

**FIG. 1.** (A) Anterior Tc-99m sulfur colloid scan shows portal defect. (B) Scanning after administration of DTPA shows that a normal kidney was responsible for this abnormality.

raphy noted normal renal size in these patients, renal impression was prominent on the lateral scintigram. Repeat liver imaging was then performed with DTPA, and a normal kidney was seen to be responsible for the periportal defect (Fig. 1). Long-term followup has indicated no hepatic disease. I am not implying that normal-sized kidneys contribute to the periportal defect commonly, for we have tried this technique many other times on thin patients to no avail.

The purpose of this letter is not only to add the normal kidney to the list of anatomic structures that can—although rarely—contribute to a portal defect, but also to comment on the remarkable accomplishment of Sample to remove the “nonspecific periportal defect” from nuclide reporting in his department by use of the tomographic scanner and improved ultrasound techniques.

PAUL J. MYERSON  
The Griffin Hospital  
Derby, Connecticut

REFERENCES

1. MCCLELLAND RR: Focal porta hepatis scintiscan defects: What is their significance? *J Nucl Med* 15: 1007-1012, 1975
2. SAMPLE WF, GRAY RK, POE ND, et al: Nuclear imaging, tomographic nuclear imaging and gray-scale ultrasound in the evaluation of the porta hepatis. *Radiology* 122: 773-779, 1977

**Error Due to Radionuclide Decay during Rectilinear Scanning**

Short-lived radiopharmaceuticals and the gamma camera have contributed to the development of multiple diagnostic procedures in nuclear medicine. Rectilinear scanners however are still used to obtain “static images” of relatively large areas of the body. During the time required to obtain a rectilinear scan, significant radioactive decay can sometimes occur. This introduces further uncertainties into the diagnostic reliability of the image. Therefore clinical laboratories should know the magnitude of error introduced by the time interval involved in scanning. To simplify such calculations, we present a readily usable figure.

The laboratory determines two things: (a) What is the half-life of the tracer to be used? (b) What is the maximum error (“limiting error”) due to decay that is acceptable during the scan (2%, 5%, 10%)?

In Fig. 1 we look up the half-life and the maximum limiting error. The vertical axis then gives the permissible scanning time so that the error due to decay is not exceeded. For example, along the horizontal axis choose 360 min (the  $T_{1/2}$  of Tc-99m), and read upward to the 5% line. The corresponding vertical intercept is about 27 min. A whole-body bone scan taking longer than 27 min will have a decay factor of over 5% between beginning and end. The scanning times that do not involve 10% errors due to decay for six clinically utilized short-lived radionuclides are: Ga-68, 11 min; In-113m, 15 min; F-18, 17 min; Sr-87m, 27 min; Tc-99m, 55 min; Fe-52, 74 min.

It is possible to apply correction factors to the rectilinear scanner to compensate for the intensity losses (1). Below, we show the origin of the equation used to generate the above values as well as Fig. 1.

Let  $f$  be the fractional decay of the radionuclide during the scan (for example,  $f = 0.1$  if one-tenth of the activity has decayed away). The remaining activity is then the original activity times  $(1 - f)$ . In the radiodecay equation, this becomes

$$N(1 - f) = Ne^{-\lambda t},$$

or

$$1 - f = e^{-\lambda t}.$$

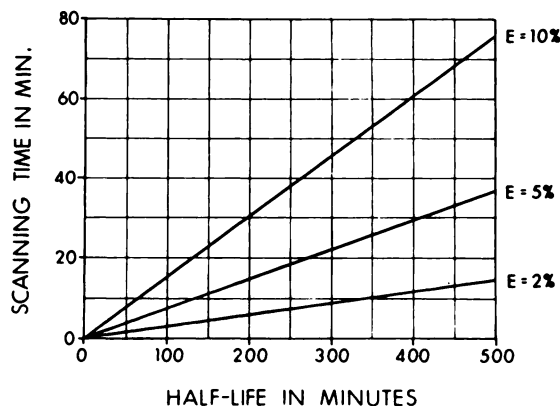
Solved for  $t$  (the scanning time), this equation becomes

