Time of maximum uptake of Technetium-99m pertechnetate (TcO_4) in the thyroid gland and its correlation with thyroid functional status

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ABSTRACT

During thyroid scan with Technetium-99m (Tc-99m) Pertechneate, the maximum uptake is supposed to occur after 15 to 20 minutes of intravenous administration for normal healthy persons. The purpose of this study is to determine the time of maximum uptake of Technhetium Pertechneate by measuring counts over the thyroid gland during thyroid scan and to correlate the time of maximum uptake with thyroid functions measured biochemically. The number of patients studied was 136 of which 113 were females and 23 were males with the age range between 7 to 70 years. Among all, about 46% cases showed maximum count in the interval of 10-25 minutes. Though 38.2% of patients showed maximum uptake of tracer after 25 minutes, the count rate did not increase significantly after this time which justifies the conventional time of thyroid scanning. In general, the time of maximum uptake was earlier in females than males. Percentage of patients with hyperthyroidism is almost same for both males and females (13% and 12% respectively) but for females occurrence of hypothyroidism is higher than males (26% vs 17%). The total uptake of Tc-99m Pertechnetate for hyperthyroidism patients in each interval is greater than that of euthyroid patients but the time of maximum uptake is random for both males and females without any correlation with thyroid function.

INTRODUCTION

Thyroid gland function and structure can be evaluated using uptake and scintigraphy studies. Iodine -131 (I-131) which was introduced in the late thirties, was the first radiopharmaceutical used for measuring thyroid uptake and for many years it was the main study agent used in the evaluation of thyroid function [Chapman, 1983] . Despite the fact that the sensitivity and specificity of in vitro tests for evaluation of thyroid function have evolved over time, thyroid uptake and scintigraphy still play an important role in various clinical situations, such as the detection of ectopic thyroid tissue in neck masses, functional assessment of single or multiple nodules, increasing the likelihood of detecting hyperthyroidism in difficult cases, identification of other causes of thyrotoxicosis and calculation of therapeutic doses of I-131 [Cavalieri, 1996].

For thyroid scintigraphy and uptake I -131 and I-123 have some limitations and Tc-99m Pertechneate is very much popular today due to some of its useful characteristics. Tc-99m in the chemical form of pertechnetate, is used for thyroid scintigraphy and uptake. The similarity of volume and charge between the iodide and pertechnetate ions is the explanation for the uptake of Tc-99m pertechnetate by the thyroid gland [Andros , 1965; Smith, 1990]. Tc-99m pertechnetate has been used worldwide to study the thyroid function because of a number of advantages, such as a short half-life (6 hours), short retention in the gland and no β radiation, thus providing low dosage to the thyroid gland (10,000 times less than that of I-131), as well as to the body as a whole [Andros , 1965]. Its gamma photon of 140 KeV is ideal for

imaging using scintillation cameras and in addition, it has low cost and is readily available [Byeong-Cheol, 2012].

This was a prospective study to evaluate the uptake pattern of Tc-99m pertechnetate specially the time of maximum uptake as measured by counts during thyroid scan procedure and correlate the time of maximum uptake with thyroid functions measured biochemically.

PATIENTS AND METHODS

The number of patients studied was 136 of which, 23 were male and 113 were female. The age range was 7 to 70 years. Tc-99m of 2-5 mCi was injected intravenously and then imaging was performed using a dual head SPECT gamma camera. Images were obtained on a 1024×1024 pixel matrix with a zoom of 2.0. Images were acquired at 5 minutes interval, starting from zero to a time of maximum uptake, which varied from patient to patient. Time for maximum count in the thyroid gland were determined by the counts obtained during two consecutive measurements; if these do not show an increasing trend and are almost equal, was taken as the time for maximum count. Tc-99m uptake or total counts in the thyroid gland were obtained from the image through a region of interest (ROI) analysis in the region of the gland. Side by side, for each patient, blood specimens were analyzed for T3, T4 and TSH in the Radio Immuno Assay (RIA) laboratory. The normal range of these hormones used in the corresponding lab is shown in table 1.

