# CORRELATION BETWEEN EARLY AND LATE RADIOIODINE THYROID UPTAKE IN NORTHEASTERN THAI GRAVES' DISEASE PATIENTS

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## ABSTRACT

A retrospective study was undertaken at the Department of Radiology, Faculty of Medicine, Khon Kaen University to determine the correlation between early (3-hrs) and late (24-hrs) radioiodine ($^{131}I$) thyroid uptake in hyperthyroid Graves' disease patients who were referred for the first $^{131}I$ treatment. Nine hundred and sixty-nine patients residing in the Northeastern Thailand were enrolled into the study. Their clinical background regarding age, sex, province of residence, indication for $^{131}I$ treatment, and estimated thyroid gland weight were presented. Thyroid uptake test results of all subjects were analyzed for the correlation between early (Eup) and late (Lup) uptake value. Fairly good correlation between Eup and Lup was found ($r = 0.6$, $P < 0.001$). The best fitted regression equation was the logarythmic model: $Lup = 7.8 + 17.3 \ln Eup$. These data are useful in the prediction of 24-hrs $^{131}I$ uptake value from the 3-hrs value in order to reduce a visit in performing thyroid uptake test before $^{131}I$ treatment.

**Key word:** Correlation, Thyroid uptake, Graves' disease, Radioiodine treatment

**Eup** = Early uptake
**Lup** = Late uptake

## INTRODUCTION

$^{131}I$ has been recognized as an effective, safe and convenient isotope, using for the treatment of hyperthyroidism for more than 50 years.[1-2] Apart from toxic adenoma and toxic multinodular goiter, Graves' disease is the most common cause of primary hyperthyroidism. Estimation of appropriate dose of $^{131}I$ for individual Graves' disease patient is usually calculated from the size of thyroid gland and the result of radioiodine thyroid uptake test, which is the ratio of amount of $^{131}I$ uptake in thyroid gland at early (3-6 hrs) or late (24-hrs) periods of time after drinking of $^{131}I$ solution and the total amount of orally administered radioiodine, expressed as a percentage dosages. Good correlation between the early uptake value (Eup) and the late uptake value (Lup) were reported by some researchers and a predicted 24-hrs uptake value was then established in order to be used instead of the measured 24-hrs uptake value. This can reduce the time and cost of the second visit in undertaking a 24-hrs uptake measurement.[3-5]

Because of the varying amount of daily iodine diet in the population of various regions in the world, resulting in a varying thyroid uptake value, both

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in normal and hyperthyroid individuals, the predicted 24-hrs uptake value conducted at one place may not be suitably applied at another place. We therefore conducted the study to find the correlation between Eup and Lup of hyperthyroid Graves' disease patients referred for the first $^{131}I$ treatment and then to obtain the appropriate regression model to predict 24-hrs uptake value from 3-hrs value.

## PATIENTS AND METHODS

### Patients

We retrospectively studied the medical records of 1,029 consecutive Graves' disease patients, residing in the Northeastern provinces, referred for $^{131}I$ treatment at the Division of Nuclear Medicine, Department of Radiology, Faculty of Medicine, Khon Kaen University from June 1994 to August 2000. The clinical diagnosis of Graves' disease was supported by the elevation of serum thyroxin or triiodothyronine with or without serum thyrotropin measurement. Patients with a prior history of $^{131}I$ therapy or any type of thyroidectomy were excluded. Data regarding age, gender, province of residence, indication for $^{131}I$ treatment, estimated thyroid gland weight by palpation, and result of $^{131}I$ thyroid uptake test were recorded.

### Radioiodine thyroid uptake test

Patients with contraindications of $^{131}I$ treatment, pregnancy and lactating, were firstly excluded before selecting the patients for the test. Anti-thyroid drug (ATD), if taken, was discontinued at least 5-7 days in all cases before the test. Drugs or foods known to interfere with iodine uptake were refrained for an appropriate period of time. At least 4-hours fasting on the first day of the test was recommended to all subjects.

