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Original Research

# Deciding on Fine Needle Aspiration Biopsy in Thyroid Incidentalomas in FDG-PET/CT: Should Ultrasonographic Evaluation or FDG Uptake Be in the Foreground?

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## Abstract

**Objectives:** 18-Fluorodeoxyglucose Positron Emission Tomography/Computed Tomography (FDG-PET/CT) is a widespread imaging technique for whole-body scanning. Incidental lesions may be detected in thyroid gland and the importance and management of these lesions are still a matter of debate. The aims of this study were the evaluation of the diagnostic success of ultrasonography and FDG-PET/CT for predicting malignancy and contribution of these techniques for the decision of Fine Needle Aspiration Biopsy (FNAB) in incidental thyroid lesions detected in FDG-PET/CT.

**Methods:** Patients who underwent FDG-PET/CT in Nuclear Medicine Unit in a single institution between January 2018 and December 2022 were screened for thyroid incidentaloma with increased focal FDG uptake. Imaging studies and pathology results of the patients with Focal Thyroid Incidentalomas (FTI) were reviewed retrospectively.

**Results:** A total of 14.003 FDG-PET/CT reports of 8.259 patients were evaluated. In FDG-PET/CT imaging, 495 (6.0%) patients had increased uptake in thyroid gland, 383 (4.6%) patients had focal and 112 (1.4%) patients had diffuse FDG uptake. The rate of malignancy in FTIs was 19.2%. In the ROC curve analysis, regarding the prediction of malignancy in FTIs with FDG uptake, a SUVmax value of 5.5 and above predicts malignancy with a sensitivity of 71.4% and a specificity of 68.6% (AUC:0.718, p=0.018, 95%CI:0.564-0.872). The sensitivity of ACR-TIRADS-5 was 35.7% (95%CI:14.6-61.7) and sensitivity of the combination of SUVmax>5.5 and ACR-TIRADS-5 was 30.0% (95%CI:8.5-60.7).

**Conclusion:** FDG-PET/CT findings can be used for determining malignancy risk and cutoff values such as 5.5 can be threshold for ordering FNAB. In patients with SUVmax less than 5.5, ultrasonographic risk classification criteria should be used for decision-making.

**Keywords:** Positron Emission Tomography, thyroid cancer, thyroid nodule, ultrasonography

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18-Fluorodeoxyglucose Positron Emission Tomography/Computed Tomography (FDG-PET/CT) imaging is a frequently used imaging modality for searching entire body in order to obtain clues for malignant and metastatic diseases.[1] FDG-PET/CT shows metabolic activity of cells and the working principle of this imaging modality depends on high glucose consumption of malignant diseases. Due to the growing importance of FDG-PET/CT scan in oncology, a large number of patients are screened with this imaging method. Several lesions that are unrelated to the clinical indication can be detected in thyroid gland incidentally and these lesions are called as thyroid incidentaloma.[2] In thyroid gland, detection of increased incidental diffuse or focal uptake is not rare. Increased diffuse uptake is mostly related to thyroiditis and Graves' disease. Increased focal uptake is commonly related to the thyroid nodules and these nodules are called focal thyroid incidentaloma (FTI).[3-5] FTIs were observed between 0.16% and 11.74% of FDG-PET/CT imaging studies and prevalence of malignancy was between 10.3% and 66.7% in FTIs.[5] Additionally, in cross-sectional imaging studies (Computed Tomography or Magnetic Resonance Imaging) incidental thyroid nodules can be seen without FDG uptake in PET imaging. However, rate of malignancy is lower in these nodules and cancer prevalence was reported between 0-11%. Ultrasonographic evaluation is recommended for assessing the characteristics and malignancy risk of incidental thyroid nodules detected in CT.[6]

Due to the increased prevalence of FTI and high risk of malignancy, a recommendation for management of these suspicious nodules was addressed in the 2015 American Thyroid Association guideline on Thyroid Nodules and Differentiated Thyroid Cancer. Authors recommended doing Fine Needle Aspiration Biopsy (FNAB) for FTIs which were confirmed with ultrasonography and measured more than 1 cm. In the same guideline, the management of FDG-positive thyroid nodules less than 1 cm was suggested as similar to the high-risk thyroid nodules. However, there is still a need for further evaluation of ultrasonographic characteristics of FTIs and the level of FDG uptake.[7]

