

# $^{99m}\text{Tc}$ Pertechnetate Uptake and its Agreement with $^{131}\text{I}$ Uptake by Thyroid Gland

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## ABSTRACT

**Background:** With the advancement of science, the scope of thyroid uptake in diagnosis and treatment of thyroid diseases has become limited. Uptake test with  $^{99m}\text{Tc}$  pertechnetate along with a thyroid scan, which is done almost routinely, could be a better option when needed. This will not only exempt the patients from relatively higher radiation burden but also cause significant reduction of procedural time. Moreover, the thyroid image we get along with the uptake may guide with additional information. This study was done to provide preliminary data regarding thyroid uptake test with  $^{99m}\text{Tc}$  in our population and to assess the possibilities of introducing this safer and convenient radionuclide in our routine practice.

**Patients and methods:** This cross sectional, comparative study was conducted from January to December of 2015 on 59 participants in Institute of Nuclear Medicine and Allied Sciences, Dhaka. Patients coming for a radioactive iodine uptake test along with a thyroid scan were enrolled. Uptake of  $^{99m}\text{Tc}$  pertechnetate at 20 minutes and at 24 hours was measured. Data were analyzed between the two uptake values based on clinical conditions, serum TSH levels and gland size.

**Results:** Almost perfect agreement and a strong positive correlation (Kappa value=0.933 &  $r=0.845$ ) were found between the results of two modalities. The hyperthyroid group showed a moderate agreement ( $k=0.5$ ) and a moderate positive correlation ( $r=0.6$ ). The participants with thyroiditis revealed a perfect agreement ( $k=1$ ) and a strong positive correlation ( $r=0.981$ ). Almost perfect correlation was found between participants with enlarged and non-enlarged glands ( $r=0.776$  &  $0.801$  respectively). Agreement analysis revealed almost perfect agreement ( $k=0.88$ ) in the group with enlarged and moderate agreement ( $k=0.6$ ) in participants with non-enlarged glands. Low serum TSH group showed perfect agreement ( $k=1.0$ ) and a strong positive correlation ( $r=0.748$ ). The group with normal TSH level revealed a perfect agreement with  $k=1$  but a moderate correlation ( $r=0.418$ ).

**Conclusion:** Good agreement and correlation were found between thyroid uptakes of  $^{99m}\text{Tc}$  at 20 minutes by gamma camera and that of at 24 hours. Agreement and correlation in different clinical settings also showed consistency. So,  $^{99m}\text{Tc}$  may be considered for uptake test in a regular basis in the limited fields where an uptake is still required as it may yield a reliable result in a simple, quicker and more convenient method.

**Key words:**  $^{99m}\text{Tc}$  uptake test, uptake test, hyperthyroid state.

## INTRODUCTION

Thyroid disorders are among the commonest endocrine disorders worldwide, as well as in Bangladesh. As thyroid gland is the major regulator of metabolism in

virtually all organs, an early detection of diseases may prevent grave sequel. Thyroid uptake test using radioactive agents is one of the oldest methods for assessing functional status of the gland (1) and has been a widely used tool for quite a long period. Due to discovery of sensitive biomarkers, like serum TSH, the role of uptake test has become limited. But it is still needed for differential diagnosis of thyrotoxicosis, dose estimation of in case of Graves' disease, detection of residual thyroid tissue after total thyroidectomy, estimation of therapeutic effectiveness in follow up of DTC etc. is the commonest agent used for this purpose (2). This traditional agent is cheap and easily available but has relatively higher radiation dose, longer half-life, associated  $\beta$ -radiation and may cause thyroid stunning (2,3). To avoid these  $^{123}\text{I}$  is used in the developed countries but it is expensive with a complex production method.  $^{99m}\text{Tc}$  is a pure gamma-emitter with almost 1/1000 times of the radiation burden of needed for the test (4,5). Maximum thyroid uptake of technetium can be measured at 20 minutes and its avidity for thyroid gland is same as. The gamma radiation is readily collimated and excellent thyroid scans can be obtained within 30 minutes of administration of the isotope with higher count rates, greater statistical reliability and better resolution (6). Another important issue for  $^{99m}\text{Tc}$  is that no special setting is required as data acquisition can be done simultaneously with a thyroid scan which is frequently performed in almost all thyroid disorders with the same dose.  $^{99m}\text{Tc}$  was introduced for thyroid uptake test due to its benefits but at present it is long

