The Correlation of Post-Operative Radioiodine Uptake and Tc-99m Pertechnetate Thyroid Scintigraphy and the Result of Thyroid Remnant Ablation

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Objective: *Determine the relationship between postoperative thyroid remnant using 24 h radioiodine uptake and Tc-99m pertechnetate scintigraphy, and the success of high dose radioiodine ablation.*
Material and Method: *Retrospectively enrolled 250 patients with DTC who underwent thyroidectomy and radioiodine ablation. Postoperative Tc-99m pertechnetate and 24 h I-131 uptake were reviewed to evaluate thyroid remnant and the directly compared with ablation outcome. The successful ablation was defined using negative WBS and stimulated Tg <10 ng/ml in the absence of TgAb at six to 12 months after treatment. The relationship between success of ablation and other variables were evaluated.*
Results: *One hundred twenty four patients (49.6%) were successfully ablated after single high dose radioiodine ablation. The authors found no association with age, sex, extent of surgery, tumor histology, tumor size, mutifocal, extrathyroidal invasion, I-131 administered dose, interval from surgery to radioiodine ablation, Tc-99m pertechnetate scan, or 24 h I-131 uptake, and successful ablation. The initial Tg level was the only variable found to be associated with success ($p<0.001$).*
Conclusion: *Neither Tc-99m pertechnetate thyroid scintigraphy nor 24 h I-131 uptake percentage in the evaluation of postsurgical thyroid remnant can predict radioiodine ablation outcome in patients with DTC. Serum Tg level at the time of ablation could be a reasonable predictor of the success of ablation.*

Keywords: *Radioiodine, I-131 uptake, Tc-99m pertechnetate, Thyroid scintigraphy, Thyroid ablation*

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Postoperative Radioiodine remnant ablation is well established in the management of patients with differentiated thyroid carcinoma (DTC). The success of remnant ablation is reported as an important factor for disease-free interval and survival in DTC patients[1-3]. The success of ablation depends on various factors, including the presence of distant metastases, sensitivity of tumor cells to iodine, number of cervical remnant, preablative serum Tg level and the I-131 dose administered[4]. Therefore, determination of thyroid remnant after surgery may provide useful information in predicting remnant ablation effectiveness.

Postoperative I-131 diagnostic whole body scan (WBS) and/or thyroid bed uptake measurement have been traditionally used to confirm the presence and extent of residual functioning thyroid tissue, and to evaluate the amount of thyroid remnant before ablation. However, currently, the use of pretherapeutic I-131 WBS has become more restricted due to concerns regarding the potential to cause stunning, which may lead to ablation failure[5,6].

Tc-99m pertechnetate has been used as an imaging agent for evaluating thyroid diseases due to its being inexpensive, widely available, with ideal characteristics and favorable dosimetry. However, there is limited data describing its role in post-thyroidectomy remnant scintigraphy. With relatively high sensitivity and a very high PPV in the detection of thyroid remnant after surgery, this technique may have a particular role in avoiding the possible stunning effect caused by I-131 imaging[7]. Our departmental guideline suggests the combination of 24-hour radioiodine uptake and Tc-99m pertechnetate thyroid scintigraphy results to evaluate the adequacy of surgical treatment. If uptake percentage >15% with remarkable activity at thyroid bed is detected, the

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patient will be referred for re-operation if possible. However, the relationship between the amount of postsurgical thyroid remnant and ablation success in our patients have never been investigated.

The purpose of this study was to determine the relationship between postoperative thyroid remnant estimation using 24-hour radioiodine uptake and Tc-99m pertechnetate thyroid scintigraphy, and the success of thyroid remnant ablation with high dose radioiodine. Another aim of the study was to determine which variables, if any, are associated with successful ablation.

Material and Method

Patients

All patients with histologically proven differentiated thyroid cancer who were referred to the Nuclear Medicine Division, Siriraj Hospital for postoperative radioiodine remnant ablation between January 2002 and December 2005 were reviewed retrospectively. Patients with distant metastasis or those without diagnostic whole body scan at six to 12 months follow-up to assess the ablation outcome were excluded. The remaining patients who underwent both postoperative Tc-99m pertechnetate thyroid scan and 24-hour I-131 uptake measurement and subsequent radioiodine ablation with high dose I-131 were selected. The sample size (n = 250) was calculated using nQuery advisor software (Statistical Solutions Ltd., Ireland) according to successful ablation rate in four groups of patients based on 24 hour I-131 uptake results[4], with statistical significance of 0.05 and power of 80%. The present study was approved by the research ethics committee of our institution (Siriraj Institute Review Board, Mahidol University).

Tc-99m pertechnetate thyroid scans

The planar thyroid scan in anterior view was performed 20 minutes after intravenous administration of 2 mCi of Tc-99m pertechnetate. The interpretation of thyroid scan images were graded into grade 0 for no uptake at thyroid bed, grade 1 for equivocal cervical uptake, grade 2 for obvious single focal uptake, and grade 3 for obvious multiple foci uptake.

