Evaluation of Incidental Thyroid Findings Detected by Positron Emission Tomography/Computed Tomography

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Abstract

**Background:** Thyroid incidenteloma detected on 18F-FDG PET/CT carries a high risk of malignancy. This high risk of malignancy supports the performance of a further diagnostic procedure, such as ultrasonography and fine needle aspiration biopsy.

**Aim of Study:** To determine the role of PET/CT in evaluation of incidental thyroid lesions detected in patients being studied for lymphomas and/or cancers other than of thyroid.

**Material and Methods:** This study included thirty four patients with incidental abnormal increased FDG uptake. All patients were subjected to ultrasound examination and patients with focal increased tracer uptake were subjected to fine needle aspiration biopsy.

**Results:** This study included a total of 1263 consecutive patients who underwent a FDG PET/CT study for staging of an advanced cancer of any site of the body other than the thyroid gland during the period. An incidental abnormal increase in FDG uptake in the thyroid gland was observed in 39 (3.08%) patients. Out of these patients, 26/39 (66.6%) presented with a focal and 13/39 (33.4%) with a diffuse thyroid uptake giving a prevalence of 2.06% for focal uptake and 1.03% for diffuse uptake. Six patients out of 23 patients with focal abnormal thyroid uptake were proven to have thyroid malignancy (Four patients with papillary thyroid carcinoma, one patient with follicular thyroid carcinoma and the remaining patient with atypical Hurthle cells). Thus the malignancy rate in patients with thyroid incidentalomas which proceeded to tissue biopsy was about 26%.

**Conclusion:** An incidental focal uptake of 18F-FDG in the thyroid gland is of significant risk of malignancy. A high value of SUVmax increases the risk of malignancy and SUVmax does not correlated with the diameter of malignant lesions, so FDG-PET/CT can detect malignancy in small thyroid lesions.

**Key Words:** Thyroid incidentaloma – FDG-PET/CT – Standardized uptake value – Cancer thyroid.

Introduction

**THYROID** incidentaloma (TI) is defined as a thyroid gland lesion fortuitously discovered during radiology examinations, like computed tomography or ultrasound and the increased use of whole body PET-CT studies, has resulted in an increase in the discovery of those lesions [1].

In the last decade, (18) F-fluorodeoxyglucose (18F-FDG) positron emission tomography (PET and PET/CT) has become one of the major diagnostic tools used in oncology. A significant number of patients who undergo this procedure, due to non-thyroidal reasons, present incidental uptake of (18F-FDG) in the thyroid, accurate interpretation of such findings can impact the clinical management and overall health of the patient [2].

Thyroid lesions on PET-CT can be either diffuse or focal. Diffuse 18F-FDG uptake is usually associated with autoimmune thyroiditis or Graves' disease, whereas focal 18F-FDG uptake can be either due to a benign or malignant process in the thyroid [3].

Most recent scientific literature tends to demonstrate a detection rate of 0.1-4.3% for incidental findings of thyroid focal uptake identified by 18F-fluorodeoxyglucose Positron Emission Tomography with computed tomography (18FDG-PET/CT) initially prescribed for nonthyroid disease [4]. With positive predictive values for underlying thyroid malignancy of 20% to 50% [5].

The presence of risk factors such as a focal FDG uptake and a high SUVmax. on the FDG-PET/CT warrant ultrasonography and fine needle aspiration biopsy [4].
More recently, guidelines from the American Thyroid Association recommended that all sonographically confirmed thyroid nodule > 1 cm incidentally discovered on 18FDG-PET/CT should be biopsied with an FNA [6].

Patients and Methods

This study was performed in Diagnostic Radiology and Medical Imaging Department at Tanta University Hospital and in Nuclear Medicine Department, Oncology Hospital at Maadi Armed Forces medical compound for staging of an advanced cancer of any site of the body other than the thyroid gland during the period between September 2016 and the end of March 2018.

The current study included a total of 1263 consecutive patients who underwent a FDG PET/CT. An incidental abnormal increase in FDG uptake in the thyroid gland was observed in 39 patients. Out of these patients, 26 patients presented with a focal and 13 patients presented with a diffuse thyroid uptake, only 34 patients out of the 39 patients with abnormal increased thyroid uptake continued with us in this study.

