Comparative Evaluation of Two Different Dosage Calculation Protocols of Iodine-131 in the Treatment of Hyperthyroidism

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Objective: *To compare the effectiveness of radioiodine therapy with estimated dose and calculated dose in hyperthyroid patients.*
Material and Method: *A prospective randomized study in 144 hyperthyroid patients referred for ^{131}I treatment was performed between June and December 2007. The patients were divided into two groups according to the ^{131}I dose administered, estimated group using dose based on gland size and calculated group using dose based on both gland size and 24-hour ^{131}I uptake. Outcome assessment was done at 12 months post-treatment.*
Results: *Eleven of 144 patients were excluded due to loss to follow-up and five became euthyroid before ^{131}I treatment. Fifty-six of 128 patients (45.3%) experienced persistent/recurrent hyperthyroidism, 26 (20.3%) developed hypothyroidism, and 44 (34.4%) were euthyroid. Outcome was unrelated to the methods of I-131 dosing. Only gender and goiter size were found to be correlated with the clinical outcomes.*
Conclusion: *An estimated I-131 dosing method using gland size determined by palpation is as effective as calculated method using ^{131}I uptake. This method is more cost effective and brings greater patient convenience.*

Keywords: *Hyperthyroidism, Radioiodine, Iodine-131, Radio-iodine uptake*

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Hyperthyroidism is a substantial health issue, approximately a population prevalence of up to 3% of thyrotoxicosis related disease each year. There are three treatment modalities of hyperthyroidism, antithyroid drug therapy, surgery, and radioactive iodine.

Radioactive iodine (^{131}I) therapy is the most common modality for treatment of hyperthyroidism. At Songklanagarind Hospital, approximately 500-600 new cases per year of hyperthyroidism were referred to the Nuclear Medicine department for ^{131}I therapy and the incidence is increasing each year[1]. Between 80% and 95% of patients with Graves' disease are controlled after a single dose of ^{131}I, which is a relatively safe, simple, and effective form of therapy[2,3].

However, persistent controversy as to the best approach to radioiodine dose selection in the treatment of hyperthyroidism still exists[4]. Dosing regimens vary from methods aiming at a cure for hyperthyroidism, using large doses of ^{131}I, to methods using smaller doses, which aim at euthyroid outcome[5-7]. To avoid excessive ^{131}I-induced thyroid damage resulting in post-treatment hypothyroidism, complex formulas have been introduced to calculate the appropriate dose[8,9]. Most of these formulas take thyroid weight, type of disease, and ^{131}I uptake into account.

Measurement of radioiodine uptake by the thyroid gland has been used in the assessment of thyroid function since its introduction in 1940[10-12]. At present, radioiodine uptake testing is more commonly used to make the distinction between patients whose

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hyperthyroxinemia is due to thyroiditis from those with Graves' disease or toxic nodular goiter[13].

Another indication for radioiodine uptake measurement is to use in calculation of treatment doses for patients with Graves' disease[14]. The traditional basis for calculation of ^{131}I therapy doses using 24-hour ^{131}I uptake by the thyroid still demands more visits to the outpatient clinic. Some authors recommended modified early ^{131}I uptake in dose calculations to reduce the inconvenience of more patient visits and cost of patient care without compromise in the treatment quality. However, some patients with rapid ^{131}I thyroidal turn over might receive an inadequate radiation dose, causing less successful treatment rate[15].

As the rational of the direct relationship between the radiation dose absorbed by the thyroid (estimated by ^{131}I half-life, thyroid weight and uptake), cure rate and the amount of ^{131}I-induced hypothyroidism, adjustment of the therapeutic dose to the amount of ^{131}I taken up by the thyroid from the tracer dose seems logical[16]. However, some investigators using fixed dose regime found no difference in outcome in different uptake groups[5]. The adjusting of the ^{131}I dose to the uptake percentage seems not to gain a strong clinical benefit.

The present study aimed to analyze the effectiveness of radioiodine therapy in hyperthyroid patients in order to compare the estimated dose based on gland size assessed by palpation, with the calculated ^{131}I dose base on formula using gland size and 24-hour ^{131}I uptake protocol. The second purpose was to detect further parameters that might predict treatment outcome.