24-hour I-131 uptake

The 24-hour I-131 uptake percentage in the neck region was measured using a gamma probe after oral administration of 100 μCi of I-131. A standard of 100 μCi I-131 that was calibrated and measured in a neck phantom after 24 hours was used as a reference. The uptake percentage results were then divided into four subgroups, <2%, 2 to 5%, >5 to 10%, and >10%.

Radioiodine ablation and whole body scan

I-131 ablative dose was administered at least four weeks post-operation and after patient preparation with iodine diet avoidance and thyroid hormone withdrawal (reduce dose to 50 μg/day for 4 weeks and withdraw 2 weeks thereafter until the date of ablation) in the cases previously treated with thyroid hormone in an inpatient setting. Post-treatment scans were performed 72 hours thereafter using dual-head gamma camera equipped with high-energy collimators and thick crystals. Anterior and posterior whole body images and spot view of the neck, with and without thyroid markers were obtained. Approximately six months to one year later, the patient was subjected again to thyroid hormone withdrawal, and a follow-up whole body I-131 scan using the same imaging technique was performed in conjunction with serum Tg, Tg-Ab, and TSH measurements. All post-treatment and diagnostic whole body radioiodine scans were reviewed by one board-certified experienced nuclear medicine physician (TT).

Thyroglobulin and hormone assays

Two-step immunoradiometric assay (IRMA) of serum Tg and TgAb were performed using Cis-bio international kits with assay sensitivity of 0.6 ng/ml and 2.86 IU/ml, respectively. TgAb level was measured using Tg coated ELSA and protein A-I-125. TSH was assayed by one step sandwich RAI-gnost kits using anti-hTSH monoclonal antibodies for both tubes coating and labeling with I-125, with sensitivity of 0.03 mIU/L.

Criteria for successful ablation

The criteria for successful ablation were defined as no visual evidence of radioiodine concentration in the neck or elsewhere in the body on whole body scans obtained six months to one year later together with normal or low serum thyroglobulin levels (<10 ng/ml) in the absence of serum Tg-antibody.

Statistical analysis

All the data were analyzed by using statistical software package SPSS version 15.0 for Windows (SPSS Inc., Chicago, Illinois, USA) and MS-Excel 2010. Descriptive statistics such as mean, standard deviation, median, range, etc. were applied to

summarize clinical and demographic characteristics of the patients. Unpaired Student's t-test and non-parametric Mann-Whitney U-test were used to assess the relation between various independent quantitative parameters with ablation outcome (success/unsuccessful). Chi-square test and Fisher's exact test were used to evaluate association between various categorical independent variables and outcome. A p-value <0.05 was considered to indicate statistical significance.

Results

There were 207 out of 457 patients excluded from the study due to various reasons, including presence of distant metastasis or residual gross tumor prior to ablation, loss to follow-up, incomplete preablative evaluation of thyroid remnant, receiving low dose I-131 ablation, unfavorable histology cell type, and if the first I-131 ablation was not performed in our hospital. The remaining 250 patients were included in the study (215 women and 35 men) ranging in age from 18 to 85 years (156 were <45 years and 94 were ≥45 years). Approximately 93% underwent subtotal or near total thyroidectomy and cervical node dissection was performed in 30%, 24.9% of those who had node dissection found nodal metastasis. In terms of pathologic findings, 87.2% demonstrated papillary carcinoma, 11.6% follicular carcinoma, and 1.2% Hurthle cell carcinoma. Large tumor size, multifocal and extrathyroid invasion were revealed in 14.4%, 33.1% and 32.8%, respectively (Table 1).

The overall success rate of ablation in this study was 49.6% (n = 124). Among the remaining 126 patients with unsuccessful ablation, 79 (62.7%) were only detected by WBS, 23 (18.3%) were only detected by Tg level, and 24 (19%) were positive for both WBS and serum Tg. No significant differences in base line clinical presentation between outcomes was observed according to age, sex, extent of surgery, tumor histology, tumor size, mutifocality, extrathyroidal invasion, I-131 administered dose or interval period from surgery and I-131 ablation. For laboratory results, the only significant factor in ablation outcome was preablative serum Tg level, which was significantly lower in those with successful ablation (median 2.4 ng/ml vs. 4.7 ng/ml, p<0.001), while significant difference in TSH level was not demonstrated (Table 2).

There was good correlation between results of the two methods in estimation of postoperative thyroid remnant tissue (p<0.001) (Fig. 1). However, both 24-hour I-131 uptake percentage and Tc-99m pertrechenetate showed no significant differences between each ablation response group, although a higher proportion of multiple uptake foci in Tc-99m pertechnetate scan was noted in those with unsuccessful ablation. However, this difference was not statistically significant (p = 0.076). The success of ablation rates did not differ in patients with each range (<2%, 2-5%, >5-10%, >10%) of 24-hour I-131 uptake percentage (Fig. 2, 3 and Table 2). Small amount of thyroid remnant (score 0-1) detected by pertechnetate scintigraphy showed poor sensitivity (24.2%, 95% CI: 17%, 32.7%) and fair specificity (79.4%, 95% CI: 71.2%, 86.1%) to predict successful remnant ablation. The radioiodine uptake result less than 10% in predicting successful ablation showed high sensitivity (84.7%, 95% CI: 77.1%, 90.5%) but poor in specificity (22.2%, (95% CI: 15.3%, 30.5%).