FDG-PET/CT was mostly performed in patients with malignancy, sometimes with widespread diseases. However, increased FDG uptake can be seen in both benign and malignant lesions. In order to get a better risk stratification in FTIs in the first evaluation, there is a need for understanding the relationship between characteristics of FDG-PET/CT findings, thyroid nodule ultrasonographic malignancy risk scoring systems and risk of malignancy.[8,9]

Our aim is to evaluate the ability of the level of FDG uptake, ultrasonographic scoring systems for predicting the risk of malignancy in incidental thyroid nodules and to assess superiority of these findings for deciding to order an FNAB.

## Methods

FDG-PET/CT imaging studies were performed in the Nuclear Medicine Unit of our institution, where they were screened for thyroid incidentaloma with increased focal uptake. Patient inclusion period was between January 2018 and December 2022. Patients younger than 18 years were excluded. Also, patient files were reviewed and patients with previous thyroid surgery or patients having imaging for known thyroid cancer were excluded from the study. The medical files of the patients with FTIs and FDG (-) thyroid incidentalomas which are detected in CT scans were reviewed retrospectively. Demographic information, findings in FDG-PET/CT imaging, ultrasonographic findings and American College of Radiology Thyroid Imaging Reporting and Data System (ACR-TIRADS) levels[10], FNAB results, pathology results after thyroidectomy were obtained. Cutoff value that predicts malignancy with the highest sensitivity and specificity was calculated using Receiver Operating Characteristics Curve. Patients were divided into subgroups according to this level of FDG uptake and then ACR-TIRADS scores. Pathology results were evaluated in each subgroup. Malignant and benign nodules were evaluated for their FDG uptake and ultrasonographic findings. The sensitivity and specificity of these two imaging studies were compared. This study was approved by the Local Ethics Committee of Sisli Hamidiye Etfal Training and Research Hospital (Date: 13/06/2023, Number: 3988). This study was conducted in compliance with the Declaration of Helsinki.

### FDG-PET/CT Imaging Protocols

For the preparations before FDG-PET/CT scan, patients were required to fast for at least six hours, and an oral contrast agent was advised to be started the night before the imaging. Blood glucose levels were checked before the radiopharmaceutical injection, as advised in the international guidelines.[11] All patients received approximately 2.5 MBq/kg of body weight and were administered approximately 185-333 MBq (5-9 mCi) of FDG intravenously. Sixty minutes after the injection, head to mid-thigh, low dose whole-body CT (130kV, 50-80 mAs; slice thickness 3 mm) and PET images were obtained by Discovery IQ PET/CT scanner (GE Healthcare, Wisconsin, USA). All whole-body PET/CT images were evaluated in transaxial, coronal and sagittal planes by an experienced Nuclear Medicine specialist. Lesions with higher activity than the background were evaluated with CT images to assess the lesions. The free-hand region of interest was drawn and the maximum standardized uptake value (SUVmax) was obtained from the lesions defined as pathological.

## Ultrasonography Imaging Protocols

Ultrasonography was performed by an experienced radiologist in our institution which is a tertiary training hospital. ACR-TIRADS levels were calculated during imaging by the radiologists.[10]

## Statistical Analysis

Normal distribution of patient data was evaluated by Shapiro-Wilk test. Results were presented as mean and standard deviation for normally distributed parameters and median and interquartile range for other parameters. Categorical variables were evaluated by using chi-square test and Fisher's exact test. In order to compare means between groups Student's t-test and Mann-Whitney U test for parametric and nonparametric data, respectively. Receiver Operating Characteristics (ROC) curves were calculated to find out sensitivity and specificity of imaging techniques. In addition, positive predictive values and negative predictive values were calculated. Results were considered as statistically significant when p-value was less than 0.05. Statistical analysis was performed using Statistical Package for Social Sciences (SPSS) version 25.0 (IBM Co., Armonk, NY, USA).

