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Diffuse Liver Uptake of Iodine-131

TO THE EDITOR: Recently several papers and abstracts have been published in this and other journals reporting diffuse liver uptake of iodine-131 (^{131}I) in thyroid carcinoma patients after surgery, detected either during diagnostic procedures or after the administration of ablative doses of ^{131}I (*1–4*). Detectable liver activity persisting after the administration of ^{131}I for up to 2 mo has already been reported by Chapman et al. in 1955, without any comment (*5*). In the same year, Baumgart stated "that surveying the whole body distribution of I-131, 3 days after the administration of larger doses, activity over the liver was 2–3 times higher than over all other organs, except the thyroid" [(*6*)—our translation]. Pochin reported in 1949, using profile counting (*7*), that 48 hr after an oral dose of ^{131}I as well as a few minutes after an i.v. injection of ^{131}I labeled T4, the liver had significantly higher counts than plasma in patients with thyrotoxicosis. He concluded that the activity was due to labeled thyroid hormones. In 1963, Pochin reported progress made in his investigations into the role of the liver in thyroid hormone metabolism and stressed again the importance of the presence of liver activity in the management of patients who had had thyroid carcinoma with ablated thyroids (*8*). He also stressed the parallelism between plasma PBI concentration and liver activity. In 1963, Van Middlesworth et al. obtained good liver images with 2 MBq (60 μCi) of labeled T4. On the basis of these reports, Sharma et al. proposed in 1965 (*1*) and in 1975 (*11*) the use of external liver counting after the administration of 1 MBq (25 μCi) ^{131}I for the diagnosis of hyperthyroidism instead of PBI-131 plasma levels.

We have data on 48 patients treated for Graves' disease with ^{131}I during 1973 to 1983 in whom counts over the liver were recorded with a thyroid uptake probe. In 30 patients, count rates were also recorded in a similar manner over other tissues and organs. The count rates were recorded after the administration of individually calculated treatment activities estimated to deliver 50 Gy to the thyroid. In most patients, four to five determinations were made most often within one month of treatment. A review of 94 whole-body scans of 41 patients treated during 1981 to 1989 in the Division of Nuclear Medicine at Vancouver General Hospital, after surgery for cancer, has also been carried out. Images were evaluated by two nuclear physicians (BCL, MC) for diffuse liver uptake, the presence of metastases, and uptake in the region of the ablated thyroid. Uptake of ^{131}I, when done, was also noted. We found 16 patients with pronounced liver uptakes and a further 32 had faint uptake: no uptake was seen in the remaining 46 patients. The scans were read blind and different opinions were recorded with respect to 13 scans; after discussion an interpretation was agreed upon. Inspection of the data shows that the more often a patient had whole-body scans the more often was diffuse liver uptake seen. Whereas in only one third of scans, it was noted in patients with one investigation, in two-thirds when two scans were done, and near 100% in patients with three or more scans. It should be stressed that with two exceptions (2963 and 5556 MBq-80 and 150 mCi), 82 scans were done only with 185 or 370 MBq (5 or 10 mCi). Ninety percent of the scans were done 72 hr after the administration of ^{131}I, the rest after 24 to 96 hr.

TABLE 1
Uptake of [^{131}I]sodiumiodide

	Metastases	Residual thyroid tissue
Liver		
48	18	41
Liver negative		
46	6	28

Table 1 shows the correlation between positive and negative liver images and the presence of positive uptakes in the other regions studied. (Patients with no uptake at all are not included.)

In patients with thyroid uptake >1%, only one with an uptake of 2% shows no uptake in the liver, in the neck or in metastases. In a thyroid cancer patient treated recently with 7407 MBq (200 mCi) of ^{131}I, no nonspecific labeling of plasma proteins could be detected. In vitro labeling of the plasma of four euthyroid volunteers with the equivalent of 7407 MBq (200 mCi) of ^{131}I showed no nonspecific labeling.

From the references cited and our own results we conclude:

1. Administration of radioactive iodine (e.g., ^{131}I) results in an *in vivo* labeling of thyroid hormones, which can be detected in principle in all tissues and organs, where it is present, including the liver.
2. Liver activity after ^{131}I administration can always be detected with a sensitive detector if labeling of thyroid hormones has occurred.
3. Diffuse liver uptake of ^{131}I is mainly due to (labeled) thyroid hormones (mostly T4) and therefore indicates hormonification.
4. When present after thyroid ablation, diffuse liver activity indicates either functioning thyroid remnants, reoccurrence of the tumor, functioning metastases or a combination of these, and is of importance to management decisions.

