

The effect of an iodine restricted including no sea foods diet, on technetium-99m thyroid scintigraphy: A neglected issue in nuclear medicine practice

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Abstract

Although it is recommended to patients to avoid sea food and iodine-containing medications prior to iodine-131 (¹³¹I) scanning, the efficacy of this diet as for technetium-99m pertechnetate (^{99m}Tc-P) thyroid scintigraphy is not well addressed in the literature. We evaluated a self-managed, outpatients, iodine restricted diet (IRD) designed to reduce total body iodine in preparation for such a scan. *We have studied 39 patients* who referred to our Department for multinodular goiter, 30 females and 9 males, aged: 14-54 years and their ^{99m}Tc-P thyroid scintigraphy showed poor visualization of the thyroid gland. These patients were living in regions with high consumption of sea foods went underwent a two-weeks iodine restriction including restriction of sea food diet for the reduction of iodine body content. These patients were called for a repeated scan after going on a IRD for at least two weeks. The two scans were compared visually, and by semiquantitative analysis. Semiquantitative analysis was applied in 8 regions of interest (ROI) by using Wilcoxon signed rank test. *Thirty-six subjects* had better quality scintigraphy images in the post IRD thyroid scan, as was visually assessed by two nuclear medicine physicians. Semiquantitatively, there was a significant difference in the mean counts of ROI of the right and the left thyroid lobes in favor of the post IRD scans ($P < 0.05$). *In conclusion*, this study suggests that in patients with multinodular goiter, living in regions with high consumption of sea foods a two-weeks diet for the reduction of iodine body content induces in most of the cases a slightly better diagnostic thyroid ^{99m}Tc-P scan.

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Introduction

Technetium-99m-pertechnetate (^{99m}Tc-P) is used worldwide to evaluate thyroid function due to its short half life, low radiation exposure and a favorable energy for routine imaging [1-3]. Technetium-99m-pertechnetate is a spherical monovalent anion that like iodide accumulates in follicular cells via an energy-dependent anion pump [4] but it is not organified. Iodine and ^{99m}Tc-P thyroid distribution usually parallel to each other and most factors that influence iodine accumulation, like nonradioactive iodine in serum and serum thyroid stimulating hormone (TSH) also influence ^{99m}Tc-P uptake [3]. When ^{99m}Tc-P is applied for thyroid assessment, remarkable decrement of its uptake, due to higher iodine content impairs thyroid gland evaluation [4].

Low iodine diets (LID) to prepare patients for radioiodine (¹³¹I) imaging and treatment have been well described [5]. In these diets, patients were requested to avoid sea food and iodine-containing medications prior to ¹³¹I scanning; however there are only a few reports which have assessed the efficacy of this approach for ^{99m}Tc-P thyroid scintigraphy [4, 6, 7]. All three previous reports emphasized on relating iodine content with iodide trapping function using ^{99m}Tc-P thyroid uptake.

In the present study, we assessed a self-managed and instructed by one of our technicians, outpatients restricted for iodine diet (IRD) including restriction of sea foods in order to assess the effect of this diet on ^{99m}Tc-P thyroid scan.

Patients and methods

Thirty-nine patients living in an area by the sea and usually consuming sea food, with simple multinodular goiter had 02009. The study was implemented in Golestan province with a population of about 1.5 million. Before this scan they were advised not to take levothyroxine (LT4) for at least 4 weeks, triiodothyronine (T3) for at least 2 weeks and other drugs containing iodine for 3 months. All patients did not have a history of recent contrast consumption. Patients with a history of thyroiditis were also excluded from the study. Their first performed thyroid scans showed visually diffused reduction of ^{99m}Tc-P uptake and poor visualization of the thyroid gland. The 39 patients were selected out of 56 patients, because they fitted to our criteria and were willing to participate. They were 30 females and 9 males. The mean age of males and females was 31.60±7.02 and 30±12.25 years, respectively. The mean interval between the two scans was between 2-3 weeks. All patients had a normal thyroid function blood test including thyroxine (T4) (normal range: 4.7-12.4µg/dL), triiodothyronine (T3) (normal range: 1.2-2.8 nmol/l) and TSH (normal range: 0.2-5.00 IU/mL) before scanning.