$$t = -1.44 T_{1/2} \ln(1 - f),$$

where  $\ln$  is the logarithm to the base  $e$  and  $T_{1/2}$  is the half-life of the radionuclide. This equation can be simplified by noting that for small values of  $f$ ,  $\ln(1 - f) = -f$ , or that  $e^{-\lambda t} \approx 1 - \lambda t$  for small time intervals. The resulting equation is:

$$t = 1.44 \cdot f \cdot T_{1/2}.$$

Bear in mind that the approximation is valid only for small values of  $f$  (when elapsed times are a minor part of the half-life of the radionuclide). We also recognize that, dur-



**FIG. 1.** Relation between half-life and scanning interval for 2, 5, and 10% limiting errors.

ing the scanning interval, biological decay might contribute to the loss of activity.

RICHARD P. SPENCER  
FAZLE HOSAIN  
Department of Nuclear Medicine  
University of Connecticut Health Center  
Farmington, Connecticut

#### ACKNOWLEDGMENT

This work was supported by USPHS CA 17802 from the National Cancer Institute.

#### REFERENCE

1. SPENCER RP: Radionuclide scanner and analogue computer coupling. *Int J Appl Radiat Isotopes* 18: 421-427, 1967

### The Usual Dose of I-131 Used to Ablate Thyroid

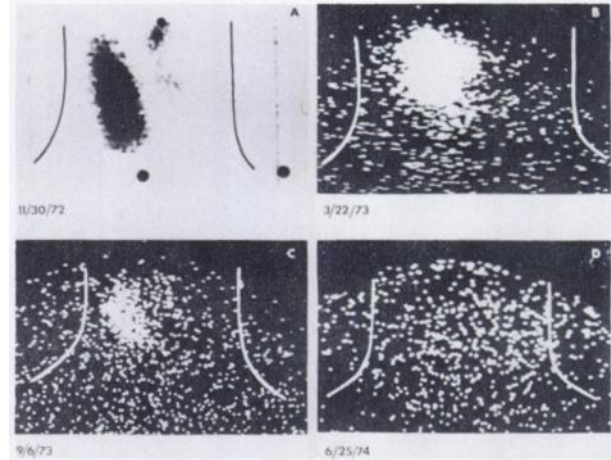
For the ablation of a thyroid remnant after bilateral subtotal thyroidectomy for differentiated carcinoma, the usual dose of I-131 is 50-100 mCi (1). Since 1973, however, we have failed to ablate thyroid remnants in three of six patients who received 75-100 mCi of I-131. We infer thyroid ablation from the absence of visible uptake in the neck in an Anger-camera scintiphoto, either 24 hr after the oral administration of a 100- $\mu$ Ci dose of I-131, or 30 min after intravenous injection of 5 mCi of pertechnetate. The surgical remnants in our patients were not unduly large, and thyroid uptake was maximally stimulated in five patients by the intramuscular injection of bovine thyrotropin\* for 3 or 4 consecutive days. Such a failure of ablation is illustrated in Fig. 1.

Of the three patients in whom the thyroid remnant was successfully ablated, two had been treated with a low-iodine diet and furosemide for 3 days before the therapeutic dose of I-131; one of these patients, who had a functional bone metastasis, received 150 mCi of I-131.

In 1969 we determined the 24-hr uptakes of radioactive iodine (RAIU) in 44 euthyroid subjects (2). In contrast to the normal range of 15-45% quoted in the literature, our normal range was 0-24%. The urinary iodine of  $351 \pm 290$   $\mu$ g/24 hr (mean  $\pm$  s.d.) and iodine kinetic studies in these subjects were compatible with a high intake of dietary iodine. In 1974 the mean RAIU value obtained in nine clinically euthyroid subjects was  $9.7 \pm 4\%$ . Urinary excretion of iodine determined in 15 euthyroid subjects ranged from 205 to 1,124  $\mu$ g/24 hr; the mean value ( $571 \pm 383$   $\mu$ g/24 hr) was significantly higher than mean values obtained in 1969 ( $p < 0.05$ ). Direct chemical analysis of diets, blenderized without added salt, showed that they contained from 246 to 1,531  $\mu$ g of iodine/day (3).

