responsible for conservatism in the past, but modern techniques in vascular surgery have reduced the risk of excision of carotid body tumours. Although the morbidity in this series is not inconsiderable, consisting mainly of nerve injury, complications occurred almost exclusively in patients with larger tumours (⩾ 3 cm in diameter and corresponding to Shamblin *et al.*'s[6] type II and III tumours).

Most carotid body tumours grow slowly, but if not removed timeously they also kill slowly. Two of our patients with longstanding tumours led a miserable existence before succumbing to respiratory obstruction from recurrent growth in the neck, and 1 patient died in severe pain from secondary lesions in the skull. With modern techniques in vascular surgery and an interdisciplinary approach the incidence of complications should be reduced to a minimum, especially in patients with smaller tumours. Because malignancy cannot be ruled out on the histological features of the primary tumour, a conservative approach is not warranted unless there are medical contraindications to surgery, such as age or infirmity of the patient, or excision is not possible for technical reasons.

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The elimination of errors caused by prior technetium-99m scintigraphy on iodine-131 thyroid uptake measurements

H. J. WASSERMAN, C. MÜLLER, J. F. KLOPPER

Summary

Coincidence summing of technetium-99m (^{99m}Tc) pulses may disturb iodine-131 (^{131}I) thyroid uptake measurements if these are obtained after ^{99m}Tc thyroid scintigraphy performed on the same day. The magnitude of the error was assessed in 26 patients. It was found that when pre-dose measurements were subtracted, the 6-hour and 24-hour ^{131}I uptakes could be falsely decreased by up to 137 percentage points using a lower discriminator level of 250 keV and by up to 35 percentage points with a discriminator level of 300 keV. When pre-dose measurements from ^{99m}Tc were ignored, there was a general increase in ^{131}I uptake values at 6 hours. Increases of up to 22 and 9 percentage points occurred when 250 keV and 300 keV lower discriminator levels respectively were used. These errors may be eliminated by performing ^{131}I uptake measurements through a 1 mm lead filter.

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Department of Nuclear Medicine, Tygerberg Hospital, Parowvallei, CP
H. J. WASSERMAN, PH.D.
C. MÜLLER, B.SC. HONS
J. F. KLOPPER, M.D., M.B. CH.B.

In many hospitals technetium-99m (^{99m}Tc) is used for thyroid imaging while iodine-131 (^{131}I) is still used for determining thyroid uptake.[1,2] ^{131}I uptakes may thus frequently be performed on patients who have received 70 MBq or more of ^{99m}Tc earlier the same day, as one would not expect the 140 keV photons from ^{99m}Tc to contribute to counts in the ^{131}I window centred around 364 keV.

In a previous report[3] we used phantom measurements to show that it may be expected that the presence of several MBq of ^{99m}Tc in the necks of thyroid patients may disturb ^{131}I uptake measurements, because of coincidence summing of the 140 keV ^{99m}Tc pulses at high count rates. Our analysis[3] of the ^{99m}Tc spectrum in the region 190 - 330 keV showed that any depression of count-rate in the ^{131}I window by high activity of ^{99m}Tc was masked by the presence of ^{99m}Tc summation pulses. The phantom studies indicated that large errors could occur in the determination of ^{131}I uptakes if its oral diagnostic dose was administered immediately after completion of the ^{99m}Tc scintigram, but that the error could be avoided by performing measurements through a 1 mm lead filter. Unless the lead filter is used, erroneous ^{131}I uptakes could be calculated in two possible ways:

1. If a pre-dose measurement is performed to account for ^{131}I retained in the thyroid from a previous test or therapy, subtraction of such a measurement would falsely lower the 6-hour and 24-hour uptake measurements, to the extent by which the ^{99m}Tc contribution has decreased at these times.

2. If no pre-dose measurement is performed, on the assumption that ^{99m}Tc would not contribute to the ^{131}I measurement, the 6-hour uptake may appear falsely high.