Material and Method

Patient populations

All hyperthyroid patients being referred to the Nuclear Medicine department, Songklanagarind university Hospital for a first radioiodine treatment were potentially eligible for the present study. Recruitment began in December 2006 and ended in December 2007.

Hyperthyroidism was diagnosed based on compatible symptoms, suppressed TSH level, and elevated serum thyroid hormones with or without gland enlargement. Patients who had previously been treated with radioactive iodine were excluded.

The authors prospectively recruited 144 patients with confirmed hyperthyroidism. Eleven patients failed to report for follow-up and five did not receive radioiodine therapy due to clinically and biochemically euthyroid at the time of the first treatment date, leaving 128 in the study cohort.

During the enrollment period, the patients underwent a complete physical examination. Data about previous antithyroid drug treatment and surgery were extracted from the medical record. The protocol was approved by the institutional review board and the research ethic board of Prince of Songkla University's Faculty of Medicine. Informed written consent was obtained from each participant.

Evaluation of thyroid function

Thyroid function was assessed by measuring serum free T4 (FT4), free T3 (FT3) and serum TSH. Hormone assay were performed on single system (Modular Analytics E170, Roche, USA) using electrochemiluminessence essay (Cobas® kit, Roche, USA) with the following adult normal ranges: TSH, 0.27-4.2 μIU/mL; free T4, 0.93-1.7 ng/dL; free T3, 2.0-4.4 pg/mL.

Hyperthyroidism was defined as an abnormally high serum FT4 and/or FT3 concentration and suppressed serum TSH concentration; hypothyroidism was defined as an abnormally low serum FT4 concentration and a high serum TSH concentration.

Radioiodine treatment

Most patients received antithyroid medication before radioiodine administration. Antithyroid drugs were discontinued at least 10 days before radioiodine and were not restarted unless there was evidence of persistent or recurrent hyperthyroidism at each visit at 3, 6, 9, and 12 months post treatment.

β-blockers were not systematically stopped and were allowed for symptom control during the peri-radioiodine period. Pregnancy was excluded in females of childbearing potential.

Subjects were randomized into two groups according to dose adjustment method. Group I (67 patients) was classified as estimated group using radioiodine dose calculated from gland size by palpation only (100 μCi/g of thyroid weight for those with diffuse goiter and 200 μCi/g for those with nodular goiter, maximum treatment dose per visit was 30 mCi). Group II (61 patients) was classified as calculated group, using radioiodine dose calculated from gland size by palpation and% 24 hour uptake.

Each subject in the calculated group underwent radioiodine uptake measurements 3 and

24 hours after a tracer dose of ^{131}I (0.2 MBq). A single investigator (TT) examined all patients and estimated thyroid gland size. Radioiodine uptake at 24 hours was used for dose calculation; whereas, radioiodine uptake at 3-hour was used for further formulate equation of 3 and 24 hour uptake correlation. The radioiodine dose used in group II calculated from the following formula[17].

$$^{131}I\ (mCi) = \frac{\text{desired dosage } (\mu Ci/g) \times \text{gland weight } (g) \times 100}{\%\ 24 \text{ hour uptake} \times 1000}$$

Radioiodine therapy was accompanied by standardized radiation protection guidelines, information that permanent hypothyroidism was a likely outcome from radioiodine, and verification that the patient had a follow-up assessment until 1 year after radioiodine therapy.

Outcomes assessment

The same nuclear medicine specialist (TT) was involved in the pre-radioiodine assessment, clinical follow-up, monitored for the following clinical outcomes: persistent/recurrent hyperthyroidism requiring additional radioiodine therapy; hypothyroidism, confirmed biochemically with elevated serum TSH and requiring permanent LT4 treatment; and euthyroidism, a clinically and biochemically euthyroid state to the end of follow-up in the absence of further thyroid treatment.

