

A Kinetic Study of [^{131}I] Iodide and [$^{99\text{m}}\text{Tc}$] Pertechnetate In Thyroid Carcinoma to Explain a Scan Discrepancy: Case Report

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A study of unusual I-131 and [$^{99\text{m}}\text{Tc}$] pertechnetate kinetics was carried out in a case of thyroid carcinoma. A major discrepancy in the handling of iodide, probably resulting from a deficient iodine organification process, was shown.

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Some patients with thyroid adenomas or carcinomas when scanned, occasionally fail to show significant I-131 uptake and retention 24 hr after the radionuclide is administered. Yet [$^{99\text{m}}\text{Tc}$] pertechnetate scans obtained 30 min after injection, in the same patients, frequently confirm the existence of a trapping function (1–3,10). This is to be expected since the two radionuclides assess essentially different aspects of gland function, namely the trapping and organification mechanisms, respectively. To date, the kinetics of uptake and discharge of the nuclides has not been reported in patients showing this anomaly. The case presented here quantitatively illustrates the reasons for such scan differences in terms of tracer kinetics.

CASE REPORT

A 78-year-old woman presented with follicular carcinoma of the thyroid gland. She had undergone right lobectomy in 1964, and in January 1974 was found to have a nodular mass in the right side of her neck. She was scanned with [$^{99\text{m}}\text{Tc}$] sodium pertechnetate at 30 min and with I-131 at 24 hr (Figs. 1A and 1B). Although appearing hot on the pertechnetate scan, the iodide scan failed to show any retention of iodide by the right lobe. Subsequent total thyroidectomy showed that the tumor was recurrent poorly differentiated follicular carcinoma. The left lobe was histologically normal. Postoperative scans revealed a small amount of functioning thyroid tissue (Figs. 1C and 1D), which was treated with 150 mCi of I-131. The biologic half-life (T_{biol}) for this dose of I-131 was 1.7 days as estimated using lithium fluoride thermoluminescent discs by the

method of Malone, Cullen et al. (4,5). Thyroxine (300 $\mu\text{g}/\text{day}$) was commenced.

In January 1976 she presented again with suspected recurrence of the carcinoma. Thyroxine was discontinued for 3 weeks. A pertechnetate (2 mCi) scan at 30 min revealed two areas of functioning thyroid tissue (Fig. 1E), but when an I-131 (70 μCi) scan at 24 hr was attempted, insufficient tracer remained in the gland for scanning purposes. However when 1 mCi of I-131 was administered and the patient scanned after 5 hr, the results (Fig. 1F) were similar to those obtained with Tc-99m at 30 min. The opportunity was taken during these scans to monitor the uptake and discharge by the gland of I-131 and Tc-99m, by uptake methods (11). The activity of the two nuclides was measured at 15–30-min intervals for 12 hr after administration and thereafter 2 or 3 times daily. Corrections for extrathyroidal activity were made by determining the calf activity and subtracting this from the measured thyroid activity (12).

These measurements indicate a somewhat higher uptake of Tc-99m than of I-131—approximately 17 and 11%, respectively. However more exact knowledge of extrathyroidal activity is necessary to determine whether or not the difference is significant. The biologic half-lives of I-131 and Tc-99m were found to be similar and equal to 12 hr, but the thyroidal I-131 showed a second biologic half-life of 7.2 days,

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which was applicable to only 3% of the retained dose or approximately 0.3% of the administered dose (Fig. 1G). Histologic examination of the nodules at neck exploration showed the carcinoma to have dedifferentiated further, with only an occasional follicle evident amongst the tumor cells. No normal thyroid tissue was found (Table 1).