The magnitude of the error obviously depends on the ^{99m}Tc uptake and its rate of decrease in the thyroid, which may vary from one individual to another. Since the amount of ^{99m}Tc retained in the thyroid as estimated from the literature[4,5] varies by more than 100%, the present study was undertaken during routine measurements on patients in order to determine whether such errors as envisaged in the phantom study did indeed occur in the clinical situation.

Patients and methods

Twenty-six patients referred for ^{99m}Tc scintigraphy and ^{131}I uptake measurements were included in the study. ^{131}I measurements were performed according to the recommendations of the International Atomic Energy Agency (IAEA)[6] using a 50 x 50 mm NaI (Tl) scintillation detector connected to a two-channel spectrometer/scaler (Packard Instruments) with a resolving time in a 120-450 keV window of approximately 4 μs. Since counts may be lost due to summation of pulses[3] the system behaves at least in part as one with paralysable resolving time. The spectrometer channels were peaked weekly. One-minute counts were obtained simultaneously in 300 - 440 keV and 250 - 440 keV windows. All measurements were immediately repeated after placing a 1 mm lead filter in front of the detector.

Thyroid scintigraphy was performed on a gamma-camera 20 minutes after intravenous administration of 70 - 110 MBq ^{99m}Tc-pertechnetate. Immediately after scintigraphy, pre-dose measurements in the ^{131}I windows were performed on the uptake counter, followed by oral administration of 0,2 - 0,7 MBq ^{131}I. Uptake measurements were performed 6 hours and 24 hours after the oral dose had been administered and compared with a 100% standard in an IAEA perspex phantom.

^{99m}Tc thyroid uptakes were calculated from the computer-stored gamma-camera images, and ^{131}I thyroid uptakes were calculated in the usual manner from counts obtained in both windows with and without a 1 mm lead filter. In one set of calculations the pre-dose measurements were left out of consideration, and in a second set they were subtracted. ^{131}I uptakes only were determined in a similar manner in another group of 10 patients who had not received any ^{99m}Tc beforehand, and who registered no pre-dose counts.

Results

^{99m}Tc pre-dose counts varied up to 57 000 and 12 000 counts per minute (cpm) in the two ^{131}I windows respectively, with the ^{131}I standard yielding about 37 000 cpm. The lead filter reduced the ^{99m}Tc pre-dose counts to less than 2% and the ^{131}I count to about 75% of the unfiltered values. Accordingly, ^{131}I uptake percentages (x) obtained in the 330 - 440 keV window with the lead filter with pre-dose readings substracted, equalled those calculated without subtracting pre-dose readings (y) at both 6 hours and 24 hours. The regression curve was:

$$y = 1{,}00x + 0{,}40;\ r = 1{,}00.$$

The uptake values obtained in the 330 - 440 keV window (pre-doses subtracted) with the lead filter were thus not influenced by the presence of ^{99m}Tc pre-dose counts and were therefore used as reference points in order to assess the magnitude of the errors when uptakes were obtained by the other methods.

Table I shows the regression constants obtained when the uptake (y) calculated with pre-dose counts subtracted are correlated with the reference values (x). Fig. 1 presents these results graphically for those patients who had ^{99m}Tc uptake values greater than 4%.