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Influence of Kidney Depth on the Renographic Estimation of Relative Renal Function

TO THE EDITOR: Using kidney depth measurements derived from x-ray CT images, Maneval and colleagues (*1*) concluded that "individual measurements from lateral scintigraphy appear to be accurate measures of kidney depth and should be directly incorporated for the quantitative evaluation of the renogram in children."

Two issues are raised by this statement which we think require clarification. First, although the paper is mainly concerned with the renographic estimation of *absolute* renal function (individual kidney GFR in ml/min), we feel that use of the general phrase "quantitative evaluation" leaves the conclusion open to misinterpretation, and we would like to comment specifically on the influence of kidney depth on the renographic estimation of *relative* renal function. Second, we do not think that the accuracy of kidney depth measurements derived from lateral scintigrams (acquired after renography) can be properly assessed from the data presented.

For technetium-99m agents, if the left kidney is 1 cm deeper than the right, a true relative (%) function (L:R) of 50:50 would, if uncorrected, be calculated as 46:54. For a 2-cm difference, a true relative function of 50:50 would appear as 42:58. The above calculations are based on the assumption that the theoretical value for the linear attenuation coefficient (μ) of 0.153 cm^{-1} is valid in this context, which has been questioned (*2*).

Reported values for the *effective* linear attenuation coefficient (μeff) vary (emphasizing the importance of performing this measurement on-site), but all are lower than the theoretical value [0.10 cm^{-1} (their refs. 1,20), 0.11 cm^{-1} (*3*), 0.12 cm^{-1} (*4*), 0.14 cm^{-1} (*5*)]. For a 1-cm difference in kidney depth, use of a more realistic value for μ of 0.10 would result in a true relative function of 50:50 being calculated (without correction) as 48:52 which, in our view, constitutes an acceptable error given the other factors affecting the accuracy of the measurement (choice of background subtraction algorithm, choice of method for estimating relative function, etc).

Given that a minority of patients exhibit a difference in renal depth of >1 cm [~34% of (seated) adults (their ref. *5*) and ~8% of (supine) children (*1*)], it would obviously be helpful if there was a simple way of predicting this discrepancy during the acquisition of the (posterior) renographic images. In the context of quantitative ^{99m}Tc-DMSA imaging, it has been reported that depth correction is only necessary when the upper border of one kidney is below the mid-point of the other (*6*). However, Wujanto et al. (*7*) found that in 57 (out of 261) cases, where the difference between geometric mean and posterior estimates of relative DMSA uptake was >5%, only 29 (51%) showed an obvious anatomical reason for applying the correction.

In the renographic estimation of *absolute* function, however, we agree with Maneval et al. (*1*) that attenuation correction is mandatory. One well-known method (their ref. 8) advocates the use of the Tonnesen formula (their ref. 19), although it has been shown to be invalid in children (*1*, their ref. 15), and its accuracy has also been disputed in adults (their ref. 5). In practice, therefore, most workers prefer to *measure* kidney depth using lateral views (their refs. 1,5,14,22).

Maneval et al. (*1*) found that two of the four formulae tested showed reasonably good agreement with CT-measured kidney depth and suggested that, because these formulae were derived by reference to lateral scintigrams, lateral images acquired at the end of a (^{99m}Tc-DTPA) renogram therefore represent an accurate means of measuring renal depth in children. We do not agree that this necessarily follows, since the radiopharmaceuticals used in the derivation of these formulae were ^{99m}Tc-DMSA (their ref. 20) and $^{197}HgCl_2$ (their ref. 21), respectively.

In general, the activity distribution within the kidneys 35–45 min after injection of ^{99m}Tc-DTPA (or ^{123}I-OIH) will be significantly different to that at 2–3 min (when the relative function is actually measured), meaning that depth measurements derived from 'late' lateral views may be somewhat misleading; the magnitude of the error depending on the degree of hydronephrosis. For the same reason, the 'geometric mean' method referred to by Maneval et al. (*1*) is inappropriate for DTPA renography, since the anterior image cannot be acquired until at least 30 min after the optimum (2–3 min) posterior view. Furthermore, a normal kidney in a well-hydrated patient may contain relatively little activity at the end of the renogram and may therefore be poorly visualized on 'late' static images.

Despite these potential problems, Gruenewald et al. (their