Table 1: Normal range of T3, T4 and TSH level

Hormone	Normal range	Unit
T3	1.23-3.50	Nano mole per liter
T4	54-174	Nano mole per liter
TSH	0.3-5.0	Millie international unit per liter

Usually when the T3 and T4 level goes up and TSH level goes down from their normal range, the patient is considered as hyperthyroid and vice versa.

RESULTS

Time of maximum count of Tc-99m pertechnetate in the thyroid gland for all patients (136) is shown in Table 1.Time of maximum count for male and female patients are shown in Table 2 and Table 3 respectively. No maximum count occurred in the interval of 0 to 5 minutes, only one patient showed maximum count after 45 minutes (70 to 75 interval) and in rest of all, maximum count occurred between 5 to 45 minutes.

Table 1: Percentage of patients getting maximum count in different intervals (136 patients)

Time (mins)	0-5	5-10	10-15	15-20	20-25	25-30	30-35	35-40	>40
% and no. of patients	0	16.2(22)	16.9(23)	19.1(26)	9.5(13)	13.2(18)	11(15)	9.6(13)	4.4(6)

Table 2: Percentage of male patients getting maximum count in different intervals (23 patients)

Time (mins)	0-5	5-10	10-15	15-20	20-25	25-30	30-35	35-40	>40
% and no. of patients	0	4.3(1)	8.7 (2)	17.4 (4)	13.0 (3)	8.7(2)	21.7(5)	21.7(5)	4.3(1)

Table 3: Percentage of female patients getting maximum count in different intervals (113 patients)

Time (mins)	0-5	5-10	10-15	15-20	20-25	25-30	30-35	35-40	>40
% and no. of patients	0	18.6(21)	18.6(21)	19.5(22)	8.8(10)	14.2(16)	8.8(10)	7.1(8)	4.4(5)

Percentage of patients falling under the categories of hypothyroid, hyperthyroid and euthyroid are shown in Figure-5 and Figure-6 for males and females respectively. 17 % male patients are hypothyroid and 13% are hyperthyroid. The percentages of hypothyroid and hyperthyroid for females are 26% and 12% respectively.

The patient who showed maximum uptake at 65-70 minutes interval was euthyroid biochemically.

DISCUSSION

This study was started with the hypothesis that the maximum uptake of Tc-99m by the thyroid gland takes place within 15 to 20 minutes of the administration of the radiopharmaceutical [Rafat, 2012]. At first acquisition was started along with observation of number of counts in the region of interest during 5 to 30 minutes after intravenous injection of 3-5 mCi of Tc-99m pertechnetate. But it was observed that in some cases the maximum uptake occurred at the initial phase or at the last phase of this period. Therefore, it was difficult to identify the time of maximum count. Then the count was started immediately after the injection of the radiopharmaceutical and it was continued even beyond the time of maximum count, where the maximum count was confirmed by observing the last two counts.

To justify the thyroid scan procedure, the time intervals are reduced into three groups; 0 to 10 min, 10 to 25 min and over 25 min. Figure 1 represents the percentage of maximum count for each of these groups. Since the recommended time for thyroid scanning procedure is between 15 to 20 minutes of Tc-99m injection, one group is chosen near this interval (10 to 25 mins) and it is observed that 45.6% of patients have fallen under this group. Though in 38.2% cases, maximum count occurred after 25 minutes of Tc-99m injection, the count rate did not increase significantly after this time (Figure 2). The count rates for different intervals are shown in Figure 2.

In the interval of 0 to 5 minutes, no patient showed maximum count, only in one patient maximum count occurred after 45 minutes (70 to 75 interval) and in rest of all maximum count occurred between 5 to 45 minutes.