# Results

After retrospective search, a total of 14,003 FDG-PET/CT reports, which belong to 8,259 patients were evaluated. In the FDG-PET/CT imaging studies, increased uptake in thyroid gland was observed in 495 (6.0%) patients, focal FDG uptake was observed in 383 (4.6%) patients, and diffuse FDG uptake was observed in 112 (1.4%) patients. FDG (-) thyroid incidentaloma was observed in 375 (4.5%) patients in CT imaging. Descriptive information is presented in Table 1. Ultrasonography findings of patients with FDG (+) and (-) thyroid incidentalomas were evaluated retrospectively. Only 113 (30.1%) patients with FDG (-) thyroid incidentaloma and 135 (35.2%) patients with FDG (+) incidentaloma had ultrasound imaging in our hospital.

Ultrasonography findings of FTIs were evaluated and ACR-TIRADS levels were 1 in 6 (4.4%) patients, 2 in 32 (23.7%) patients, 3 in 49 (36.3%) patients, 4 in 34 patients (25.2%), 5 in 14 (10.4%) patients. Ultrasonography findings of FDG (-) thyroid nodules were evaluated and ACR-TIRADS levels were 1 in 10 (8.9%), 2 in 34 (30.1%) patients, 3 in 31 (27.4%) patients, 4 in 32 (28.3%) patients and 5 in 6 (5.3%) patients. Mean ACR-TIRADS levels of FTIs and FDG (-) thyroid nodules were 3.13±1.03 and 2.91±1.07, respectively (p=0.101). In FNAB-performed patients, Mean ACR-TIRADS levels of FTIs and FDG (-) thyroid nodules were 3.48±0.89 and 3.13±0.96, respectively (p=0.093). None of the FNAB results of FDG (-) nodules were malignant. Mean SUVmax of FTIs were 2.87±1.59 for ACR-TIRADS 1 nodules, 4.31±3.46 for ACR-TIRADS 2 nodules, 6.96±6.52 for ACR-TIRADS 3 nodules, 4.98±3.11 for ACR-TIRADS 4 nodules, 4.93±1.75 for ACR-TIRADS 5 nodules (p=0.054). There was no correlation between SUVmax and ACR-TIRADS as well as SUVmax and Bethesda scores (p=0.884, p=0.364, respectively). The results of FNAB are presented in Table 2.

Mean ACR-TIRADS levels and SUVmax values were compared and were significantly lower in FTIs with benign pathology (either in FNAB or final pathology results after surgery) (n=35) than the FTIs with malignant pathology (either in FNAB [Bethesda 6] or final pathology) (n=18) (Mean ACR-TIRADS levels: 3.29±0.94 vs. 4.00±0.88; p=0.029, respectively; Mean SUVmax: 5.27±3.57 vs. 9.76±8.31; p=0.018 respectively). The rate of malignancy in FTIs was 19.2%, which includes patients with malignant pathology results and FNAB results. Postoperative pathology results for 14 FTIs were obtained from retrospective analysis. The results

**Table 1.** Descriptive information for patients with FDG (+) and (-) thyroid incidentaloma at FDG-PET/CT.

| Demographics Informations of Patients | Focal Thyroid Incidentalomas (n=383 [4.6%]) | FDG(-) Incidentalomas (n=375[4.5%]) |
|---|---|---|
| Age (years)(Mean±Standart Deviation)(range) | 64.3±12.65 (24-98) | 65.6±12.01 (29-95) |
| Gender | | |
| Female | 270 (70.5%) | 226 (60.2%) |
| Male | 113 (29.5%) | 149 (39.8%) |
| Thyroid Nodule Diameter (mm) according to FDG-PET/CT (Mean±Standart Deviation) (range) | 16.1±10.76 (5-60) | 15.4±9.72 (5-60) |
| SUVmax (Mean±Standart Deviation) (range) | 4.8±3.89 (1.3-34.1) | - |
| Indication for FDG-PET/CT | | |
| Staging of primary malignancy or evaluation of response to the treatment | 296 (77.3%) | 268 (71.5%) |
| Screening for unknown malignancy | 87 (22.7%) | 107 (28.5%) |

SUVmax: Maximum Standardized Uptake Value; FDG-PET/CT: 18-Fluorodeoxy glucose Positron Emission Tomography/Computed Tomography.

