

# Agreement between Thyroid Uptake of $^{99m}\text{Tc}$ Pertechnetate and $^{131}\text{I}$ in Hyperthyroid Patients

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## ABSTRACT

**Objectives:** With the advancement of science, the scope of  $^{131}\text{I}$  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 required. This will not only exempt the patients from relatively higher radiation burden of  $^{131}\text{I}$  but will 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 & 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 27 participants in Institute of Nuclear Medicine and Allied Sciences, Dhaka. Hyperthyroid 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  $^{131}\text{I}$  at 24 hours were measured.

**Results:** Among 27 participants, 25 had raised, 2 had normal  $^{131}\text{I}$  uptake. Two normal value of  $^{99m}\text{Tc}$  uptake was found and rest showed high uptake. Two patients had high uptakes in both the method but  $^{131}\text{I}$  uptake was extremely high (90% and 80%) in comparison to  $^{99m}\text{Tc}$  uptake (10% and 7% respectively). Statistical analysis revealed a moderate agreement ( $k = 0.5$ ) along with a moderate positive correlation ( $r = 0.6$ ) between the two uptake methods.

**Conclusion:** Good agreement and correlation were found between two modalities of thyroid uptake in case of hyperthyroid patients. 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 way.

**Key words:**  $^{99m}\text{Tc}$  uptake test,  $^{131}\text{I}$  uptake test, hyperthyroid state.

## INTRODUCTION

Nuclear thyroid study is still considered the gold standard in diagnosis and treatment of hyperthyroidism, compared to combined clinical, endocrine, immunological and cytological assays. Though uptake test is the earliest method in diagnosing thyroid diseases, it still remains an important tool (1) regarding diagnosis and determination of dose of radio-iodine. In conventional uptake test we use  $^{131}\text{I}$  and the maximum uptake of thyroid gland can be measured at 24 hours (2).

$^{131}\text{I}$  is a radioisotope of iodine with a half-life of eight days. Besides the  $\gamma$ -ray needed for diagnostic purpose, it emits  $\beta$ -radiation in course of decay (3).

$^{99m}\text{Tc}$  is a pure gamma-emitter with almost 1/1000 times of the radiation burden of  $^{131}\text{I}$  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  $^{131}\text{I}$ . 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).  $^{99m}\text{Tc}$  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  $^{123}\text{I}$  which is preferred over technetium as it is an isotope of the iodine itself.

In a developing country like Bangladesh, where use of  $^{123}\text{I}$  is not possible on a regular basis,  $^{99m}\text{Tc}$  can be a better alternative to  $^{131}\text{I}$ . No reported studies regarding thyroid uptake assessment by technetium using gamma camera is found in our country. So this study was aimed to assess the possibilities of application of this process in diagnosis and dose calculation of hyperthyroidism on 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, (27) was calculated for discordance rate of 0.10

and tolerance probability of 95% for agreement of two measurement methods assuming no discordant pair of measurement allowed (7). Twenty seven hyperthyroid patients were selected purposively among patients coming for a radioactive iodine uptake test along with a thyroid scan. Patients on thyroid related medications, history of ingestion of any food or drug interfering with uptake of 131-I, pregnancy, lactation and patients with any associated comorbid conditions or other endocrine diseases were excluded.

Normal level of 131-I uptake at 24 hours was considered 10-30% (8) while that of 99mTc 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 two mCi of 99mTc 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 99mTc was calculated from the image using standard formula.

Then the participants were given five µCi of 131-I 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 is expressed by r (Pearson's correlation coefficient).

**RESULTS**

Among 27 study sample 14 were female (52 %) and rest 13 were male (48 %); 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 = 27)**

Sex	Number of patients	Percentage
Male	13	48
Female	14	52

Twenty four participants showed high while one had normal uptake values in both the methods. One participant had normal 131-I uptake but 99mTc uptake was high (10.2% and 6.3%). The remaining one had high 131-I uptake with normal 99mTc uptake (43% and 1.8%) and was later diagnosed as a case of borderline hyperthyroid with mildly raised serum T3 and T4 and a normal TSH value.

**Table 2: Range of thyroid uptake of 99mTc and 131-I in hyperthyroid patients (n=27)**

Method	Normal range (%)	Range of uptake in study subjects (%)
99mTc uptake at 20 minutes	1-4	1.8-14
131-I uptake at 24 hours	10-30	10.2-90

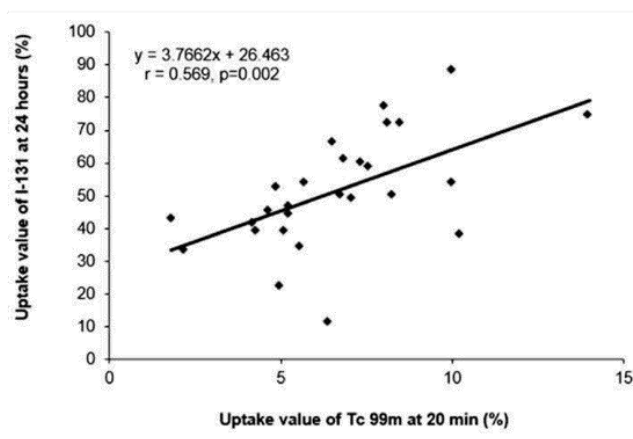
Two of the participants with high uptake values in both the uptakes had extremely high 131-I uptake (90% and 80%) in relation to the 99mTc uptake values (10% and 7% respectively).