Table 1. Demographic and clinical characteristics of patients included in the study

Characteristics	Number of patients (n = 250)
Age (years) (mean ± SD)	40.67±13.14
<45	156 (62.4%)
≥45	94 (37.6%)
Sex	
Male	35 (14.0%)
Female	215 (86.0%)
Extent of surgery	
Total thyroidectomy (TT)	178 (71.2%)
Near total thyroidectomy (NTT)	54 (21.6%)
Subtotal thyroidectomy (STT) or less	18 (7.2%)
Histopathology	
Papillary	218 (87.2%)
Follicular	29 (11.6%)
Other	3 (1.2%)
Tumor size (n = 229)	
≤4 cm	196 (85.6%)
>4 cm	33 (14.4%)
Multifocal	81/245 (33.1%)
Extrathyroid invasion	82 (32.8%)
Angiolymphatic	42 (16.8%)
Adjacent soft tissue	68 (27.2%)
Positive cervical node metastasis	62/249 (24.9%)
Ablation outcome	
Success	124 (49.6%)
Unsuccess	126 (50.4%)
Median follow-up (months) (range)	74 (10-115)

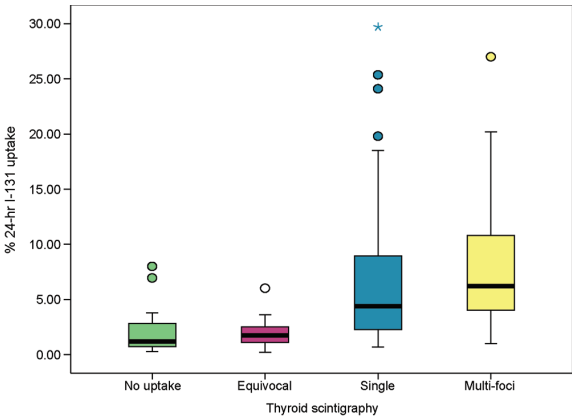

Fig. 1 Correlations between thyroid scan results and 24-hr I-131 uptake percentage in all patients (p<0.001).

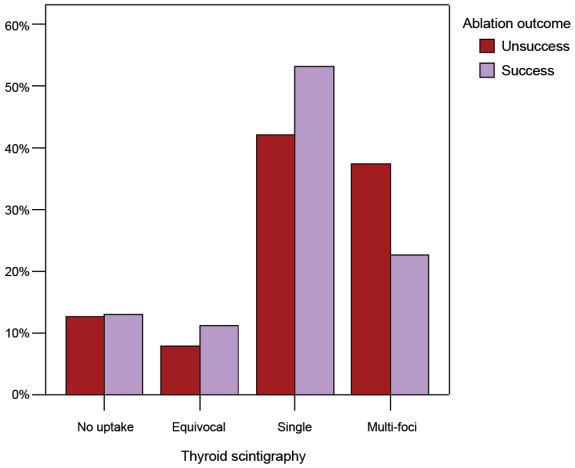

Fig. 2 Comparative thyroid scan results in patients with successful ablation and those with unsuccessful ablation (p = 0.076).

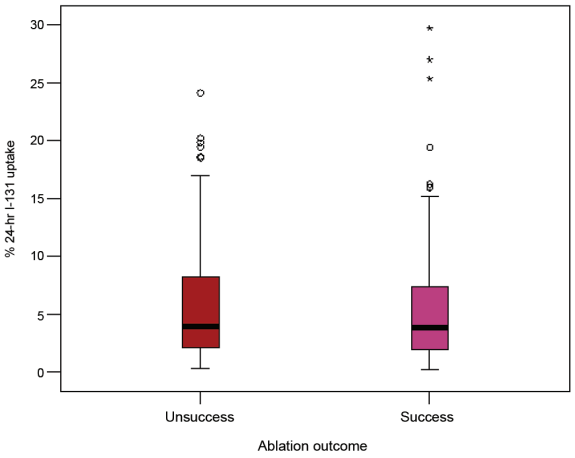

Fig. 3 Boxplot of the 24-hr I-131 uptake percentage in patients with successful ablation and those with unsuccessful ablation (p = 0.405).

No patient died during the follow-up period (median 74 months, range 10-115). In the successful ablation group, 102/124 (82.2%) were still free of disease, while 22 developed tumor recurrence. For those with unsuccessful ablation, only 70 (55.5%) were disease free, but the remaining 56 had persistent diseases although multiple high doses of I-131 were used with maximum accumulative dose as high as 1,300 mCi. There was significant relationship between the success of ablation and outcome with p<0.001 (data not shown).