Ethics committee approval and informed consent were obtained. Inclusion criteria were patients with incidental abnormal increased thyroid tracer uptake. Five patients Five patients with incidental increased thyroid tracer uptake were excluded as 2 of them were not medically fit for further investigation, 2 others were undergoing active treatment of their primary malignancy as a priority and therefore investigation of the incidentaloma was postponed while the remaining 1 patient refused to be included in the study. All patients were subjected to relevant history taking and, ultrasound examination and all patients with focal increased tracer uptake were subjected to fine needle aspiration biopsy.

Focal thyroid lesion was defined as a focally increased 18F-FDG uptake on the PET images or focal lesion on the CT images. A diffuse thyroid lesion was defined as 18F-FDG uptake in the whole thyroid gland. The lesions that could be distinguished from the physiological background activity and with SUVmax >2.5 were accepted as pathologic. Of the PET positive lesions, the maximum standard uptake (SUVmax) value was calculated from the site of maximum FDG uptake on the transaxial images. The size of the focal lesion was also measured on CT images.

Ultrasonography of the thyroid gland was performed using a real-time ultrasonographic scanner (Toshiba) with 7- to 15-MHz linear transducers. The site (right lobe, left lobe or isthmus), the size and the shape of the nodules were assessed. The echo structure (solid, cystic or mixed), echogenicity (hyperechoic, isoechoic, hypoechoic or mixed), calcification (punctuate, coarse, egg-shell or absent), and characteristics of nodule margin (well-defined or ill-defined) were assessed, if there was multiple nodules, FNAB was taken from the nodules that were correspond to the active nodules detected on PET/CT.

Fine needle aspiration biopsy was performed with a 21-gauge needle on a 10-ml syringe in 23 patients. Ultrasonography guidance was used to confirm the placement of the needle in the nodule. Two to three passes were made per nodule.

Statistical analysis:

Data were fed to the computer and analyzed using IBM SPSS software package version 20.0. (Armonk, NY: IBM Corp). Qualitative data were described using number and percent. The Kolmogorov-Smirnov test was used to verify the normality of distribution Quantitative data were described using range (minimum and maximum), mean, standard deviation. Significance of the obtained results was judged at the 5% level.

Results

This study included 34 patients out of 39 patients with incidental abnormal increased thyroid tracer uptake as 5 patients were excluded from this study, an incidental abnormal increase in FDG uptake in the thyroid gland was observed in 39 patients from the 1263 patients who undergo PET/CT examination with an incidence rate (3.08%). Twenty six (65%) patients were females while the remaining twelve (35%) were males. The age of the studied patients ranged from 20 to 80 years old (mean age 53.4 years). (Table 1).
Table (1): The age and sex distribution in the studied 34 patients with incidental abnormal increased thyroid tracer uptake.

<table>
<thead>
<tr>
<th>Age group</th>
<th>Sex of patients</th>
<th>Total number of patients</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>20–&lt;30</td>
<td>Male</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>30–&lt;40</td>
<td>Male</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>40–&lt;50</td>
<td>Male</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>50–&lt;60</td>
<td>Male</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>60–&lt;70</td>
<td>Male</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>70–80</td>
<td>Male</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Total number of patients</td>
<td>12</td>
<td>22</td>
<td>34</td>
</tr>
</tbody>
</table>

Among the 34 patients who performed PET/CT study, 23 (67.7%) patients showed incidental focal increased tracer uptake and 11 (32.3%) patients showed incidental diffuse increased tracer uptake. The site, size, SUVmax of nodules with focal uptake were assessed.

All patients with diffuse or focal uptake were subjected to ultrasound examination and the 23 patients with focal uptake were subjected to fine needle aspiration biopsy, in 2 patients, the biopsy was insufficient and containing blood only in another 2 patients. Three patients of them were rebiopsed, while the remaining 1 patient refused rebiopsy in whom we depended only on US criteria for diagnosis that showed evidences of a nodular goiter.

As regards to the ultrasound manifestations in the patients with incidental diffuse increased tracer uptake. Five (14.7%) patients were diagnosed as chronic thyroiditis, 4 (11.8%) patients showed normal thyroid US examination and the remaining 2 (5.9%) patients were diagnosed as diffuse goiter.