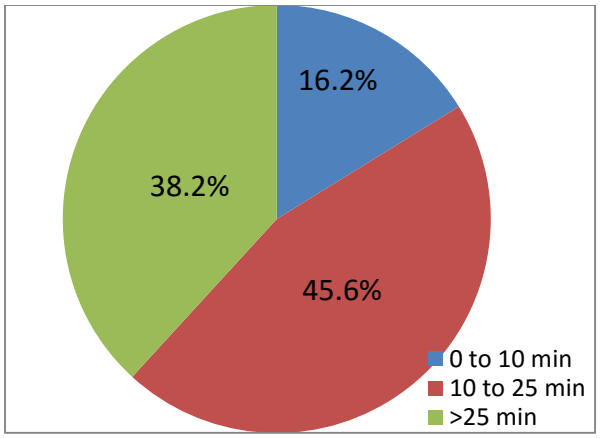

Figure 1: Percentage of patients getting maximum count for the intervals of 0 to 10 min, 10 to 25 min and beyond 25 min

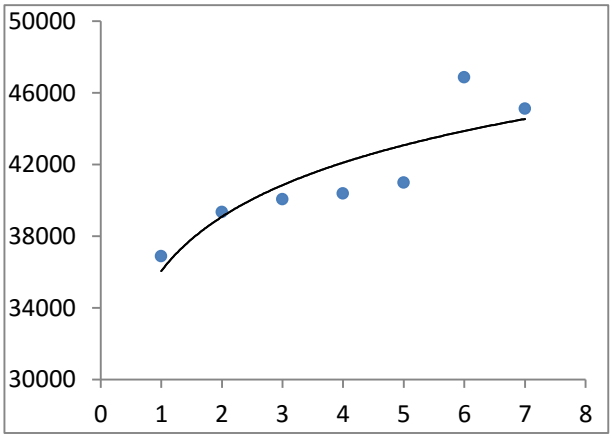

Figure 2: Count rate at different intervals***

***(In horizontal axis, 1 is corresponding to 5 to 10 min interval, 2 is corresponding 10 to 15 min interval and so on)

Study was also carried out to find if any correlation of time of maximum count rate for male and female patients. The count rate results for the intervals of 0 to 10 minutes, 10 to 25 minutes and beyond 25 minutes are shown in Figure 3 and Figure 4 for female and male patients respectively. An important characteristic is seen for thyroid count rate between male and female patients. For female patients ~47 % cases (majority) maximum count rate occurred between 10 to 25 minutes interval but for male patients in ~57% cases (majority) maximum count rate occurred after 25 minutes of Tc-99m injection. No clear explanation is found for this finding.

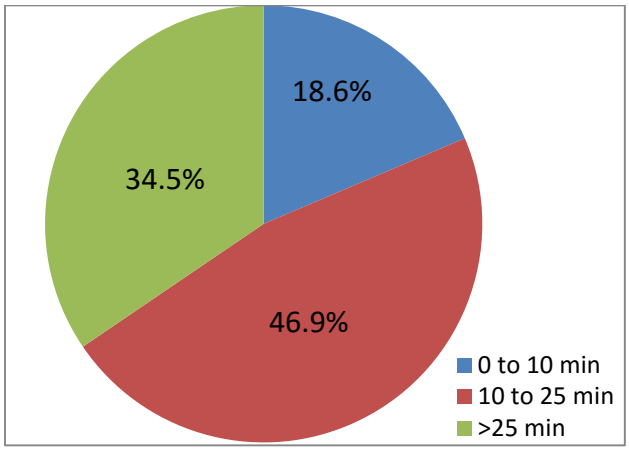

Figure 3: Percentage of female patients getting maximum count for the intervals of 0 to 10 min, 10 to 25 min and beyond 25 min (population 113)

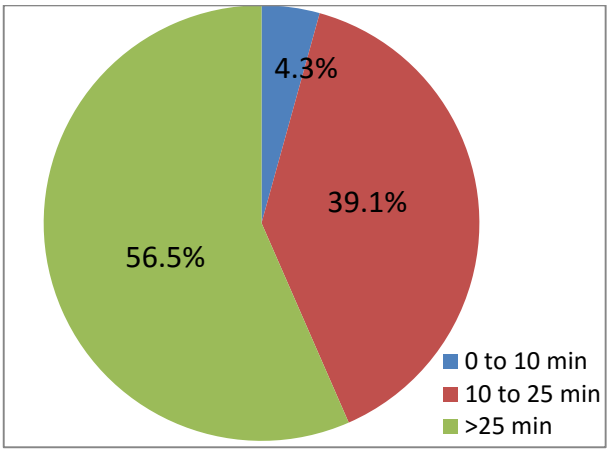

Figure 4: Percentage of male patients getting maximum count for the intervals of 0 to 10 min, 10 to 25 min and beyond 25 min (population 23)