These patients after they remained on a IRD avoiding seafood, multivitamins and iodinated salt for a fortnight were recalled for a second thyroid scan performed under the same technical conditions. We applied IRD instead of LID, because limitations were not conducted for all iodinated foods. The usual weekly diet of the studied patients contained before IRD three times seafood. All patients during the RID were given verbal dietary instructions by a nuclear medicine technologist every 2-3 days. We did not objectively monitor dietary obedience, by measuring urinary iodine levels [8].

This study complied with the declaration of Helsinki and was approved by the Ethics Committee of Golestan University of Medical Sciences. All patients provided both verbal and written consent to participate in this study.

Study design

Acquisition was performed 20min after an intravenous injection of 185MBq of ^{99m}Tc-P by a double-head single photon emission tomography (SPET) scintillation camera (ADAC Genesys Malpitas, CA, USA) with a low energy all purpose

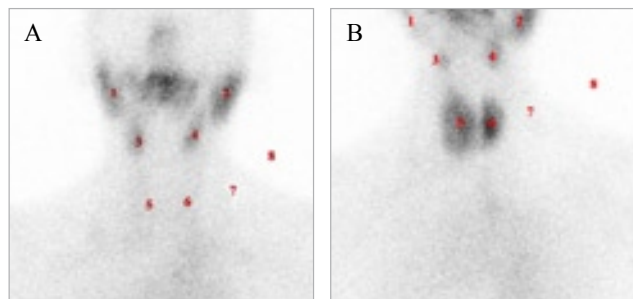


Figure 1. A, (left image) Pre and **B,** (right image) post IRD ^{99m}Tc-P thyroid scintigraphy of a 37 years old woman. There is a remarkable increase in thyroid uptake on the post IRD thyroid scintigraphy.

ROI 1, right parotid gland; ROI 2, left parotid gland; ROI 3, right submandibular salivary gland; ROI 4, left submandibular salivary gland; ROI 5, right thyroid lobe; ROI 6, left thyroid lobe; ROI 7, background of the left neck; ROI 8, background of outside body.

(LEAP) collimator using a matrix of 256 by 256 on a 20% window at the 140keV peak. Images were acquired for at least 400,000 counts. All 39 thyroid scans pre and post IRD were compared qualitatively by two experienced nuclear medicine physicians. The thyroid gland images were further semiquantitatively analyzed by drawing 8 ellipsoid regions of interest (ROI) including about 88 pixels for each thyroid lobe (Fig. 1). Mean counts per pixel in each one of these 8 regions were calculated. The mean uptake count ratio for every one of the 8 regions of each lobe between pre- and post IRD scans was statistically evaluated.

Statistical analysis

The distribution of variables was checked using probability plots and the Shapiro-Wilk test and they were not fit to a Gaussian distribution. The ROI data are represented as median with interquartile range. The ROI measurements were compared using Wilcoxon signed rank test. A value of P<0.05 was considered as statistically significant. All statistical computations were performed using PASW 18.0 software (SPSS, Inc., Chicago, USA).

Results

In the qualitative evaluation, IRD resulted in better quality scintigraphy images in 36 subjects, while 3 showed the same results, as before IRD.

There was some difference in the mean counts per pixel between the ROI of the pre and post IRD thyroid scans. For ROI No.5 of the right thyroid lobe this difference was: median 9.81, interquartile range (9.04-14.62) vs. 33.62, 15.90-57.60 and for ROI No.6 of the left thyroid lobe was 9.26, 7.83-13.86 vs. 25.22, 13.14-52.57. Enhanced count rates were found in the post IRD scans (P<0.05). The ROI of both parotids, right submandibular salivary gland and background of outside body (ROI no. 1, 2, 3, 4 and 8) had insignificantly higher count rates in the pre IRD scintigraphy images, whereas left submandibular salivary gland (ROI no.7) had approximately equal count rates in both pre and post IRD images (Table 1).

