diagnostic and post-therapeutic body scans [Abstract]. *J Nucl Med* 1989; 30:4Ab.
5. Chapman EM, Maloof F. The use of radioactive iodine in the diagnosis and treatment of hyperthyroidism: ten years experience. *Medicine* 1955; 34:261–321.
6. Baumgart W. Discussion to Fellinger K, Mannheimer E, and Vetter H. Zur Kenntniss der patho-physiologischen Grundlagen der Diagnostik and Therapie der Schilddrusenerkrankungen mit radioaktiven In: Fellinger K, Vetter H, eds. *Radioaktive Isotope in Klinik and Forschung.* Munchen-Berlin: Urban and Schwarzenberg; 1955:114.
7. Pochin EE. Profile counting. Medical radioisotope scanning. Proc. of Semin. by I.A.E.A. & WHO. Int. Atom. Energy Agency, Vienna, 1959: pp 143–162.
8. Pochin EE. Liver concentration of thyroid metabolites: dynamic clinical studies with radioisotopes. In: Kniesly RM, Tauxe WN, eds. *Symp. Oak Ridge Institute Nucl. Studies.* 1963:413–432.
9. Van Middlesworth L, Turner JA, Lipscomb A. Liver function related to thyroxine metabolism. *J Nucl Med* 1963; 4:132–138.
10. Sharma SM, Desai KB, Mehan KP, et al. Diagnosis of hyperthyroidism by external liver counting. *J Nucl Med* 1965; 6:598–604.
11. Desai KB, Patel MC, Mehta NM, et al. Usefulness of liver counts in diagnosis of hyperthyroidism. *Int J Nucl Med Biol* 1976; 3:71–73.

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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

ref. 5) found a good correlation (in adults) between kidney depth measured by lateral views (at the completion of renography) and that measured by ultrasound. It is unfortunate that Maneval et al. (*1*) were not able to include renography studies as part of their protocol, as this would have provided useful data on the accuracy of renal depth measurement derived from lateral (^{99m}Tc-DTPA) images in children.

An important factor in this debate which was not discussed by Maneval et al. (*1*) is patient positioning. It is known that kidney depth in the sitting position can vary by a centimeter or more from that in the recumbent posture (*8*); the difference in renal depth being minimized by employing supine positioning (*6,9*). There are, however, physiologic reasons for preferring the sitting position, which explains why, for patients over 4 yr of age, opinion in the U.K. is divided on this issue (supine: 56% of centers, sitting: 32%, 'other': 12%) (*10*).

In summary, we agree that it is necessary to apply a depth correction when attempting to estimate *absolute* kidney function from gamma camera renography (in adults *and* children) and that, despite the limitations mentioned, lateral views (performed with the patient in the same posture as that used for renography) provide a more accurate estimate of kidney depth than currently available empirical formulae. It is important to appreciate, however, that there are numerous sources of error in the renographic estimation of absolute function and, for some of the methods, the *overall* error in the measurement of individual kidney GFR (or ERPF) may not be significantly reduced by the use of lateral views (c.f. formula) for kidney depth estimation (their ref. 1). In general, renographic methods for estimating absolute function may be more accurate in children then adults (*2*, their ref. 1).

For *routine* renography, we concur with other workers who have concluded that the error (in the estimation of relative function) introduced by not applying a correction for differences in depth of the left and right kidney is small enough to be ignored in most adults (*11,12*) and the vast majority of children (*13*, their ref. 15); the extra work involved in routine depth correction therefore being difficult to justify. A U.K. renography survey conducted in 1987 revealed that only 2 out of 34 (6%) centers routinely performed a depth correction when estimating relative renal function (*10*).

REFERENCES

1. Maneval DC, Magill HL, Cypess AM, Rodman JH. Measurement of skin-to-kidney distance in children: implications for quantitative renography. *J Nucl Med* 1990; 31:287–291.
2. Russell CD, Dubovsky EV. Gates method for GFR measurement [Letter]. *J Nucl Med* 1986; 8:1373–1374.
3. Cosgriff PS. Gamma camera collimator design with special reference to the dynamic study. M.Sc thesis. University of Leeds. 1981:101–110.
4. Fleming JS, Keast CM, Waller DG, Ackery DM. Measurement of glomerular filtration rate with ^{99m}Tc-DTPA: a comparison of gamma camera methods. *Eur J Nucl Med* 1987; 13:250–253.
5. Corrigan DM, Collis SA. Estimation of glomerular filtration rate, without blood sampling, during renography. *Clin Phys Physiol Meas* 1984; 5:279–284
6. Nimmo MJ, Merrick MV, Allan PL. Measurement of relative function. A comparison of methods and assessment of reproducibility. *Br J Radiol* 1987; 60:861–864.
7. Wujanto MB, Lawson RS, Prescott MC, Testa HJ. The importance of using anterior and posterior views in the calculation of differential renal function using ^{99m}Tc-DMSA. *Br J Radiol* 1987; 60:869–872.
8. Tauxe WN. Use of radioactive media in assessment of renal perfusion: a review. *Br J Radiol* 1969; 41:64–75.
9. Merrick MV. The kidneys. In: *Essentials of nuclear medicine.* Edinburgh: Churchill Livingstone; 1984:128.
10. Cosgriff PS. U.K gamma camera renography survey [Abstract]. *Nucl Med Comm* 1989; 10:214
11. Lawson RS. Mathematics. In: O'Reilly PH, Shields RA, Testa HJ, eds. *Nuclear medicine in urology and nephrology.* London: Butterworths; 1986:256.
12. Britton KE, Maisey MN. Renal radionuclide studies. In: Maisey MN, Britton KE, Gilday DL. eds. *Clinical nuclear medicine.* London: Chapman and Hall; 1983:122.
13. Ash JM, Antico VF, Gilday DL, Houle S. Special considerations in the paediatric use of radionuclides for kidney studies. *Semin Nucl Med* 1982; 12:345–369.

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REPLY: We would like to thank Drs. Cosgriff and Brown for their comments on the recent publication and would like to respond to the two specific issues raised. We feel that the initial sentences of our introduction sufficiently define the context of this investigation and agree fully that the concluding sentence should not be misinterpreted to apply to the evaluation of relative renal function. Secondly, it was neither our intent nor was it possible to critically assess the accuracy of lateral measures of renal depth with the gamma camera in this retrospective study. However, we do feel that the arguments put forth in our discussion provide motivation for including lateral scintigraphy after renography for the clinical assessment of absolute renal function (e.g., GFR) in children.

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Noninvasive Imaging of Giant Hematomas

TO THE EDITOR: The paper by Lisbona et al. (*1*) on scintigraphic and ultrasound features of giant liver hemangiomas was of great interest to us. We agree with the authors that definite, noninvasive imaging of giant hemangiomas is important to avoid angiography, biopsy, or exploration laparotomy when excluding primary or metastatic malignancy. In our recent publication (*2*) in which we described 56 hemangiomas diagnosed by ^{99m}Tc-red blood cell (RBC) SPECT, we identified five cases of giant hemangiomas, which we describe below.

Our hemangiomas ranged in size between 80 and 145 mm in diameter; the ultrasound appearance was in three cases a hyperechogenic mass, in two cases a mixed hyper- and hypoechogenic mass, all sharply marginated. Bolus infusion CT was only possible in three cases; the hypodense lesions (precontrast CT) showed an initially peripheral enhancement followed by centripetal fill-in. Moreover, bolus infusion was