**Table 2.** Fine Needle Aspiration Biopsy results in FDG (-) and FDG (+) thyroid incidentalomas

| FNAB results | FDG (-) (n=45) | FDG (+) (n=73) |
|---|---|---|
| Bethesda 1 | 7 (15.6%) | 12 (16.4%) |
| Bethesda 2 | 37 (82.2%) | 34 (46.6%) |
| Bethesda 3 | 1 (%2.2) | 9 (12.3%) |
| Bethesda 4 | | 8 (11%) |
| Bethesda 5 | | 2 (2.7%) |
| Bethesda 6 | | 8 (11%) |

FNAB: Fine Needle Aspiration Biopsy; FDG: 18-Fluorodeoxy glucose.

were concluded as 10 FTIs (71.4%) with papillary thyroid cancer, 1 (7.1%) FTI with follicular thyroid cancer, 1 (7.1%) FTI with anaplastic thyroid cancer, 2 (14.3%) FTIs with benign thyroid pathologies.

ROC curve analysis was used for the prediction of malignancy in FTIs with FDG uptake; an SUVmax value of 5.5 and above predicts malignancy with a sensitivity of 71.4% and a specificity of 68.6% (Area Under Curve: 0.718, p=0.018, 95% Confidence Interval: 0.564-0.872) (Fig. 1). In order to evaluate diagnostic success of ultrasonography and FDG-PET/CT for prediction of malignancy in FTIs, cutoff values were determined as ACR-TIRADS level 4 or ACR-TIRADS level 5 for ultrasonography and SUVmax>5.5 for FDG-PET/CT. Sensitivity, specificity, positive predictive value and negative predictive value were calculated according to these cutoff values. Results are shown in Table 3. The sensitivity of ACR-TIRADS 5 was 35.7% (95% CI: 14.6-61.7) and sensitivity of the combination of SUVmax>5.5 and ACR-TIRADS 5 was 30.0% (95% CI: 8.5-60.7). This combination did not make any additional contribution to predicting malignancy.

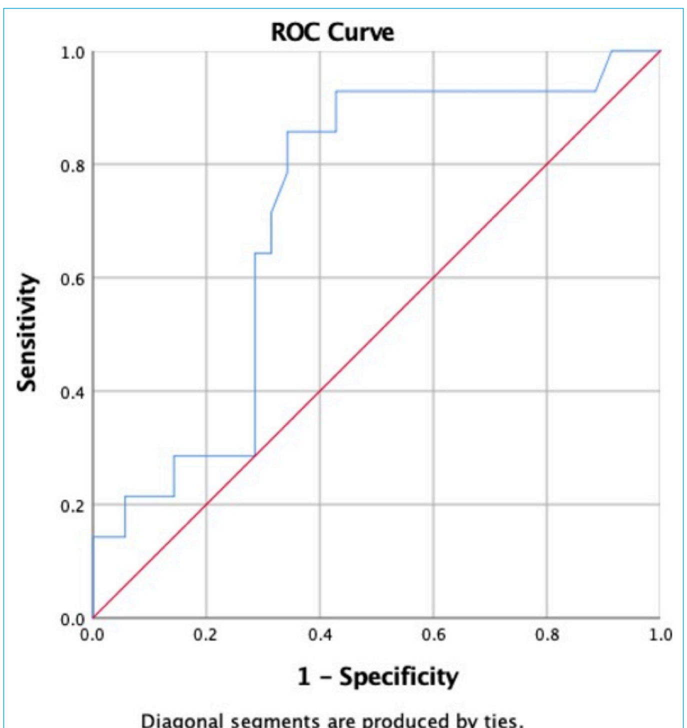


**Figure 1.** Receiver operating characteristics analysis of SUVmax for prediction of malignancy in focal thyroid incidentalomas.

A total of 33 patients with SUVmax≥5.5 were biopsied or operated and the rate of benign and malignant results was 33.3% and 30.3%, respectively. However, 40 patients with SUVmax<5.5 were biopsied or operated and the rate of benign and malignant results were 60.0% and 10.0%, respectively. Malignant nodules were significantly higher in patients with SUVmax≥5.5 (p=0.023). The distribution of the patients in each group are presented in Figures 2 and 3.