The results of FNAB in patients with incidental abnormal focal increased thyroid tracer uptake was: Fourteen (41.2%) patients with nodular goiter, 3 (8.8%) patients with Hashimoto’s thyroiditis, 3 (8.8 %) patients with papillary thyroid carcinoma, 2 (5.9%) patients with atypical Hurthle cells and 1 (2.9%) patient with follicular neoplasm. Four patients with malignant findings underwent total thyroidectomy followed by histopathology which revealed papillary thyroid carcinoma in 3 patients and follicular thyroid carcinoma in the remaining 1 patient. In the other 2 patients with atypical Hurthle cell, 1 patient died before any intervention and the remaining 1 patient underwent total thyroidectomy which revealed a papillary thyroid carcinoma by histopathology (Table 2).

Table (2): The final diagnosis of the studied 34 patient with the diffuse and focal incidental increased thyroid tracer uptake.

<table>
<thead>
<tr>
<th>Diagnosis by FNAB and/or US study</th>
<th>Benign Percentage (%)</th>
<th>Malignant Percentage (%)</th>
<th>Total number of patients</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diffuse:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Chronic thyroiditis</td>
<td>5 14.7</td>
<td>- -</td>
<td>5 14.7</td>
<td></td>
</tr>
<tr>
<td>- Normal</td>
<td>4 11.8</td>
<td>- -</td>
<td>4 11.8</td>
<td></td>
</tr>
<tr>
<td>- Diffuse goiter</td>
<td>2 5.9</td>
<td>- -</td>
<td>2 5.9</td>
<td></td>
</tr>
<tr>
<td>Focal:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Nodular goiter</td>
<td>14 41.2</td>
<td>- -</td>
<td>14 41.2</td>
<td></td>
</tr>
<tr>
<td>- Hashimoto’s thyroiditis</td>
<td>3 8.8</td>
<td>- -</td>
<td>3 8.8</td>
<td></td>
</tr>
<tr>
<td>- Papillary thyroid carcinoma</td>
<td>- -</td>
<td>3 8.8</td>
<td>3 8.8</td>
<td></td>
</tr>
<tr>
<td>- Atypical Hurthle cells</td>
<td>- -</td>
<td>2 5.9</td>
<td>2 5.9</td>
<td></td>
</tr>
<tr>
<td>- Follicular thyroid neoplasm</td>
<td>- -</td>
<td>1 2.9</td>
<td>1 2.9</td>
<td></td>
</tr>
<tr>
<td>Total number of patients</td>
<td>28 82.4</td>
<td>6 17.6</td>
<td>34 100</td>
<td></td>
</tr>
</tbody>
</table>

Mean SUVmax for benign nodules was (7.75 ± 8.30) and mean SUVmax in cases of malignant nodules was (8.97 ±2.96). The difference between SUVmax of the benign and malignant nodules was statistically significant (p=0.032). The mean maximal diameter for benign nodules was (2.88 ±2.23) and the mean maximal diameter for malignant nodules was (2.07±0.69). There was no statistically significant difference between the mean size of benign and malignant nodules (p=0.833) (Table 3).

Table (3): Comparison between benign and malignant focal thyroid uptake incidentally detected on 18F-FDG PET/CT study.

<table>
<thead>
<tr>
<th>PET/CT parameter</th>
<th>Benign (n=17)</th>
<th>Malignant (n=6)</th>
<th>U-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size on CT &amp;/or on US (mm)</td>
<td>2.88±2.23</td>
<td>2.07±0.69</td>
<td>48.0</td>
<td>0.833</td>
</tr>
<tr>
<td>SUVmax of the nodule</td>
<td>7.75±8.30</td>
<td>8.97±2.96</td>
<td>20.50</td>
<td>0.032*</td>
</tr>
</tbody>
</table>

- U, p: U and p-values for Mann Whitney test for comparing between benign and malignant. *: Statistically significant at p≤0.05.
Sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) were calculated for selected SUVmax thresholds. A receiver-operating-characteristic (ROC) curve analysis of sensitivities and specificities was performed to determine a clinically useful SUVmax cut-off value to aid in differentiating between benign and malignant lesions as shown in the following Figure 

![Fig. (1): Sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) were calculated for selected SUVmax.](image)

Table (4): Sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) which were calculated for selected SUVmax.