Discussion

Radioiodine ablation using I-131 is indicated after total thyroidectomy in DTC patients with moderate to high risk of recurrence, based on age, tumor size, lymph node involvement, extrathyroid extension, and histological type[8]. Postoperative radioiodine ablation also allows a highly sensitive WBS that may detect persistent disease and facilitates follow-up by improving the specificity of serum Tg measurement by destroying thyroid remnant[9], apart from its possible ability to destroy microscopic residual tumor cells.

The overall success rate of ablation in this present study was 49.6%, which was significantly lower than 76% to 96% as reported in other articles[4,10-12]. However, different success rates for thyroid remnant ablation can be partly explained by the different criteria for the determination of success, such as cervical uptake value <1% on diagnostic I-131 scans, visually negative diagnostic WBS using I-131 2-5 mCi, and stimulating Tg level with a variety of cut-off levels from <1 to 10 ng/ml. According to the use of the combination of I-131 whole body scan and serum Tg measurement as evaluation tools, the authors' success rate of ablation was comparable to previous results of 43% and 56%, using uptake-related and fixed-dose protocols, respectively[13]. If I-131 whole body scan was used as single evaluation tool as in some published reports[10,14,15], the rate of successful ablation in this study would rise to 58.8%.

According to the recent ATA recommendations[8], diagnostic WBS is not suggested among the routine methods used to determine disease status of postablative DTC patients. Although the negative predictive value of an undetectable stimulated Tg level at six to 18 months after ablation is very high, the recent published report by Park et al[16] found a significant number (6.3%) of DTC patients with functioning metastasis were Tg-/TgAb negative despite

Table 2. Differences in population characteristics for the treatment outcomes at 1 year follow-up

	Successful ablation (n = 124)	Unsuccessful ablation (n = 126)	p-value
Mean age (years) (range)	40.9 (18-85)	40.5 (19-77)	0.824
Gender			0.896
Male	17 (13.7%)	18 (14.3%)	
Female	107 (86.3%)	108 (85.7%)	
Extent of surgery			0.595
TT	91 (73.4%)	87 (69.1%)	
NTT	26 (21.0%)	28 (22.2%)	
STT or less	7 (5.6%)	11 (8.7%)	
Histology			0.275
Papillary	106 (85.5%)	112 (88.9%)	
Follicular	15 (12.1%)	14 (11.1%)	
Other	3 (2.4%)	0 (0%)	
Tumor size (n = 229)	(n = 114)	(n = 115)	0.578
≤4 cm	96 (84.2%)	100 (87.0%)	
>4 cm	18 (15.8%)	15 (13.0%)	
Multifocal			0.414
Positive	37 (30.6%)	44 (35.5%)	
Negative	84 (69.4%)	80 (64.5%)	
Lymph node (LN) metastasis (n = 123)			0.288
Positive	27 (22.0%)	35 (27.8%)	
Negative	96 (78.0%)	91 (72.2%)	
Extrathyroid invasion			0.652
Positive	39 (31.5%)	43 (34.1%)	
Negative	85 (68.5%)	83 (65.9%)	
% 24-hr I-131 uptake			0.405
<2	33 (26.6%)	30 (23.8%)	
2-5	43 (34.7%)	46 (36.5%)	
>5-10	29 (23.4%)	22 (17.5%)	
>10	19 (15.3%)	28 (22.2%)	
Thyroid scan			0.076
No uptake	16 (12.9%)	16 (12.7%)	
Equivocal	14 (11.3%)	10 (7.9%)	
Obvious single	66 (53.2%)	53 (42.1%)	
Obvious multiple	28 (22.6%)	47 (37.3%)	
1st Tg (ng/ml) (median) (range)	2.4 (0-116.9)	4.7 (0-1,236.6)	<0.001
1st TSH (mIU/L) (median) (range)	66.0 (2-228.3)	64.4 (0-237.9)	0.670
Interval surgery to ablation (month) (median) (range)	3 (1-60)	3 (1-188)	0.531
I-131 dose (mCi)			0.866
≤100	44 (35.5%)	46 (36.5%)	
≥150	80 (64.5%)	80 (63.5%)	

a positive WBS finding and another report indicates it may be as high as 8.5%[17]. The Tg false negativity had been previously explained as a result of reduced Tg synthesis and/or release, or by synthesis of a Tg variant, from a marginally differentiated metastatic tumor or an unusual rapid clearance from plasma[18]. Of our 126 patients with unsuccessful ablation, 79 (62.7%) were only detected by whole body scan, 23 (18.3%) were only detected by thyroglobulin level, and 24 (19%) were positive for both whole body scan and serum thyroglobulin. Therefore, the authors agree with the suggestion to use routine WBS as a

complementary modality to detect functioning recurrence and metastasis regardless of serum Tg results.

As mentioned above, there was no association between the result of thyroid scan (Fig. 1) or 24-hour I-131 uptake percentage and ablation outcome (Fig. 2). Whilst some investigators found that thyroid scintigraphy and/or I-131 uptake play important role in predicting ablative response[4,11,19,20,21], others failed to reach that conclusion[10,15,22].