forgotten in the developed world due to availability of <sup>123</sup>I which is preferred over technetium as it is an isotope of the iodine itself.

In our country, where <sup>123</sup>I is not feasible for regular use, <sup>99m</sup>Tc could be a good alternative. As no reported studies regarding thyroid uptake assessment by technetium using gamma camera is found in our country, this study was aimed to assess the possibilities of application of this process in diagnosis of thyroid diseases in a regular basis in our country which will significantly reduce the procedural time as well as radiation burden.

**PATIENTS AND METHODS**

This cross sectional, comparative study was conducted from January to December of 2015 in Institute of Nuclear Medicine and Allied Sciences, Dhaka. Sample size (59) was calculated for discordance rate of 0.05 and tolerance probability of 95% for agreement of two measurement methods assuming no discordant pair of measurement allowed (7). Fifty nine participants were selected purposively among patients coming for a radioactive iodine uptake test along with a thyroid scan. Patients on thyroid related medications, H/O ingestion of any food or drug interfering with uptake of, pregnancy, lactation and patients with any associated comorbid conditions or other endocrine diseases were excluded.

Normal level of uptake at 24 hours was considered 10-30% (8) while that of <sup>99m</sup>Tc uptake at 20 minutes was 1-4% (2).

Informed written consent was taken from all participants. At first clinical history, anthropometric measurements (standing height, weight) were recorded in a structured data sheet. Then the participants were injected 2 m Ci of <sup>99m</sup>Tc pertechnetate intravenously. Pre and post syringe counts were taken for 60 seconds. After 20 minutes the patient was placed in supine position under standard gamma camera equipped with low energy parallel hole collimator. Thyroid uptake was measured for 60 seconds. Neck count was measured for background count in neck drawing a

region of interest leaving the thyroid. Uptake of <sup>99m</sup>Tc was calculated from the image using standard formula.

Then the participants were given 5 µCi of orally in liquid form. Uptake was calculated at 24 hours with standard procedure with a standard uptake machine.

Statistical analysis was performed by SPSS 20.0 (SPSS Inc, Chicago, Illinois, USA). Categorical data were expressed in percentage and number. p value was calculated by Chi square test. Pearson correlation and Kappa tests were applied for assessing correlation and agreement between variables. Degree of relation between variables was expressed by r (Pearson’s correlation coefficient).

**RESULTS**

Among 59 participants 39 were female (66.1 %) and rest 20 were male (33.9 %); data is shown in Table-1. Range of uptake values in two methods are summarized in Table-2.

**Table 1: Distribution of the study population by sex (n = 59)**

Sex	Number of patients	Percentage (%)
Male	20	33.9
Female	39	66.1

**Table 2: Range of thyroid uptake of <sup>99m</sup>Tc & in different clinical condition (n=59)**

Clinical condition	Number of patients	Range of <sup>99m</sup> Tc uptake (%)	Range of <sup>131</sup> I uptake (%)
Hyperthyroidism	27	4.2-14	42-89
Thyroiditis	9	0.4-4.4	0.2-39
Others	23	0.5-3.0	5-26

A total of 5 cases of low uptake value of at 24 hours were found, and all these 5 (100.0%) cases showed same status of <sup>99m</sup>Tc uptake at 20 min. Twenty four cases of normal uptake of at 24 hours were observed, out of which 23(95.8%) had normal and 1(4.2 %) had high uptake value of <sup>99m</sup>Tc at 20 min.