## Discussion

Thyroid nodules in population are not rare and can be detected in 19% to 67% of patients with ultrasonography.[12] The rate of malignancy in these nodules can be seen up to 20% and incidentally detected nodules should be further evaluated to rule out malignancy.[13] FDG-PET/CT is an imaging study for whole-body screening mostly for patients with oncologic diseases. During screening thyroid incidentalomas can be detected and these incidentalomas must be evaluated for their risk of malignancy. Most of these patients have ongoing oncological treatment and further testing of these incidental lesions might decrease patient's quality of life even more. To better understand risk of malignancy of these thyroid nodules, the diagnostic value of FDG-PET/CT for thyroid nodules should be determined.[14]

In this study, the rate of FTIs was 4.6% and the rate of diffuse FDG uptake was 1.4%. In a recent meta-analysis, fifty studies were evaluated and the prevalence of FTIs ranged from 0.16% to 11.74%. The pooled prevalence was 2.22% (95% Confidence Interval: 1.9%-2.54%, I2: 99%).[5] The rate of FTIs in our patient group was higher than the pooled prevalence; however, still in the range of prevalence in this meta-analysis. Furthermore, geographical differences may affect the prevalence of thyroid nodules.[15] There are five studies from Türkiye and the rates of FTI were between 0.94%-2.9%.[16-20] The rates of diffuse FDG uptake were between 0.1%-4.5% in literature and results in this study were similar to these results.[21] In the previous studies, the rates of malignancy in FTIs were detected between 16.8%-41.7% and the rate of malignancy was 19.2% in this study population. This rate was concordant with the literature.[22-27]

Most of the patients undergoing FDG-PET/CT have malignant diseases other than thyroid cancer. Due to the ongoing treatment or advanced stage of cancer some of the patients cannot finish their diagnostic tests, refuse the offered

**Table 3.** Evaluation of diagnostic success for cutoff values of ACR-TIRADS and FDG uptake.

| Diagnostic Success for Malignancy | Sensitivity (95% CI) | Specificity (95% CI) | Positive Predictive Value (95% CI) | Negative Predictive Value (95% CI) |
|---|---|---|---|---|
| ACR-TIRADS 5 | 35.7% (14.6-61.7) | 87.5% (73.3-95.9) | 55.6% (24.9-83.5) | 75.7% (60.4-87.5) |
| SUVmax>5.5 | 71.4% (45.5-90.1) | 68.6% (52.3-82.3) | 47.6% (27.5-68.3) | 85.7% (69.9-95.3) |
| SUVmax<5.5 and ACR-TIRADS 5 | 50.0% (10.7-89.3) | 81.0% (61.1-93.7) | 33.3% (6.5-71.9) | 89.5% (70.9-98.2) |
| SUVmax>5.5 and ACR-TIRADS 5 | 30.0% (8.5-60.7) | 100%* | 100%* | 61.1% (38.2-81.0) |
| SUVmax<5.5 and ACR-TIRADS 4-5 | 75.0% (27.8-98.4) | 55.0% (33.6-75.2) | 25.0% (6.9-52.8) | 91.7% (68.1-99.5) |
| SUVmax>5.5 and ACR-TIRADS 4-5 | 60.0% (30.0-85.4) | 63.6% (34.6-87.0) | 60.0% (30.0-85.4) | 63.6% (34.6-87.0) |
| ACR-TIRADS 4-5 | 64.3% (38.3-85.4) | 58.1% (40.6-74.3) | 40.9% (22.2-61.6) | 78.3% (50.9-91.6) |

*Confidence interval for Specificity and positive predictive value could not be calculated due to the fact that there is no benign nodule having characteristics of both SUVmax>5.5 and ACR-TIRADS 5. ACR-TIRADS: American College of Radiology Thyroid Imaging Reporting and Data System; SUVmax: Maximum Standardized Uptake Value; CI: Confidence Interval.

