Problems and pitfalls in thyroid uptake measurements with iodine-131

To the Editor: We consider of use to remind possible errors in the measurement of radioidine uptake (RAIU) because in articles published in HJNM in the past these errors have not been mentioned [1]. Measurement of RAIU by the thyroid introduced in 1930s, remained an essential test for several years to confirm the diagnosis of hyperthyroidism, to distinguish other causes of thyrotoxicosis and to provide data for calculation of the therapeutic 131I dosage [2]. Today RAIU test is used only in some centres for the calculation of the therapeutic dose of 131I in hyperthyroid patients. Nevertheless, differences in neck phantom characteristics, high voltage fluctuations on phantom count rates, problems of attenuation and unpredictable scatter characteristics, among other causes, have been shown to induce significant errors in RAIU measurements [3]. We describe 4 cases of incorrect RAIU due to error. As a standard procedure all patients before the RAIU study, refrained from taking T3 for 6 weeks, antithyroid drugs for 1 week and iodinated drugs for 4-6 weeks [4]. All patients had an iodine free diet the last week before the RAIU study. After fasted for 4-6 h, all patients received 185 kBq 131I orally in liquid form. An accurately measured aliquot was used as standard, placed in the thyroid uptake phantom. The dose was counted with the same scintillation detector from a distance of 25 cm from the crystal. Counts were obtained for 2 min with the same detector-to-skin distance, from the neck and from the thigh, for background correction. Calculation was performed with the formula described below [4]:

$$\text{RAIU} = \frac{\text{Neck counts (cpm)} \times 100}{\text{Administered counts (cpm)} - \text{Background counts (cpm)}}$$

The reference values for RAIU in our centre range from 6% to 18% for 4h and 10% to 35% for the 24h.

In the first case, a 32 years old female patient with hyperthyroidism underwent a RAIU study and thyroid scintigraphy. Free triiodothyronine (FT3), free thyroxin (FT4) and thyroid-stimulating hormone (TSH) levels were measured as: TSH: 0.005 µU/mL, FT4: <100 pmol/L and FT3 was 20.75 pmol/L). A diffuse hyperplasic thyroid gland was seen on the thyroid scan (Fig. 1C). The RAIU study, performed before haemodialysis, showed 4h uptake of 0.7% and 24h uptake of 0.8%. Two weeks later the study was repeated after haemodialysis and the uptake values were 4.6% and 11.2%, respectively. The patient had an ex-

![Figure 1. A-D. All patients had a thyroid scintiscan with 99mTcO4- 20 min after the i.v. injection of 105 MBq. A, C and D: Diffusely hyperplastic thyroid gland. B: Hyperactive thyroid nodule on the right thyroid lobe. The left lobe is suppressed.](image-url)
panded iodine pool due to renal failure. Haemodialysis may have a lessening effect on serum iodine levels, which may have increased RAIU [13].

Other factors that may induce low RAIU values are: a) When capsules were used instead of the liquid form of $^{131}$I [6]. Although the mechanism for this effect is not clear it may take longer for the capsule to dissolve in the intense and thus measurements of RAIU at 15-45 min may be low. b) The presence of non-absorbable $^{131}$I in the capsule [7]. It has been suggested that the United States Pharmacopeia (USP) dissolution test could be applied to radioiodide capsules as a quality assurance procedure [7]. c) The depth of the thyroid gland, its mass and lobe separation (distance between the centre points of each simulated lobe where the maximum value is 6.5 cm). [8]. Phantom studies showed that the depth of the thyroid gland caused a variation of a factor of two in the uptake of $^{99m}$Tc and $^{131}$I, and of a factor of 4 for $^{125}$I. Gland mass and lobe separation cause only small errors for medium energy isotopes [8]. d) High voltage power supply stability, selection of energy window and attenuation characteristics of neck phantoms [3]. Recent administration of another radionuclide is a source of error, but with 20% windowing, it was unlikely that the 140 keV photons of $^{99m}$Tc would interfere with the 364 keV photopeak of $^{131}$I. e) Dead time losses for commercial probe systems in thyroid RAIU with $^{123}$I, underlined the role of linearity studies.

To avoid many of the above errors in measuring RAIU, Quality control consists of: daily calibration using Cs-137, monthly testing of absolute sensitivity of the probe and yearly examination of the energy spectrum of multiple channel analyser.

Bibliography


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