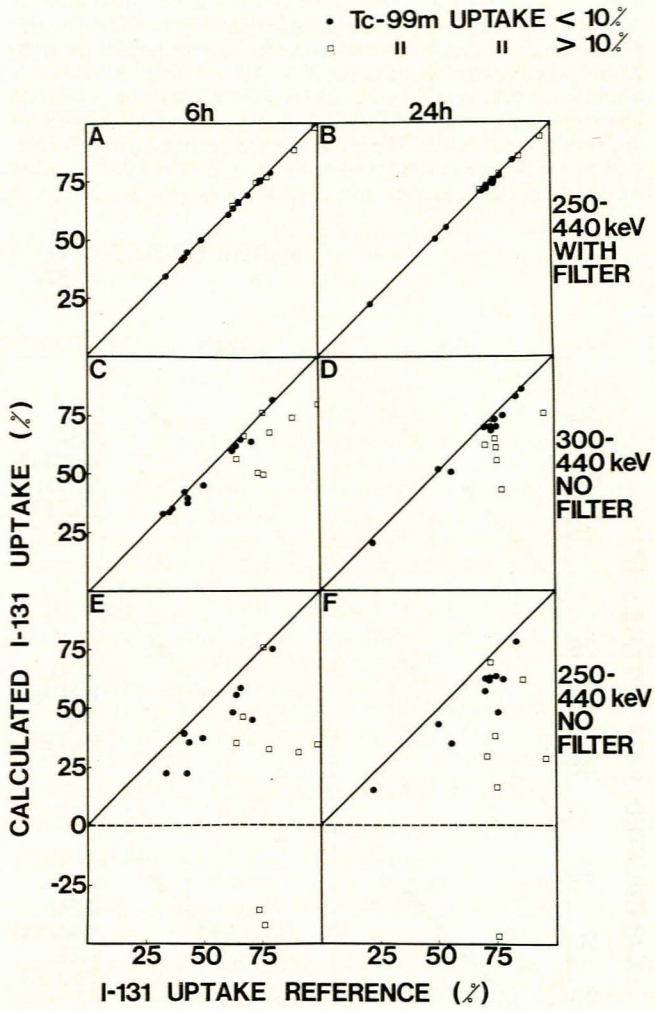

Fig. 1. ^{131}I uptakes calculated with subtraction of pre-dose counts, plotted against reference values for ^{99m}Tc uptakes > 4%. Reference values are ^{131}I uptakes obtained in the 300 - 440 keV window with 1 mm lead filter. Solid line indicates equality with reference value.

TABLE I. REGRESSION CONSTANTS* WITH PRE-DOSES SUBTRACTED

Technique	PHA window (keV)	Time	^{99m}Tc uptake < 4% a	b	r	> 4% a	b	r
Without lead filter	**300 - 400**	**6 h**	**-0,21**	**0,98**	**1,00**	**9,94**	**0,74**	**0,87**
		24 h	**-0,41**	**1,03**	**1,00**	**6,43**	**0,80**	**0,82**
	250 - 440	**6 h**	**-0,16**	**0,94**	**1,00**	**25,10**	**0,27**	**0,31**
		24 h	**-0,18**	**0,99**	**1,00**	**15,20**	**0,43**	**0,33**
With lead filter	**250 - 440**	**6 h**	**0,38**	**0,98**	**1,00**	**1,31**	**0,97**	**1,00**
		24 h	**0,36**	**0,99**	**1,00**	**0,37**	**0,98**	**0,99**

*$y = a + bx$; x = percentage uptake with lead filter, 300 - 440 keV window and pre-dose subtracted.
PHA = pulse height analyser.

Without the lead filter the calculated uptakes were underestimated by up to 35 percentage points in the 300 - 440 keV window and up to 137 percentage points in the 250 - 440 keV window. Use of the lead filter eliminated errors.

When pre-dose measurements were not subtracted, good correlations with the reference values were obtained in both windows at 6 hours and 24 hours with and without a lead filter. If y represents the ^{131}I uptake percentages obtained without subtracting pre-dose measurements, and x the reference values in the equation $y = a + bx$, the constants of the regression lines lay in the following ranges: $2{,}60 > a > -0{,}75$; $1{,}07 > b > 0{,}97$; and $r > 0{,}93$. The results for patients who had ^{99m}Tc uptakes greater than 4% are plotted in Fig. 2. At 6 hours calculated ^{131}I uptakes were overestimated by up to 22 and 9 percentage points in the 250 - 440 keV and 300 - 440 keV windows respectively. Even at 24 hours, the uptake in 3 patients was increased by more than 5%. There was a general significant increase at 6 hours if ^{99m}Tc uptakes were greater than 10% ($P < 0{,}02$ by the Wilcoxon test for paired samples). When the lead filter was used, no excess greater than 2,5 percentage points occurred.