DISCUSSION

We have been able to study some of the kinetics

	Iodide		Per technetate
	Thyroid		Thyroid
Uptake	11%	Uptake	17%
T ¹ _{biol}	12 hr	T _{biol}	12 hr
T ² _{biol}	7.2 days		
	Calf		Calf
T _{biol}	7.6 hr	T _{biol}	9.6 hr

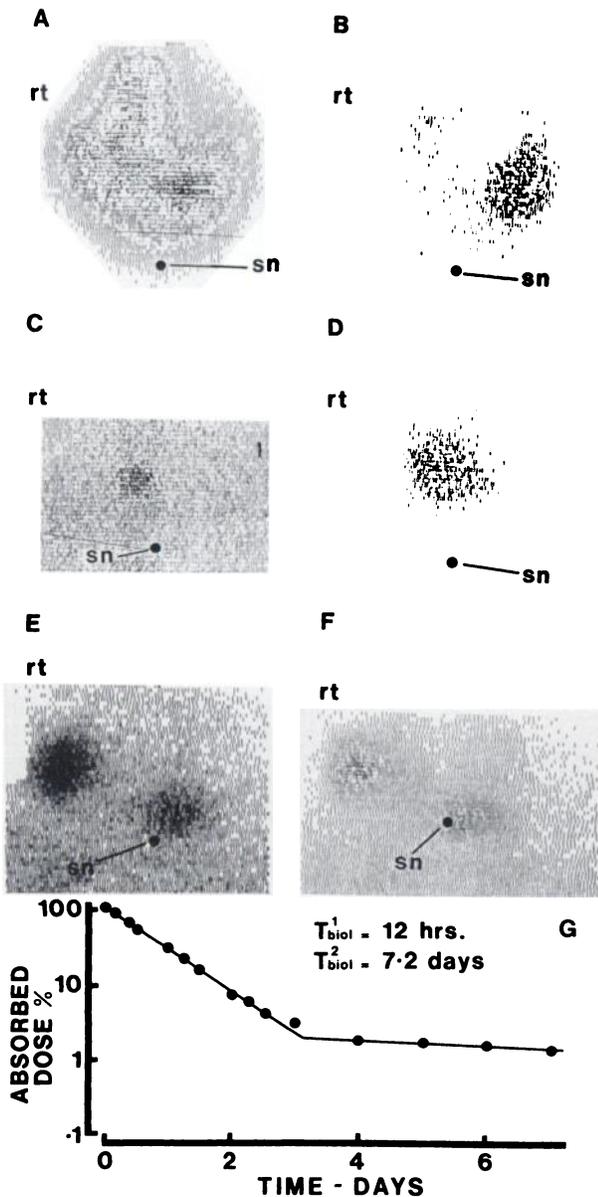


FIG. 1. (A and B) Preoperative ^{99m}TcO₄-scan at 30 min, and I-131 scan (70 μCi) at 24 hr. (C and D) Postoperative technetium scan at 30 min, and I-131 (1 mCi) at 24 hr. (E and F) Two years after operation; technetium at 30 min, and I-131 (1 mCi) at 5 hr. (G) Plot of biologic release of I-131 from gland. Note: The Tc-99m dose was 2 mCi iv throughout; I-131 was given by mouth. sn = sternal notch.

of pertechnetate and iodide in the metastases of a follicular carcinoma without the complicating presence of normally functioning thyroid tissue. The results have revealed unusual iodide and pertechnetate kinetics. The major defect of iodine metabolism in the metastases is the ability to trap but not organically bind iodide. This is supported by the excellent correlation between the 30-min pertechnetate scan (Fig. 1E) and the 5-hr I-131 scan (Fig. 1F), showing that the trapping mechanism is effective despite the small amount of I-131 retained at 24 hr. As pertechnetate has been found to be metabolized by thyroid tissue to a small but variable degree, it has been utilized as an estimate of iodide trapping (6,9). Others have noted quantitative differences in simultaneously determined anion gradients for the two nuclides (9). The fact that iodine behaved qualitatively like pertechnetate suggests that it was not appreciably organically bound. Further support derives from the similarity in blood background (calf) and thyroidal iodide kinetics. No evidence was available as to the cause of the defective organification mechanism. It has been studied, however, by Demeester-Mirkine et al. (2) in a nodule showing a similar defect. Our case highlights the need for caution in the evaluation of pertechnetate "hot" nodules, a point stressed by many authors (1,7,8). It also raises questions about dose estimates made for I-131 treatment of thyroid carcinoma where the effective half-life might be assumed to be longer.

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