Clinically and biochemically examination was evaluated at 3, 6, 9, and 12 months after at least 14 days of antithyroid drug withdrawal. Clinical assessment using 5-scale scoring system in terms of hyperthyroid score (tiredness, tremor, palpitation, sweating, and ophthalmopathy), and hypothyroid score (swelling, cramp, bloating, constipation, and cold) were recorded at each follow-up. Patients were followed-up until 1 year after radioiodine therapy. Secondary outcomes (*e.g.* hypothyroidism developing after a second radioiodine therapy for recurrent hyperthyroidism) were not considered.

Statistical analysis

All statistical analysis was performed using PASW® statistic 17.0 (Mahidol university license) software. $P < 0.05$ was taken as indicating a statistically significant effect. The baseline characteristics of the present study population and nonparticipants were compared using two-tailed t-test (quantitative variables) or two-tailed χ^2 test (qualitative variables). Comparison of the baseline characteristics for the two treatment arms was performed with two-tailed t-test and two-tailed χ^2 test, as appropriate for the quantitative and qualitative variables, respectively.

Logistic regression was performed to compare rates of clinical outcomes (hyperthyroidism, hypothyroidism, or euthyroidism) according to treatment using coding variables for dose calculation method (estimated vs. calculated) and within each subgroup.

Results

Clinical outcome

During 12 months follow-up, 58 of 128 subjects (45.31%) experienced persistent/ recurrent hyperthyroidism, 26 (20.3%) developed hypothyroidism, and 44 (34.4%) were euthyroid to the end of the follow-up period.

The baseline characteristics of patients in the estimated group and the calculated group were similar in age, sex, goiter type, antithyroid drug used, duration of antithyroid drug treatment before radioiodine, and dose of I-131 on the first treatment. However, statistically significant difference among the dose adjustment groups were found in goiter size, hyperthyroid score, and thyroid hormone levels (Table 1).

Almost all patients had been treated with antithyroid drug before I-131 treatment except three patients in the estimated subgroup. In the estimated group, 33 patients received PTU and 31 patients received MMI, while 38 and 23 patients in the calculated group received PTU and MMI, respectively. The majority of patients in both groups still needed continuous antithyroid drug for at least three months and drug withdrawal was considered if clinically or biochemically suggested euthyroidism or hypothyroidism.

Overall outcome at 1 year after I-131 treatment in 121 Graves' disease together with seven toxic nodular goiter patients (Fig. 1) revealed similar results in both dose adjustment methods. The incidence of hypothyroidism in the estimated versus the calculated group was 48% vs. 52% and of persistent/recurrent hyperthyroidism was 55% vs. 45%. Euthyroid outcome was 52% vs. 48%. The cumulative incidence of euthyroid and hypothyroid outcomes at each follow-up period after I-131 treatment also showed similar results in both subgroups (Fig. 2A, B). The diagnosis of recurrent/persistent hyperthyroidism was associated with mean FT4 over 1.7 ng/dL, FT3 over 4.4 pg/mL and suppressed TSH. Hypothyroidism was diagnosed at a

Table 1. Patient characteristics according to the dose adjustment methods

	Estimated group (n = 67)	Calculated group (n = 61)	p-value
Age (year)	41.61 ± 14.38	43.31 ± 12.63	0.478
Gender (% female)	64.18%	65.57%	0.869
Antithyroid drug (% PTU)	49.25%	62.29%	0.119
Duration of ATD treatment prior to I-131 (year)	3.09 ± 2.80	3.19 ± 3.25	0.841
Goiter type (% diffuse goiter)	82.09%	90.16%	0.211
Goiter size (gm)	59.70 ± 37.48	47.87 ± 21.99	0.034
Hyperthyroid score	2.48 ± 1.28	1.77 ± 1.21	0.005
FT4 (ng/dl)	5.83 ± 4.50	3.87 ± 2.59	0.005
FT3 (pg/ml)	17.96 ± 10.59	13.25 ± 10.34	0.020
I-131 dose (mCi)	8.69 ± 4.35	9.32 ± 4.16	0.402