Radioactivity of 20 microcuries (μCi) of the standard $^{131}I$ NaI solution, supplied by the Office of Atomic Energy for Peace, Thailand, were counted before and after ingestion, and then radioactivity at the 10-cm distance from the subject's neck extended by a pillow under the shoulders were measured at 3 and 24 hours later. Background radioactivity was corrected by measuring the activity at the 10-cm distance from the subject's thigh at the level of 10-cm above knee joint. Time-decay correction was also computed. All measurements were performed by the external counter probe system of Elscint Company, model DTR-4A. Thyroid uptake value was calculated according to the following equation:

$$\%\ \text{thyroid uptake of } ^{131}I = \frac{\text{neck counts - background}}{\text{standard counts - background}} \times 100$$

### Statistical analysis

A personal computer with an SPSS program for Windows was used for statistical analysis. The continuous variables were shown as mean, standard deviation and range. Pearson correlation was used to show the correlation between 3-hrs and 24-hrs uptake values. The least square fit method was used to determine the best fit regression model of these values. Scatter plots of 3-hrs against 24-hrs uptake values and the regression line were shown.

## RESULTS

Of 1,029 subjects, 46 were excluded due to having previous history of thyroidectomy and another 14 subjects were excluded due to having an incomplete history. The rest 969 subjects were enrolled for analysis. Female to male ratio was 776: 193 (4:1). Mean age was 40.9 ± 11.7 years (range 14-75). All subjects were from the provinces in the Northeastern Thailand: 31.3% from Khon Kaen, 9.2% from Udorn Thani, 9.2% from Chaiyaphum,

7.0% from Leoi, 6.8% from Mahasarakam, 6.3% from Sakonnakorn, and few subjects from various other provinces including Kalasin, Nakornratchasima, Roi-Ed, Nongkai, Yasothorn, Nongbualumphu, Petchaboon, Nakornphanom, Ubonratchathani, Bureerum, Mukdaharn, Surin, and Srisagate.

Various indications for $^{131}$I therapy were noted: 23 cases (2.4%) were new cases without prior ATD treatment; 831 cases (85.8%) were failed to ATD treatment; and 115 cases (11.9%) has disease relapse after ATD withdrawal.

Mean estimated thyroid gland weight was 44.4 ± 23.5 g (range 20-200). Mean 3-hrs uptake value was 68.8 ± 20.7 % dose (range 11.1-98.7) and mean 24-hrs uptake value was 79.7 ± 11.1 % dose (range 33.5-98.8). Fairly good correlation between Eup and Lup was found ($r = 0.6$, $P < 0.001$).

**ATD** = Antithyroid drug

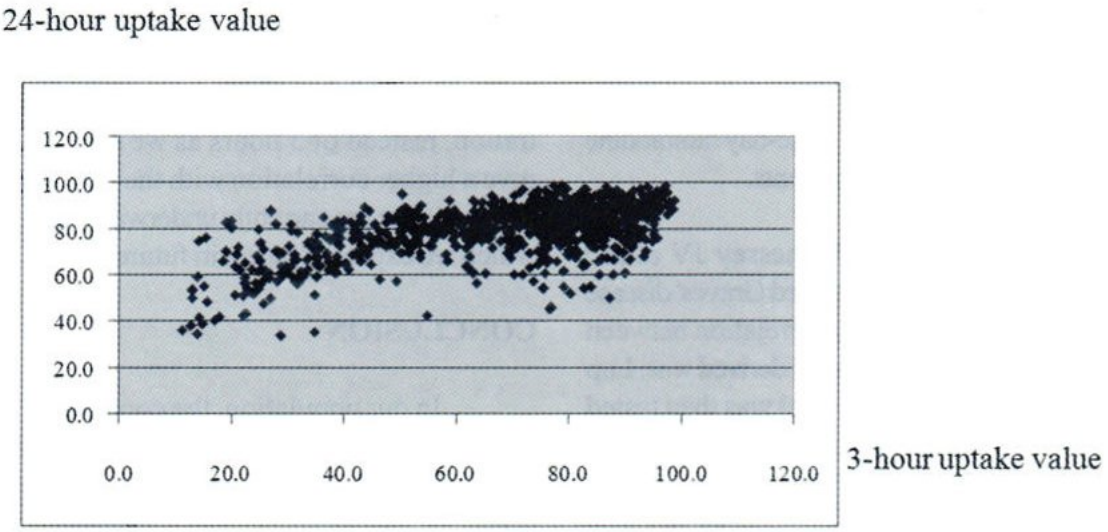


**Fig.1** shows the scatter plots of 3-hour and 24-hour 131I thyroid uptake value showing a logarythmic relationship between the two variables. The best appropriated regression equation was: Lup = 7.8 + 17.3 ln (Eup).