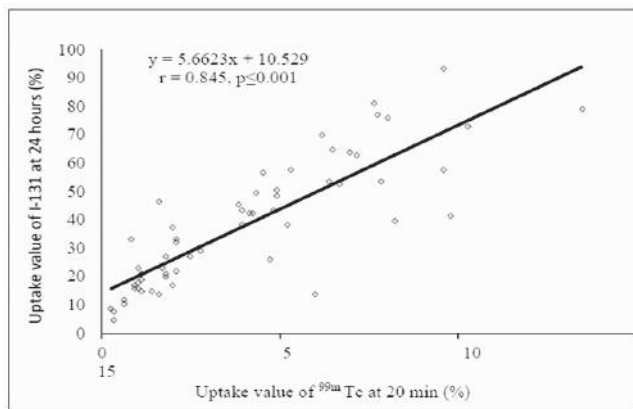
There were a total of 30 cases of high uptake value with at 24 hours, among which 1 (3.3%) were found to be normal and 29 (96.7%) showed high uptake of <sup>99m</sup>Tc at 20 minutes. The analysis of the results of two modalities (uptake of <sup>99m</sup>Tc at 20 minutes and uptake of at 24 hours) shows Kappa value = 0.933 with p value <0.001, which is statistically significant with almost perfect agreement. Correlation co-efficient, r was 0.845 indicating a strong positive correlation.

**Table 3: Association between uptake values of <sup>131</sup>I at 24 hours with uptake value of <sup>99m</sup>Tc at 20 min (n=59)**

Uptake value of <sup>99m</sup> Tc at 20 min	Uptake value of <sup>131</sup> I at 24 hours					
	Low (n=5)		Normal (n=24)		High (n=30)	
	n	%	n	%	n	%
Low	5	100.0	0	0.0	0	0.0
Normal	0	0.0	23	95.8	1	3.3
High	0	0.0	1	4.17	29	96.7

s=Significant

Measures of agreement: Kappa Value 0.933, p value <0.001s



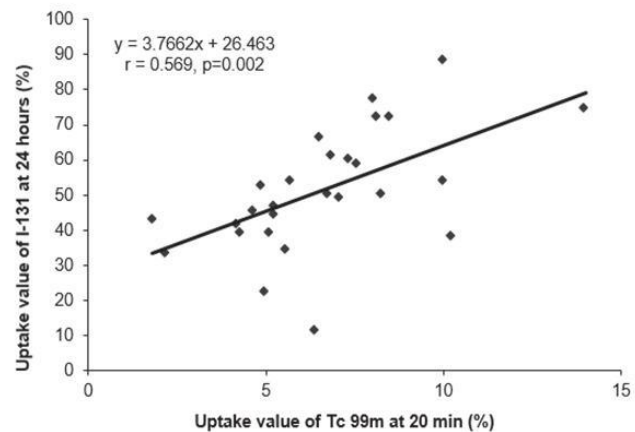
**Figure 1: Scatter diagram showing positive correlation (r=0.845; p<0.001) between uptake value of <sup>99m</sup>Tc at 20 minutes and that of at 24 hours in all the study cases.**

**Table 4: Association between uptake value of <sup>131</sup>I at 24 hours with uptake value of <sup>99m</sup>Tc at 20 min in participants with hyperthyroidism (n=27)**

Uptake value of <sup>99m</sup> Tc at 20 min	Uptake value of <sup>131</sup> I at 24 hours				
	High	Normal			
	n	%	n	%	Total
High	24	92.6	1	3.7	25
Normal	1	3.7	1	3.7	2
Total	25		2		27

S=significant

Measures of agreement: Kappa Value 0.5. p Value<0.002<sup>s</sup>  
Here Kappa value indicates moderate agreement