Rosario et al[4] concluded that the number of postoperative cervical remnants is an important factor in the efficacy of thyroid ablation, which can be determined by iodine uptake in the thyroid bed and perhaps be a guide in deciding the ablative dose of radioiodine or indicating the need for re-intervention in the cases with large remnants. Using negative diagnostic WBS as favorable outcome, their study showed a significantly higher successful rate in patients with lower cervical uptake (96% in those with uptake <1% vs. 50% with uptake >10%, $R^2 = 0.9272$). In the present study, the authors found no such associations between the success of ablation and I-131 cervical uptake in any of our subgroups (<2%, 2-5%, >5-10% and >10%, as shown in Table 2).

Nadig et al[11] claimed that masses of the remnant thyroid tissue evaluated by Tc-99m pertechnetate SPECT ($p = 0.02$) and 24-hour RAIU ($p = 0.045$) are the most important parameters influencing complete remnant ablation following I-131 therapy in 55 postsurgical patients of DTC. In their study, significantly lower 24-hour RAIU percentages (7.1±5.85) were found in the ablated group as compared to 10.9±5.77 in the non-ablated group. Contrary to their report, neither Tc-99m pertechenetate scintigraphy nor 24-hour RAIU percentage showed significant influence on ablation response, although the correct estimation of remnant mass using planar images in our study may be inferior as compared to SPECT technique. Our result was supported by Kueh et al[7] who showed that despite pertechnetate scans had a relative high sensitivity for detection of thyroid remnant, a negative scan could not reliably exclude remnant tissue due to its low NPV, which reduced overall accuracy down to approximately 60% when compared to I-131 WBS result (per site analysis).

A recent report by Giovanella et al[19] suggested that a visually negative ^{99m}Tc scan ($p<0.001$), a Tc-99m uptake percentage <1.4% ($p<0.01$) and pre-ablative serum Tg levels >4.3 ng/mL ($p<0.01$) were the best predictive factors for successful ablation following total thyroidectomy in 168 DTC patients. According to their results, lesser post-surgical thyroid remnants evident on scintigraphy and uptake percentage showed a significant association with the rate of successful ablation. In our study, we found no significant difference in proportion of visually negative preablative ^{99m}Tc-pertechnetate among response groups (12.9% vs. 12.7%), although there were slightly higher proportion of multiple uptake foci and high 24-hour uptake >10% in those with unsuccessful ablation. These differences were not statistically significant ($p = 0.076$ and 0.405, respectively).

After taking these results into consideration, our data do not support the need to adjust the therapeutic radioiodine dose or re-intervention, i.e. re-surgery according to postsurgical remnant determined by 24-hour I-131 uptake or Tc-99m pertechnetate scan, as there was no association between these variable and ablation success. However, the role of other important factors, which are barely measurable, in achieving ablation success should be considered, such as radiosensitivity and I-131 retention time of tumor cells, nutrition status and individual genetic makeup[11,19].

The authors also investigated whether there was any potential relationship between remnant ablation rates and demographic or clinical patient variables. Our previous study in 79 patients treated with high dose radioiodine after at least single low dose ablation found that older age ($p = 0.018$) and higher accumulative small dose prior to treatment ($p = 0.043$) had negative effect on the treatment outcomes in DTC patients with metastasis but not in those without[23]. In the present study, there was no association between successful thyroid ablation and age, gender, extent of surgery, histology, tumor size, nodal metastasis, multifocal, extrathyroid invasion, % 24-hour I-131 uptake, thyroid scan, TSH level, interval between surgery and ablation, or I-131 ablative dose. A detailed analysis of these variables and ablation outcomes is described in Table 2. Other published reports reached similar conclusions[10,15,24]. Logue et al[15] found no statistical significant differences in age, sex, type of surgery, I-131 uptake or administered activity of I-131 between response groups, although in their study, only absent visible uptake on follow-up I-131 scan was used to define patients as having achieved successful ablation.

The only variable found to be associated with ablation success in this study was pre-ablative serum Tg level ($p<0.001$). Since Tg is only produced by

normal or neoplastic thyrocytes, higher Tg levels could represent a larger amount of functioning thyroid cells. As reported earlier, Tg level at the time of ablation was proved to be useful to predict both post-treatment WBS results and further outcomes of radioiodine treatment, although the optimal cut-off is still controversial[2,19,25,26]. However, the prognostic significance of pre-ablative Tg in successful ablation rate was not observed in some reports[12,23], but differences in Tg cut-off level and criteria for ablation success, small number of patients, and different baseline characteristic (prior low dose treatment) in the previous study, may partly explained these discordant results.