The increasing dietary iodine is not limited to the La Crosse, Wisconsin area. In 1969 the average U.S. diet contained 150  $\mu$ g/day. By 1974 the average was estimated to be 450 and 382  $\mu$ g/day in males and females, respectively. All available data suggest that the levels of iodine in the American diet have increased since 1970, and with the addition of iodized salt may reach 1,050  $\mu$ g/day (4).

The increase in dietary iodine has affected the RAIU in hyperthyroid patients as well as euthyroid subjects. Despite reestablishment of the normal range, the RAIU in our laboratory is currently "normal" in 14% of patients with Graves' disease and in 80% of patients with toxic nodular goiter (5).



**FIG. 1.** (A) Scintigram of thyroid 24 hr after oral administration of I-131. Large nonfunctional mass is present in left lobe of thyroid. (B) Scintigram of thyroid 30 min after i.v. administration of [ $^{99m}\text{Tc}$ ] pertechnetate. Two months after surgical removal of left lobe, isthmus, and subtotal removal of right thyroid lobe, only remnant of right lobe remains. Triiodothyronine (Cytomel<sup>®</sup>) therapy was discontinued 2 weeks prior to scanning to increase endogenous thyrotropin secretion. (C) Thyroid scintigram 8 months after administration of 80 mCi of I-131. Cytomel<sup>®</sup> was discontinued 3 weeks prior to scanning. Thyroid remnant remains. (D) Thyroid scintigram 9 months following second therapeutic dose, 150 mCi of I-131. Cytomel<sup>®</sup> therapy was discontinued 3 weeks before scanning. Thyroid remnant has disappeared.

In summary, the dietary iodine consumption in the United States is relatively high and continues to increase, with a consequent decrease of the thyroid clearance of iodine and release of inorganic iodine from the thyroid gland. Although the number of cases is small and the evidence is indirect, we believe that the "autoregulatory" mechanisms, which are independent of thyrotropin concentration, decrease the uptake of I-131 by a thyroid remnant and are probably the most important factors in the failure to ablate postsurgical thyroid remnants.

In view of these findings, a low iodine diet and diuretic augmentation of I-131 uptake as recommended by Hamburger (6) deserve further study.

ROBERT H. CAPLAN  
DENNIS DVORAK  
Gundersen Clinic, Ltd.  
La Crosse, Wisconsin

#### FOOTNOTE

- \* Thyropar<sup>®</sup>, Armour Pharmaceutical Co., Phoenix, AZ.

#### REFERENCES

1. DEGROOT LJ, STANBURY JB: *The Thyroid and Its Diseases*, 4th ed. New York, Wiley, 1975, p 710
2. CAPLAN RH, KUJAK R: Thyroid uptake of radioactive iodine: A re-evaluation. *JAMA* 215: 916-918, 1969
3. CAPLAN RH, KUJAK R, MURVICH S, et al: Current status of the radioactive  $^{131}\text{I}$  uptake test. *Minn Med* 59: 530-535, 1976
4. TALBOT JM, FISHER DK, CARR CJ: A review of the effects of dietary iodine on certain thyroid disorders. *Fed Am Soc Exp Biol* 7: 11-13, 1976
5. HOOPER PL, CAPLAN RH: Thyroid uptake of radioactive iodine in hyperthyroidism. *JAMA*: in press
6. HAMBURGER JI: Diuretic augmentation of  $^{131}\text{I}$  uptake in inoperable thyroid cancer. *New Engl J Med* 280: 1091-1094, 1969