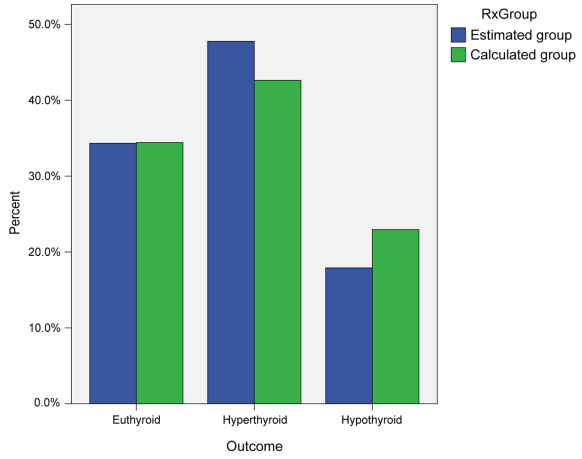

Fig. 1 Clinical outcomes after 1 year of I-131 therapy in hyperthyroidism patients according to dose adjustment method

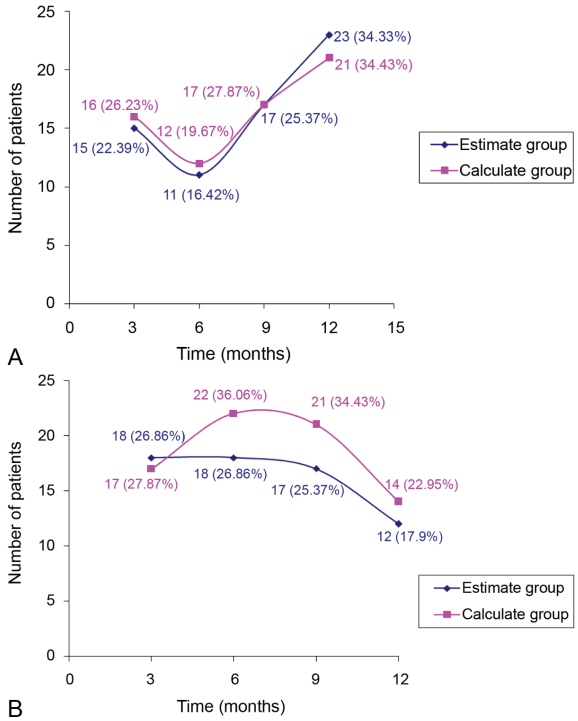

Fig. 2 A) Cumulative incidence of euthyroid outcome during follow-up period after I-131 treatment in each subgroup B) Cumulative incidence of hypothyroid outcome during follow-up period after I-131 treatment in each subgroup

mean FT4 under 0.93 ng/dL, FT3 under 2.0 pg/mL and serum TSH over 4.2 µIU/mL.

The logistic regression model showed significant difference in clinical outcomes related to gender and goiter size. Other variables (patient age, goiter type, duration of antithyroid drug given prior to radioiodine therapy, severity of hyperthyroidism according to baseline hyperthyroid score, and biochemical level) seemed not related to the treatment outcomes (Table 2). The outcome was also unrelated to the administered radioiodine dose. In individual subgroup analysis, only goiter size was considered to have correlation with the treatment outcomes in the estimated subgroup while none of these variables had significant effect on outcome in the calculated subgroup (Table 3, 4).

Discussion

Although there is general consensus that radioiodine is a safe and effective therapy in the majority of hyperthyroidism, the optimal method for dose calculation and even what criteria should be used for defining optimal dosing is still argued[4].

Table 2. Overall clinical outcomes and characteristics of all study participants

	Euthyroid (n = 44)	Hyperthyroid (n = 58)	Hypothyroid (n = 26)	p-value
Age (yr)	40.11 ± 12.29	43.66 ± 13.8	43.58 ± 14.96	0.381
Gender (% female)	79.54%	55.17%	61.54%	0.036
% diffuse goiter	84.1%	91.38%	76.92%	0.095
Goiter size (g)	48.49 ± 24.21	63.28 ± 37.75	42.50 ± 19.14	0.006
ATD type (% PTU)	56.82%	56.9%	50%	0.343
Duration of ATD (yr)	3.43 ± 3.62	3.08 ± 2.87	2.77 ± 2.08	0.671
Hyperthyroid score	2.08 ± 1.44	2.24 ± 1.55	2.04 ± 1.34	0.739
Baseline FT4 (ng/dL)	4.52 ± 4.55	5.26 ± 3.51	4.31 ± 2.81	0.505
Baseline FT3 (pg/mL)	13.28 ± 11.0	17.60 ± 10.36	14.51 ± 10.47	0.151
Treatment dose (mCi)	8.16 ± 3.25	9.71 ± 4.78	8.79 ± 4.40	0.185