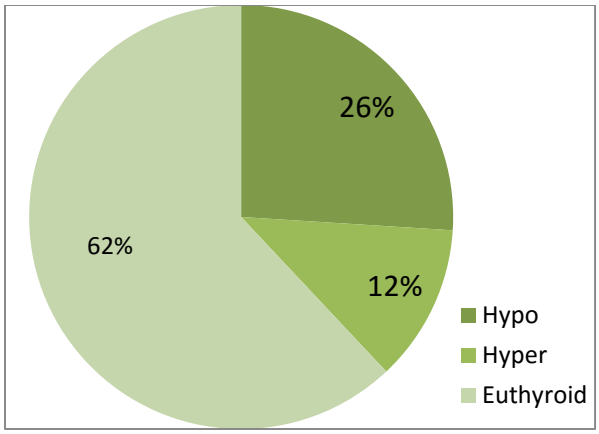

Figure 5: Distribution of Hypo, Hyper and Euthyroid patient for female (population 113)

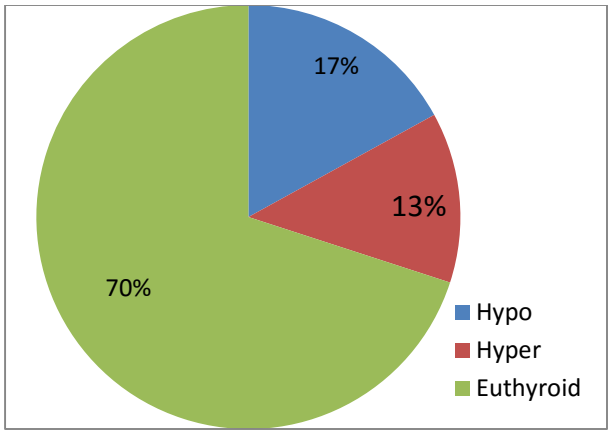

Figure 6: Distribution of Hypo, Hyper and Euthyroid patient for male (population 23)

Out of 23 male patients 4 (17 %) are hypothyroid and 3 (13%) are hyperthyroid. The number of hypothyroid patient is 29 (26%) and hyperthyroid patient is 14 (12%) for females. For male patients numbers of hypothyroid and hyperthyroid are very close but for females, hypothyroid patients are almost double than hyperthyroid patients. Figure 5 and Figure 6 show the ratio of hyperthyroid, hypothyroid and euthyroid patients for females and males respectively. This is a random study of patients attending the Institute of Nuclear Medicine and Allied Sciences, Faridpur for thyroid function study and the sample size is not large, so no conclusion can be drawn for the considerable variation in between males and females.

The total uptake of Tc-99m Pertechnetate for hyperthyroidism patients in each interval is greater than that of euthyroid patients due to overacting of thyroid gland. The time of maximum uptake for each case (Hypothyroid, Hyperthyroid or Euthyroid) is random. Sometimes maximum uptake occurs at the initial, sometimes middle or sometimes at the end of the 0-45 minutes time interval for all cases.

CONCLUSION

The study justifies the recommended time interval of 15-20 minutes for thyroid scan procedure. Overall 45.6% of patients in this study showed maximum uptake of tracer in the thyroid gland around the time interval of 10-25 minutes. Though 38.2% of patients showed maximum uptake of tracer after 25 minutes, the count rate did not increase significantly after this time. Difference is found in time of maximum uptake between males and females but no conclusion can be drawn due to small sample size. No correlation was found between time of maximum uptake of tracer and thyroid functional status. Further research can be done about these phenomena with large sample size.

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