Significant association of successful ablation and long-term outcome (median follow-up of 6 years) was observed in this study ($p<0.001$). As mentioned earlier by Verburg et al[2], 87% of the patients with successful ablation were still free of disease after 10 years, whereas only 50% of patients with unsuccessful ablation achieved that goal and had a considerably higher risk of recurrence. The clinical response to I-131 therapy also significantly related to cancer-specific mortality ($p = 0.0001$) and overall recurrence rate in patient who had initial complete response (1,281 in 1,503) was only 0.6% during 10-year follow-up[3]. Although stimulated Tg level was not a significant mortality-related factor in another large study in 1,056 Thai patients with DTC[27], again, differences in baseline patient characteristics and treatment protocol might be considered as a cause of this discrepancy between outcomes.

In the present study, despite multiple doses of further I-131 treatment were given (maximum 7 doses with maximum accumulative dose of 1,300 mCi), 44% of those with unsuccessful ablation had persistent disease. Surprisingly, although the majority (n = 102, 82%) of patients with successful ablation were still disease free during follow-up period, a significant number (18%) of these patients developed recurrent diseases with mean interval of 41.83 months (SD = 13.6, range 14.1-61.1). Persistent and recurrent tumors were detected by various detection methods, including physical examination (n = 4), diagnostic imaging (n = 22), subsequent WBS (n = 54), and Tg level (n = 30). The sites of recurrence located at cervical region (n = 26), lung (n = 13), mediastinum (n = 10) and bone (n = 2), respectively. Similarly to the short-term response, none of the determined variables apart from high initial thyroglobulin level ($p<0.001$) had significant influence on the long-term outcome in our study population.

The authors are aware of the limitations of this study. First, it is a retrospective study. However, prospective studies on ablation in DTC patients are scarce. Second, 8.4% of data on tumor size were unavailable particularly in those who underwent surgery from other hospitals. However, since the number of available data in both groups were similar (114 vs. 115), the prognostic impact of this variable might be hardly interfered. Third, near total thyroidectomy/total thyroidectomy is now well accepted as the ideal surgical method in DTC even if a small number of our patients (7.2%) underwent lesser extent surgery and refused re-operation. However, the proportion of this surgical type in each subgroup was not significantly different (5.6% in the success group vs. 8.7% in the unsuccessful group). Fourth, the median follow-up of the study is only approximately six years, which is often too short to evaluate long-term outcomes. However, as most relapses are known to occur within five years after initial treatment[28] and the primary objective of this study is to evaluate short-term rather than long-term outcome, the authors' aim is still achieved.

Conclusion

Neither Tc-99m pertechnetate thyroid scintigraphy nor 24-hour I-131 uptake percentage in the evaluation of postsurgical thyroid remnant can predict the outcome of radioiodine ablation in patients with differentiated thyroid carcinoma. Serum Tg level at the time of ablation could be a reasonable predictor of the success of ablation, in which high Tg level contributes to a higher risk of unsuccessful ablation.

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Potential conflicts of interest

None.

References

1. Mazzaferri EL, Jhiang SM. Long-term impact of initial surgical and medical therapy on papillary and follicular thyroid cancer. Am J Med 1994; 97: 418-28.
2. Verburg FA, de Keizer B, Lips CJ, Zelissen PM,