ATD = antithyroid drug

Table 3. Clinical outcomes and characteristics of estimated subgroup

	Euthyroid (n = 23)	Hyperthyroid (n = 32)	Hypothyroid (n = 12)	p-value
Age (yr)	37.91 ± 12.51	42.88 ± 13.48	45.33 ± 19.14	0.328
Gender (% Female)	82.61%	53.12%	58.33%	0.071
% Diffuse goiter	78.26%	93.75%	58.33%	0.005
Goiter size (g)	50.23 ± 21.18	74.53 ± 44.89	37.50 ± 20.17	0.004
ATD type (% PTU)	47.83%	50%	50%	0.217
Duration of ATD (yr)	3.30 ± 3.64	2.80 ± 2.31	3.46 ± 2.14	0.719
Hyperthyroid score	2.54 ± 1.25	2.56 ± 1.24	2.17 ± 1.47	0.640
Baseline FT4 (ng/dL)	5.66 ± 5.79	6.09 ± 4.03	5.24 ± 2.89	0.880
Baseline FT3 (pg/mL)	13.95 ± 10.72	20.35 ± 10.04	17.55 ± 11.06	0.137
Treatment dose (mCi)	7.65 ± 2.72	10.28 ± 5.28	6.42 ± 2.19	0.010

Table 4. Clinical outcomes and characteristics of calculated subgroup

	Euthyroid (n = 21)	Hyperthyroid (n = 26)	Hypothyroid (n = 14)	p-value
Age (yr)	42.52 ± 11.89	44.62 ± 14.38	42.07 ± 10.73	0.787
Gender (% Female)	76.19%	57.69%	64.28%	0.412
% Diffuse goiter	90.48%	88.46%	92.86%	0.753
Goiter size (g)	46.67 ± 27.45	49.42 ± 19.71	46.79 ± 17.82	0.896
ATD type (% PTU)	66.67%	65.38%	50%	0.555
Duration of ATD (yr)	3.56 ± 3.67	3.42 ± 3.46	2.22 ± 1.93	0.446
Hyperthyroid score	1.57 ± 1.49	1.85 ± 0.91	1.93 ± 1.27	0.642
Baseline FT4 (ng/dL)	3.44 ± 2.68	4.27 ± 2.49	3.74 ± 2.71	0.557
Baseline FT3 (pg/mL)	12.69 ± 11.5	14.02 ± 9.87	12.77 ± 10.11	0.902
Treatment dose (mCi)	8.71 ± 3.73	9.00 ± 4.07	10.82 ± 4.86	0.302
% 3-hour uptake	31.35 ± 23.42	42.94 ± 20.89	30.20 ± 14.24	0.144
%24-hour uptake	49.82 ± 19.01	61.26 ± 15.05	50.64 ± 17.44	0.091

Furthermore, opinions still differ on the goal of radioiodine therapy. Some clinicians aiming at a low percentage of ^{131}I induced hypothyroidism at the expense of a higher relapse rate and need for repeated dose[18,19], others prefer to induce a 100% physician-controlled dose on occurrence of hypothyroidism[5,20].

Some physicians continue the dosimetric methods to cure hyperthyroidism with the least amount of ^{131}I over-treatment possible[21]. Institutions that aim at euthyroidism continue the search for improvement of efficacy and patient wellbeing in the method of dose selection, and omission of uptake adjustment in dosimetry has been studied successfully[5,22].

The present study was performed to examine estimated gland size versus ^{131}I uptake adjusted dosing in radioiodine therapy of hyperthyroidism. The results suggested similar outcomes (hyperthyroid, hypothyroid, and euthyroid status at 1-year follow-up) between the two treatment groups.