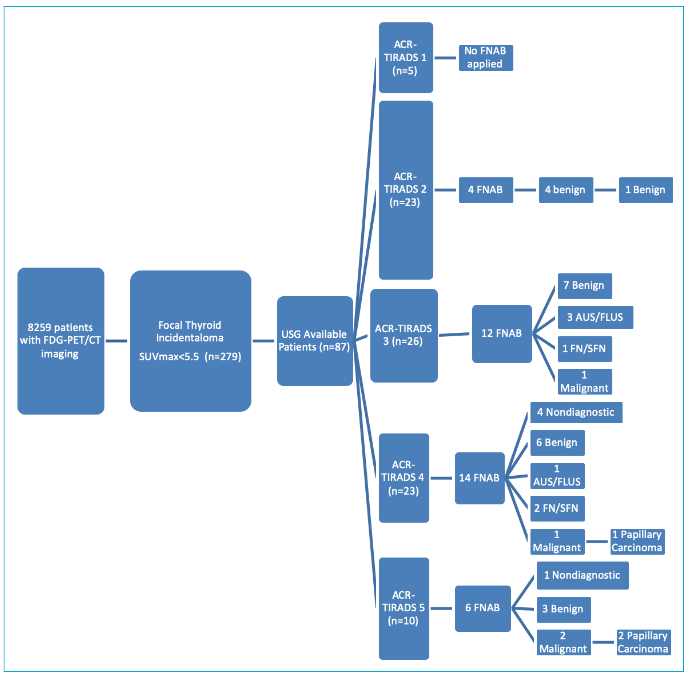


**Figure 2.** The distribution of patients with SUVmax<5.5 thyroid nodules.

*FDG-PET/CT: 18-Fluorodeoxy glucose Positron Emission Tomography/Computed Tomography; USG: Ultrasonography; ACR-TIRADS: American College of Radiology Thyroid Imaging Reporting and Data System; FNAB: Fine Needle Aspiration Biopsy; AUS/FLUS: Atypia of Undetermined Significance/Follicular Lesion of Undetermined Significance; FN/SFN: Follicular Neoplasm/Suspicious for Follicular Neoplasia; SM: Suspicious for Malignancy.*

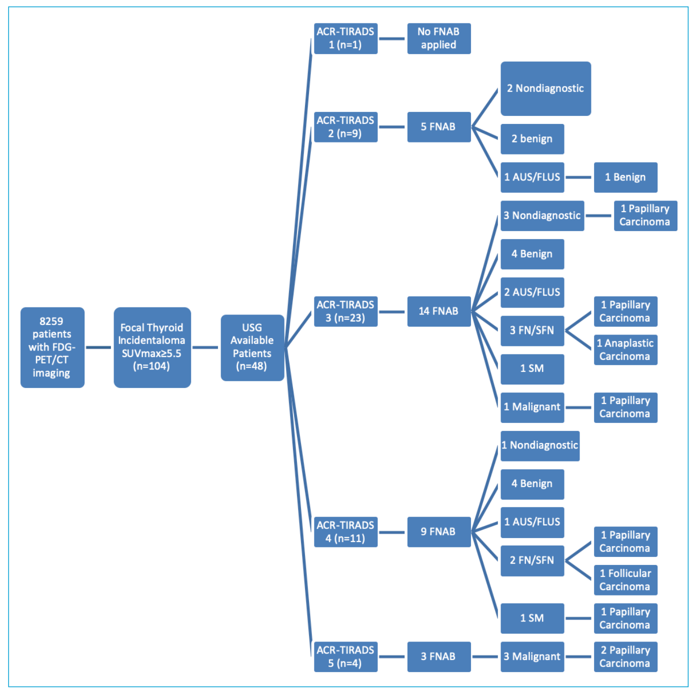


**Figure 3.** The distribution of patients with SUVmax≥5.5 thyroid nodules.

*FDG-PET/CT: 18-Fluorodeoxy glucose Positron Emission Tomography/Computed Tomography; USG: Ultrasonography; ACR-TIRADS: American College of Radiology Thyroid Imaging Reporting and Data System; FNAB: Fine Needle Aspiration Biopsy; AUS/FLUS: Atypia of Undetermined Significance/Follicular Lesion of Undetermined Significance; FN/SFN: Follicular Neoplasm/Suspicious for Follicular Neoplasia; SM: Suspicious for Malignancy.*

surgical operation or pass away before final diagnosis. This is a limitation of the studies in the literature and causes a wide range of numbers for rate of malignancy in thyroid incidentalomas.[5]