de Klerk JM. Prognostic significance of successful ablation with radioiodine of differentiated thyroid cancer patients. Eur J Endocrinol 2005; 152: 33-7.
3. Sciuto R, Romano L, Rea S, Marandino F, Sperduti I, Maini CL. Natural history and clinical outcome of differentiated thyroid carcinoma: a retrospective analysis of 1503 patients treated at a single institution. Ann Oncol 2009; 20: 1728-35.
4. Rosario PW, Maia FF, Cardoso LD, Barroso A, Rezende L, Padrao EL, et al. Correlation between cervical uptake and results of postsurgical radioiodine ablation in patients with thyroid carcinoma. Clin Nucl Med 2004; 29: 358-61.
5. Cooper DS, Doherty GM, Haugen BR, Kloos RT, Lee SL, Mandel SJ, et al. Management guidelines for patients with thyroid nodules and differentiated thyroid cancer. Thyroid 2006; 16: 109-42.
6. Brown RL. Standard and emerging therapeutic approaches for thyroid malignancies. Semin Oncol 2008; 35: 298-308.
7. Kueh SS, Roach PJ, Schembri GP. Role of Tc-99m pertechnetate for remnant scintigraphy post-thyroidectomy. Clin Nucl Med 2010; 35: 671-4.
8. Cooper DS, Doherty GM, Haugen BR, Kloos RT, Lee SL, Mandel SJ, et al. Revised American Thyroid Association management guidelines for patients with thyroid nodules and differentiated thyroid cancer. Thyroid 2009; 19: 1167-214.
9. Nascimento C, Borget I, Al Ghuzlan A, Deandreis D, Chami L, Travagli JP, et al. Persistent disease and recurrence in differentiated thyroid cancer patients with undetectable postoperative stimulated thyroglobulin level. Endocr Relat Cancer 2011; 18: R29-40.
10. Karam M, Gianoukakis A, Feustel PJ, Cheema A, Postal ES, Cooper JA. Influence of diagnostic and therapeutic doses on thyroid remnant ablation rates. Nucl Med Commun 2003; 24: 489-95.
11. Nadig MR, Pant GS, Bal C. Usefulness of ^{99m}Tc-pertechnetate single-photon emission computed tomography in remnant mass estimation of postsurgical patients of differentiated thyroid cancer during internal dosimetry. Nucl Med Commun 2008; 29: 809-14.
12. Johansen K, Woodhouse NJ, Odugbesan O. Comparison of 1073 MBq and 3700 MBq iodine-131 in postoperative ablation of residual thyroid tissue in patients with differentiated thyroid cancer. J Nucl Med 1991; 32: 252-4.
13. Verkooijen RB, Verburg FA, van Isselt JW, Lips CJ, Smit JW, Stokkel MP. The success rate of I-131 ablation in differentiated thyroid cancer: comparison of uptake-related and fixed-dose strategies. Eur J Endocrinol 2008; 159: 301-7.
14. Doi SA, Woodhouse NJ. Ablation of the thyroid remnant and 131I dose in differentiated thyroid cancer. Clin Endocrinol (Oxf) 2000; 52: 765-73.
15. Logue JP, Tsang RW, Brierley JD, Simpson WJ. Radioiodine ablation of residual tissue in thyroid cancer: relationship between administered activity, neck uptake and outcome. Br J Radiol 1994; 67: 1127-31.
16. Park EK, Chung JK, Lim IH, Park do J, Lee DS, Lee MC, et al. Recurrent/metastatic thyroid carcinomas false negative for serum thyroglobulin but positive by posttherapy I-131 whole body scans. Eur J Nucl Med Mol Imaging 2009; 36: 172-9.
17. Phan HT, Jager PL, van der Wal JE, Sluiter WJ, Plukker JT, Dierckx RA, et al. The follow-up of patients with differentiated thyroid cancer and undetectable thyroglobulin (Tg) and Tg antibodies during ablation. Eur J Endocrinol 2008; 158: 77-83.
18. Brendel AJ, Lambert B, Guyot M, Jeandot R, Dubourg H, Roger P, et al. Low levels of serum thyroglobulin after withdrawal of thyroid suppression therapy in the follow up of differentiated thyroid carcinoma. Eur J Nucl Med 1990; 16: 35-8.
19. Giovanella L, Suriano S, Ricci R, Ceriani L, Anton VF. Postsurgical thyroid remnant estimation by ((9)(9)m) Tc-pertechnetate scintigraphy predicts radioiodine ablation effectiveness in patients with differentiated thyroid carcinoma. Head Neck 2011; 33: 552-6.
20. Hodgson DC, Brierley JD, Tsang RW, Panzarella T. Prescribing 131Iodine based on neck uptake produces effective thyroid ablation and reduced hospital stay. Radiother Oncol 1998; 47: 325-30.
21. Rosario PW, Reis JS, Barroso AL, Rezende LL, Padrao EL, Fagundes TA. Efficacy of low and high 131I doses for thyroid remnant ablation in patients with differentiated thyroid carcinoma based on post-operative cervical uptake. Nucl Med Commun 2004; 25: 1077-81.
22. Vermiglio F, Violi MA, Finocchiaro MD, Baldari S, Castagna MG, Moleti M, et al. Short-term effectiveness of low-dose radioiodune ablative treatment of thyroid remnants after thyroidectomy for differentiated thyroid cancer. Thyroid 1999; 9: 387-91.

23. Thientunyakit T, Premprapha T, Thongmak S. High-dose I-131 therapy for varied aspects of well-differentiated thyroid carcinoma. Asean J Radiol 2007; 13: 99-109.
24. Muratet JP, Giraud P, Daver A, Minier JF, Gamelin E, Larra F. Predicting the efficacy of first iodine-131 treatment in differentiated thyroid carcinoma. J Nucl Med 1997; 38: 1362-8.
25. Kim TY, Kim WB, Kim ES, Ryu JS, Yeo JS, Kim SC, et al. Serum thyroglobulin levels at the time of 131I remnant ablation just after thyroidectomy are useful for early prediction of clinical recurrence in low-risk patients with differentiated thyroid carcinoma. J Clin Endocrinol Metab 2005; 90: 1440-5.
26. Giovanella L, Ceriani L, Ghelfo A, Keller F. Thyroglobulin assay 4 weeks after thyroidectomy predicts outcome in low-risk papillary thyroid carcinoma. Clin Chem Lab Med 2005; 43: 843-7.
27. Yipintsoi T, Premprabha T, Geater A, Thientunyakij T, Thongmak S. Mortality-related factors in 1056 radioiodine-treated patients with well-differentiated thyroid cancer in southern Thailand. World J Surg 2010; 34: 230-6.
28. Mazzaferri EL, Kloos RT. Clinical review 128: Current approaches to primary therapy for papillary and follicular thyroid cancer. J Clin Endocrinol Metab 2001; 86: 1447-63.