Table 1. The semiquantitative analysis of patients on pre and post technetium thyroid scintigraphy.

ROI	Pre- RID	Post-RID	P value
1	24.28(17.13- 63.96)	23.92(15.66-29.04)	0.08
2	22.54(16.58- 51.55)	22.10(16.16-30.15)	0.27
3	20.61(16.88-28.22)	16.64(13.90-19.06)	0.08
4	19.28(15.90-24.09)	15.84(13.49-21.52)	0.43
5	9.81(9.04-14.62)	33.62(15.90-57.60)	0.02*
6	9.26(7.83-13.86)	25.22(13.14-52.57)	0.02*
7	4.31(3.03-4.93)	4.37(3.40-4.86)	0.83
8	0.30(0.17-0.34)	0.24(0.15-0.30)	0.13

*The data are median (interquartile range). ROI 1, right parotid gland; ROI 2, left parotid gland; ROI 3, right submandibular salivary gland; ROI 4, left submandibular salivary gland; ROI 5, right thyroid lobe; ROI 6, left thyroid lobe; ROI 7, background of the left neck; ROI 8, background the outside body. RID, restricted iodine diet. (*P<0.05)

Discussion

Most centers that routinely perform radioiodine scanning recommend a low iodine diet, typically 30-50 μ g of 131 I per day, to enhance radioiodine accumulation [5, 9, 10].

In a study for the evaluation of parameters affecting thyroid 99m Tc-P uptake, in 190 patients concluded that except for iodine administration, the other factors such as sex, estrogen treatment and goiter type, can be neglected under routine conditions [6]. Others, evaluated how thyroid 99m Tc-P uptake related to changes in iodine supply in 1069 patients and described that the influence of TSH on 99m Tc-P uptake was secondary in comparison to the effect of iodine administration [4].

The theoretical rationale for the LID is to augment the uptake of radioiodide by depletion of the plasma inorganic iodide concentration. The enhanced uptake of radioiodide may also be due to increased sodium-iodide symporter (hNIS) gene expression [7, 10].

World Health Organization (WHO), United Nations Children's Fund (UNICEF) and International Council for the Control of Iodine Deficiency Disorders (ICCIDD) have recommended universal salt iodination as the main strategy to eliminate iodine deficiency disorders shown in many countries in 1990 [11, 12]. According to this advisement, iodine deficiency was eradicated in many countries as well as in Iran [12] but no study to assess this iodine supply on thyroid 99m Tc-P uptake in Iran has been performed. Others, have studied the influence of high iodine diets on the efficacy of technetium thyroid scan in normals [4] and in Graves disease [7].

We observed that 56 of all 540 (10.3%) 99m Tc-P thyroid scans were reported as suboptimal which may result from consumption of interfering foods with thyroid uptake. It could be due to daily diet customarily containing large quantities of sea foods in this geographic region. It is known that each kilogram of marine fish in Iran has an average value of 1.77mg iodine [13]. We don't know the daily iodine intake of our population, but in some countries location near the sea, like in Korea, the average estimated iodine intake is 479 μ g/day, and the average urine iodine excretion is 674 μ g/g creatinine (Cr) [14]. In Britain, the iodine intake has been estimated to be 166 μ g/day and in Finland, 340 μ g/day [15, 16]. Nevertheless, our results showed that a IRD for two weeks was sufficient to achieve rather adequate iodine restriction as shown by a slightly better thyroid scan. Urine iodine levels if tested after IRD, may indicate the actual effect of iodopenia [8].

Limitations of our study are the relatively small sample size, the absence of TBI and of urine iodine measurements. We have tried to use a simple and self-managed diet to be carried out in any nuclear medicine center. Additional research should be undertaken to reevaluate regional and national dietary iodine consumption in the light of restricted food and of eating habits.

In conclusion, this study indicates that in patients with multinodular goiter, living in regions with high consumption of sea foods a two-weeks diet, which included sea food for the reduction of iodine body content induced in 36 of the 39 cases a slightly better diagnostic thyroid 99m Tc-P scan.

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