Although ^{131}I is relatively inexpensive, costs of treatment may be increased with a requirement for complex measurements of radioiodine uptake, turn over, and thyroid volume. The combined costs for performing radioiodine uptake measurements and a thyroid ultrasound may exceed the cost of the radioiodine itself[23,24]. The authors' finding that the estimated dose method using gland size by palpation only has comparable results as the calculated methods using 24 hours I-131 uptake. This simplified method could lead to more patient convenience together with reducing medical costs. However, the measurement of I-131 uptake before therapy is still necessary in the prevention of the inappropriate administration of radioiodine to a patient with silent thyroiditis.

Most studies have reported the predicted dose-response relationship between administered dose and rates of post-treatment hypothyroidism, as demonstrated in a meta-analysis[25]. Beierwaltes et al[26] observed a higher incidence of hypothyroidism in patients receiving a higher dose of ^{131}I. However, the ability to predict permanent hypothyroidism was relatively poor with an accuracy of only 60% in a multivariate logistic regression model[27]. In the present study, there was no statistically significant difference between ^{131}I dose and outcomes of therapy ($p = 0.185$).

Giovanella et al[28] reported treatment outcomes of radioiodine therapy in hyperthyroidism patients using calculated dose base on 24-hours radioiodine uptake. In Graves' disease patients, at three months post-treatment the patients were hypothyroid, euthyroid, and hyperthyroid 74%, 11%, and 15%, respectively. One year after treatment, 89% of these patients were hypothyroid while 11% remained euthyroid. The rate of euthyroidism in patients with nodular goiters at 3 and 12 months post-treatment was as high as 92% and 94%, respectively. They concluded that their simplified dosimetric method is very effective although the ratio of hypothyroidism in patients with Graves' disease is relatively high. As their major clinical targets are the control of hyperthyroidism and the prevention of relapse, then hypothyroidism should not be considered as a major collateral effect[28].

Another study reported by Calegaro et al[29] using four different protocols of ^{131}I administration in Graves' disease patients based on formula using estimated thyroid weight and 24-hours ^{131}I uptake. At 1-year post treatment, there was a higher percentage of euthyroidism in patients not submitted previously to antithyroid drug treatment. Their results supported the hypothesis that hyperthyroid subjects submitted to a therapy with antithyroid drugs become rather resistant to a radioiodine therapy.

Previous retrospective study in our institute reported by Yipintsoi et al[30] was conducted during 1991-1996. Of 387 patients with greater than 12 months follow-up after their last dose, 187 received single treatment dose and 203 belong to multiple dose (2-7 times). At 1-3 years, about 22% remained euthyroid, which reduced to about 15%, three or more years thereafter. The rate of hypothyroid patients added up to 70% and 80% at 1-3 years and after three years, respectively. Although RAIU was used in treatment dose calculation, the authors mentioned the non-reliable estimation of uptake by that period to illustrate that the malfunction resulted in very low values of uptake perhaps providing the reason for the higher dosing and causing this high rate of hypothyroidism.

A number of limitations can be made in the present study. Radioiodine dose adjustment was based upon clinically estimated thyroid gland size by palpation and RAIU at 24 hours. Clinical estimate of gland size by palpation seems to be a less accurate method than ultrasonography and depends on investigator experience. However, estimation of thyroid volume has been found to correlate well with ultrasonography[31] and surgically removed gland volume especially in the small to intermediate goiter size[32]. Furthermore, palpation is still the most widespread method used for estimating gland size in many centers. Accordingly, the authors method reflects clinical practice. However, the clinical experience of the physician who manipulates and evaluates the thyroid size, which might significantly influence the I-131 dosage recommendation, must also be taken into account. In an effort to minimize intra-observer variability in the present study protocol, the gland size estimation was done by only a single physician (TT) who had 8 years experience in thyroid clinic.

The relatively low incidence of hypothyroidism in our institution in the first year after ^{131}I was achieved at the cost of recurrent hyperthyroidism; also, almost our patients were treated with an antithyroid drug, which influences the efficacy of ^{131}I is still debated[33,34]. This is not expected to lead to different treatment outcomes between methods, since almost all subjects received antithyroid drugs before and after ^{131}I. Withdrawal of antithyroid medication had been instructed 10 days before ^{131}I therapy and at least two weeks before each follow-up period to avoid clinically and biologically treatment effect in all patients.