การศึกษาความสัมพันธ์ระหว่างค่าการจับสารเภสัชรังสีไอโอดีน-131 ที่คอ และผลการตรวจสแกนต่อมไทรอยด์ด้วย ^{99m}Tc-pertechnetate หลังการผ่าตัดและผลการรักษามะเร็งต่อมไทรอยด์ด้วยไอโอดีน-131

ธัญญลักษณ์ เธียรธัญญกิจ, ภาวนา ภูสุวรรณ, พงษ์พิชา ตู้จินดา, เบญจาภา เขียวหวาน

วัตถุประสงค์: *เพื่อศึกษาความสัมพันธ์ของค่านับวัด 2 ค่า ได้แก่ ปริมาณร้อยละของการจับสารกัมมันตรังสีไอโอดีน-131 และค่าปริมาณรังสีสะสมบริเวณคอจากผลการตรวจสแกนต่อมไทรอยด์ด้วยสารเภสัชรังสี ^{99m}Tc-pertechnetate กับผลการรักษาด้วยสารกัมมันตรังสีไอโอดีนปริมาณสูงในผู้ป่วยมะเร็งต่อมไทรอยด์ชนิด well-differentiated ตลอดจนศึกษาปัจจัยอื่น ๆ ที่อาจมีความสัมพันธ์กับผลการรักษาด้วยสารกัมมันตรังสีไอโอดีนปริมาณสูงในผู้ป่วยดังกล่าว*

วัสดุและวิธีการ: *การศึกษาข้อมูลย้อนหลังจากแฟ้มประวัติผู้ป่วยมะเร็งไทรอยด์ชนิด well-differentiated ที่มารับการรักษาด้วยกัมมันตรังสีไอโอดีน-131 ปริมาณสูงที่คณะแพทยศาสตร์ศิริราชพยาบาล ระหว่างเดือนมกราคม พ.ศ. 2545 ถึงเดือนธันวาคม พ.ศ. 2548 จำนวน 250 ราย โดยวิเคราะห์ความสัมพันธ์ระหว่างปริมาณเนื้อเยื่อไทรอยด์ที่เหลือจากการผ่าตัดที่บริเวณลำคอจากค่าร้อยละของการจับไอโอดีน-131 ที่เวลา 24 ชั่วโมง ร่วมกับภาพสแกนต่อมไทรอยด์ด้วย ^{99m}Tc-pertecnetate กับผลสำเร็จของการรักษาโดยอาศัยผลการสแกนทั่วร่างกายด้วยไอโอดีน-131 ที่เป็นลบร่วมกับระดับ thyroglobulin ในกระแสเลือดต่ำกว่า 10 นาโนกรัมต่อมิลลิลิตรที่ ระยะเวลา 6 เดือนถึง 1 ปี หลังจากได้รับการรักษาด้วยสารกัมมันตรังสีไอโอดีนปริมาณสูง และวิเคราะห์ปัจจัยอื่น ๆ ที่อาจเกี่ยวข้องกับผลสำเร็จในการรักษา*

ผลการศึกษา: *หลังจากรักษาด้วย I-131 ปริมาณสูง 1 ครั้ง พบว่าสามารถรักษาได้สำเร็จในผู้ป่วยจำนวน 124 ราย (ร้อยละ 49.6) โดยไม่พบว่าผลสำเร็จในการรักษามีความสัมพันธ์กับอายุ เพศ ชนิดการผ่าตัด ลักษณะทางจุลกายวิภาคของมะเร็ง ขนาดหรือจำนวนก้อนมะเร็ง การลุกลามของเซลล์มะเร็งนอกต่อมไทรอยด์ ปริมาณรังสีไอโอดีนที่ใช้ระยะเวลาระหว่างการผ่าตัดจนกระทั่งได้รับไอโอดีน-131 รวมถึงปริมาณเนื้อเยื่อไทรอยด์ที่เหลือจากการผ่าตัดที่บริเวณลำคอ ทั้งจากค่าร้อยละของการจับไอโอดีน-131 ที่เวลา 24 ชั่วโมง หรือภาพสแกนต่อมไทรอยด์ โดยมีเพียงระดับ Tg ตั้งต้นเท่านั้นที่มีความสัมพันธ์กับผลสำเร็จของการรักษาอย่างมีนัยสำคัญทางสถิติ ($p<0.001$)*

สรุป: *ปริมาณเนื้อเยื่อไทรอยด์ที่เหลือจากการผ่าตัดที่บริเวณลำคอทั้งจากค่าร้อยละของการจับไอโอดีน-131 ที่เวลา 24 ชั่วโมง หรือภาพสแกนต่อมไทรอยด์ไม่สามารถพยากรณ์ความสำเร็จในการรักษาผู้ป่วยมะเร็งไทรอยด์ชนิด well-differentiated ด้วยไอโอดีน-131 ปริมาณสูงได้ และระดับ Tg ตั้งต้นเป็นปัจจัยเดียวที่สัมพันธ์กับผลสำเร็จในการรักษา*