<table>
<thead>
<tr>
<th>Cut off SUVmax thresholds</th>
<th>Sensitivity (%)</th>
<th>Specificity (%)</th>
<th>PPV (%)</th>
<th>NPV (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;3</td>
<td>100.0</td>
<td>11.76</td>
<td>28.6</td>
<td>100.0</td>
</tr>
<tr>
<td>&gt;4</td>
<td>100.00</td>
<td>29.41</td>
<td>33.3</td>
<td>100.0</td>
</tr>
<tr>
<td>&gt;5</td>
<td>100.00</td>
<td>52.94</td>
<td>42.9</td>
<td>100.0</td>
</tr>
<tr>
<td>&gt;6</td>
<td>100.00</td>
<td>70.59</td>
<td>54.5</td>
<td>100.0</td>
</tr>
<tr>
<td>&gt;7</td>
<td>83.33</td>
<td>76.47</td>
<td>55.6</td>
<td>92.9</td>
</tr>
<tr>
<td>&gt;8</td>
<td>33.33</td>
<td>82.35</td>
<td>40.0</td>
<td>77.8</td>
</tr>
</tbody>
</table>

AUC: Area under a curve  
CI : Confidence Intervals  
*: Statistically significant at \( p \leq 0.05 \)

No correlation was found between lesions diameter and SUVmax in the whole group \( (p=0.949) \). Also there was no significant correlation in cases of benign nodules \( (p=0.934) \) or in malignant nodules \( (p=0.180) \) as shown in (Table 5).

![Table (5): Correlation between size by CT &/or US images (mm) and SUVmax of the nodule in each group.](image)

AUC: Area under a curve  
CI : Confidence Intervals  
*: Statistically significant at \( p \leq 0.05 \)

- Final diagnosis was a papillary thyroid carcinoma, grade II with metastases to upper and lower right deep cervical lymph nodes by histopathology, following a total thyroidectomy.
Fig. (3): Axial multislice (128) non-enhanced CT. (A) Axial PET (B) and axial PET/CT (C) Images show a metabolically-active nodule in the mildly enlarged right thyroid lobe with SUVmax 6.5 (notched arrows). US study images showed a hypoechoic solid nodule measuring 15x20mm with ill-defined outlines, corresponding to the focal uptake on PET-CT scan. US-guided FNAB was a follicular neoplasm lesion.

- Final diagnosis was a follicular thyroid carcinoma by histopathology, following a thyroidectomy.

Discussion

Incidental findings in the thyroid gland are of specific interest and interpretation of these incidental findings remains a challenge to clinicians especially that detected by FDG-PET/CT as the clinical situation may override the need to investigate a possible second primary thyroid cancer or metastases to the thyroid gland [7].

This study included a total of 1263 consecutive patients who underwent a FDG PET/CT study for staging of an advanced cancer of any site of the body other than the thyroid gland during the period between September 2016 and the end of March 2018.

An incidental abnormal increase in FDG uptake in the thyroid gland was observed in 39 (3.08%) patients. Out of these patients, 26/39 (66.6%) presented with a focal and 13/39 (33.4%) with a diffuse thyroid uptake giving a prevalence of 2.06% for focal uptake and 1.03% for diffuse uptake. Agrawal et al., 2015 [8] also stated that the prevalence of focal uptake within the thyroid varies from 0.1% to 4.8% and from 0.1 to 4.5% in diffuse uptake within the thyroid gland.

This study included 22 females (64.7%) and 12 males (35.3%). This matches with the fact that females are significantly affected more than males as reported by Vaish et al., 2016 [9] in their study which was conducted on 78 patients with incidental abnormal increased thyroid tracer uptake. Sixty one (78%) were females and 17 (22%) were males.

The ultimate diagnosis for the focal thyroid incidentalomas was found from cytological/histological records in patients who had undergone fine needle aspiration cytology (FNAC) or surgical resection specimen. In the current study 6 patients out of 23 patients with focal abnormal thyroid uptake were proven to have thyroid malignancy (Four patients with papillary thyroid carcinoma, one patient with follicular thyroid carcinoma and the remaining patient with atypical Hurthle cells which was considered as malignant as well). Thus the malignancy rate in patients with thyroid incidentalomas which proceeded to tissue biopsy was about 26%.