Statistical assessment revealed a moderate agreement (k=0.5) which is shown in Table 3, along with a moderate positive correlation (r=0.6) between the two uptake methods (Figure 1).

**Table 3: Association between uptake value of 131-I at 24 hours with uptake values of 99mTc at 20 min (n=27)**

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

s = significant; Measures of agreement: Kappa value 0.5, p value<00.2<sup>S</sup> Here kappa value indicates moderate agreement.



**Figure 1: Scatter diagram showing positive correlation between uptake of  $^{99m}\text{Tc}$  at 20 min and uptake of  $^{131}\text{I}$  at 24 hours in 27 participants.**

Figure 1 shows the uptake values of the participants in both the methods. X-axis shows uptake values of  $^{99m}\text{Tc}$  uptake while the Y-axis is for denoting the  $^{131}\text{I}$  uptake values. The graph is drawn at maximal intersect and reveals Pearson's correlation,  $r$  to be 0.6 which is statistically significant.

## DISCUSSION

In the current study, a moderate agreement ( $k=0.5$ ) and a moderate positive correlation ( $r=0.6$ ) between the two uptake methods were observed. The moderate values were observed most probably due to i) two sets of discordant values and ii) two participants with discrepantly high uptake values. Moreover, as the sample size was small, minor variations in the result have much greater effect on overall impression. However, the result shows similarity with that of Atkins et al. (6) where the moderate correlation between the two modalities was supposed to be due to an extremely high uptake value of  $^{99m}\text{Tc}$ . But the authors suggest that despite the lesser coefficient no significant difference of diagnostic accuracy was observed.

Kunii et al. (9) 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.

Use of  $^{99m}\text{Tc}$  pertechnetate for thyroid uptake is not a novel concept. It was introduced in the late seventies due to its added benefits like low radiation dose, easy and faster acquisition of result, lesser time needed for the whole process, low cost and finally an opportunity to perform a  $^{99m}\text{Tc}$  scan alongside in the same visit. Now a days it is abandoned in the western world due to availability of  $^{123}\text{I}$ , an isotope of iodine itself with significantly lower radiation dose and half-life than  $^{131}\text{I}$ . As  $^{123}\text{I}$  is not still available in our country due to complex and costly production process, we may consider  $^{99m}\text{Tc}$  pertechnetate a solution for convenient uptake test.

## CONCLUSION

Thyroid uptake of  $^{99m}\text{Tc}$  at 20 minutes with gamma camera and that of  $^{131}\text{I}$  at 24 hours showed a positive agreement and significant correlation. So,  $^{99m}\text{Tc}$  may be considered for thyroid uptake test in a regular basis as it is a simple, quicker and more convenient method in diagnosis and dose calculation of hyperthyroidism.

## REFERENCES

1. Chapman EM. History of the discovery and early use of radioactive iodine, *The Journal of the American Medical Association* 1983;15:2042-4.
2. Ziessman A. Harvey, O' Malley P. Janis, Thrall James H, 3rd edition, *Nuclear medicine: the requisites*, Elsevier Limited 2006;76-78.
3. Cherry SR, Sorenson JA, Phelps ME. 4th edition. *Physics in Nuclear Medicine*, Elsevier Limited 2003;chap-4:70-76.
4. Andros, G., Harper, P. V, Lathrop, K. A. & McCardle, R. J. Pertechnetate- $^{99m}$  localization in man with applications to thyroid scanning and the study of thyroid function. *The Journal of Clinical Endocrinology and Metabolism* 1965; 25:1067-1076.
5. Becker D, Charkes ND, Dworkin H, McDougall RI, Price DC, Royal HD, Sarkar SD, and Dworkin HD. Society of Nuclear Medicine Procedure guideline for thyroid scintigraphy, *Journal of Nuclear Medicine* 1996; vol.37:1264-6.
6. Atkins HL and Richards P. Assessment of thyroid function and anatomy with technetium- $^{99m}$  as pertechnetate. *Journal of nuclear medicine* 1967; vol.9:7-15.
7. Hoque Md. M, 2nd edition. *abc of research methodology & biostatistics*, Asian Color Printing, Dhaka 2014;chap-12:163.
8. Lele RD, Bindu S, and Joshi SR. One Minute Cost Effective Nuclear Thyroid Diagnostic Imaging in a Resource Limited Indian Environment. *Journal of the Association of Physicians of India* 2004; 52:712-714.
9. Kunii KY, Emoto N and Oikawa S. Analysis of the factors associated with  $^{99m}\text{Tc}$  pertechnetate uptake in thyrotoxicosis and Grave's disease. *Journal of Nippon Medical School* 2006, 73:10-17.