Ethical notice: Though the recent change of recommendation for I-131 treatment for hyperthyroidism is more flexibility, however, it can be prescribed for a younger age group and even those in the reproductive period. The high incidence at 20.3% of patients turning to be hypothyroid is a remarkable event. These people might be life-long suffering from hypothyroidism or even myxedema, requiring continuous therapy, and bearing life-time low quality of life and suffering. Good practitioners must be strictly aware of the sympathy and the good clinical practice policy.

Conclusion

Radioactive iodine (I-131) therapy with a semiquantitative approach using gland size by palpation works as well as the more elaborately calculated method using formula base on 24-hours RAIU. In view of simplicity and time-saving, this method is a practical choice because of it is more cost effective while at the same time leads to greater patient convenience.

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การเปรียบเทียบผลการรักษาผู้ป่วยไทรอยด์เป็นพิษด้วยปริมาณสารกัมมันตรังสีไอโอดีน-131 ที่ประเมินโดยค่าการจับไอโอดีน-131 โดยต่อมไทรอยด์กับการใช้ขนาดของต่อมไทรอยด์

ธัญญลักษณ์ เธียรธัญญกิจ, สุจิตรา ทองมาก, ธีรพล เปรมประภา

วัตถุประสงค์: *เพื่อศึกษาผลการรักษาผู้ป่วยไทรอยด์เป็นพิษด้วยปริมาณสารกัมมันตรังสีไอโอดีน-131 ที่ประเมินโดยการใช้ขนาดต่อมไทรอยด์เปรียบเทียบกับการใช้ขนาดต่อมไทรอยด์ร่วมกับค่าการจับไอโอดีน-131 โดยต่อมไทรอยด์*

วัสดุและวิธีการ: *เปรียบเทียบผลการรักษาผู้ป่วยไทรอยด์เป็นพิษด้วยไอโอดีน-131 ในกลุ่มผู้ป่วยที่คำนวณปริมาณรังสีจากสูตรโดยใช้ค่าการจับไอโอดีน-131 โดยต่อมไทรอยด์ และกลุ่มควบคุมซึ่งคำนวณปริมาณรังสีจากขนาดของต่อมไทรอยด์ ที่เข้ารับการรักษาครั้งแรกที่หน่วยเวชศาสตร์นิวเคลียร์ โรงพยาบาลสงขลานครินทร์ ระหว่าง มิถุนายน พ.ศ. 2550 ถึง ธันวาคม พ.ศ. 2550 โดยพิจารณาผลที่เวลา 1 ปี หลังจากการรักษา*

ผลการศึกษา: *ในผู้ป่วยจำนวน 128 ราย ที่ติดตามการรักษาครบ 1 ปี พบว่า 56 ราย (45.3%) ยังคงมีภาวะไทรอยด์เป็นพิษ ส่วน 26 ราย (20.3%) เกิดภาวะพร่องฮอร์โมนไทรอยด์ในขณะที่ 44 ราย (34.4%) มีการทำงานของต่อมไทรอยด์เป็นปกติ ไม่พบความแตกต่างอย่างมีนัยสำคัญทางสถิติระหว่างผู้ป่วยที่คำนวณปริมาณรังสีทั้งสองวิธี พบว่าปัจจัยด้านเพศ และขนาดของต่อมไทรอยด์มีความสัมพันธ์กับผลการรักษา*

สรุป: *การรักษาภาวะไทรอยด์เป็นพิษด้วยสารกัมมันตรังสีไอโอดีน-131 โดยคำนวณปริมาณรังสีจากการประเมินขนาดต่อมไทรอยด์ด้วยการคลำ มีประสิทธิภาพในการรักษาทัดเทียมกับการคำนวณจากสูตรที่ใช้ค่าการจับไอโอดีน-131 โดยต่อมไทรอยด์ ซึ่งวิธีการแรกจะช่วยลดค่าใช้จ่ายในการตรวจรักษาผู้ป่วย ตลอดจนทำให้ผู้ป่วยได้รับความสะดวกมากยิ่งขึ้น*