the study period. Note that one patient had a 20% uptake of Technetium-99m at one hour.

Hypothyroidism (Table I). In hypothyroidism whether it be primary or secondary, the Technetium concentration in the thyroid was below that of the euthyroid patients. The most reliable time period for this difference seems to be at one hour with the cut-off point being 1.5% concentration.

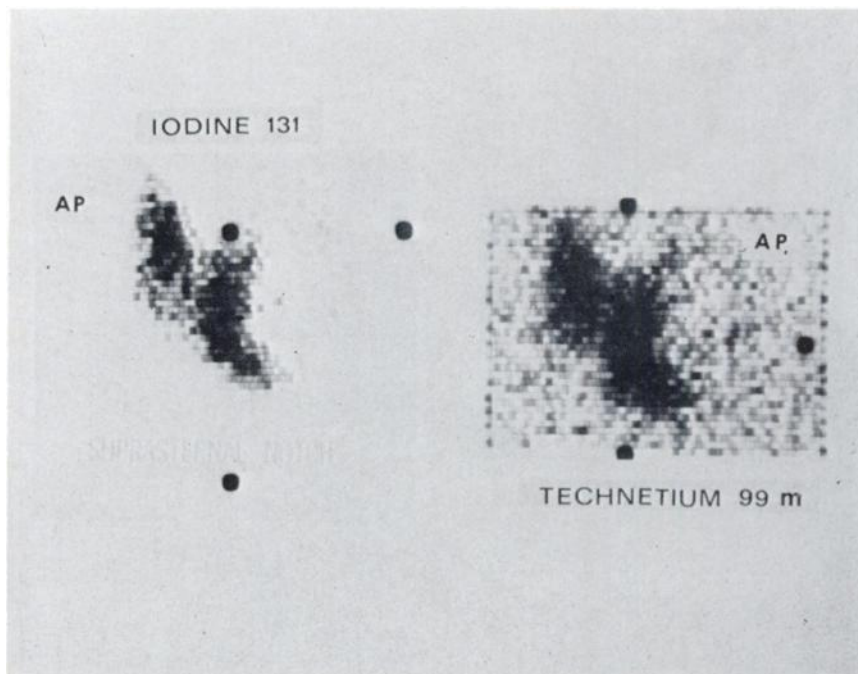


Fig. 1. Thyroid scan reveals a $2\frac{1}{2} \times 3\frac{1}{2}$ cm nodule involving the lateral portion of the left lobe. At surgery this was found to be a hemorrhagic nodule. The ^{131}I and Technetium-99m thyroid scans are comparable.

Euthyroid (Table I). Our euthyroid group had Technetium uptakes above 1.7% at one hour. It is interesting to note that the highest Technetium concentration in the euthyroid group was six per cent at one hour in a patient who had an autonomous nodule. The highest concentration of the other 20 patients at one hour was four per cent.

SPECIAL CATEGORIES (TABLE I)

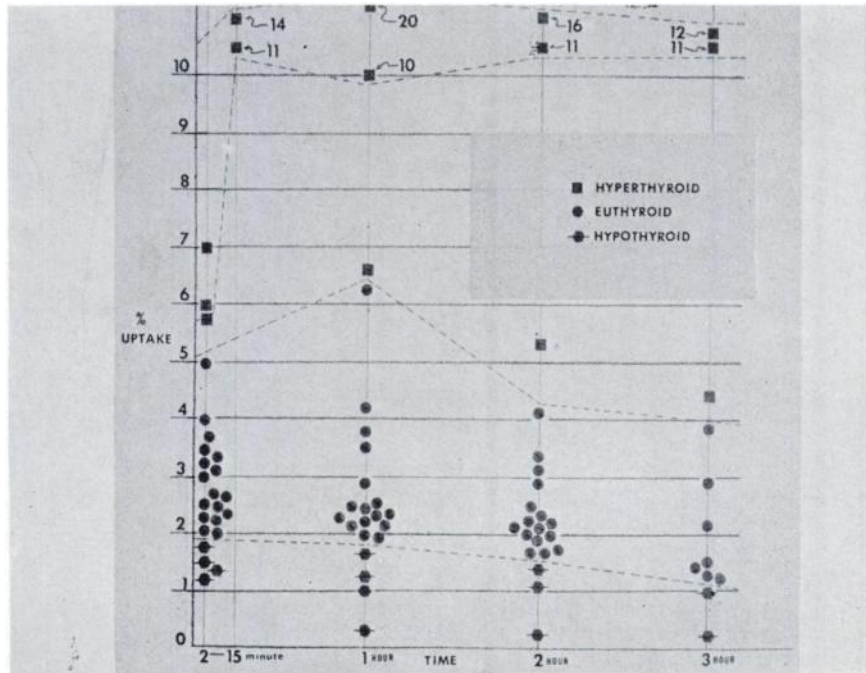
Post ^{131}I therapy: Our one hyperthyroid patient two weeks post dose 5mC of ^{131}I therapy had a Technetium concentration throughout a four hour period of ten per cent. In the few patients who have been on Lugol's solution and/or had contrast studies, the Technetium uptake was lowered. This was probably because iodine has an affect on the thyroid trapping mechanism.

Pituitary Hypothyroidism: In our one patient who had a positive ^{131}I TSH stimulation test, the Technetium concentration in the thyroid was not affected by thyroid stimulating hormone.

Medically Treated Hyperthyroidism (Table I). Two patients on propothiouricil and Lugol's solution in preparation for thyroid surgery were studied. These patients, by their T 3 uptakes, were physiologically hypothyroid and Technetium concentration throughout the study period remained in the euthyroid range in one patient, and in the other patient was in the hypothyroid range. Another patient, with previously proven hypothyroidism on thyroid medication, had a Technetium concentration of one per cent at one hour.

Table I

Range of Technetium neck accumulations over a period of three hours.



SCANNING

Thyroid scanning, with Technetium-99m has proven to be practical and in this controlled study were comparable to the 24 hour ^{131}I scans. The increased count rate that we acquire with Technetium allows us to scan the thyroid at a more rapid rate. Because of the rapid accumulation time we were able to begin our scan anywhere from two-to-ten minutes post intravenous administration of Technetium and the scan was completed in three-to-four minutes.

Thyroid carcinoma still appears as a cold nodule on scan with Technetium-99m.

CONCLUSION

In this preliminary report we have presented 34 patients studied with ^{131}I and Technetium-99m to determine whether Technetium has a place in the study of thyroid physiology. In this study the euthyroid range of Technetium concentration at one hour is 1.5-to-4 per cent. In the three hyperthyroid patients, Technetium concentration at one hour post dose was between 10-to-20 per cent. The Technetium uptake is also decreased in hypothyroidism whether it be primary or secondary. The Technetium scans may be performed in conjunction with the uptake and are comparable to the 24 hour ^{131}I scans.

Because of the low radiation dose delivered to the thyroid and to the whole body (1), these studies indicate the possibility of extending the thyroid physiology studies into children and the pregnant woman.

This study would suggest that sodium pertechnetate warrants further investigation as an indicator of thyroid physiology.

REFERENCES

1. MCAFEE, J. G., FUEGER, G. F., STERN, H. S., WAGNER, H. N., AND MIGITA, T.: $\text{Tc}^{99\text{m}}$ Pertechnetate for Brain Scanning, *J. Nuc. Med.*, 5:811, November 1964.
2. LATHROP, K. A. AND HARPER, P. V.: Applications of Technetium 99m, *Clinical Applications of Nuc. Med.* Page 8-11 (Renner Clinic Foundation) 1965.