This is in agreement with Bonabi et al., 2012 [10] who reported that the risk of malignancy in incidental focal thyroid uptake in FDG-PET/CT studies ranges between 25 and 50%. The largest systematic review of thyroid incidentaloma studies (27 studies) which were done by Bertagna et al., 2012 [11] who revealed that a biopsy rate of incidental focal thyroid uptake in FDG-PET/CT studies is only 35%. Soelberg et al., 2012 [12] admitted in their meta-analysis and stated that one can't exclude that surgical confirmation is most likely obtained in those patients with the highest likelihood of malignancy and therefore the malignancy risk of focal uptake is overestimated and they suspected that the reported average malignancy rate of 35% in the literature is overestimated and that the actual value is significantly lower.

Standardised uptake value (SUV) is the accepted measurement of intensity of FDG uptake in tissue on scanning, and is a reflector of the degree of metabolic activity. The SUVmax for each patient with a focal thyroid incidentaloma in the FDG-PET/CT was calculated and patients with malignant lesions had a statistically significant higher standardized uptake value (SUVmax.) compared to those with benign lesions in this study (p-value=0.032).
A few potential $SUV_{max}$ cut-offs were examined and a kappa statistic was calculated for each value to determine which would maximize sensitivity and specificity. These calculations were performed to determine if there is a satisfactory $SUV_{max}$ cut-off to differentiate benign thyroid lesions from malignant ones. The SUV max cut-off with the highest kappa coefficient was provided and we found that SUV max more than 7 has the most specificity and sensitivity in diagnosis of malignancy (specificity 76.47%, sensitivity 83.33%) in the studied cases.

There are differences in opinions in literatures on role of $SUV_{max}$ in differentiating benign and malignant lesions with several studies showing statistically significant differences of $SUV_{max}$ between benign and malignant lesions, whereas others showed no significant difference. Agrawal K et al., 2015 [8] reported that the $SUV_{max}$ of malignant thyroid lesions has been significantly higher than that of benign lesions and $SUV_{max}$ cut-off value of 9.1 had 81.6% sensitivity and 100% specificity in differentiating benign from malignant lesions within thyroid nodules demonstrating incidental focal FDG uptake to determine if there is a significant difference in $SUV_{max}$ between benign nodules and thyroid cancer. On the other hand, Bonabi et al., 2012 [10] found no statistically significant difference in the $SUV_{max}$ between benign and malignant focal lesions ($p=0.0982$).

The size of the malignant thyroid lesions as measured on CT was not statistically significant in discriminating benign from malignant lesions in this study ($p=0.833$). Calcifications were detected in 3 malignant thyroid lesions (1 showed macrocalcifications and the other 2 lesions showed microcalcifications) and in 3 benign thyroid lesions (all showed macrocalcifications). This was discordant with Yaylali et al., 2014 [13] who reported that the size of the malignant thyroid lesions is significantly larger than that of the benign thyroid lesions ($p<0.05$), and calcifications were detected in 4 malignant thyroid lesions and only in 2 benign thyroid lesions in their study.

In the current study, no significant correlation between maximal diameter of the lesion and $SUV_{max}$ was found either in the total sample ($p=0.949$), in the malignant group ($p=0.180$) or in the benign group ($p=0.934$). These results suggested that PET/CT is effective in the evaluation of small thyroid cancers (such as microcarcinomas), as they have significantly high $SUV_{max}$ when malignant in spite of their small size. This came in agreement with Kalender et al., 2014 [14] who found no significant correlation between maximal diameter of the lesion and $SUV_{max}$. On the other hand, Kim et al., 2005 [15] and Stangier et al., 2014 [16] found a significant correlation between maximal diameter of the lesion and $SUV_{max}$ in the malignant group ($p=0.03$) and no significant correlation was found in the group of benign lesions ($p=0.77$) or in the whole group ($p=0.16$). These results suggested that PET/CT may be less effective in the evaluation of small thyroid cancers (such as microcarcinomas), as they have significantly lower $SUV_{max}$ than the larger ones.

The cytological results of the FNAB were benign in 17 patients with focal increased thyroid tracer fixation (14 patients with nodular goiter and 3 patients with Hashimoto’s thyroiditis), and malignant in 6 patients (3 patients with papillary thyroid carcinoma, 2 patients with atypical Hurthle cells and 1 patient with follicular neoplasm). In 1 patient with possible benign US features, FNAB was insufficient and he refused to be rebiopsied with insufficiency rate of 4.3% in 1/23 patients. Kim et al., 2013 [17] found that the insufficiency rate of FNAB from thyroid nodules is 13.4% in 141/1054 patients.