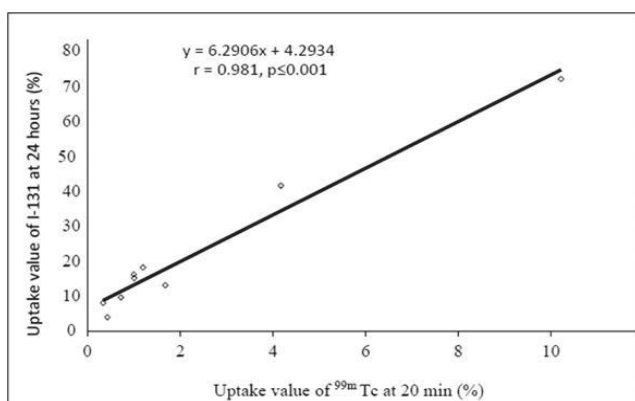
**Figure 2: Scatter diagram showing positive correlation (r=0.60; p<0.002) between uptake of <sup>99m</sup>Tc at 20 min and uptake of at 24 hours in patients with hyperthyroidism.**

**Table 5: Association between uptake values of <sup>131</sup>I at 24 hours and <sup>99m</sup>Tc at 20 min in participants with thyroiditis (n=9)**

Uptake value of <sup>99m</sup> Tc at 20 min	Uptake value of <sup>131</sup> I at 24 hours				Total
	Low	Other			
	n	%	n	%	
Low	4	0.5	0	0.0	4
Other	0	0	5	0.5	5
Total	4		5		9

S=significant

Measures of agreement: Kappa Value 1.0. p Value<0.001<sup>s</sup>  
Here Kappa value indicates perfect agreement

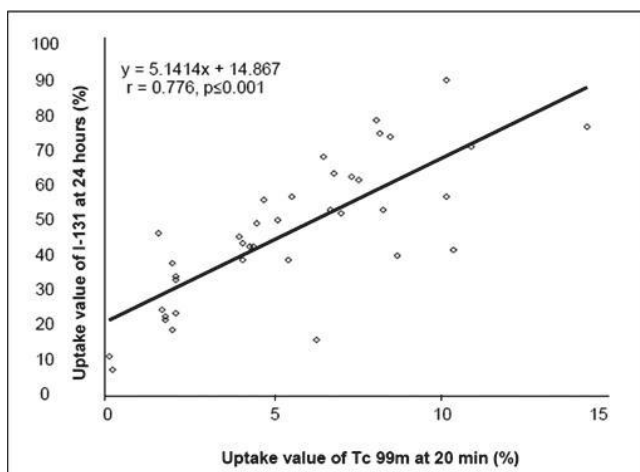


**Figure 3: Scatter diagram showing positive correlation (r=0.981; p<0.001) between uptake of <sup>99m</sup>Tc at 20 minutes and uptake of at 24 hours in cases with thyroiditis**

**Table 6: Association between uptake values of <sup>131</sup>I at 24 hours and <sup>99m</sup>Tc at 20 minutes in participants with enlarged glands (n=39)**

Uptake value of <sup>99m</sup> Tc at 20 min	Uptake value of <sup>131</sup> I at 24 hours				
	High		Normal		Total
min	n	%	n	%	
High	27	70	00	00	27
Normal	2	5	10	25	12
Total	29		10		39

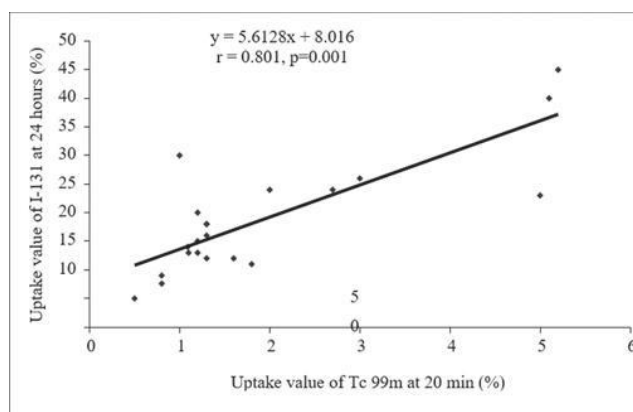
S=significant  
 Measures of agreement: Kappa Value 0.88. p Value<0.001<sup>s</sup>  
 Here Kappa value is near 1 and indicates almost perfect agreement