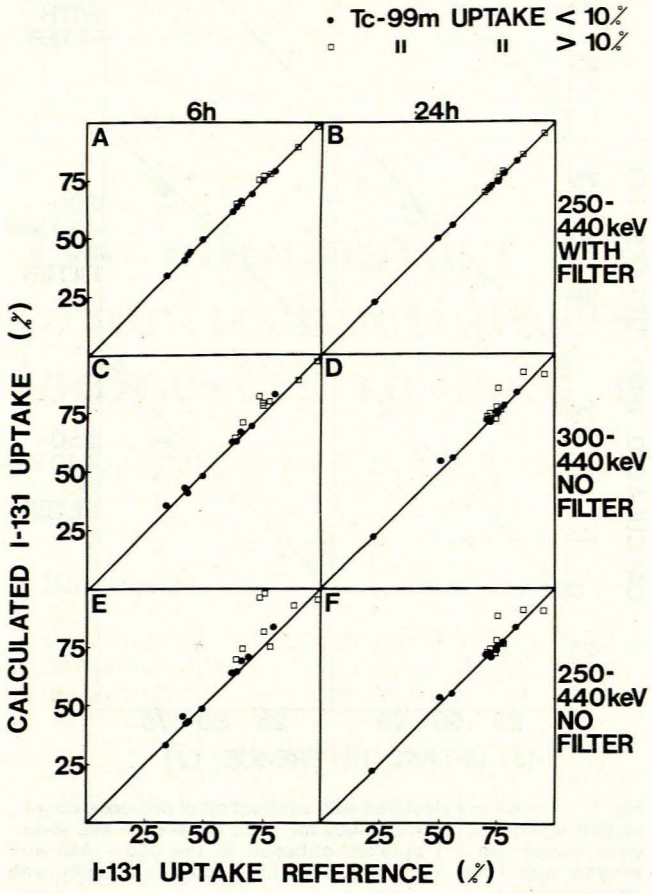

Fig. 2. ^{131}I uptakes calculated without subtraction of pre-dose counts, plotted against reference values as in Fig. 1 for ^{99m}Tc uptakes > 4%. Solid line indicates equality with reference value.

In order to ascertain that the increase when the lead filter was not used was not due to increased scatter being detected, the average ratio

$$R = \frac{\text{counts in 300 - 440 keV window}}{\text{counts in 250 - 440 keV window}}$$

was calculated with and without the lead filter in the 10 patients without ^{99m}Tc, and on the IAEA phantom. The ratio increased from 0,826 ± 0,010 without the filter to 0,847 ± 0,009 with the filter, indicating an increased scatter contribution over the reference value without filter. However, the same ratios were obtained in the IAEA phantom. Any effect of scatter is therefore eliminated by use of the phantom. Furthermore, errors only occurred in patients with more than 10% ^{99m}Tc uptakes from which it may also be concluded that the observed differences are due to the effect of ^{99m}Tc and not due to attenuation of scatter by the filter.

Discussion

Our results show that significant errors may occur in the calculated thyroid uptake values of patients if one is unaware of the contribution made by ^{99m}Tc to counts in an ^{131}I window, and a ^{99m}Tc scintigraphy dose is given immediately before an ^{131}I uptake dose. If this contribution is detected in a pre-dose measurement the error will be even larger if the pre-dose measurement is subtracted from subsequent measurements. Even if the pre-dose reading is due to ^{99m}Tc alone, it would still not be possible to calculate its 6-hour contribution. The estimates of ^{99m}Tc retention[3] show that the decrease in ^{99m}Tc activity in the thyroid is in large part due to biological factors, which may be subject to individual variations. We have shown that these errors may be avoided by performing ^{131}I uptake measurements with a 1 mm lead filter in front of the detector.

If the possibility of the occurrence of this problem is recognised, the problem may be avoided by completing the 24-hour ^{131}I uptake before administration of the scintigraphy dose. However, as in our hospital, it may be logistically advantageous to complete the scintigram and obtain the 6-hour ^{131}I uptake on the first day of an outpatient visit since patients sometimes do not return after 24 hours. It is then recommended that the ^{131}I uptake measurements be performed through a 1 mm lead filter.

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