Mean ACR-TIRADS levels were evaluated for FDG (+) and (-) thyroid nodules. There was no difference between mean ACR-TIRADS levels between two groups; however, patients who underwent FNAB for the FDG (+) nodules were having higher ACR-TIRADS levels than FDG (-) nodules and FDG (+) nodules without having FNAB. Even though this difference is not statistically significant, these results may give a clue about daily routine for thyroid incidentalomas. Especially in cases with low ACR-TIRADS levels, FNAB may be postponed or omitted by the physicians when ongoing oncologic treatment is considered. In order to give a better decision for the FNAB in patients with FTIs, SUVmax can be helpful in patients with comorbidities and widespread malignant diseases.

FNAB results were evaluated in FDG (+) and FDG (-) thyroid incidentalomas and FDG (-) incidentalomas were mostly benign (82.2%), on the contrary, FDG (+) incidentalomas were more likely to have inconclusive or malignant results after FNAB (53.4%). These results show that FDG (-) incidentalomas that were detected in CT scan of FDG-PET/CT should be evaluated with ultrasonography and FNAB should be done when FNAB is indicated by the ACR-TIRADS criteria.[10]

In this current study, high number of malignant (11%) and inconclusive (42.4%) FNAB results as well as high numbers of malignancy rate (19.2%) after thyroid surgery in FTIs should increase the suspicion on these nodules for malignancy. In a previous study that evaluated 6900 patients, FNAB results of FTIs were evaluated and 55.2% of patients were reported as benign. Remaining 44.8% of the FTIs were reported malignant, suspicious for malignancy or inconclusive. These results showed that FDG-PET/CT gives an important clue for suspicious nodules and FTIs should be further evaluated. Additionally, FNAB should be performed in suspicious nodules before referring patients to surgery. In a previous meta-analysis, patients with indeterminate FNAB results were evaluated with FDG-PET/CT and the ability of FDG-PET/CT for discriminating malignant or benign nodules was assessed. FDG-PET/CT had a sensitivity of 74% and negative predictive value of 74% for discriminating malignant and benign nodules with indeterminate FNAB. These results showed that a low number of false negative thyroid nodules for malignancy were missed by FDG-PET/CT.[4,28]

In this study, although the ACR-TIRADS levels were higher in malignant FTIs than in benign nodules, ACR-TIRADS levels were similar in FDG (-) and (+) nodules. ACR-TIRADS risk classification on ultrasonography in FTIs does not significantly contribute to patient selection for FNAB or follow-up. Data regarding the contribution of ultrasonography risk classification systems in FTIs is still controversial and the number of studies on this subject is limited. On the other hand, there are studies in the literature reporting that ultrasonography risk classification systems may contribute to determining the risk of malignancy in FTIs. Several studies have reported that the risk of malignancy is low, regardless of PET-CT findings, especially in FTIs when there are no specific suspicious USG features.[8,29] In a previous study, malignancy risk of FDG-positive thyroid nodules was evaluated with ultrasonography and ACR-TIRADS levels were significantly lower in low-risk nodules than high-risk nodules (13.3% vs. 43.4%, respectively, $p<0.001$).[30]

Researchers showed that although the risk of malignancy in FDG-positive nodules with high or indeterminate risk according to the ATA Ultrasonography risk classification is higher than in the rates mentioned in the ATA guideline, in low or very low suspicious nodules it is within rates mentioned in the ATA guideline. Researchers have stated that selective biopsies may be necessary for low or very low suspicious nodules according to ultrasonography.[31] In another study, it was stated that ACR-TIRADS classification could be applied to FTI nodules. However, the malignancy rate in the series was 46%, and it was claimed that fine needle aspiration guided by ultrasonography was compulsory even if there were no suspicious findings on ultrasonography.[32] In another study, the risk of malignancy in nodules with FTI was 58.2%, and although the risk of malignancy was high in FTIs without any suspicious ultrasonography features, no malignancy was found in nodules with benign cytology in FNAB and no suspicious ultrasonography findings. The researchers concluded that ultrasonography cannot replace FNAB in the diagnosis of thyroid incidentalomas in PET/CT, and in thyroid incidentalomas with benign cytology on FNAB and without suspicious ultrasonography features, follow-up may be considered.[33]