## DISCUSSION

Since its introduction in the mid-1940s, $^{131}$I therapy has become the most widely used treatment for adults with hyperthyroid Graves' disease in the United States.[6] However, there has been no consensus concerning the optimal $^{131}$I dose or the most satisfactory method of dose calculation. Although a fixed dose regimen is being used in many institutes, calculation of an administered dose for each individual patient according to the thyroid gland weight, avidity of thyroid gland for iodine measured by $^{131}$I thyroid uptake test, and biologic half-life of $^{131}$I in the gland is still performed in many nuclear medicine laboratories. However, calculation of biologic half-life is time consuming and often inaccurate.[7] One common approach in determining $^{131}$I dosage for the treatment of Graves' disease is from the following formula:

$$\text{Dose}_{\text{admin}} = \frac{100\ \mu\text{Ci of } 131\text{I/ g TW x estTW x } 10}{\%\text{ dose of 24-hour } ^{131}\text{I uptake}}$$

$\text{Dose}_{\text{admin}}$ = administered dose of $^{131}$I in milli curies, mCi
estTW = estimated thyroid gland weight (in g)

Since the thyroid uptake pattern including the 24-hrs thyroid uptake value is needed to calculate the administered dose, the patients have to come to the hospital for two consecutive days. In order to omit the second visit, a prediction of Lup from the Eup has been proposed. In a retrospective study in 27 Graves' disease patients of Hayes AA et al,[3] the best fit regression model to predict the Lup at 20-28 hours from the Eup at 3-6 hours was: Lup = - 55.7 + 73.2 log Eup. The authors used this relationship to find the correlation between the measured Lup and the predicted Lup in another 24 patients. Very high correlation was obtained (r = 0.94). Moreover, $^{131}$I dose calculation based on these two Lup values showed a very high correlation (r = 0.97). The authors proposed the use of predicted Lup for the same-day radioiodine treatment for Graves' disease patients.

A similar study by Hennessey JV et al [4] performed in 51 previously untreated Graves' disease patients confirmed a very high correlation between Eup and Lup. The regression model derived was: Lup = 28.94 + 0.584 (Eup). This model was then tested in another 21 Graves' disease patients and showed that the measured Lup and the predicted Lup correlated well to each other ($r = 0.85, P < 0.001$), resulting in a very small difference in the mean $^{131}$I administered dose.

Vemulakonda US et al.[5] retrospectively studied in 35 Graves' disease patients and found the regression model from the Eup value at 4 hours in predicting the Lup at 24 hours as: Lup = - 38.618 + 65.216 log Eup and the $^{131}$I administered dose predicted from the Eup studied in another 34 Graves' disease patients also correlated well with the dose calculated from the measured Lup (r = 0.82204).

Our study revealed that 3-hrs uptake value correlated fairly well with the 24-hrs uptake value in the logarythmic pattern. It should be noted that the degree of correlation in our study was not as high as those from the previous studies mentioned above. This might be in part due to some of our Graves' disease subjects had a rapid turnover pattern of uptake, in which the Lup was lower than the Eup.

Although conducted in the retrospectively manner, our study included the largest number of sample size, 969 Graves' disease patients, so far published in the literatures. In particular, all patients were from the local residents. This regression model therefore is highly appropriate to apply for Graves' disease patients living in the Northeastern part of Thailand.

Further study should be carried out to apply the regression from this study into a new group of population to test the difference of $^{131}$I administered dose calculated from the measured and predicted 24-hrs uptake value. In addition, a different time for Eup such as 4 or 6 hours after a tracer dose administration, instead of 3 hours as we had done, might give a higher correlation with the Lup at 24 hours. These studies are currently underway at our Institute, which we expect to report in future.

## CONCLUSION

In our population, the correlation between 3-hrs and 24-hrs thyroid uptake value were fairly high and $^{131}$I treatment dose can be calculated using the predicted 24-hrs uptake value estimated from the 3-hrs uptake value. The data from our study can be appropriately used in the prediction of 24-hrs uptake value to provide the same-day thyroid uptake test and $^{131}$I treatment in Graves' disease population living in the Northeastern part of Thailand.

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