**Figure 4: Scatter diagram showing positive correlation (r=0.776; p=0.001) between uptake of <sup>99m</sup>Tc at 20 minutes and at 24 hours in cases with enlarged gland.**

**Table 7: Association between uptake values of <sup>131</sup>I at 24 hours and <sup>99m</sup>Tc at 20 min in participants with non-enlarged glands (n=15)**

Uptake value of <sup>99m</sup> Tc at 20 min	Uptake value of <sup>131</sup> I at 24 hours				Total
	Normal		High		
min	n	%	n	%	
Normal	13	86.7	00	00	13
High	1	6.7	01	5.7	2
Total	14		01		15



**Figure 5: Scatter diagram showing positive correlation (r=0.801; p=0.001) between uptake of <sup>99m</sup>Tc at 20 minutes and at 24 hours in patients with non-enlarged gland**

**DISCUSSION**

The analysis of the results of two modalities among all the cases shows Kappa value of 0.933 with p value <0.001, which is statistically significant with almost perfect agreement. Correlation co-efficient, r was 0.845 indicating a strong positive correlation.

In the current study the subjects were sorted out according to the clinical conditions. Among the total 59 subjects, 27 were diagnosed as hyperthyroidism (45.8%) followed by 9 (15.3%) cases of thyroiditis, 4 (6.8%) with iodine deficiency goiter, 1(1.7%) thymomegaly with euthyroidism, and the remaining 18 (30.5 %) had other non-thyroid related diagnoses.

Participants with hyperthyroidism showed a moderate agreement (k=0.5) along with moderate correlation (r=0.6) between two uptake modalities. Two thyrotoxic patients were found to have normal values of <sup>99m</sup>Tc uptake at 20minutes. Moreover, two participants had high values of both the uptakes, but uptake values of were extremely high (90% and 70%) in relation to that of <sup>99m</sup>Tc (10% and 7% respectively). These may be the reason for both slightly lower agreement and correlation between the two modalities in this group. As the small sample size was small, minor variation in the results have had much greater effect on overall results which is reflected in this statistical analysis. Besides, Kunii et al. showed in

their study that there is a significant relationship between uptake value of  $^{99m}\text{Tc}$  pertechnetate and serum levels of free triiodothyronine, free thyroxine, TSH binding inhibitory immunoglobulin (TBII) and thyroid stimulating antibody along with patient age in case of Graves' disease. This may be another cause of dissimilarities in uptake values in the patients mentioned above.

Statistical analysis of the participants with thyroiditis revealed a perfect agreement ( $k=1$ ) and a strong positive correlation ( $r = 0.981$ ) between the two modalities. No discordant values were found in the uptake values by two methods.

20 patients in the present study had normal sized thyroid gland while the rest 39 had enlarged glands. In the participants with enlarged glands an almost perfect agreement was observed with  $k$  value 0.88. Pearson's correlation test revealed a strong correlation ( $r=0.776$ ). A moderate agreement ( $k=0.6$ ) with strong correlation ( $r=0.801$ ) was also observed in the group having non-enlarged thyroid glands.

## CONCLUSION

Thyroid uptake tests using  $^{99m}\text{Tc}$  pertechnetate gives almost similar results like and in a more convenient way. Good agreement and correlation were found between the two modalities in different thyroid states in most of the cases.

As regular use of  $^{123}\text{I}$  is not technically feasible in our country, possibilities of introduction of  $^{99m}\text{Tc}$  may be

considered as a safer and convenient alternative.

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