Mean ACR-TIRADS score and SUVmax were significantly higher in malignant nodules (Bethesda 6 or malignant pathology results) compared to benign nodules (Bethesda 2 or benign pathology). However, similar results were not observed when comparing nodules with Bethesda 2 and results other than benign (Bethesda 1,3,4,5,6). The main reason was inconclusive FNAB results may be related to benign pathologies and these nodules may have lower SUVmax and ACR-TIRADS levels. Comparison between benign and malignant cytology and pathology results showed that higher SUVmax was related to an increased possibility of malignant thyroid nodules. The ROC curve of SUVmax also supported this hypothesis. SUVmax higher than 5.5 predicted malignancy with high sensitivity and specificity. SUVmax value is clinically valuable, however, not a single value was proven for widespread use. In previous studies, cutoff values were estimated between 3.5 and 7.1 for predicting malignancy with higher sensitivity and specificity. Different numbers for cutoff values may be related with different imaging protocols and different image processing software and hardware.[19,26,34]

In addition to the high sensitivity and specificity, SUVmax≥5.5 showed a very high negative predictive value (85.7%, 95% CI:69.9-95.3). This number was even higher than negative predictive value of ACR-TIRADS level 5. This cutoff value can be easily adapted to clinical use and can be helpful for decision-making strategies in high-volume settings. Also, ordering FNAB for all FTIs also would not be cost-effective. Therefore, determining a clinical strategy based on SUVmax seems helpful for both the physician and the patient. Using a cutoff value is best for prediction of malignancy in daily practice. However, in SUVmax<5.5 FTIs, ACR-TIRADS levels have a high negative predictive value in ACR-TIRADS 5 nodules and high sensitivity and negative predictive value in ACR-TIRADS 4-5 nodules. Therefore, ultrasonographic findings have more importance in FTIs with SUVmax<5.5.

There are limitations to this study. One of them is the retrospective nature of this study. Due to the short life expectancy of malignant diseases some of the patients were lost during the follow-up. Patients may refuse further diagnostic studies due to the ongoing medical therapy for their diseases. The other limitation is different physicians reported USG and FDG-PET/CT. Although these data were collected from a university-affiliated research hospital, reports were still operator dependent.

## Conclusion

As a conclusion, FDG-PET/CT findings can give important clues about possible malignancy risk and cutoff values such as 5.5 for SUVmax can be easily implemented in clinical settings with high sensitivity and specificity. FNAB should be planned in thyroid nodules with SUVmax higher than 5.5 and in nodules with SUVmax less than 5.5, ACR-TIRADS criteria should be used for patient management.

*This study was partially presented in Turkish National Congress of Endocrine Surgery, March, 16-19, 2023, Antalya, Türkiye.*

### Disclosures

**Ethics Committee Approval:** The study was approved by the Sisli Hamidiye Etfal Training and Research Hospital Clinical Research Ethics Committee (date: 13.06.2023, no: 3988).

**Informed Consent:** Informed consents were taken from patients.

**Peer-review:** Externally peer-reviewed.

**Conflict of Interest:** The authors declared no conflicts of interest.

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**Authorship Contributions:** Concept – M.Ko., H.K., N.A., M.U., A.O.; Design – M.Ko., O.C., M.T.U., Y.C., Z.S.; Supervision – A.O., M.U., M.Ka., O.E.; Fundings –O.E., M.Ka., N.A., M.U., O.C.; Materials – M.Ko., H.K., N.A., A.O.; Data Collection and/or Processing – M.Ko., H.K., Z.S., Y.C., O.E.; Analysis and/or Interpretation – M.Ka., Z.S., Y.C., M.U., A.O.; Literature Review – M.Ko., H.K., M.T.U., O.C., A.O.; Writing – M.Ko., H.K., M.U., N.A., M.T.U., O.C.; Critical Review –M.U., A.O., O.E., M.Ka., N.A.

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