Five out of 6 patients with suspicious malignant cytology underwent further thyroidectomy and the results were confirmed by histopathology (4 patients with papillary thyroid carcinoma and 1 patient with follicular thyroid carcinoma). The last patient died before any surgical intervention. Brindle et al., 2014 [18] studied 26 patients with focal increased thyroid tracer uptake by cytological and histological evaluations and found no differences in the results obtained from the two techniques.

**Conclusion:**

From this study, the following conclusions could be reached:

- An incidental focal uptake of 18F-FDG in the thyroid gland is of significant risk of malignancy. A high value of $SUV_{max}$ further increases the risk of malignancy and should indicate the necessity for further cytological and/or histological evaluation. Also $SUV_{max}$ does not correlate with the diameter of malignant lesions, so FDG-PET/CT can detect malignancy in small thyroid lesions.

- US examination and $SUV_{max}$ of 18F-FDG PET/CT study have complementary roles to each other: if $SUV_{max}$ is elevated in focal uptake lesions on FDG PET/CT images or features of malignancies are seen on US, then malignancy
is possible and US-guided FNAB should be considered.

- Malignancy detected by 18F-FDG PET/CT further alters prognosis, mortality, and most importantly quality of life of the patients.

Competing interests:
The authors declare that they have no competing interests.

References


تقييم التهيجات العرضية بالغدة الدرقية والمكتشفة عن طريق التصوير المقطعي بالإنبعاث البوزيتوني مع الأشعة المقطعتية

يُشتمل هذا البحث على عدد 1152 من وحاتين وثلاثين وستين مريضاً خضعوا جميعاً لفحص التصوير المقطعي بالإنبعاث البوزيتوني ولاسباب ليس لها أي علاقة بالغدة الدرقية.

وقد خضع كل هؤلاء المرضى لطرق الفحص المختلفة بداية من التاريخ المرضي الكاملاً بكل تفصيلاته السابقة والحالية مع التركيز على أنواع العلاجات المستخدمة وأسبابها بنتائج التحاليل الطبية والكيميائية للأنابيب. بعد كل ذلك تم تحديد الموجات المناسبة لعمل هذا الفحص لكل مريض وكذا إعداد طريقة التشخيص المناسبة بما قبل الفحص ثم قيام كل منهم بالإستراحه الكامل لمدة قد تصل إلى سبعة به قنات الماده المشعة ويعزل عن الآخرين ثم القيام بالفحص مباشرة بعد حقن الأوساط المدفوعة بثلاثية الجسم من عينة الجسم إلى منتصف الفخذ ثم تم تصوير الفحوصات وأرسلها إلى جهاز المرض لعمل التقارير.

للحظ الألفاظ العرضية بالغدة الدرقية في عدد تسعة وثلاثين فقط من الحالات التي تم فحصها ثم تم استبعاد عدد خمسة منهم لأسباب متعددة تلي ذلك إجراء فحص الموجات فوق الصوتية لعدد أربعة وثلاثين من المرضى ثم خضع لمريض ذو الألفاظ العرضية لعدد العينات الطبية بمساعدات الموجات فوق الصوتية وكذا التحاليل الطبية لعدد ستة حالات منهم فقط بعد خضعهم لعمليات إستئصال الغدة الدرقية وفي النهاية تم التحليل الإحصائي للنتائج البحثية باستخدام الإصدار مع حزمة برنامج IBM

أيضاً فإن الألفاظ الجزيئي العرضية للمادة المشعة بالغدة الدرقية تكون مصحوبةً بارتفاع نسبة وجود البؤر السرطانية بها بنسبة متغيرة وخصوصاً فإن كان مصحوباً بارتفاع أقصى قيمة لارتفاع المادة المشعة وهذا يتطلب أخذ عينات تحليلية سواء سيتولوجية أو هستولوجية منها ولأن أقصى قيمة لارتفاع المادة المشعة لا تعتمد على حجم الأورام الخبيثة وذلك فإن الممكن اكتشاف الأورام الصغيرة منها.